

Sept. 27, 1949.

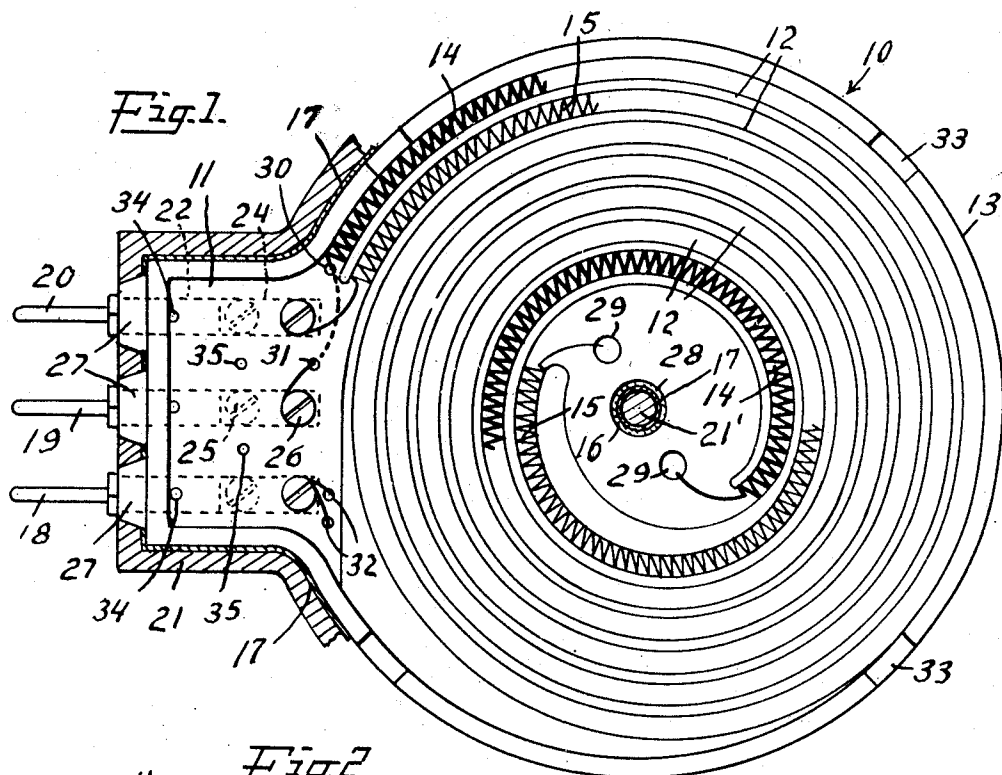
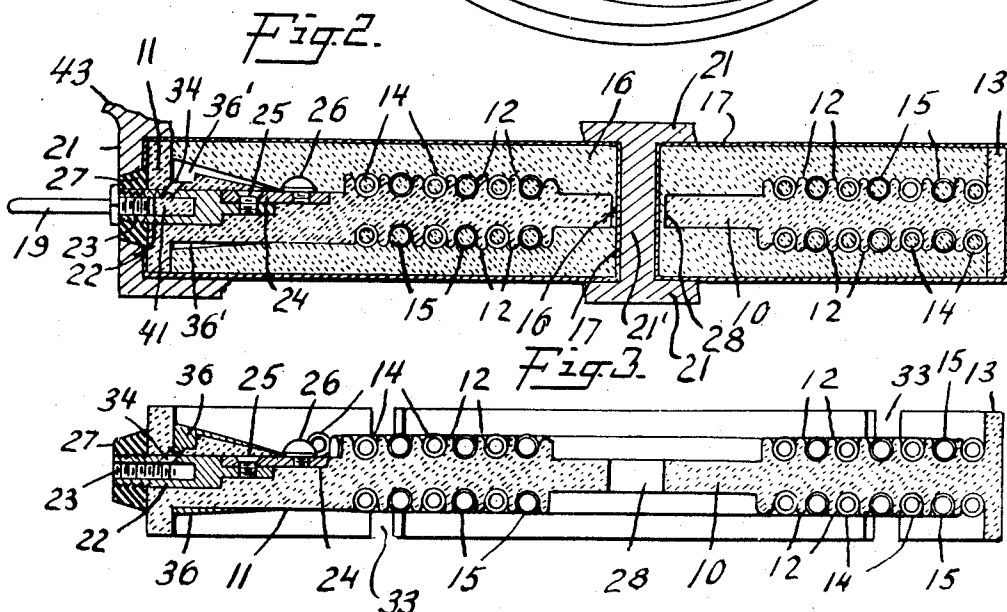
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2,483,056

METHOD OF CASTING ELECTRIC HEATING UNITS

Filed Feb. 7, 1947

2 Sheets-Sheet 1



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Fig. 4

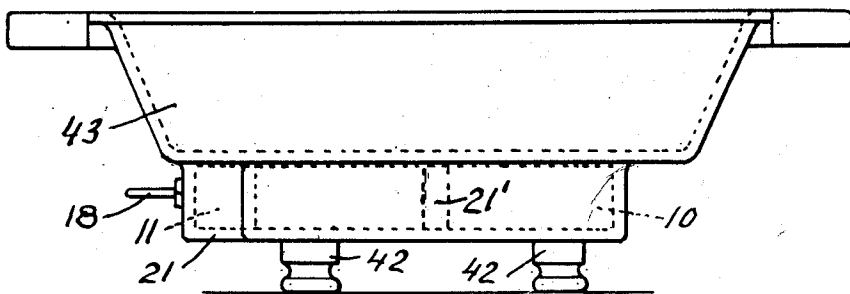
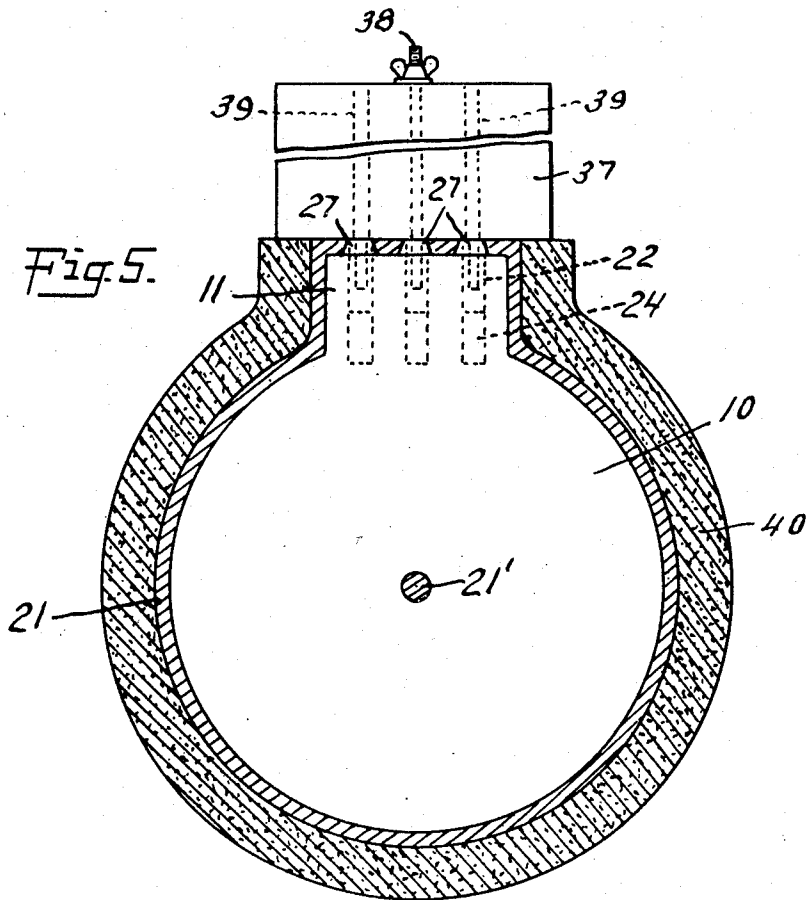


Fig.5.



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UNITED STATES PATENT OFFICE

2,483,056

METHOD OF CASTING ELECTRIC HEATING
UNITS

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Application February 7, 1947, Serial No. 727,037

8 Claims. (Cl. 22—202)

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This invention relates to electric heating units, and more particularly to enclosing such units in cast metal. The invention aims to provide an improved method of casting metal around an electric heating unit so that the unit is enclosed in a sound casting of metal. More particularly, the invention aims to provide an improved method of integrally casting an electric heating unit with the body of a cast metal utensil. A further object of the invention is the provision of an improved heating unit completely enclosed in a layer of cast metal except for the outer ends of its terminal connectors.

The invention will be best understood from the following description taken in conjunction with the accompanying drawings, in which

Fig. 1 is a sectional plan of the heating unit, only part of the cast metal covering being shown,

Fig. 2 is a sectional elevation through the center of the unit, with only part of the cast metal covering shown,

Fig. 3 is a sectional elevation of the unit in an intermediate stage of its manufacture,

Fig. 4 is an elevation of a utensil embodying the unit as an integrally cast part thereof, and

Fig. 5 is a diagrammatic explanatory view of the mounting of the unit in a mold.

The heating unit comprises a molded base 10 of cement-like insulating material. The base is relatively shallow and generally circular in shape with a terminal section 11 at one side. Each flat face of the base has an integral spiral rib or protuberance 12 and a peripheral wall 13, the wall being substantially higher than the rib. Electrically conductive heating elements 14 and 15 are positioned in the spaces or valleys between the convolutions of the spiral rib on each face of the base. The elements 14 and 15, on each face of the base, are embedded in and covered by a temperature-resistant cemental insulating material 16. The spiral rib 12 and heating elements 14 and 15 occupy, in effect, a recessed portion of the base face, and this recessed portion is filled to the top of the peripheral wall 13 with the cemental material 16. The heating unit is covered by a thin and impervious coating 17 of temperature resistant mortar.

Three terminal plugs protrude from the terminal section 11. The high temperature heating element 14 (of relatively high conductivity) is electrically connected between one end terminal plug 18 and the center terminal plug 19, and the low temperature heating element 15 (of relatively low conductivity) is electrically connected between the two end terminal plugs 18 and 20. The

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heating unit is integrally cast into the bottom 21 of a metal cooking or other utensil, such, for example, as the casserole 43' illustrated in Fig. 4. The heating unit is completely surrounded by and enclosed in the cast metal with only the protruding terminal plugs exposed. Hence the utensil can be submerged in hot water and washed, like an ordinary utensil, without danger of wetting the heating unit.

The base 10 is molded between suitably shaped dies. The base should possess sufficient mechanical strength to support the heating elements and to permit, without cracking or crumbling, the machining hereinafter described. It should also be highly heat-resistant, have good electrical insulating properties, and its coefficient of heat expansion should be approximately the same as that of the metal of which the utensil is cast. Where the utensil is made of aluminum, I have found a mixture of about equal parts of Portland cement and finely ground slate (approximating the particle size of granulated sugar) very satisfactory. The cement and ground slate are mixed with water to a consistency that can be poured into the bottom part of the die or mold.

In molding the base 10, three terminal connectors are secured in proper positions within the lower part of the die. Each connector comprises a stud 22 of brass or equivalent metal of high electrical conductivity and heat resistance. The outer end of the stud is externally threaded and has a threaded bore 23, and its inner end is flattened so that one end of a brass or equivalent metal strip 24 can be fastened thereto by a screw 25. The other end of the strip 24 is provided with a screw 26. A frustrum-shaped insulator 27 is screw-threaded on and cemented to the outer threaded end of the stud 22, with its smaller face flush with the end of the stud. The insulator 27 should have high heat-resistance and be capable of withstanding the hot molten metal in the casting of the utensil, and should furthermore be impervious to water. American lava has been found a suitable material for the purpose. The connector assemblies may be conveniently held in position within the lower part of the die by bolts suitably secured to the die and threaded into the bores 23 of the studs 22. The connector assemblies are so positioned that the inner and larger faces of the insulators 27 will be approximately flush with but firmly attached to the end face of the terminal section 11 of the molded base.

The die parts are preferably dipped in molten paraffin preparatory to molding in order to facilitate subsequent separation of the molded base

therefrom. The molding mixture of cement and ground slate is poured into the lower part of the die and completely surrounds and embeds the studs 22, screws 25 and strips 24. The heads of the screws 26, however, are not embedded in the base, but protrude above it when molded. The top of the die is then forced under appropriate pressure onto the top of the molding mixture. When set the molded base is removed from the die and dried. The dried base is then soaked in a dilute solution of sodium silicate (water glass) at a temperature of about 190° F. for 24 hours. It is then drained, washed and dried. The sodium silicate treatment increases the mechanical strength of and hardens the base, and may to some extent reduce its porosity.

The central hole 28 of the base is preferably formed in molding, and the other holes are drilled, the sodium silicate treatment of the base enabling such drilling to be done without cracking or crumbling. Holes 29, on opposite sides of the central hole 28, are provided for the passage of the heating elements 14 and 15 from one face of the base to the other. One end of the high temperature heating element 14 passes down through a hole 30 in the terminal section, up through a hole 31 and is secured to the center strip 24 by its screw 26 (Fig. 1). The corresponding end of the low temperature heating element 15 is secured to the adjacent end strip 24 by its screw 26. The other ends of the heating elements pass upwardly, from the lower face of the base, through the holes 32 and are secured to the other end strip 24 by its screw 26. The heating unit illustrated in the drawings is particularly designed for use in the casserole of Fig. 4, and gives two cooking heats, one of high temperature in the neighborhood of 450° F., for baking etc., and the other of low temperature in the neighborhood of 212° F., for boiling, stewing etc. Thus, when the terminal plugs 18 and 19 are connected to the source of electric energy only the high temperature heating element 14 carries electric current, and the predetermined high heat is obtained. When the terminal plugs 19 and 20 are connected to the source of electric energy, the heating elements 14 and 15 are connected in series and the predetermined low heat is obtained.

The heating elements are preferably made of Nichrome or equivalent resistance wire, appropriately coiled to give the desired length of resistance conductor, and the two elements occupy alternate valleys on both faces of the base. In assembling, the coiled wire elements are conveniently held in the valleys by a 4-armed star-fixture operatively held in the spaced recesses 33 of the peripheral wall 13. When the elements are assembled, they are cemented to the base by patches of cemental insulating material 16 between the arms of the fixture, and when the cemental material has set, the fixture is removed.

Near the outer end of the terminal section 11, a hole 34 is drilled through the top of the base into the threaded bore 23 of each stud 22. Two or more holes 35 are drilled through the terminal section. With the heating elements assembled and cemented to the opposite faces of the base as hereinbefore described, a thin layer, say $\frac{1}{8}$ to $\frac{1}{4}$ inch thick, of melted paraffin wax 36, or equivalent material of low melting temperature, is poured over the top face of the terminal section completely covering the holes 34 and 35, and permitted to harden (Fig. 3). The bottom face of

the terminal section is then similarly covered with a thin layer of paraffin wax 36.

Each face of the base, including the wax layer 36 of the terminal section, is then covered up to the top of the peripheral wall 13 with the cemental insulating material 16. This material may advantageously be an Alundum cement, which is characterized by its high melting temperature, high electrical resistance, and good heat conductivity. The heating unit is then placed in an oven with the terminal section down and heated to a sufficiently high temperature to melt the paraffin wax layers, and the melted wax flows out through the bores 23 of the studs 22, leaving on the face of each terminal section a shallow void or air pocket 36' communicating with one another through the holes 35, and with the bores 23 through the holes 34. The unit is then placed in a furnace and heated to a temperature of about 1400° F. This furnace treatment merely involves heating of the unit to the stated temperature, and cooling down without any special precautions.

Following the furnace treatment, the unit is covered, by painting or otherwise, with a thin coating or film 17 of a fire-brick mortar. Sillimanite is admirably adapted for the purpose, and in the form of a fine powder is mixed with water to the consistency of paint, and applied by brush, spraying or other convenient manner. The painted unit is then again heat-treated at a temperature of about 1400° F., the treatment consisting in heating the unit to the stated temperature, and cooling. The baked coating of fire brick mortar paint 17 covers the entire unit, with the exception of the protruding insulators 27, and forms an impervious covering for the unit.

The completed heating unit is appropriately secured within the mold in which the utensil is to be cast. The terminal section 11 of the unit is uppermost and is advantageously attached to a chill block 37 (Fig. 5) by a bolt 38 extending through a center hole in the block and threaded into the bore 23 of the center stud 22. The chill block has a hole 39 on each side of the center hole aligned with and communicating respectively with the bores of the two end studs 22. The chill block forms in effect a wall of the mold opposite the end face of the terminal section and is flush with the common plane of the outer faces of the three insulators 27. Any suitable mold may be used for casting the utensil, and, merely by way of example, a sand mold 40 is diagrammatically shown in Fig. 5. The molten metal, preferably aluminum, enters the mold through two or more gates near the bottom, and completely covers and encloses the heating unit, the metal of this enclosure being integral with that of the utensil proper. Thus, the heating unit is completely enclosed in metal integrally cast on the bottom of the utensil. During casting, the central hole 28 of the heating unit is filled with molten metal which upon solidification forms a center anchoring bolt 21' for the unit integrally united with the metal enclosing the opposite faces of the unit.

One of the difficulties heretofore experienced in attempts to enclose the heating unit in a cast metal covering integral with the utensil is the development of blow holes or cracks in the metal enclosure of the heating unit. Attempts to subsequently close such blow holes by welding have not been successful. These blow holes appear to be caused by the expansion of air within the pores

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or interstices of the base or other cemental parts of the unit. For example, I have found that substantially 30% of the volume of the molded base 10 consists of voids or pores filled with air. Preheating of the base, prior to molding, will drive out some of this air, but enough still remains to cause serious trouble by expansion at the high temperature of the molten casting metal. In accordance with the present invention, expanding air in the interstices of the base 10 is vented during casting through the holes 39 of the chill block. As the temperature of the base rises during casting, the air in the interstices expands and is forced into the shallow pockets 36' and thence through the holes 34 into the venting holes 39 of the chill block. In this manner the expanding air escapes during casting to such an extent that no unduly high air pressure exists within the base 10, and the molten metal flows freely around and completely encloses the heating unit, except for the outer ends of the apertured connectors and the outer faces of the insulators 27 in contact with the adjacent face of the chill block (Fig. 5). Upon cooling and removal from the mold, the heating unit is enclosed in a sound metal casting, without cracks, blow holes or other imperfections, integrally united with the cast utensil. Venting of the air during casting is facilitated by positioning the terminal section of the base uppermost in the mold, so that the holes 39 serve as vertical chimneys for the escaping air.

When the cast utensil has been removed from the mold the end face of the terminal section 11 will be covered with metal to a plane flush with the outer faces of the insulators 27. The base or inner ends of the threaded bores 23 are now filled to a depth beyond the holes 34 with plugs 41 of iron oxide cement, such as smooth-on-cement or the like (Fig. 2). The cement is tamped or hammered into the bores and when hardened provides an impervious and water-proof seal for the holes 34 and the communicating air pockets 36'. The terminal plugs 18, 19 and 20 are then screwed into the bores 23 of the three studs 22, and porcelain feet 42 are suitably attached to the bottom of the cast metal enclosure of the heating unit.

The method of the invention enables the enclosure of the electric heating unit in a sound metal casting with practically no failures. Paraffin wax has a melting temperature of about 110-150° F., and while I have used it with complete satisfaction and success as the material of low melting temperature, the venting air pockets 36' may be formed by evacuating similar thin layers of other waxes and the like of equivalent low melting temperature, say from 100 to 200° F. The unit itself is rugged, durable and practically indestructible, and its cast metal covering renders it completely waterproof. The utensil, with which the unit is integrally united, can be immersed in water and washed like any common non-heated utensil. The detachable terminal plugs may be readily replaced when bent, burned or otherwise damaged, and they are the only parts of the heating unit that may require renewal in ordinary usage.

I claim:

1. The method of casting metal around an electric heating unit, which comprises making up the unit of an outer cemental covering and a conductive heating element mounted on an inner insulating base having at least two apertured connectors for the element and forming between the base and covering an air pocket in

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communication with the aperture of one of said connectors, securing the unit to a chill block of a mold with the connector apertures registering with passages extending through the chill block, the unit being secured to the block by a bolt extending through one passage and threaded into the registering aperture and the aperture in communication with said air pocket registering with another passage in the block, and introducing molten metal into the mold and around the unit and venting from said pocket through said communicating aperture and passage air occluded in the interstices of said base whereby the metal upon cooling forms a sound casting around the unit.

2. The method of casting metal around an electric heating unit made up of an outer insulating covering and a conductive heating element mounted on an inner insulating base, which comprises forming between said base and covering an air pocket in communication with an aperture extending to the exterior of the unit, mounting the unit within a mold having a passage through a wall thereof with the passage in communication with said aperture, introducing molten metal into the mold and around the unit and venting from said pocket through said aperture and passage air occluded in the interstices of said base whereby the metal upon cooling forms a sound casting around the unit, and introducing sealing material into the communication between said pocket and aperture to seal the communication against entry of water.

3. The method of casting metal around an electric heating unit, which comprises making up the unit of an outer cemental covering and a conductive heating element mounted on an inner insulating base having an apertured connector for the element and forming between the base and covering an air pocket in communication with the aperture of said connector, securing the unit to a chill block of a mold with the connector aperture registering with a passage extending through the chill block, introducing molten metal into the mold and around the unit and venting from said pocket through said aperture and passage air occluded in the interstices of said base whereby the metal upon cooling forms a sound casting around the unit, and sealing the communication between said pocket and aperture.

4. The method of casting metal around an electric heating unit made up of an outer cemental covering and a conductive heating element mounted on an inner insulating base, which comprises including between said base and covering a layer of a substance of low melting temperature overlying the inner end of an aperture in the base extending to the exterior of the unit, melting the substance of said layer and evacuating the molten substance through said aperture thereby forming an air pocket between said base and covering communicating with said aperture, mounting the unit within a mold having a passage through a wall thereof with the passage in communication with said aperture, and casting a molten metal around the unit in the mold while venting from said pocket through said aperture and passage air occluded in the interstices of said base whereby the metal upon cooling forms a sound casting around the unit.

5. The method of casting metal around an electric heating unit made up of an outer cemental covering and a conductive heating ele-

ment mounted on an inner insulating base having at least two apertured connectors for the element, which comprises including between said base and covering a layer of a substance of low melting temperature overlying the inner end of a hole in the base communicating with the aperture in one of said connectors, melting the substance of said layer and evacuating the molten substance through said hole and communicating aperture and thereby forming an air pocket between said base and covering communicating with said hole and aperture, securing the unit to a chill block of a mold with the connector apertures registering with passages extending through the chill block, the unit being secured to the block by a bolt extending through one passage and threaded into the registering aperture and the aperture in communication with said pocket registering with another passage in the block, and introducing molten metal into the mold and around the unit and venting from said pocket through said communicating aperture and passage air occluded in the interstices of said base whereby the metal upon cooling forms a sound casting around the unit.

6. The method of casting metal around an electric heating unit made up of an outer cemental covering and a conductive heating element mounted on an inner insulating base having an apertured connector for the element, which comprises including between said base and covering a layer of a substance of low melting temperature overlying the inner end of a hole in the base communicating with the aperture in said connector, melting the substance of said layer and evacuating the molten substance through said hole and communicating aperture and thereby forming an air pocket between said base and covering communicating with said hole and aperture, mounting the unit within a mold having a passage through a wall thereof with the passage in communication with said aperture, and casting a molten metal around the unit in the mold while venting from said pocket through said aperture and passage air occluded in the interstices of said base whereby the metal upon cooling forms a sound casting around the unit.

7. The method of enclosing an electric heating unit in a metal casting which comprises assembling a conducting heating element on a base of insulating material having an apertured connector for the element and a hole extending from the aperture of the connector to one face of the base, covering the hole on the base face with a layer of a substance of low melting temperature, covering the assembled heating unit including the layer of said substance with a cemental insulating material, melting the substance of said

layer and evacuating the molten substance through said hole and aperture, mounting the unit within a mold having a passage through a wall thereof with the passage in communication with said aperture, introducing molten metal into the mold and around the unit and venting through said hole and aperture air occluded in the interstices of said base whereby the metal upon cooling forms a sound casting around the unit, and sealing said hole at its juncture with said aperture.

8. The method of casting metal around an electric heating unit made up of an outer cemental covering and two conductive heating elements mounted on both faces of a flat inner insulating base having three apertured connectors between which said elements are electrically connected, which comprises including on each face of the base adjacent said connectors and under said cemental covering a layer of a substance of low melting temperature, one of said layers overlying the inner ends of two holes in the base communicating respectively with the apertures in two of said connectors and each layer overlying at least one other hole through the base, melting the substance of said layers and evacuating the molten substance through said apertures and communicating holes and thereby forming an air pocket on each face of the base communicating with one another through the base and with the apertures of said two connectors through their communicating holes, securing the unit to a chill block of a mold with the connector apertures registering with passages extending through the chill block, the unit being secured to the block by a bolt extending through one passage and threaded into the aperture of the third connector, and introducing molten metal into the mold and around the unit and venting from said air pockets through said communicating holes, apertures and passages air occluded in the interstices of said base whereby the metal upon cooling forms a sound casting around the unit.

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