Aug. 15, 1961 D. V. TUTTLE 2,996,594

MOLDED ELECTRIC HEATER AND METHOD OF MAKING SAME

Filed May 18, 1956 3 Sheets-Sheet 1

Fig. 2.

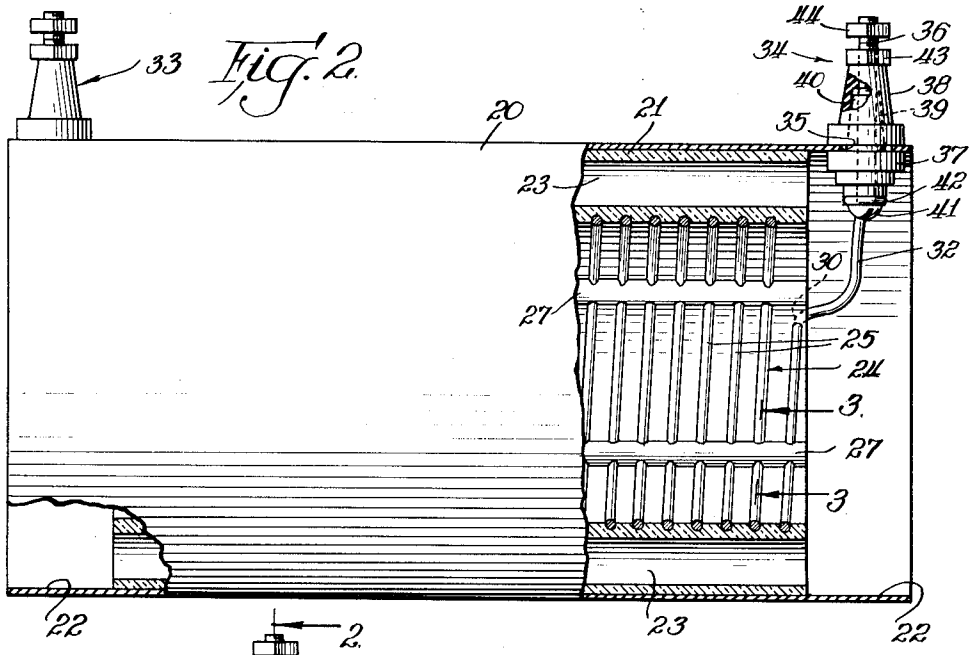


Fig. 1.

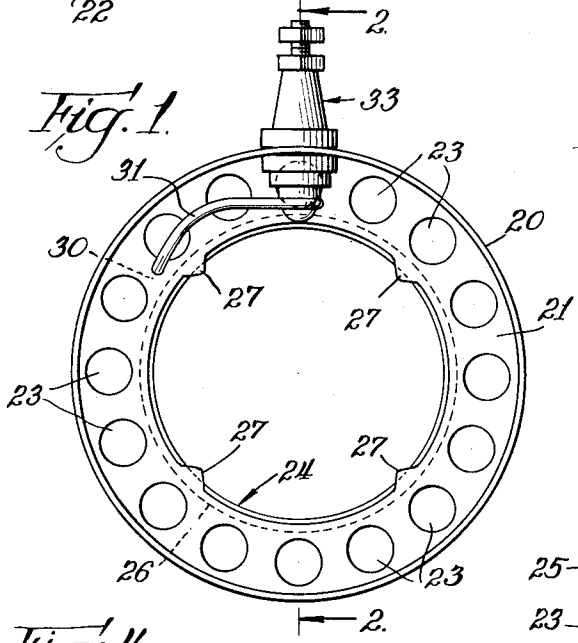


Fig. 3.

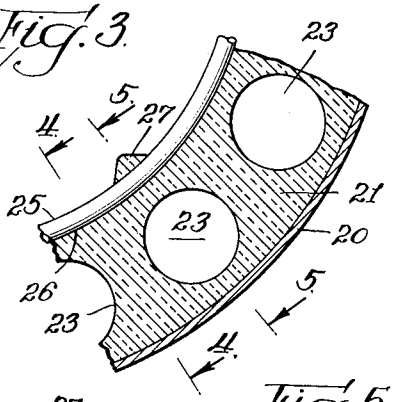


Fig. 4.

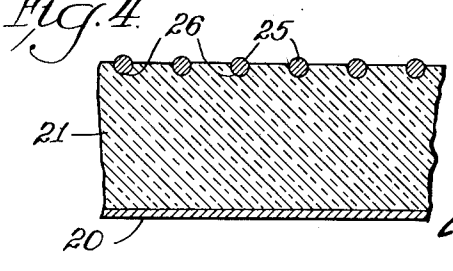
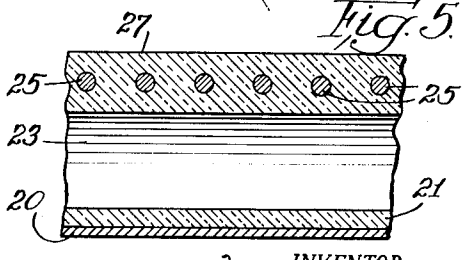


Fig. 5.



INVENTOR.
Daniel V. Tuttle
BY
Eugene M. Giles Atty.

Aug. 15, 1961 D. V. TUTTLE 2,996,594

MOLDED ELECTRIC HEATER AND METHOD OF MAKING SAME

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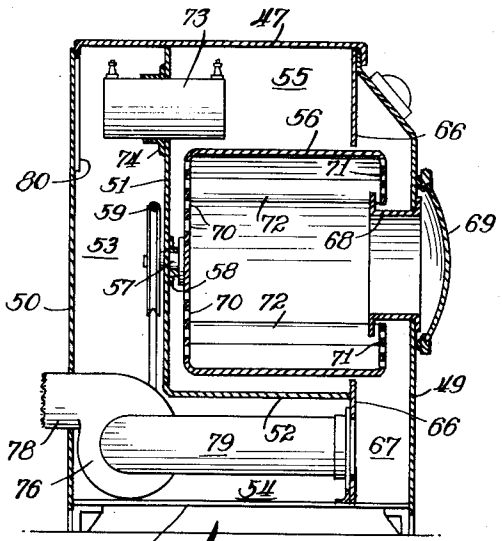


Fig. 6.

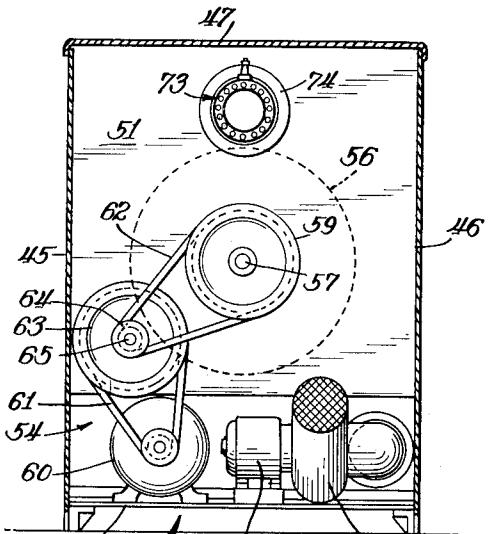


Fig. 7.

Fig. 8.

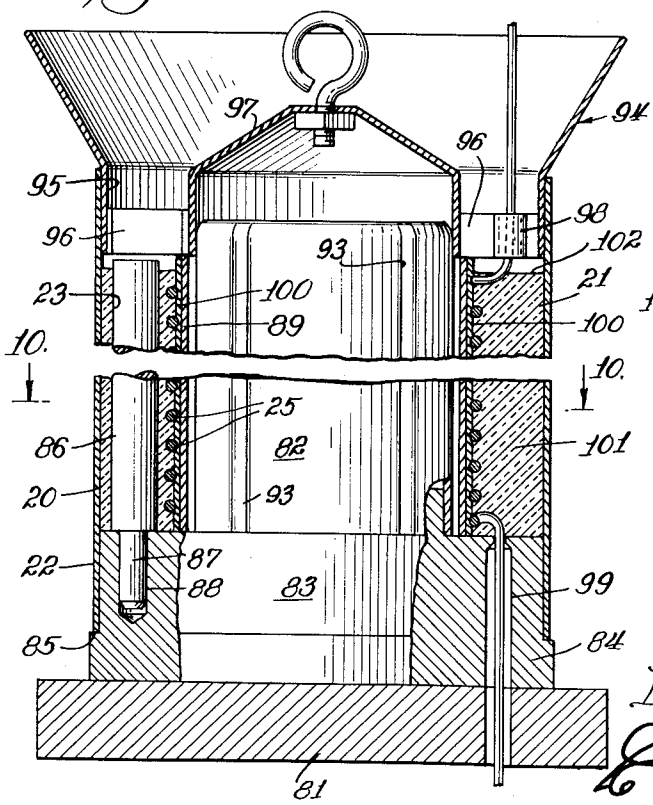
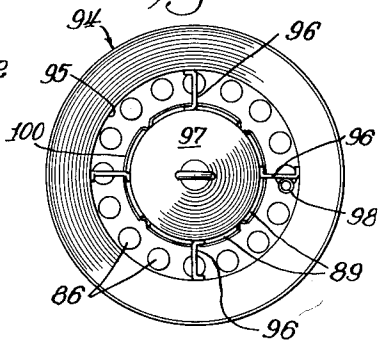


Fig. 9.



INVENTOR.
Daniel V. Tuttle
BY
Eugene M. Giles
Atty.

Aug. 15, 1961 D. V. TUTTLE 2,996,594

MOLDED ELECTRIC HEATER AND METHOD OF MAKING SAME

Filed May 18, 1956 3 Sheets-Sheet 3

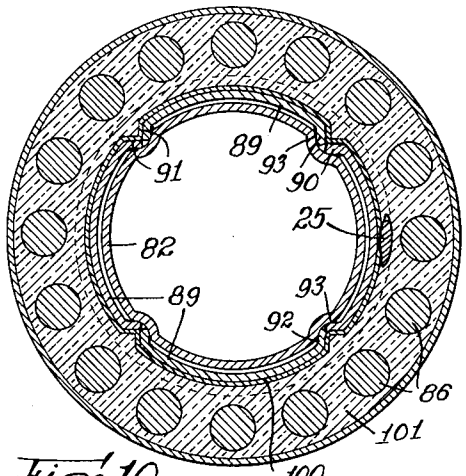


Fig. 10.

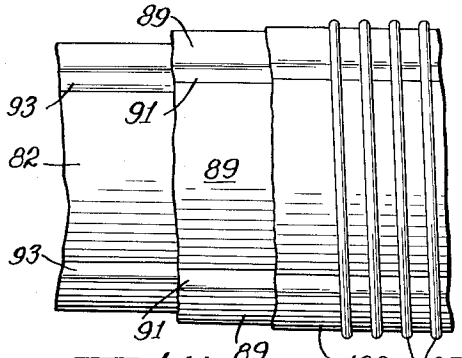


Fig. 11.

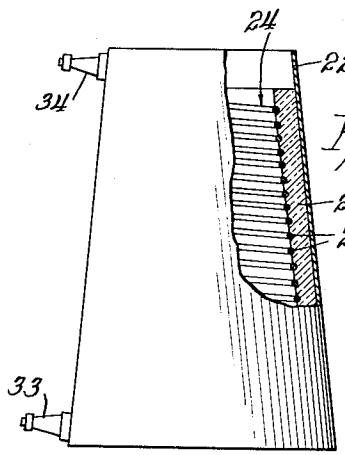


Fig. 13.

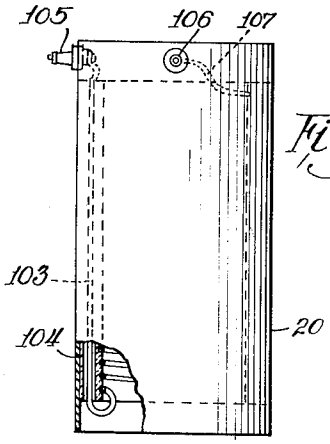


Fig. 12.

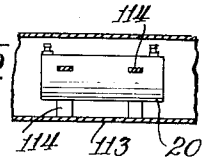


Fig. 15.

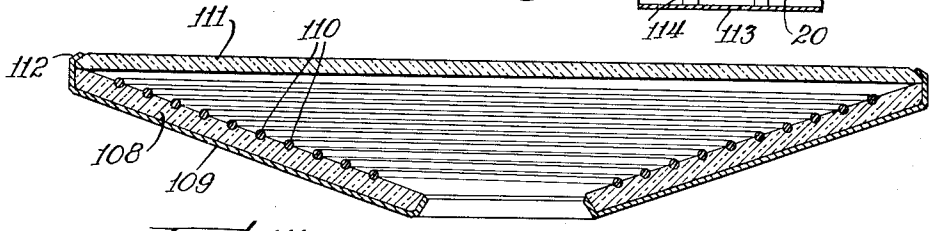


Fig. 14.

INVENTOR.
Daniel V. Tuttle
BY
Eugene M. Giles
Atty.

United States Patent Office 2,996,594
Patented Aug. 15, 1961

2,996,594

MOLDED ELECTRIC HEATER AND METHOD OF MAKING SAME

Daniel V. Tuttle, Kirkland, Ill., assignor to Tuttle Electric Products, Inc., Kirkland, Ill., a corporation of Illinois

Filed May 18, 1956, Ser. No. 585,653
14 Claims. (Cl. 219—19)

This invention relates to an electric heater in which the heating resistance is supported in an exposed manner by a molded body of refractory electrical insulating material, and has reference more particularly to such heater, and to the method of making same, with the body molded onto the resistance.

Heretofore electric heaters with exposed heating resistances have usually been made either by molding a resistance supporting body of refractory material with grooves or other facilities for attachment of the resistance thereto and thereafter attaching the resistance thereto, or by providing a metal frame with spaced apart insulators of refractory material through which the resistance is threaded to support the resistance and electrically insulate it from the frame.

Such electric heaters not only require costly equipment such as molds particularly designed for forming the refractory parts to accommodate and retain the resistance in place, or mechanisms for producing the particular form of metal frame required, but they also involve considerable assembling expense. Moreover, the construction of such previous heaters oftentimes did not afford maximum heating efficiency for the purpose for which they were designed to be used.

In accordance with the present invention the resistance is merely located in position in a mold in which the body of refractory material is shaped with the resistance securely and permanently embedded therein, and the mold employed is of simple and inexpensive construction utilizing as a part thereof an outer shell that remains attached to the molded body and becomes the outer shell of the heater and provides the mounting facilities by which the heater is installed in the place of use, thereby providing in the single molding operation a unitary heater complete with resistance, refractory body and heater protecting and mounting shell.

The principal objects of the invention are to provide an improved exposed resistance electric heater; to simplify the construction of such heaters and minimize the cost thereof; to eliminate expensive molds or equipment and assembling operations; to improve the efficiency of such heaters; and to provide an exposed resistance electric heater which is more conveniently adaptable to the various purposes for which such heaters are generally used, these and other objects being accomplished as pointed out more particularly hereinafter and as shown in the accompanying drawing in which:

FIG. 1 is an end view of a heater constructed in accordance with the present invention;

FIG. 2 is a side view of the heater of FIG. 1 with a large portion thereof at one end and a small portion at the other end shown in section, both on the line 2—2 of FIG. 1;

FIG. 3 is an enlarged fragmentary cross sectional view of the heater of FIG. 2 taken on the line 3—3 thereof;

FIG. 4 is a sectional view on the line 4—4 of FIG. 3;

FIG. 5 is a sectional view on the line 5—5 of FIG. 3;

FIG. 6 is a vertical sectional view of a typical clothes dryer showing the heater of FIGS. 1 and 2 installed therein;

FIG. 7 is a rear view of the dryer of FIG. 6 with the rear wall removed;

FIG. 8 is a vertical sectional view with an intermediate part broken away of the heater of FIGS. 1 and 2 in the mold in which it is produced;

FIG. 9 is a top view somewhat reduced in size of the mold of FIG. 8;

FIG. 10 is a sectional view on the line 10—10 of FIG. 8;

FIG. 11 is a fragmentary view showing a portion of the core of the mold and the manner of applying the resistance thereon preparatory to the molding of the heater;

FIG. 12 is a side view with a portion broken away of the heater of FIG. 1 with the terminals at one end thereof;

FIG. 13 is a side view with a portion broken away of a modification of the heater of FIGS. 1 and 2;

FIG. 14 is a central sectional view of another modified form of heater which may be made in accordance with the present invention; and

FIG. 15 is a side view partly in section of a jacketed form in which the heater may be made.

Referring to the drawings, and particularly to FIGS. 1 to 5 inclusive, which show a preferred embodiment of the invention, the reference numeral 20 indicates a thin walled cylindrical tube, preferably of metal, which constitutes the outer wall of the heater and 21 indicates a thick cylindrical lining of molded refractory material which is preferably molded in place in the tube 20 and thereby secured thereto. This lining 21 preferably terminates short of both ends of the tube 20 as shown in FIG. 2 leaving an unlined portion 22 of the tube 20 projecting beyond the refractory lining 21 at each end, and the lining 21 is preferably provided with a circumferential series of close adjoining parallel ventilating openings 23 extending therethrough from end to end.

The heating element, which is indicated at 24, is a cylindrical spiral winding of bare electrical resistance wire preferably energizable to a glowing heat and has the coils 25 thereof spaced apart as shown so that there is a substantial intervening space between the successive coils thereof, and the winding which extends from end to end of the refractory lining 21 has each of the coils 25 correspondingly embedded in the inner face of the lining to a depth to be safely retained therein but with a large portion of the interior face of each coil exposed substantially as shown in FIGS. 2 and 4.

The winding 24 is embedded in the lining 21 by molding the latter in contact with the winding and thus the inner face of the lining is formed with a spiral groove 26 in which the winding 24 and each individual coil 25 thereof is closely confined and retained against displacement.

For additionally securing the coils 25 in place, the lining 21 is formed on the inner face at suitable circumferential intervals with ribs 27 which extend from end to end of the lining, four such ribs being shown in the illustrated embodiment, and these ribs completely cover the coils 25 at the places where they extend thereacross, as shown in FIGS. 1, 2, 3 and 4 so that the coils at the rib locations are securely anchored to the lining 21.

Each end coil 25 of the resistance terminates in a portion which extends into the lining 21 to greater depth therein in the manner indicated at 30 in FIG. 1 and is continued outwardly from that place through and projects from the respective end of the lining 21 for connection of current supply conductors thereto, such projecting portions being indicated respectively at 31 and 32.

The current supply conductors may be connected directed to these projecting end portions 31 and 32 of the winding 24, but it is preferred to provide the opposite unlined end portions 22 of the cylindrical shell

20 with attached terminal posts 33 and 34 respectively to which the projecting end portions 31 and 32 of the resistance 24 are respectively connected.

Each post 33 and 34 is preferably located in the immediate vicinity of the place where the respective end portion 31 or 32 of the resistance projects from the end of the lining 21 and projects radially outward through an opening 35 in the respective unlined end portion 22 of the tube 20, and if the tube 20 is of metal each post 33 and 34 is electrically insulated from the respective end portion 22 thereof in any convenient manner.

For example, each terminal post may comprise a metal stem 36 extending through inner and outer porcelain parts 37 ad 38 respectively with the inner part 37 provided with a sleeve portion 39 which encircles the stem 36 and projects through the opening 35 into a central recess 40 of the part 38, the stem 36 being provided at the inner end with a head 41 between which and the inner porcelain part 37, a loop 42 of the respective end portion 31 or 32 of the resistance 24 is clamped by a nut 43 on the outer threaded end of the stem 36, the said nut serving also to clamp the porcelain parts 37 and 38 onto the respective unlined end portion 22. An extra nut 44 is provided on the outer threaded end of the stem 36 for securing a supply conductor to the stem 36.

Thus the conductors for supplying current to the resistance 24 may be connected at the exterior of the tube 20 to the outer ends respective of the stems 36 of the posts 33 and 34.

When the heater above described is energized, the place of greatest heat intensity is at the inner side of the lining 21 and concentrated in the central opening of said lining 21 and the heat is uniformly distributed throughout the length of said central opening as each coil 25 of the resistance 24 is a source of heat and exposed at its inner side to the interior of the central opening of the lining 21, and if air or other gas is passed through the central opening of the lining 21 it is heated throughout to a high temperature in its passage therethrough.

The lining 21 necessarily becomes heated and air or gas passing through the longitudinal openings 23 of the lining tends to absorb the heat transmitted to the lining 21 and provide an extra supply of heated air or gas.

While the heater above described may be used for various purposes, as for example, as a kiln, it is usable to particular advantage in clothes dryers or the like, as for example, as shown in FIGS. 6 and 7 in which a popular form of domestic clothes dryer is illustrated.

In said FIGS. 6 and 7 the dryer comprises an outer casing composed of two side walls 45 and 46 with top and bottom walls 47 and 48 respectively and front and rear walls 49 and 50 respectively, and the interior of the casing is divided by a combined vertical partition 51 and a horizontal partition 52, both of which extend from side to side of the casing, into a rear compartment space 53 and a bottom compartment space 54 which communicate with one another.

At the front of the partition 51 and above the partition 52 is a relatively large compartment space or drum chamber 55 occupied by a drum 56 in which clothes are dried and this drum has a central spindle 57 at the rear end journaled in a bearing 58 on the partition 52 to rotate on a horizontal axis and at the rear of the partition 51 the spindle 57 has a large sheave 59 fixed thereon to which power is supplied from a motor 60 through belts 61 and 62 to and from sheaves 63 and 64 on an intermediate countershaft 65 to rotate the spindle 57 and the drum 56 at a relatively low rate of speed.

The drum chamber 55 is separated from the front wall 49 of the casing by a partition 66, to which the forward end of the partition 52 is attached, and provides a chamber 67, hereinafter referred to as the exhaust chamber, at the front of the casing and this partition 66 has an opening therethrough through which the forward end of

the rotatable drum 56 projects and by which the drum is quite closely confined.

The front end wall of the drum has a large central opening to accommodate the inner end of a large thimble 68 about which the drum front wall rotates, and this thimble is secured to the front wall 49 in a position concentric with the drum 56 to afford access to the interior of the drum from the front of the dryer, the opening through this thimble being closed at the front end by a door 69 on the front wall 49.

The rear wall of the drum 56 is provided throughout the area thereof with air inlet openings 70 and the front wall of the drum is likewise provided with air outlet openings 71 throughout the area thereof, and the back wall of the drum is spaced sufficiently from the vertical partition 51 to provide ample access to air to the rear wall openings 70.

In the operation of this dryer the clothes to be dried are located in the drum 56 which is rotated by the motor 60 to tumble the clothes in the drum, the latter being provided on its peripheral wall with ribs or formations 72 to assure the required tumbling operation, and during the drying operation heated air is circulated through the interior of the drum from the rear openings 70 to the front openings 71 of the drum to dry the tumbling clothes.

To supply the heated air for drying, the vertical partition 51 is provided with an opening therethrough, above the drum, in which a heater 73, such as above described and shown in FIGS. 1 and 2 is mounted, as for example by a flanged ring 74 or circumferentially spaced angle brackets on the exterior of the cylindrical shell 20 of the heater which are secured to the partition 51, so that the rear chamber 53 of the casing communicates with the chamber 55 in which the drum 56 is located, solely through the central opening of the heater and the long openings 23 in the lining 21 thereof.

The bottom wall 48 of the casing is elevated above the floor on which the dryer is supported and has a large opening 75 therethrough through which air is supplied to the chamber 54 and therefrom to the chamber 53.

A blower 76, operable by a motor 77, is mounted on the bottom wall 48 of the casing at the rear end of the chamber or compartment 54 with the blower outlet 78 projecting through the rear wall 50 of the dryer casing and a duct 79 is connected at its front end to the partition 66 and leads from the chamber 67 to the intake of the blower 76 so that in the operation of the motor 77 and blower 76 air is exhausted from the chamber 67.

The rear end of the heater 73 is spaced sufficiently from the rear wall 50 of the dryer to afford ample space for free entry of air into the rear end of the heater, the rear wall 50 preferably having a relatively large heat reflector lining 80 on the inner face thereof opposite the rear end of the heater 73, and in the operation of the dryer the blower 76 draws a large volume of air into the compartments 54 and 53 through the opening 75 and from the chamber 53 through the central opening of the heater 73 and through the opening 23 thereof into the drum chamber 55, thereby heating the air to a high temperature in its passage through the heater 73, and the thus heated air which surrounds and heats the drum 56, is drawn by the blower 76 through the openings 70 in the rear wall of the drum and circulates through the tumbling clothes in the drum to extract moisture therefrom, and the moisture laden air is exhausted from the interior of the drum through the openings 71 in the front wall of the drum into the chamber 67 from which it is discharged to the exterior of the dryer through the duct 79 and the blower 76.

A large volume of highly heated air is required for effectively drying the clothes and in the desired minimum time, and a large amount of current is usually required for the purpose, and I have found that a heater 73 constructed and arranged as shown and described

herein dries the clothes more completely and in less time and with considerably less current consumption than with heaters heretofore employed for the purpose.

The heater of FIGS. 1 to 5 inclusive may be conveniently made with a simple mold as shown in FIGS. 8, 9, 10 and 11 wherein **81** indicates a base on which a cylindrical core **82** is supported in an upright position and is of a diameter somewhat less than the diameter of the central opening through the lining **21** of the heater, for reasons hereinafter explained, the core **82** having a cylindrical enlargement **83** at the lower end by which the core is located at an elevation above the base, and this enlargement preferably has a ring **84** therearound which has a slip fit on the enlargement **83** and is removable therefrom, although the ring **84** may be an integral part of the enlargement **83** if desired.

The ring **84** has an annular shoulder **85** therearound and the portion of said ring above the shoulder **85** is of a diameter to receive therein one end of the cylindrical tube **20** which becomes the outer shell of the completed heater and the length of the portion of the ring **84** above the shoulder **85** corresponds to the desired length of unlined portion **22** of the tube **20** in the finished heater, the arrangement being such that when the cylindrical tube **20** is placed in position on the end of the enlargement **83** and seated against the shoulder **85**, the tube **20** is concentric with the core **82** with a wide annular space of uniform width therebetween.

The ring **84** supports a plurality of long cylindrical cores **86** vertically at circumferentially spaced intervals in the annular space between the central core **82** and the cylindrical tube, these cores **86** being of suitable size and location to produce the vent openings **23** in the lining **21**, and these cores **86** and the central core **82** are of a length slightly greater than the length of the lining **21** to be provided in the cylindrical tube **20** of the heater and preferably beveled around their upper ends as shown in FIG. 8.

The cores **86** may be permanently attached to the ring **84** or may be individually removable therefrom, as desired, with reduced stem portions **87** at their lower ends which slip into elongated vertical sockets **88** in the ring **84**, and while it is indicated above that the cores **86** are cylindrical, these cores may have a slight taper to facilitate drawing thereof from the molded lining **21** which is formed therearound.

The core **82** does not provide a mold surface but instead is a core for supporting a plurality of elongated transversely curved panels **89** which are applicable around the core **82** to form an external generally cylindrical surface thereon, four quarter cylindrical segments or panels **89** being shown herein, although the number thereof may be varied.

These panels or segments **89** are of a length to extend substantially the full length of the core **82** and each has the lateral edges thereof beveled or turned in as indicated at **90** so that when they are placed in lateral edge to edge relation around the core **82**, as shown in FIG. 10, the edges of adjoining panels at the outer extremity of the bevel abut or substantially abut against one another and the exterior surfaces thereof constitute conjointly a surface of cylindrical contour with an external V-shaped groove **91** (see FIG. 11) at the juncture of each adjoining pair of panels **89** and extending from end to end thereof.

The panels **89** may be solid segments with the inner faces thereof conforming to the contour of the core **82**, but preferably are of stiff sheet metal with the lateral edges bent inwardly as shown particularly at **92** in FIG. 10 to provide the bevel **90** and minimize the bearing contact against the core **82**, and the core **82** may be solid or a cylindrical tube with plain cylindrical exterior but may be provided with external lengthwise extending grooves **93** to receive the inturned edges **92** of the panels **89** and facilitate the placing of the panels in position on the core **82**.

A funnel-like member **94** is preferably provided with a cylindrical lower end portion **95** adapted to fit into the end of the tube **20** and this cylindrical portion **95** has upright web members **96** therein which support a tapered cap **97** which fits over the upper end of the core **82** and one of the web members **96** is provided with an upright tubular sleeve **98** approximately midway between the wall of the cylindrical portion **95** and the cap **97** for holding a terminal end of the resistance winding **24** in the molding operation.

The annular ring **84** and base **81** also have a small vertical opening **99** therethrough to receive the other terminal end of the resistance winding.

In making the heater with the above described equipment, the panels or segments **89** are assembled around the core **82** as shown in FIG. 10 with their lower ends abutting against the top face of the enlargement **83**, as shown in FIG. 8, and a sheet **100** of material, such as wax paper, which will not adhere to the molded lining **21** and is sufficiently flexible to conform to the grooves **91** is wrapped around the assembled panels **89**, after which a resistance wire **24** of the required length is wound tightly around the assembled panels **89** over the wax paper **100** thereon with the coils **25** spaced apart, as shown, and an end portion of the resistance wire which is to constitute one of the terminal ends **31** or **32** of the completed heater, for example the terminal end **31**, is inserted through the opening **99** of the enlargement **83** and base **81** as shown in FIG. 8.

The ring **84** with the small cores **86** assembled thereon may then be placed in position on the enlargement **83**, or the cores **86** may be individually assembled on the already applied ring **84**, after which the cylindrical tube **20** is placed in position on the ring **84** as shown in FIG. 8, whereupon the funnel member **94** is inserted in the upper end of the tube **20** with the other terminal end portion of the resistance **24**, for example, the end portion **32** extending upwardly through the opening of the sleeve **98** as shown in FIG. 8.

A flowable plastic mass of a suitable mixture or compound, such for example as a mixture of steatite, which sets up in a hard solid form in which it withstands high temperatures and is electrically non-conductive, is then poured into the funnel **94** and into the space between the cylindrical tube **20** and the spiral winding **24** and wax paper **100** on the core **82**, as indicated at **101** in FIG. 8, up to the level indicated at **102** in FIG. 8 at such distance below the upper end of the tube **20** to leave the desired unlined portion **22** at that end of the tube **20**, and tamped in place if necessary, and then allowed to set and harden, after which the funnel member **94** is removed, and also the central core **82**, panels **89** and wax paper **100** and also the small cores **86**, leaving in the cylindrical tube **20** the molded material **101** which constitutes the lining **21** with the resistance wire **24** embedded therein.

In the molding operation, the plastic mass **101** fills in around the sides of the coils **25** but leaves a substantial width of the inner face, which is covered by the wax paper **100** in the molding operation, exposed and moreover the plastic mass forces the wax paper down into the grooves **91** between the segments or panels **89** and forms therein the ribs **27** which overlie the coils **25** at intervals therearound.

By reason of the terminal ends **31** and **32** of the resistance being extended through the sleeve **98** and opening **99** in the molding operation, these ends project outwardly from the opposite ends of the molded lining **21** and supply conductors may be connected directly thereto or they may be connected to terminal posts **33** and **34** if desired.

In some cases it may be desired to locate both terminal wires or terminal posts at one end of the heater, in which

event a terminal end portion is provided at one end of the lining **21** of said length that it may be bent back as indicated at **103** in FIG. 12 and extended through one of the openings **23** in the lining **21**, as indicated at **104**, and connected to a terminal post **105** at the same end of the cylindrical tube **20** at which the terminal post **106**, to which the other terminal end portion **107** of the resistance **24**, is located.

The above described heater may be made with a substantial taper from end to end, as shown in FIG. 13, in which the corresponding parts thereof are identified by the same reference numerals as those of FIGS. 1 to 5 inclusive, and moreover the heater may be made in a shallow conical form such as shown in FIG. 14 in which the reference numeral **108** indicates the lining of refractory material which is formed in flat conical shape in a flat conical pan or shell **109** and the resistance is in the form of a flat conical spiral **110** embedded in the upper exposed face of the lining **108**.

In this FIG. 14 form of the heater, a plate **111** of glass capable of withstanding high temperatures may be secured to the upper side of the heater by clips **112** at intervals around the heater to adapt the latter for surface heating purposes, as for example in electric ranges.

Also, the heater may be enclosed in an outer jacket to provide air circulation spaces around the heater.

For example, the heater of FIGS. 1 and 2 may be mounted, as shown in FIG. 15, within a tubular casing **113** to provide an annular passageway around the cylindrical shell **20** of the heater, and for this purpose the shell **20** may be provided near each end and at intervals therearound with arms **114** projecting radially outward therefrom and secured at their outer ends to the tubular casing **113**.

Such heater with tubular casing **113** may be advantageously employed, for example in the dryer of FIGS. 6 and 7, by providing the partition **51** with an opening to accommodate the casing **113** of the heater of FIG. 15 and securing the casing **113** containing the heater in that opening in the same manner that the heater alone of FIGS. 1 and 2 is mounted in the partition **51** in FIGS. 6 and 7.

Thus when the heater with the casing **113** is installed in the partition **51** an additional avenue of air supply is provided, between the casing **113** and the heater shell **20**, and as the latter becomes quite highly heated when the resistance **24** is energized, especially for a prolonged period of time, greater efficiency may be obtained.

While I have shown and described my invention in a preferred form, I am aware that various modifications can be made therein without departing from the spirit of my invention, the scope of which is to be determined by the appended claims.

What is claimed is:

1. An electric heater comprising a cylindrical helix of bare heat resistance wire having a series of laterally spaced substantially coaxial coils and a mounting for said coils conjointly therewith defining a passage encircled by said coils, the said mounting comprising a rigid tubular body of electrically nonconductive refractory material having an undivided circumferentially continuous wall surrounding the series of coils having the longitudinal axis of the wire of the coils substantially paralleling the inner face of the circumferentially continuous wall, the wire of each said coil being embedded in said wall substantially throughout the length of the wire thereof and the wall being irremovably molded to the wire in conformity therewith in intimate gripping engagement with the surface of the wire at opposite sides thereof in matrix relation to the cross sectional contour of the wire with the bare face of the wire at the inner sides of the coils exposed to the passage.

2. An electric heater comprising a cylindrical helix of bare heating resistance wire providing a series of laterally spaced substantially coaxial coils, and a mounting for said coils conjointly therewith defining a cylindrical passage coaxial with and encircled by said coils, the said mounting comprising a rigid tubular body of electrically nonconductive refractory material having an undivided circumferentially continuous wall surrounding the series of coils and said coils having the longitudinal axis of the wire thereof substantially paralleling the inner face of the circumferential wall and said wall being inseparably molded to the wire of each coil with the bare face of the wire at the inner sides of the coils exposed to the passage and a blower communicating with one end of the passage to discharge air therethrough crosswise of the wire of the coils and in contact with the bare face of the wire at the inner sides of the coils.

3. An electric heater comprising a heating element which consists of a distributively arranged winding of bare heating resistance wire, and a heating element backing at one side of which the bare wire heating element is embeddedly supported therein in matrix relation thereto in an exposed manner, the said backing being a rigid body of electrically non-conductive refractory material molded in inseparable supporting conformity to the cross sectional coutour of the wire of the heating element with the bare face of the wire exposed at the side thereof remote from the backing, the backing being formed with spaced apart ribs having transverse apertures through which the wire of the winding extends.

4. An electric heater comprising a heating element which consists of a distributively arranged winding of bare heating resistance wire, and a heating element backing at one side of which the bare wire heating element is embeddedly supported therein in matrix relation thereto in an exposed manner, the said backing being a rigid body of electrically non-conductive refractory material molded in inseparable supporting conformity to the cross sectional contour of the wire of the heating element with the bare face of the wire exposed at the side thereof remote from the backing, the backing being a thick walled tube and the winding being at and conformed substantially to the inner side of the tube and the wall being formed with a plurality of peripherally spaced passages extending through the wall from end to end of the tube.

5. An electric heater comprising a heating element which consists of a distributively arranged winding of bare heating resistance wire, and a heating element backing at one side of which the bare wire heating element is embeddedly supported therein in matrix relation thereto in an exposed manner, the said backing being a rigid body of electrically non-conductive refractory material molded in inseparable supporting conformity to the cross sectional contour of the wire of the heating element with the bare face of the wire exposed at the side thereof remote from the backing, the backing being a thick walled cylindrical tube externally conformed to and confined within and supported by a cylindrical metal tube and the cylindrical metal tube being contained in another tube with an annular air circulation space between the tubes and open at both ends.

6. An electric heater comprising a heating element which consists of a distributively arranged winding of bare heating resistance wire, and a heating element backing at one side of which the bare wire heating element is embeddedly supported therein in matrix relation thereto in an exposed manner, the said backing being a rigid body of electrically non-conductive refractory material molded in inseparable supporting conformity to the cross sectional contour of the wire of the heating element with the bare face of the wire exposed at the side thereof remote from the backing, the backing being a thick walled cylindrical tube externally conformed to and confined within and supported by a metal tube, the thick walled tube defining a passage which is open at both ends and around which the winding is distributively arranged, and a par

tition by which the heater is supported for communication through the said passage thereof from one side of the partition to the other side of the partition, and means for enforcing circulation of air through said passage.

7. An electric heating unit comprising an electrical heating resistance composed of a long bare wire of electrical resistance material, and a rigid body of electrically non-conductive refractory material presenting a face throughout which the long wire is distributively arranged with its longitudinal axis substantially paralleling said face, said wire being irremovably embedded in the refractory material of the body with a substantial amount of the surface of the wire exposed to radiate heat therefrom, the body having portions thereof at opposite sides of the wire conformed to the surface of and gripping the wire therebetween in intimacy of contact with the surface thereof providing permanent unification of the wire with and irremovability of the wire from the body.

8. An electric heater in accordance with claim 7 wherein the side of the wire remote from the body is exposed substantially throughout the length thereof.

9. An electric heater in accordance with claim 7 wherein the conformity of the portion of the body to the surface of and gripping of the wire therebetween in intimacy of contact is substantially continuous throughout the length of the wire.

10. An electric heater in accordance with claim 7 wherein the body is a thick wall at one side of which the wire is distributively arranged substantially in parallelism with the wall throughout the area thereof.

11 An electric heater in accordance with claim 7 wherein the body is a thick concavo-convex wall and the winding is at and conforms substantially to the concave side thereof.

12. An electric heater in accordance with claim 7 wherein the body is a thick walled tube and the resistance wire is at and conforms substantially to the inner side of the thick wall of the tube.

13. An electric heater in accordance with claim 7 wherein the body is a thick wall at one side of which the resistance wire is distributively arranged and at the opposite side of which the wall conforms to and is supported by a sheet metal shell.

14. An electric heater as defined in claim 7 wherein the body is a thick walled cylindrical tube externally conformed to and confined within and supported by a metal tube and the electrical heating resistance is a helix with a series of circumferentially extending coils of the resistance wire spaced apart in the direction of the length of the tube.

References Cited in the file of this patent

UNITED STATES PATENTS

1,693,421	Woodson	Nov. 27, 1928
1,788,107	Hynes	Jan. 6, 1931
2,019,064	Apple	Oct. 29, 1935
2,152,934	Trent	Apr. 4, 1939
2,164,265	Wilson	June 27, 1939
2,185,206	Little	Jan. 2, 1940
2,338,531	Naumann	Jan. 4, 1944
2,419,848	Morey	Apr. 29, 1947
2,433,373	Krim	Dec. 30, 1947
2,489,190	Lelong	Nov. 22, 1949
2,519,752	Fox	Aug. 22, 1950
2,599,411	Pulliam	June 3, 1952
2,611,790	Koch	Sept. 23, 1952
2,629,166	Marsten et al.	Feb. 24, 1953
2,652,622	Charbonneau	Sept. 22, 1953
2,729,733	Heron	Jan. 3, 1956
2,735,922	Johnson	Feb. 21, 1956
2,757,270	Fairbanks	July 31, 1956
2,813,182	Van Alen	Nov. 12, 1957

FOREIGN PATENTS

385,493	Germany	Dec. 11, 1923
540,367	Italy	Mar. 3, 1956