

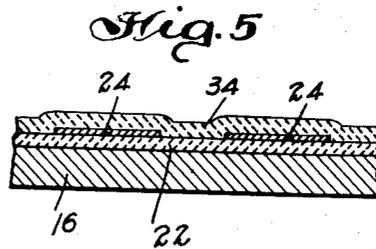
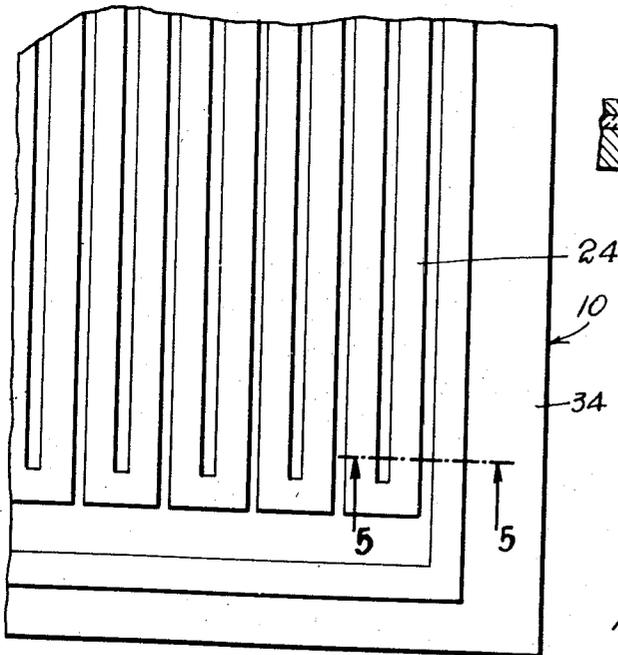
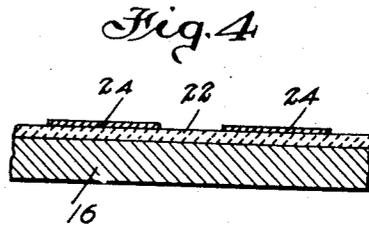
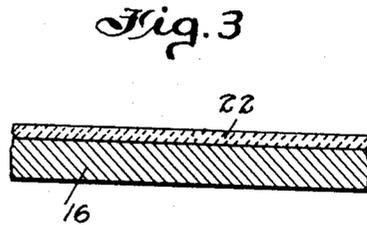
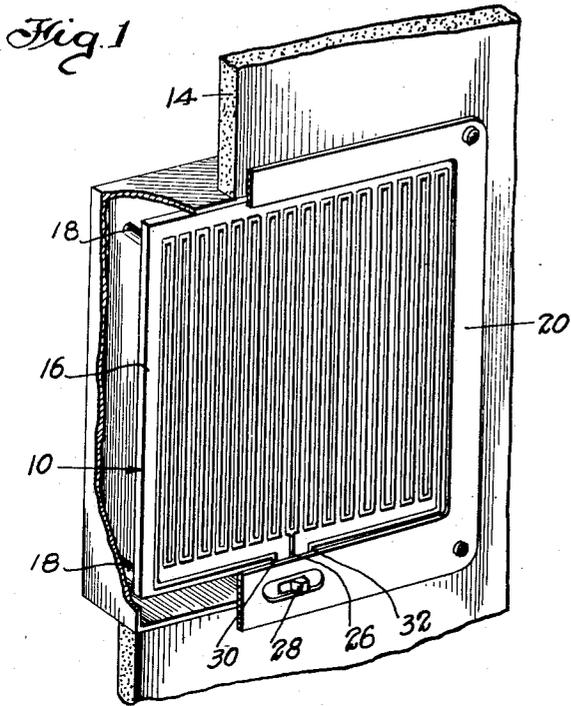
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2,859,321

ELECTRIC RESISTANCE HEATER

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**ELECTRIC RESISTANCE HEATER**

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6 Claims. (Cl. 201-73)

This invention relates to heating devices, and has particular reference to improved electrical resistance heaters.

It is a primary object of this invention to provide a heating device which occupies a minimum of space and yet is highly efficient and inexpensive.

Another object of this invention is to provide such a heating device having an insulated electrical circuit and having increased heating capacity.

Another object of this invention is to provide a heating device which can withstand conditions of extreme temperatures and possesses greater resistance to thermal shock than other heating devices.

A further object of this invention is to provide a heating device which is impervious to moisture, fumes, corrosion and the like.

Another object of this invention is to provide a heating device wherein almost immediate emission of heat rays is obtained upon activation of the device.

It is still a further object of this invention to provide a heating device particularly adaptable for use in space heaters, water heaters, immersion heaters, commercial and industrial heating and drying plates, ovens, hot plates, aircraft de-icing assemblies, spot and auxiliary heaters for pipe lines, and the like.

Other objects and advantages of this invention it is believed will be readily apparent from the following detailed description of preferred embodiments thereof when read in connection with the accompanying drawings.

In the drawings:

Figure 1 is a perspective view of a heating device embodying the invention.

Figure 2 is a fragmentary plan view of the heating device.

Figure 3 is a sectional view thereof before application of the electrical resistance elements.

Figure 4 is a sectional view after application of the resistance elements.

Figure 5 is a sectional elevation taken along the line 5-5 of Figure 2.

Briefly, the present invention comprises an electrical resistance heating device in which printed heating elements are applied to one side of a metal base, the heating elements being insulated from the base by means of a coating applied therebetween. Heretofore, attempts have been made to utilize the techniques of printed circuitry in applying heating elements to a metal base, utilizing porcelain enamel as a dielectric coating on the metal. Such attempts have not been completely successful inasmuch as the dielectric strength of porcelain or vitreous enamel decreases with increase in temperature. In fact, for most applications, the desired temperatures obtained from the resistance heating elements are such that the dielectric strength of the enamel decreases to almost zero.

The instant invention includes the discovery that devitrified ceramic enamels form excellent dielectric coat-

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ings for producing printed circuit heating elements applied to a metal base. Thus, it has been found that, while vitreous enamels are not suitable, the devitrified enamels possess unexpectedly good dielectric properties even at elevated temperatures.

One embodiment of the present invention is illustrated in the drawings and comprises a space heater device generally indicated 10, mounted in a suitable opening in a wall 14. The device comprises a base plate 16 formed of a suitable metal such as steel and supported in the opening by spacers such as 18. A face plate 20 surrounds the base plate, providing a finished appearance.

Applied to the front face of the base plate 16 is a coat of devitrified ceramic enamel 22 which completely covers the plate, insulating the same. Preferably, a primer or ground coat (not shown) is interposed between the enamel 22 and the base plate to assure a firm bond. Applied to the surface of the devitrified ceramic enamel dielectric is a printed electrical resistance circuit 24. The circuit in this embodiment is divided into two circuits having a common terminal at 26 behind switch 28 and individual terminals at 30 and 32 behind switch 28. The switch is of any type well known to those skilled in the art which, when in the "on" position, completes both circuits, connecting the same to a suitable source of electrical power, and when in the "off" position opens both circuits.

In order to protect the relatively thin printed resistance heating elements, a porcelain enamel coating 34 is applied thereover.

As is known to those skilled in the art, devitrified ceramic enamels are porous in structure but otherwise basically the same as porcelain or vitreous enamels. These devitrified enamels have been considered as produced as a result of a fault sometimes found in true enamels, due to any one of the following partial list of reasons.

(1) One or more of the ingredients in the enamel crystallizing out, produced by:

(a) Maintaining the temperature of the smelt just below the melting point for a prolonged period of time prior to shattering, or

(b) Slow cooling of the smelt, such as cooling in air instead of the usual immersion in cold water.

(2) An excess of barium carbonate; above 5%.

(3) An excess of calcium carbonate; above 5%.

(4) An excess of fluorspar; above 5%.

A specific example of a devitrified enamel particularly suitable for use in the present invention is produced by Ferro Corporation of Cleveland, Ohio, known as "XM-1 Frit," having the following chemical analysis on a parts by weight basis:

K <sub>2</sub> O	-----	22.42
Na <sub>2</sub> O	-----	2.60
ZnO	-----	4.19
B <sub>2</sub> O <sub>3</sub>	-----	5.82
Sb <sub>2</sub> O <sub>5</sub>	-----	0.92
TiO <sub>2</sub>	-----	29.54
SiO <sub>2</sub>	-----	34.57
CaF <sub>2</sub>	-----	3.27

Although not essential, it is preferred to add mill additives to this composition to provide the necessary suspension for spraying purposes and to vary the coefficient of expansion. Preferably, the following ingredients are added to 100 parts of the above composition, in the parts by weight indicated: lithium titanate, 4; ball clay, 5; sodium nitrate, 0.5; magnesium carbonate, 0.5.

In applying the devitrified ceramic enamel to the metal base plate, conventional enamelling techniques are utilized. That is, the base plate is first pickled and sand-

blasted, and a ground coat sprayed on the prepared surface. An aqueous suspension of the enamel is then sprayed over the ground coat, dried and then fired at 1500-1600° F., preferably 1550° F. for about 3 minutes. Preferably three coats of the enamel are applied to provide a coating of about 25 mils or less in thickness.

The electrical resistance elements are applied onto the devitrified ceramic enamel coat utilizing the techniques of printed circuitry. While many methods are available, silk screening is preferred. The formulation of the resistance material varies depending upon the particular design of the heating element, but in any event the material includes a metal such as silver, and a flux, the mixture being dispersed in a suitable oil suspending agent. The flux (which also serves as a bulking agent to increase the resistivity of the metal) may comprise ground mica, low-firing powdered vitreous enamels, devitrified ceramic enamel adjusted to a firing temperature of about 1400° F., mineralite, etc. A specific example of the resistance element material is as follows:

	Percent by weight
Metals Disintegrating Co., Flake Silver MD-750	31.40
325 mesh water ground mica	3.38
Drakenfeld "Squeegee" Oil #530	47.46
Drakenfeld "Squeegee" Oil #695	16.37
Sidney Springer "Syno-Oil" N-6	1.39

This suspension is applied to the enamel coat such as by the silk screening method, to form the desired configuration of the circuit, and then dried at a temperature in the approximate range of 200°-400° F. preferably at about 250° F. The heating element is then fired at about 1410° F. to bond the resistance elements to the enamel. A clear vitreous enamel glaze is then applied over the plate as a protective coat and fired at about 1410° F.

Having fully described my invention, it is to be understood that I do not wish to be limited to the details set forth, but my invention is of the full scope of the appended claims.

I claim:

1. A heating device comprising a metallic base plate, a devitrified ceramic enamel coating applied to said plate, and an electrical resistance circuit applied to said enamel surface.

2. A heating device comprising a metallic base plate, a devitrified ceramic enamel coating applied to said plate, said coating having a thickness of about 25 mils and a printed electrical resistance circuit applied to said enamel surface.

3. A heating device comprising a metallic base plate, a devitrified ceramic enamel coating applied to said plate, an electrical resistance circuit applied to said enamel surface, and a protective coating applied over said circuit.

4. A heating device comprising a metallic base plate, a devitrified ceramic enamel coating applied to said plate, a printed electrical resistance circuit applied to said enamel surface, and a protective coating applied over said circuit.

5. A heating device comprising a metallic base plate, a devitrified ceramic enamel coating applied to said plate, an electrical resistance circuit applied to said enamel surface, and a protective vitreous enamel coating applied over said circuit.

6. A heating device comprising a metallic base plate, a devitrified ceramic enamel coating applied to said plate, a printed electrical resistance circuit applied to said enamel surface, and a protective vitreous enamel coating applied over said circuit.

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