Dec. 29, 1931. W. HUDSON 1,838,680

HEATING ELEMENT

Filed July 25, 1927 5 Sheets-Sheet 1

Fig. 1.

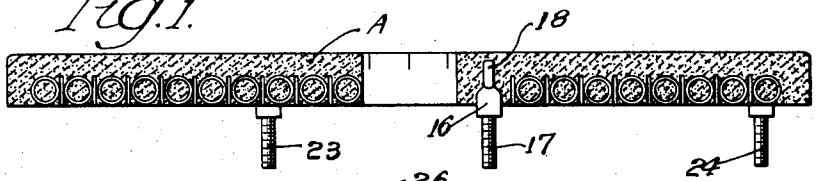


Fig. 2.

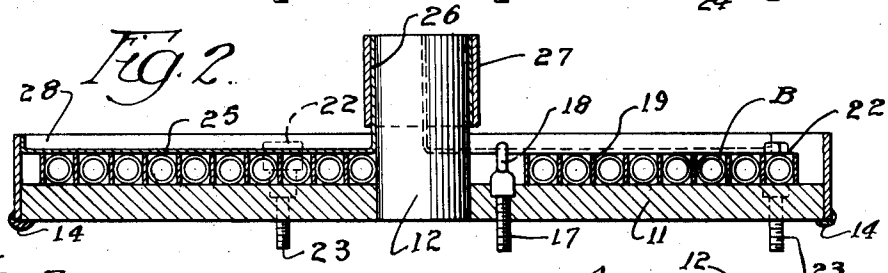


Fig. 4.

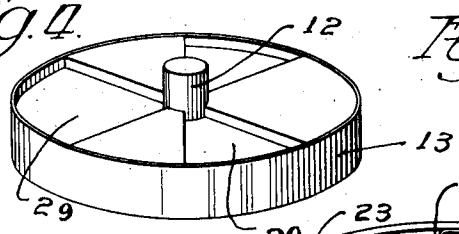


Fig. 5.

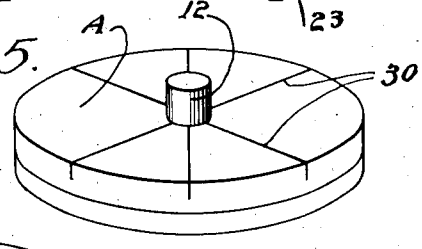
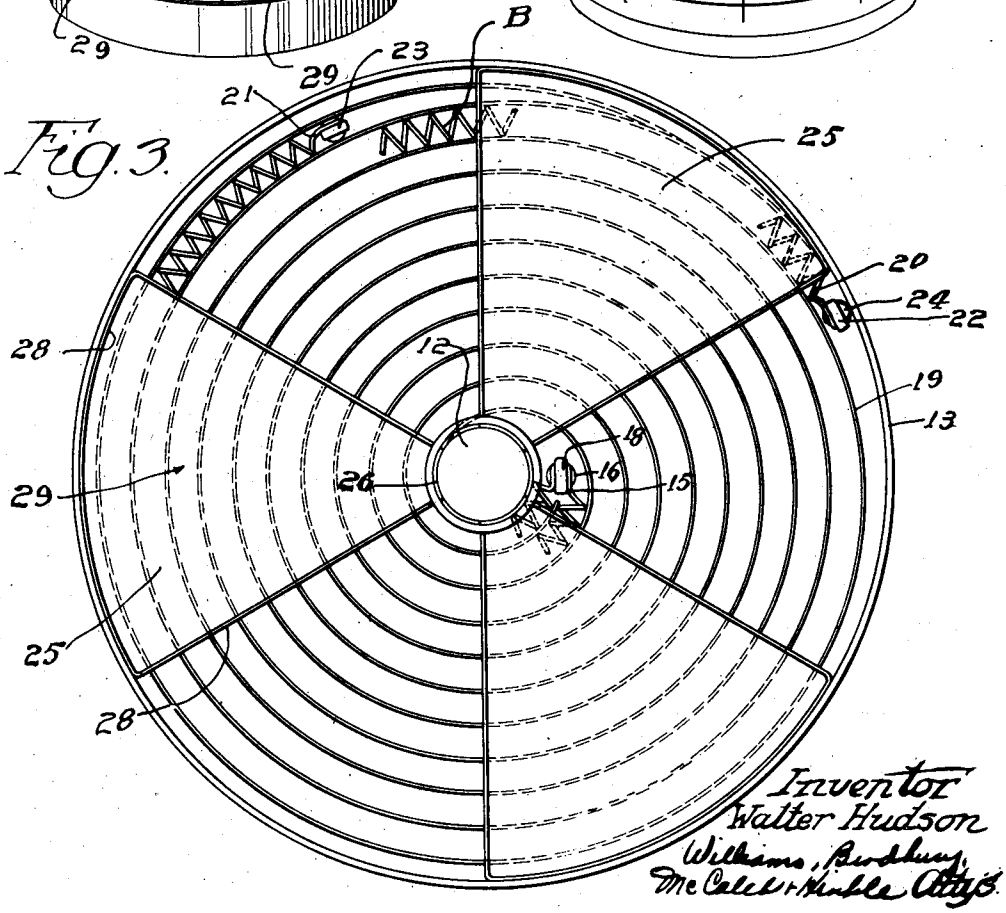


Fig. 3.



Inventor
Walter Hudson
Williams, Bradbury,
McCaleb & Hinkle Attys.

Dec. 29, 1931. W. HUDSON 1,838,680

HEATING ELEMENT

Filed July 25, 1927 5 Sheets-Sheet 2

Fig. 6.

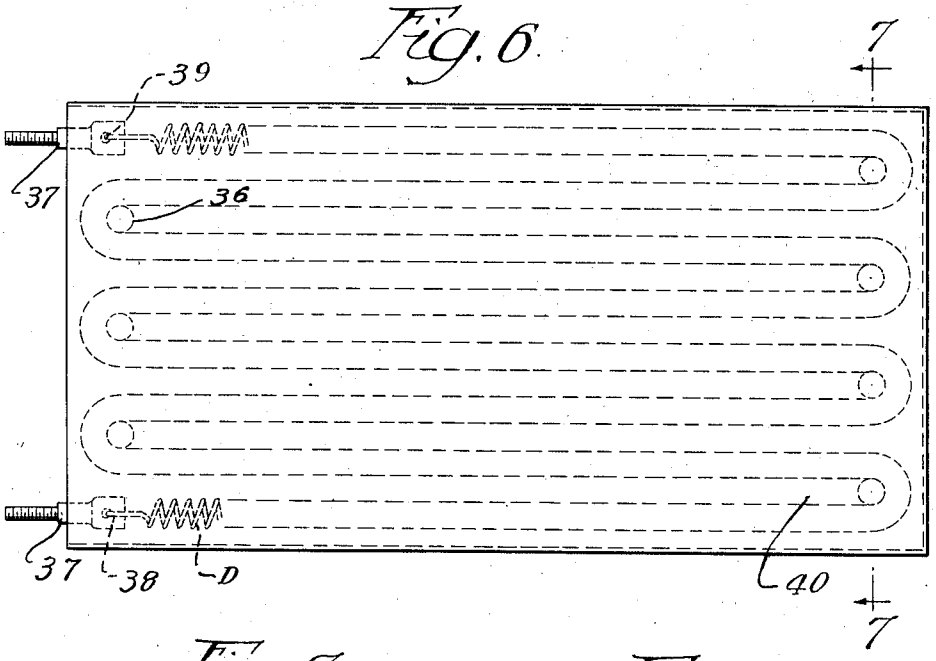


Fig. 7.

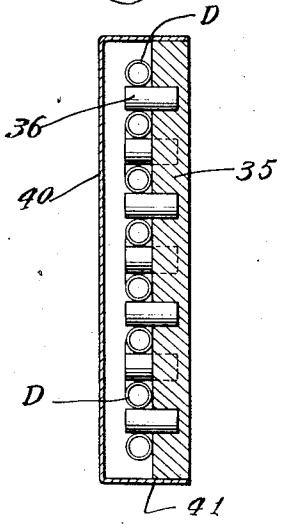
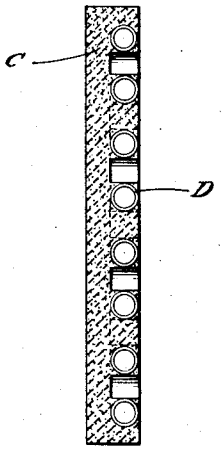


Fig. 8.



Inventor
Walter Hudson
Williams, Bradbury
McCaleb & Hinkle Attys.

Dec. 29, 1931. W. HUDSON 1,838,680

HEATING ELEMENT

Filed July 25, 1927 5 Sheets-Sheet 3

Fig. 9.

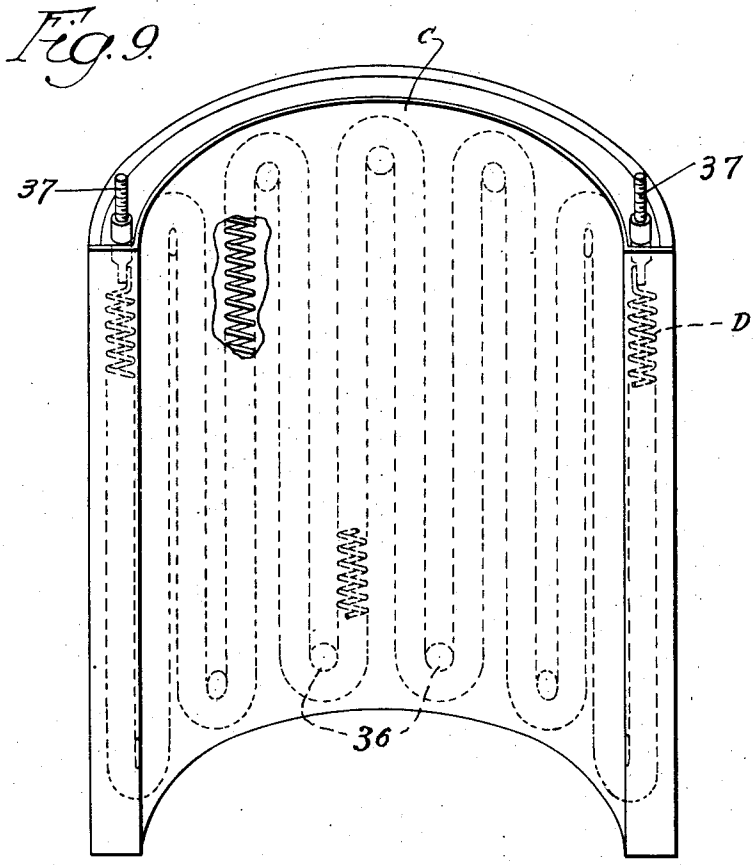
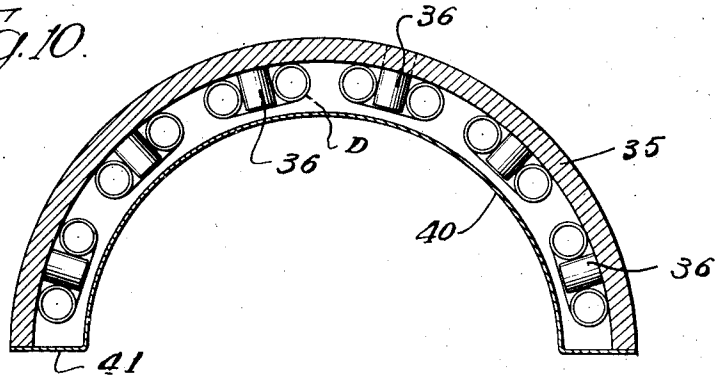


Fig. 10.



Inventor
Walter Hudson
Williams, Bradbury,
McCaleb & Hinkle Attys.

Dec. 29, 1931. W. HUDSON 1,838,680

HEATING ELEMENT

Filed July 25, 1927 5 Sheets-Sheet 4

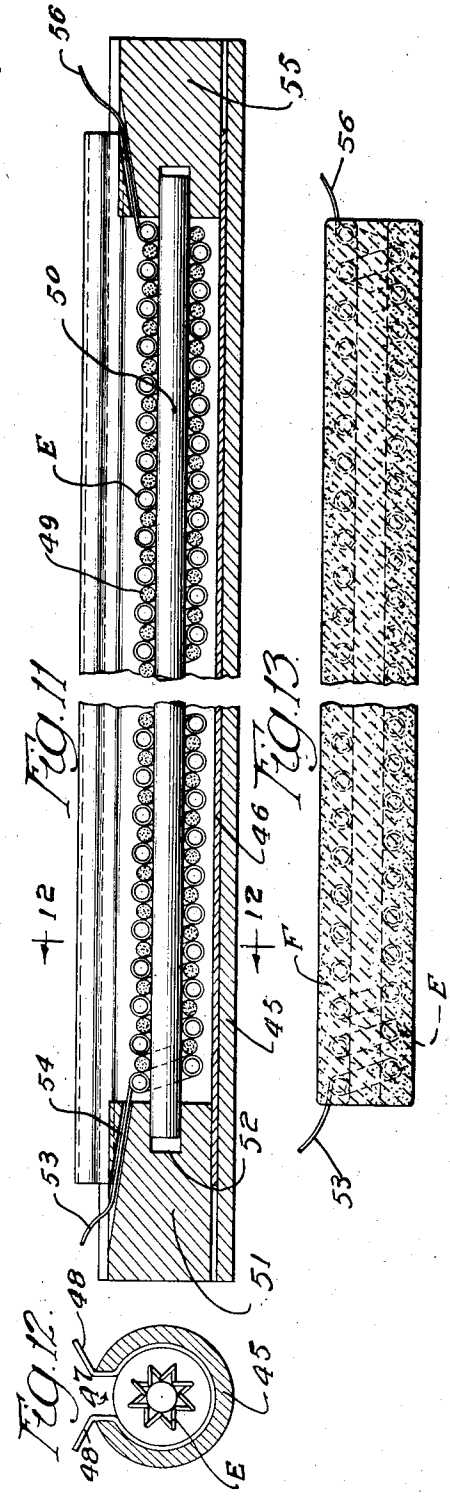


Fig. 11

Fig. 13

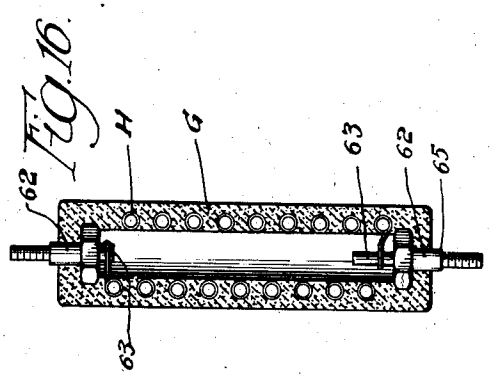


Fig. 16.

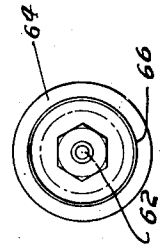


Fig. 15.

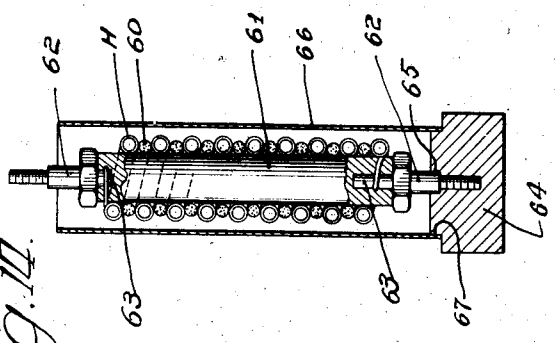


Fig. 14.

Inventor.
Walter Hudson
Williams, Bradbury,
McCaleb & Hinkle Attys.

Dec. 29, 1931. W. HUDSON 1,838,680

HEATING ELEMENT

Filed July 25, 1927 5 Sheets-Sheet 5

Fig. 17.

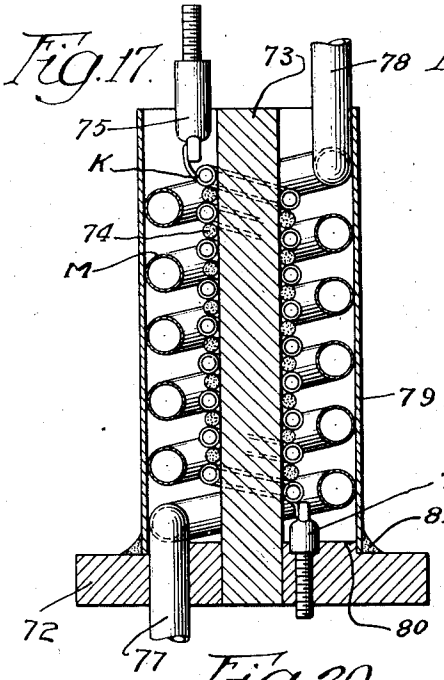


Fig. 18.

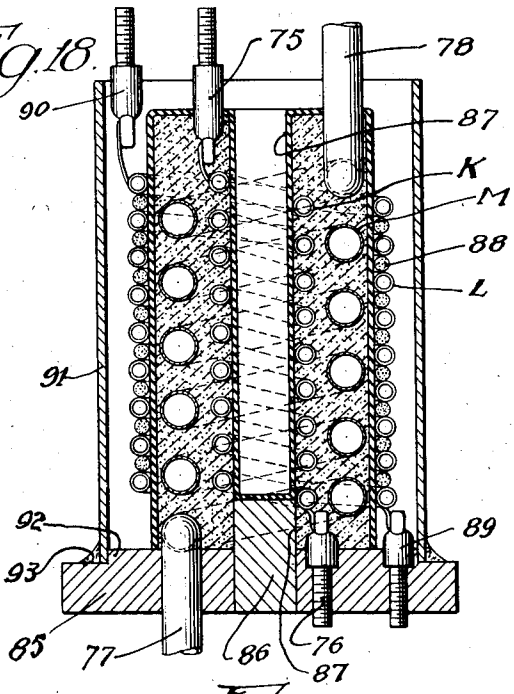


Fig. 20.

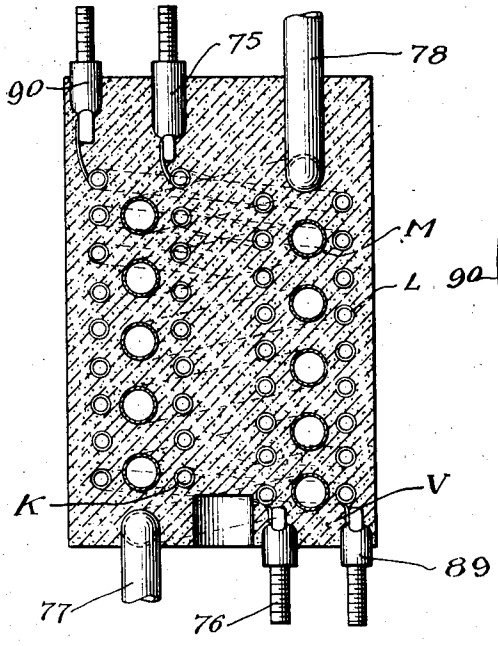
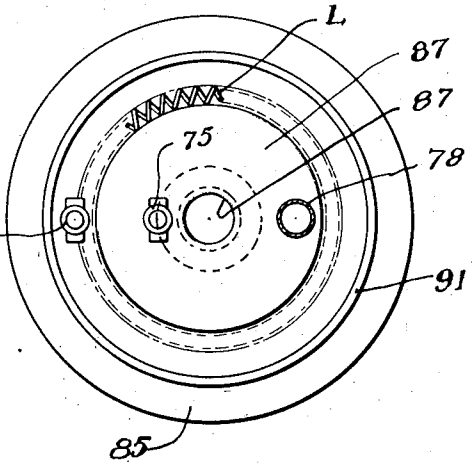


Fig. 19.



Inventor
Walter Hudson
Williams, Bradbury,
McCabe & Kirkby Attys.

Patented Dec. 29, 1931 1,838,680

UNITED STATES PATENT OFFICE

WALTER HUDSON, OF MILTON, WISCONSIN, ASSIGNOR TO THE BURDICK CORPORATION, OF MILTON, WISCONSIN, A CORPORATION OF DELAWARE

HEATING ELEMENT

Application filed July 25, 1927. Serial No. 206,212.

My invention relates to heating elements and methods of constructing the same.

Heretofore heaters have been constructed of nonmetallic refractory material with metal supporting plates, bands, or reinforcing members forming a part of the element so that it could be handled without fear of breakage or disintegration during use. The disadvantage of this type of construction is that the difference in the coefficients of expansion between the metallic reinforcing plates, bands or other members and the refractory body surrounding the heating coils tend to cause disintegration of the body when in use.

An object of my invention is to provide a heating element and method of constructing the same which is entirely self-supporting and in which the use of metallic reinforcing members, plates or bands are eliminated.

A further object is to provide a heating element in which the electrical heating coil is embedded within the refractory body so that the entire body will glow and a maximum transfer of heat from the heating element to the body is effected. This greatly increases the efficiency of the element.

A further object is to provide a heating element in which the heat radiating surfaces are substantially unbroken, therefore providing uniform heat radiation.

Other objects and advantages will hereinafter appear.

In the accompanying drawings:

Fig. 1 is a sectional view of a heating element in the form of a plate;

Fig. 2 is a sectional view of this heating element in the process of manufacture;

Fig. 3 is a top plan view of the assembly illustrated in Fig. 2;

Fig. 4 is a perspective view of the plate heating element partly constructed;

Fig. 5 is a perspective view of the heating element ready for the kiln;

Fig. 6 is a top plan view of a crucible type or heavy duty heating element in the process of manufacture;

Fig. 7 is a sectional view along the lines 7—7 of Fig. 6;

Fig. 8 is a longitudinal sectional view of the finished crucible type element;

Fig. 9 is a perspective view of a curved crucible furnace element;

Fig. 10 is a sectional view of the curved crucible furnace element in the process of manufacture;

Fig. 11 is a sectional view of a cylindrical heating element in the process of manufacture;

Fig. 12 is a sectional view taken along the line 12—12 of Fig. 11;

Fig. 13 is a fragmentary view of the finished cylindrical heating element;

Fig. 14 is a sectional view of a cartridge type heating element in the process of manufacture;

Fig. 15 is a top plan view of the element illustrated in Fig. 14;

Fig. 16 is a sectional view of the finished cartridge type heating element;

Fig. 17 is a sectional view of a water heater element in one step in the process of manufacture;

Fig. 18 is a sectional view of the water heater in a later step in the process of manufacture;

Fig. 19 is a top plan view of the parts illustrated in Fig. 18; and

Fig. 20 is a sectional view of the finished water heater.

In Figs. 1 to 5 inclusive I have shown a heating element for use in electric stoves, ranges and hot plates. This element is entirely self-supporting and provided with expansion joints in that portion of the body through which the heating coil does not extend so that the element is free of excessive internal strain should portions of the element become cooled during use.

The element consists chiefly in a body A of refractory material and an electrical heating coil B embedded within the body and provided with suitable electrical terminals for connection with a current supply.

In the manufacture of the heating element I provide a temporary base in the form of a wooden disc 11 having a wooden plug core 12 projecting upwardly therethrough and extending for a distance above the top of the

disc. A cylindrical cardboard shell or mold 13 encompasses disc 11 and may be held thereupon by frictional engagement. Shell or mold 13 extends upwardly from disc 11 a distance equal to the thickness of body A of the element. (See Fig. 1.) Wax 14 may be employed for sealing the crevice or joint between mold 13 and base 11 so that the plastic refractory material can not seep out before it is hardened.

The electrical heating coil B is in the form of a helix coiled upon the face of disc 11 being first anchored near its mid-point 15 to a stud 16 carried by the wooden disc. Stud 16, which fits tightly within a hole through disc 11 near the central plug core, has a threaded shank 17 and a head 18 projecting from opposite sides of the disc. After being anchored to stud 16, coil B is then doubled back upon itself and wound in a double spiral about core 12, cardboard spacing strips 19 being interposed between the adjacent convolutions of the coil. This results in a flat spiral of two parallel helically wound sections of electrical resistor coil. Ends 20 and 21 of coil B are connected, by silver solder or other suitable means, to heads 22 of electrical terminal studs 23 and 24 which are similar to the stud attached near the mid-point of the coil. The heads and threaded shanks of terminal studs 23 and 24 project on opposite sides of base 11, the heads serving as anchorages to which the ends of the resistor are attached and the threaded shanks affording binding post terminals therefor. The outer turns of coil B have sufficient clearance from the inner surface of shell 13 to allow for the desired thickness of the refractory body at the rim of the element.

The next step in the process consists in casting the refractory body about the heating coil and parts of the terminals to completely surround the heating coil. This is done by placing a refractory compound in plastic condition, consisting of finely ground carborundum and silicate of soda binder, upon base disc 11 so as to cover the top of coil B. The width of spacing strips 19 is approximately the same as the external diameter of coil B. This refractory compound is permitted to settle so that all of the spaces between the turns of the coil and spaces between coil and strip are completely filled. Good results can be obtained by jarring the assembly.

After the refractory compound is compacted a plate consisting of three equally spaced sectors 25 joined at their inner ends by an upright split sleeve 26 is placed over the compound sleeve 26 encompassing core 12. The edges of sectors 25 diverge at such angle that spaces between adjacent sectors and the sectors are of equal extent. A clamping ring 27 fitting over sleeve 26 serves to hold the plate against movement with respect to disc 11. The ends and sides of sectors 25 are turned up as shown at 28 and extend to the top of shell 13 when the plate is in place upon the refractory compound and strips 19.

The space between up-turned edges 28 of the sectors 25 and above the refractory compound to the top of shell 13 is then filled with refractory compound and permitted to stand until partially set.

The plate sectors 25 are next removed by first withdrawing clamping ring 27 so as to disengage split sleeve 26 from core 12 and lifting sleeve 26 upwardly. The partially constructed element now has the appearance shown in Fig. 4, with recessed portions representing space occupied by sectors 25 as indicated at 29. Spaces 29 are now filled with the refractory compound which is also allowed to stand and become partially set.

If shell 13 were now removed the unfinished element would have the appearance shown in Fig. 5, 30 representing the gaps between adjacent sectors of the refractory body which serve as expansion joints.

The element 5 is now placed in the kiln and subjected to gradually increasing temperature until the refractory compound becomes thoroughly hardened and wooden disc 11, core 12, shell 13 and spacing strip 19 are entirely burned away, leaving only the finished element as shown in section in Fig. 1.

A heating element thus constructed presents many advantages not to be found in the present type of heating element. First, it is entirely self-supporting; second, the electrical heating coil is completely surrounded by refractory compound so that all of the heat therefrom is transmitted by conduction to the refractory body A which, because of the absence of reinforcing rims, bands or plates, is uniformly heated throughout its surface; third, internal strain, such as might result from the disposition of a cool body upon the hot element, will not cause disintegration of the refractory body because of the fact that the upper portions of the body, i. e., that portion not occupied by the heating coil, consists of several segmental portions bounded on their sides by expansion joints 30. That portion forming the lower part of the element relies upon the heating coil itself as a reinforcing element.

In Figs. 6 to 8 I have shown the invention as embodied in a heavy duty crucible type furnace element. This element, as in the case of that illustrated in the preferred form of the invention, consists in a refractory body C, having embedded therein an electrical heating coil D. The element is rectangular in form and is constructed upon a rectangular wooden base 35, having short, upstanding wooden pegs 36 extending beyond the face thereof. These pegs, which serve as temporary holders in the heating

coil, are located adjacent opposite edges of the base and staggered so that the helical resistor may be laid in a zigzag layer upon the face of the base.

A pair of terminals 37 are fitted into holes provided therefor in one edge of base 35. When, as illustrated, both terminals are on one side of the element the terminals may be conveniently located beyond the two outermost pegs adjacent that edge.

The electrical heating coil D is secured at one end 38 to one of the terminals 37 and is then drawn back and forth alternately across base 35 in opposite directions and about pegs 36 at opposite ends of the base so that the resistor forms a zigzag of uniformly spaced runs of helically coiled wire. The opposite end 39 of coil B is secured to the remaining terminal 37. Silver solder or other appropriate means may be employed to attach the ends of the wire to the terminals.

A rectangular cardboard shell or mold 40, having three side walls 41 which closely engage with one end, and opposite side walls of base 35, is then disposed upon the base. The depth of this mold is such that, when filled with plastic refractory material, that material will completely cover the resistor coil to the desired thickness.

The space between mold 40 and base 35 is now filled with refractory compound C in plastic condition, consisting of a silicate of soda and carborundum as described, and permitted thoroughly to settle so as to entirely encompass coil D. The terminal end of the mold is left open for filling purposes.

The unfinished element is now placed in a kiln and kiln dried precisely in the same manner as that described in the preferred form of the invention, including the complete burning away of base 35, pegs 36 and mold 40.

The heavy duty furnace element is now ready for use. This type of element presents an entirely unbroken uniform heat radiating surface which glows throughout its entire area with uniform consistency so that maximum heat disposition therefrom is effected.

In Figs. 9 and 10 I have shown a curved crucible furnace element. This element is constructed precisely in the same manner as the flat heavy duty furnace element shown in Figs. 6 to 7 inclusive, and hereinbefore described, the only difference being that base 35 is curved as is shell 40. In all other respects the construction and operation of the element are practically identical to that of the flat furnace element.

In Figs. 11 to 13 I have illustrated the round bar heating element and method of making the same.

Such an element may be used as a space heater or for stoves, ovens, furnaces and a wide variety of similar equipment. In the construction thereof I employ a split, rigid metal tubular mold 45 somewhat greater in length than the length of the finished element. A substantially tubular split cardboard form or lining 46 is then placed within tube 45. Form 46 has a longitudinally extending opening 47 therethrough with flaps 48 at each side of the opening which are bent outwardly so as to overlie adjacent edges of the slot of tube 45.

Alternate turns of an electrical heating coil E and string 49 are then wound closely about a wooden core 50 of relatively small diameter. The length of core 50 is slightly less than the length of form 46. A wooden plug 51, having a socket 52 at the middle of one end thereof, is pressed into the tubular mold to close one end thereof and to secure and center core 50 by introduction of the end of the core into socket 52. One end 53 of coil E is threaded through a passage 54 extending obliquely from the inner end of plug 51 to a point in the side wall thereof. Core 50 with coil E and plug 51 at one end is then inserted in form 46 and a second plug 55, similar to plug 51, is fitted to the opposite end of core 50 with the remaining terminal 56 of coil E extending therethrough as in the case of plug 51.

Form 46 is now filled with a refractory compound F in plastic condition and allowed thoroughly to settle about a coil E to surround all portions of the coil and core 50.

When the compound is thoroughly settled, the partially finished element is placed in a kiln and subjected to the same treatment as described in the preferred form of the invention during which treatment core 50, string 49, form 46 and plugs 51 and 55 are entirely burned away, leaving the completed element as it appears in Fig. 13. The round bar heating element may be removed from the metal mold and is now ready for use.

In Figs. 14 to 16 I have shown a cartridge type heating element and illustrated the method of making the same.

The cartridge type element consists in a refractory body G of silicate of soda and carborundum and an electrical heating coil H embedded therein. The element is constructed by winding alternate turns of heating coil H and a string 60 upon a wooden core 61. Two electrical binding post terminals 62 are connected to opposite ends of coil H, one at each end of core 61, and secured to core 61 by longitudinally extending studs 63, which are forced into bores provided in the ends of the core. The ends of coil H are soldered or otherwise attached to studs 63.

A wooden base 64, provided with a socket 65 for receiving one of the terminal members 62, serves temporarily to support core 61 and coil H with terminal member 62 thereupon in upright position. A cardboard shell or sleeve

mold 66 is placed upon base 64 concentric with and spaced apart from coil H. Shell 66 is fixed to a reduced portion 67 of base 64.

Shell 66 is now filled with refractory compound G in plastic condition and the unfinished cartridge element is placed in a kiln and subjected to the same kiln drying treatment heretofore described.

The cartridge type heating element may be used where a short element, supported by its terminals and capable of delivering heat radiation uniformly in all directions, is desired.

In Figs. 17 to 20 I have illustrated a hot water heater embodying a heating element generally similar to the various types of heating elements already described. The water heater consists, in general, of a body V of refractory compound of silicate of soda and carborundum, electrical heating coils K and L embedded within the body V and a helical tubular water coil M which is also embedded within the body V.

In the construction of the water heater I first provide a circular wooden base 72 having an upstanding round wooden core 73 about which alternate turns of electrical heating coil K and a string 74 are tightly wound.

The upper terminal of coil K is connected to an electrical binding post terminal 75 and the lower end of the coil is connected to a binding post terminal 76 which is held in place by partial projection through base 72.

Water heating coil M is then disposed about and concentric with core 73, one end 77 projecting through base 72, and the opposite end 78 extending upwardly with its axis parallel with the axis of core 73. A tubular cardboard shell or mold 79 is mounted concentric with water coil M and core 73, its lower end fitting about a reduced upstanding portion 80 of base 72. Wax 81 is employed for sealing the connection between shell 79 and base 72.

Shell 79 is now filled with refractory compound V in plastic condition and the assembled parts, as shown in Fig. 17, are subjected to the kiln drying process heretofore described, which includes the complete burning away of base 72, core 73, string 74 and shell 79.

The partially completed heater is now placed upon a wooden base 85 larger in diameter than base 72 and provided with a short upstanding core 86 which projects into the internal bore 87 of partly completed body V. End 77 of water coil M and electrical terminal 76 project through base 85.

The partially completed body V is now sprayed with wax in liquid state so as to form a thin separating layer 87 of wax a few thousandths of an inch in thickness.

Alternate turns of electrical heating coil L and string 88 are wound about the outer wall of partially completed body V as shown in Fig. 18, the lower terminal of coil L being connected to an electrical binding terminal 89 which is partially projecting through base 85. The opposite end of coil L is connected to an electrical binding terminal 90. A tubular cardboard shell or mold 91 is disposed concentric with partially completed body V and coil L and fitted at its lower end over a reduced portion 92 of base 85. Wax 93 is employed to seal the points of contact between shell 91 and the base.

The space between shell 91 and partly completed body V, as well as bore 87 above plug 86, is then filled completely with refractory compound V and when thoroughly settled the assembly is again subjected to the kiln drying process heretofore described and the body is thoroughly hardened and shell 91, base 85, core 86 and string 88 are burned away, leaving the finished element as shown in Fig. 20.

This construction provides a compact and highly efficient water or other fluid heater, the fluid being heated as it flows through the unit. By making the element into two abutting but separate sections, the ill effects of expansion and contraction are overcome.

I claim:

1. A heating element comprising an electrical heating coil, electrical connecting terminals for the heating coil having portions fashioned for engagement with a supporting surface and a body of refractory material cast about and entirely surrounding said heating coil and a portion of said connecting terminals, said portions of said connecting terminals fashioned for engagement with a supporting surface being spaced from the adjacent surface.

2. A self-supporting heating element comprising a body of refractory material and an electrical heating coil embedded in the lower portion of said body, the upper portion of said body including that part over which articles are placed for heating being formed with expansion joints.

3. A water heating element comprising an electrical heating coil, electrical connecting terminals for said heating coil, a water conducting coil disposed parallel to said electrical heating coil and a body of refractory material cast about said electrical heating coil and said water conducting coil whereby heat from the electrical heating coil will be conducted through the refractory material to the water conducting coil.

4. A heating element comprising an electrical heating coil and a body of refractory material cast about said heating coil to entirely surround the coil, said body comprising a plurality of intimately contacting, separately cast sections.

5. A heating element comprising an electrical heating coil and a body of refractory material surrounding said heating coil comprising a plurality of contacting sections sep-

arately cast about said heating coil said sections being molecularly united to hold them together.

6. A heating element comprising a body of refractory material, a spiral coil embedded therein, the coil embedded portions of the body being separated by spiral grooves, and the portion of the body adjacent the coil embedding portions having heat expansion joints therein.

7. A heating element comprising a body of refractory material, a coil embedded in a portion thereof, the portion of the body containing the coils having grooves therein substantially parallel with the coils, and the remaining portion of the body having heat expansion joints disposed at an angle to said grooves.

8. A heating element comprising a body of refractory material, having two portions, a heating coil embedded in one of said portions, said heating coil embedding portion having grooves therein and the other portion being provided with heat expansion joints.

9. A heating element comprising a body of refractory material and an electrical heating coil embedded in said body remote from one side, said body being formed with radial expansion joints in the side remote from the coil and slots between the coils.

In witness whereof, I hereunto subscribe my name this 15th day of July, 1927.

WALTER HUDSON.