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[54] **HEATER COIL SUPPORT**

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[52] **U.S. Cl.**.....**117/35 R,** 117/70 A, 117/70 S, 117/126 GF, 117/169 A, 219/461, 219/464, 219/548, 252/62, 106/48

[51] **Int. Cl.**.....**H05b 3/68**

[58] **Field of Search**...117/35 R, 35 S, 126 AF, 126 GF, 117/23, 40, 136, 138, 169 R; 219/405, 345, 354, 460, 464, 461, 463; 252/62

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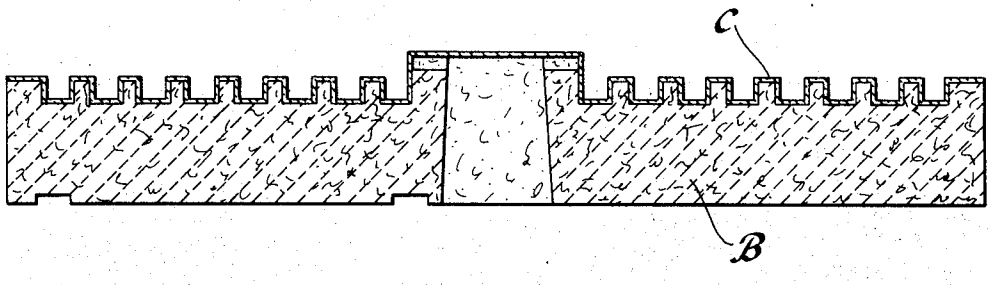
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[57] **ABSTRACT**

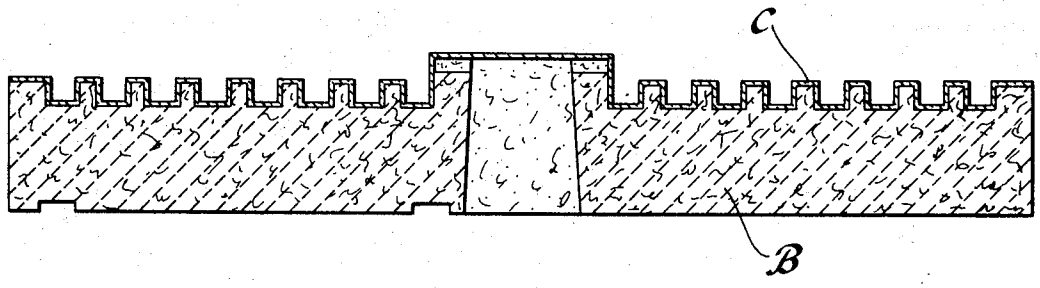
An infrared radiant type heating coil support and method for forming same, wherein the support block is a ceramic fibrous plate of low mass but having good mechanical strength and low shrinkage under the repeated heating and cooling cycling encountered in normal use and having a dull finish, craze resistant coating including an infrared reflecting metal oxide selected from the group of zirconia, titania, tin oxide and Uverite.

7 Claims, 1 Drawing Figure



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HEATER COIL SUPPORT

This invention relates to an infrared heating coil support adapted for use in a surface cooking unit for a household range, hot plate or other heating unit requiring a highly efficient, relatively low cost, durable heater capable of reflecting radiant energy in the 1–6 micron range.

The prior art relating to electric heating devices has long appreciated the concept of improving the efficiency of the heater by providing the base which supports the electric heating element with a coating to reflect heat rays to the desired surface or area to be heated. The U.S. Pat. No. 2,051,637 issued Aug. 18, 1936 to M. L. Goldbert et al discloses parabolic mirror-like surfaces obtained by using shining black glazed porcelain. Similarly, the use of an oxidation resistant and chemical resistant metal coating such as highly polished gold foil on either a metal base or a ceramic base has been known as shown in the U.S. Pat. No. 3,284,225 issued Nov. 8, 1966 to A. W. Smock et al. However, such devices have all had one or more serious limitations either relating to excessively high cost, insufficient strength under the repeated heating and cooling cycles encountered in use or relatively low efficiency in reflecting the available heat energy.

It is also known in the prior art that various materials have a greater or lesser ability to suppress or reflect radiant energy. A study of various materials to compare their emissivity in the visible-red and near-infrared regions, the 0.7 – 1.2 micron range, as applied to a low carbon steel metal plate was made at the University of Illinois prior to **1947** and is covered in the article entitled "Suppression of Radiations at High Temperatures by Means of Ceramic Coatings," D. G. Bennett, *The Journal of the American Ceramic Society*, Volume 30, No. 10, Oct. 1, 1947. However, such theoretical studies fail to disclose or anticipate the application contemplated by applicant and also fail to extend to the infrared rays as high as 6 microns.

It is therefore an object of my invention to provide an efficient infrared radiant heater support which may be formed relatively inexpensively to provide a mechanically strong and efficient member having long life under the repeated heating and cooling cycling.

It is another object of my invention to provide a relatively inexpensive method for forming the infrared radiant heater support.

The foregoing objects are achieved by forming a ceramic fibrous plate of low mass but high strength and having low shrinkage and by providing the electrical heater support surface of such a plate with a dull finish, craze resistant glass coating having an infrared reflecting metal oxide selected from the group of zirconia, titania, tin oxide and Uverite.

These and other objects of my invention will be apparent from the following description and from the drawing showing the heater support of my invention.

As shown in the drawing, the heating coil support of my invention comprises a support block or plate B formed with a grooved surface to enable the positioning therein of an electric heating element suitable for the purposes intended. In accordance with my invention, the grooved surface is provided with a continuous coating C effective to reflect substantially all radiant energy to the extent of achieving an efficiency as high as **95%** when compared with the energy reflecting

capability of a polished gold foil surface. The type of infrared radiant heating device contemplated for application of my invention is disclosed in the common assignee's copending patent application Ser. No. 48,390 filed June 22, 1970 in the name of D. C. Siegla, now U.S. Pat. No. 3,612,828 issued Oct. 12, 1971.

In order to achieve the mechanical strength required for physically supporting the electrical heating element during repeated heating and cooling cycling encountered in normal use, such cycling causing expansion and contraction of the heating element within the grooves, as well as achieving a support which is dimensionally stable, I have found that a low mass member may be readily fabricated by vacuum casting a slurry of a ceramic fibrous material such as glass fiber or aluminum silicate fibers. I have found that Fiberfrax, trade name for aluminum silicate fibers made by the Carborundum Corporation, is particularly suitable for achieving a member having the identified desired characteristics. More particularly, I have found that such ceramic fiber block having a density of at least about 20 lbs./ft.^{3} provides the best combination of mechanical strength and dimensional stability with minimum mass and optimum thermal insulation. I have found it desirable to rigidize the surface of the heater support by applying a coating of colloidal silica prior to heat curing the block.

After curing, by heating in an air atmosphere to about 300° F. to dry the block, the surface-rigidized support member is then made reflective to infrared energy, 1–6 microns, by the application of a special coating to the grooved surface. The coatings which I have developed for this purpose are listed in TABLE I and consist essentially of a metal oxide selected from the group of zirconia, titania, tin oxide and Uverite in a borosilicate type enamel slip, as shown in TABLE II. The amount of the metal oxide in per cent by weight of the solids in the coating is in the range of either 47–55 percent for titania or 65–80 percent for each of the other metal oxides, the preferred compositions being shown in TABLE I.

TABLE I

Reflector Coatings (Parts by Weight)

	(1)	(2)	(3)	(4)	(5)	% by Wt. Solids
zirconia	680	680				76%
titania			389			51%
tin oxide				490		74%
Uverite					410	71%
enamel slip A	215					
enamel slip B		219	481	219	219	
sodium pyrophosphate			12	5	5	
enameler's clay	48	48				
water	275	275	707	250	400	

Uverite is a trademark for an opaqueing composition for a vitreous enamel consisting of the following in per cent by weight as available from the Harshaw Chemical Company:

CaO	24.6%
CaF_2	4.9%
TiO_2	30.0%
Sb_2O_5	40.5%

TABLE II

Enamel Slip - (Parts by Weight)

	A	B
Enamel frit A	1000	
Enamel frit B		1000

Enameler's clay	70	70
Silica, 400 mesh	100	100
Bentonite	1.25	1.25
Magnesium carbonate	1.25	1.25
Borax	2.5	2.5
Sodium nitrate	2.5	2.5
Water	400	400
Fineness, (grams on 200 mesh sieve from 50 cm^3)	2.5	0.1

Enamel frit A is a blue ground coat frit while enamel frit B is a titania opacified frit commonly used in cast iron enamel, the compositions of each being shown in TABLE III.

TABLE III

(Parts by Weight)	Frit A	Frit B
Li_2O	0.3	
Na_2O	16.9	20.3
K_2O	0.2	
CaO	3.4	
B_2O_3	13.8	22.1
Al_2O_3	0.6	29.5
SiO_2	56.5	19.9
TiO_2	5.0	8.2
CaO_2	0.3	
MnO_2	1.0	
NiO	0.5	
CaO	1.5	
	100.0	100.0
F_2 (replaces oxygen in above)	1.3	8.0

As noted in TABLE II, each enamel slip is ground in a conventional ball type mill until such a degree of fineness is achieved as to retain 2.5 grams in the case of enamel slip A and 0.1 grams in the case of enamel slip B on a 200 mesh sieve when using 50 cubic centimeter filter samples. All other solids than those contained in the enamel slip are ground to a fineness such as to pass through a 325 mesh screen.

The coatings shown in TABLE I may be applied to the support block or plate B in any suitable manner, such as spraying, painting, or dipping, in order to achieve an unbroken coating over the surface. I have found that the thickness of the coating is not critical and that the desired coating may be advantageously achieved by rotating the support block while spraying the reflector coating on the grooved surface.

In accordance with my invention, I have found that the heater support may be formed by the following method: a Fiberfrax slurry with water is formed followed by vacuum casting in a die cavity having the desired shape. The resultant support block is subjected to vacuum to a degree sufficient to produce a body having a density of at least about 20 lbs./ft.^{3}. It has been found that a density substantially below this, i.e., 15 lbs./ft.^{3}, results in a body which lacks mechanical strength and is readily frangible during assembly operations, while a higher density does not realize any substantial improvement. Following removal of the support block from the die cavity or mold, the surfaces of the block are sprayed with colloidal silica in order to add mechanical strength to the surface. The support block is then heat cured by raising the temperature in an air atmosphere to about 300° F. in order to cure the block and silica coating and achieve sufficient strength to enable handling.

The heat dried support block is then coated with one of the compositions shown in TABLE I in order to achieve a continuous coating. The coated parts are then fired in an air furnace to 1800° F. and held at the elevated temperature for a period of about one hour following which the parts are furnace cooled, a heating schedule of about 300° rise/hour being used. I have found that as much as 2 percent shrinkage occurs during this curing operation and that subsequent heating for long periods of time at temperatures of 2000° F. result in shrinkage of less than 1 percent.

Support blocks of my invention as described above have the required durability and efficiency for use as a component in an infrared heating device such as a range burner. The support block does not change appearance or lose strength as the result of repeated extended heat cycles such as is involved in a 3500 cycle test under over-voltage conditions. More specifically, the support blocks with heater coil assembled thereon are operated at 248 volts, 5 percent over normal operating voltage, each cycle involving 40 minutes at full power heating and 20 minutes cooling with power off, a 2000 watt heater element being used. It should be here noted that the amount of silica in the coating in direct contact with the heater element must be limited to under 25 percent by weight in order to preclude reaction of the silica with the heater element. It has also been demonstrated that the heater support of my invention detracts very little from the achievement of optimum burner efficiency in that as much as 95 percent efficiency has been reached when compared with the infrared reflecting ability of a gold coated burner.

From the foregoing description it is apparent that I have achieved a relatively inexpensive support block for use in infrared heating devices, the block having the desired mechanical properties as well as being highly efficient as an infrared reflector in the 1–6 micron band when used at temperatures of from about 1500° to 2000° F. My invention is further described in the claims which follow.

What is claimed is:

1. A ceramic heater support adapted for use in an infrared radiant heating device comprising a grooved rigid support block having a density of about 20 lbs./ft.^{3} formed from ceramic fibers selected from the group of glass fibers and aluminum silicate fibers having both thermal and electrical insulating properties, and a dull reflector coating on the grooved surface of said block effective to reflect radiant energy in the 1–6 micron range, said coating consisting essentially of a borosilicate glass binder which cures at firing temperatures of about 1800° F. in which there is dispersed both a minor amount of emulsifier selected from the group of sodium pyrophosphate and enameler's clay and a single predominating metal oxide material selected from the group consisting of zirconia, titania, tin oxide and a metal oxide composition consisting essentially of CaO – 24.6 percent, CaF_2 – 4.9 percent, TiO_2 – 30.0 percent, Sb_2O_5 – 40.5 percent, each in percent by weight, the titania constituting from about 47–55 percent by weight of solids in said coating and said zirconia, tin oxide and metal oxide composition constituting from about 65–80 percent by weight, said heater support being an efficient reflector and mechanically strong to support the heating element and the coating being non-crazing under repeated heating and cooling cycling.

2. A ceramic heater support in accordance with claim 1 wherein said metal oxide material is zirconia and constitutes about 76 percent by weight of said coating.

3. A ceramic heater support in accordance with claim 1 wherein said metal oxide material is titania and constitutes about 51 percent by weight of said coating.

4. A ceramic heater support in accordance with claim 1 wherein said metal oxide material is tin oxide and constitutes about 74 percent by weight of said coating.

5. A ceramic heater support in accordance with claim 1 wherein said metal oxide material is the metal oxide composition and constitutes about 71 percent by weight of said coating.

6. A method for forming a ceramic heater support adapted for use in an infrared radiant heating device comprising the step of forming a water slurry with ceramic fibers selected from the group of glass fibers and aluminum silicate fibers, vacuum casting a grooved support block having a density of about 20 lbs./ft.^{3} from said slurry, coating the surfaces of said block with colloidal silica and heat curing said coated block in an air atmosphere at a temperature of about 300° F. to achieve sufficient strength to enable handling, applying a reflector coating to the grooved surface of said block said coating consisting essentially of a water suspension of a metal oxide material selected from the group consisting of zirconia, titania, tin oxide and a metal oxide composition consisting essentially of CaO – 24.6 percent, CaF_2 – 4.9 percent, TiO_2 – 30.0 percent, Sb_2O_5 – 40.5 percent, each in percent by weight, in a borosilicate glass enamel slip containing a small amount of emulsifier selected from the group of sodium pyrophosphate and enameler's clay sufficient to maintain the solids content in suspension in the water with a consistency proper for the mode of application, drying said coating and firing said coating at about 1800° F. for about one hour, the firing schedule being to increase temperature about 300° F./hr., the resultant heater support having a shrinkage of less than 1 percent in actual use and being non-crazing and mechanically strong so as to support the electrical heating element.

7. A method in accordance with claim 6 wherein said support block is formed of aluminum silicate fibers and said metal oxide material is titania in an amount of about 51 percent by weight of solids in said coating.

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