

Jan. 15, 1957

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2,777,930

HEATING UNIT

Filed April 28, 1954

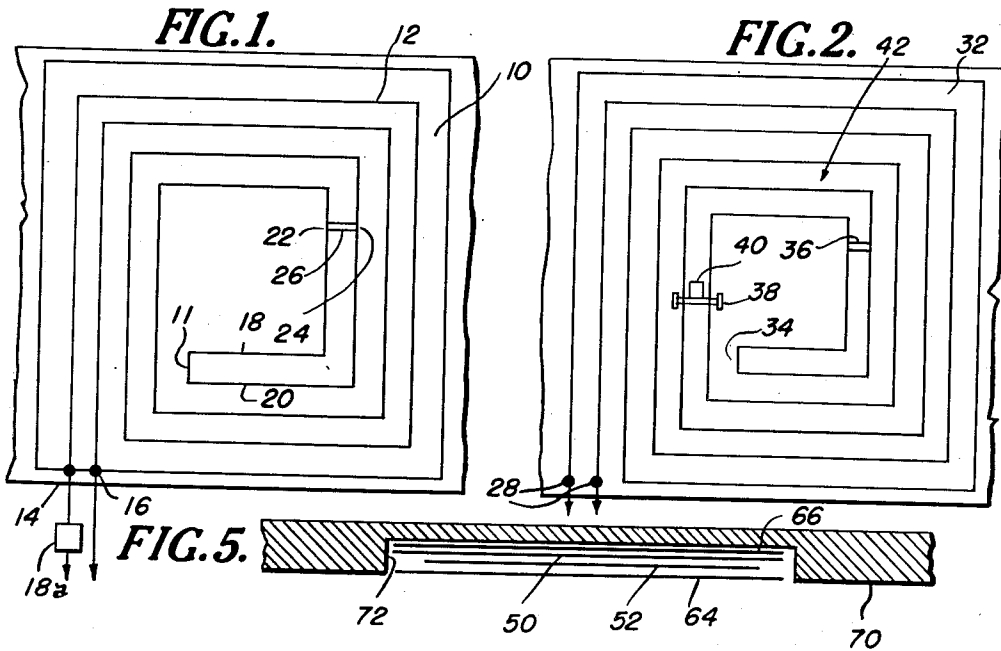
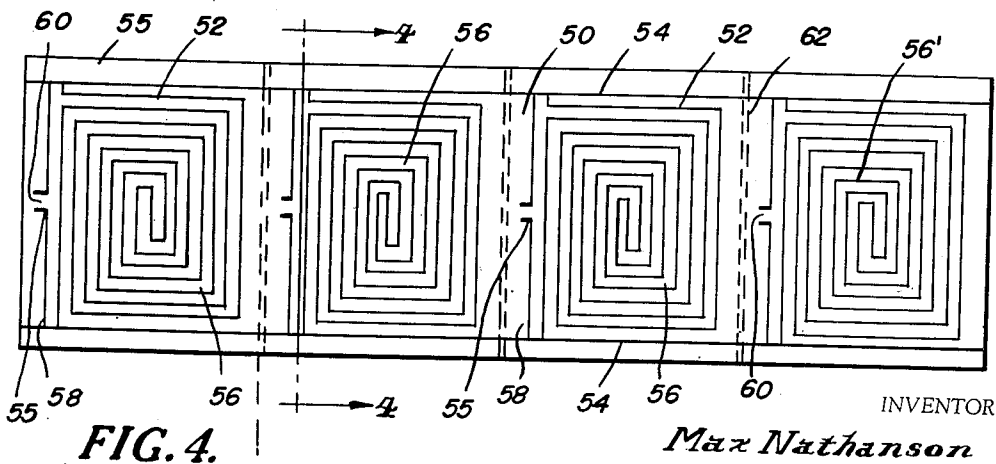
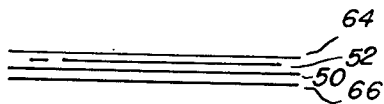


FIG. 3.



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1

2,777,930

HEATING UNIT

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Application April 28, 1954, Serial No. 426,169

2 Claims. (Cl. 219—19)

This invention relates to electrical heating devices. More particularly, this invention relates to electrical heating devices having resistance circuits imprinted upon a non-conducting base, and to methods of producing such fixtures.

It has previously been proposed to print electrical circuits on a non-conducting base and such a technique has had wide usage in certain applications in the field of electronics but, as yet, such circuits have proved themselves unacceptable for simple resistance heating when the amount of resistance, and hence the wattage output of the device is critical. In domestic, as well as in some laboratory applications, the wattage output rating must be uniform and fall within carefully defined limits. Industries specify high standards of control in their heating equipment, and the underwriter laboratories demand that a similar standard be applied to such devices sold for domestic usage. Even without the high standards set by consumers, or those controlling the market, it is nevertheless desirable to provide resistance heaters having a carefully controlled wattage output, because if the resistance is too low the initial wattage will frequently burn out the circuit and render the apparatus inoperative.

One of the major difficulties encountered with printed circuit resistance heaters is the problem of control of the cross-section of the resistance path. The metallic ink may either run or skip when printed, and the thickness frequently varies substantially through a given circuit. Thus, a given section may be too wide or too narrow, too thick or too thin. While a portion of these inaccuracies produce compensating errors, the end result is that the circuit of a given design section and length may have a resistance considerably at variance with that of the design specifications.

It has also been determined that circuits printed of metallic material upon a non-conducting base have a high resistance-temperature coefficient. As a cold metallic circuit has a resistance considerably lower than the same circuit when heated, either by its own operation or by externally applied heat, such a heating unit constructed to maintain a wattage output below a specific quantum will, if it does not exceed the specific standard when cold, have a considerably lower output when it is at its normal operating temperature.

For example, a heater with certain aluminum elements producing 1000 watts under a 118 volt potential will draw approximately 8.6 amperes when operating at its normal hot temperature. However, if such an element is energized when cold, it will draw 11 amperes and will have an output of 1298 watts. As it is the practice of the underwriters laboratories to rate the heating elements on the basis of initial input wattage, it will be readily seen that during a major portion of the operation of the element, the full rated output is not available.

It is therefore an object of this invention to provide a method of constructing printed heating circuits having a wattage output conforming to precisely defined standards.

It is another object of this invention to provide a re-

2

sistance heating unit having circuits printed on a non-conducting base.

It is a further object of this invention to provide a printed circuit electric heating unit having a controlled output so that a given wattage is maintained both when the unit is cold and when the unit is at its operating temperature.

It is still a further object of this invention to provide a heating device adapted for installation flush with a wall board panel.

These and other objects of the invention will be fully understood from the following detailed description of a typical preferred form and application of the invention, and the appended claims.

The invention may be best understood with reference to the accompanying drawings, in which:

Figure 1 is a plan view of a printed circuit illustrating the method of making a precision correlation of the total resistance;

Figure 2 is a plan view of a heating element provided with a thermal controlled shunt adapted to maintain a uniform wattage;

Figure 3 is a plan view of a heating panel;

Figure 4 is a section taken along lines 4—4 of Figure 3; and

Figure 5 is an elevational view, taken in section, of a heating panel disposed within a section of wall board.

In Figure 1, there is shown a printed resistance circuit which is particularly adapted for use as an electrical resistance heating unit. The base 10 may be a sheet of ordinary paper, plastic, or glass paper, such as is manufactured of glass fibers, or any other non-conducting material suitable for receiving printing or painting, spraying or screening, with a metallic, or other conductive paint or ink. A continuous circuit 12, which may be of any size or shape, but is here illustrated a square spiral, is printed or painted or sprayed or screened upon base 10 with an ink or paint which, when dried, leaves a conductive residue or path. The ink or paint may consist of fluids having metallic material suspended therein, or may be composed of other metallic compounds, including metallic salts. While any metallic paint or ink may be used, those containing silver, copper, or aluminum have been found to be particularly suitable. The ink or paint may be brushed, screened or printed on the base in any convenient manner.

The circuit of the heater illustrated consists of dual paths, disposed in a narrowly spaced parallel relationship, with each pair of paths formed to a diminishing square spiral, at the end of which the paths are joined at 11. The printed spiral circuit terminates at contact junctures 14 and 16, which contain standard fittings which may be readily connected with usual wiring or conduit arrangements found in domestic and commercial establishments.

The choice of the material selected as a base sheet will be determined by the temperature at which the resistance or heater is expected to operate. For example, for temperatures up to 190° F. many grades of ordinary paper will be entirely satisfactory. However, for a heater operating above this figure, a glass paper, manufactured of glass fiber, will be more acceptable. If the temperature is expected to reach 300° to 400° F., either glass paper or glass plate will be preferable. For higher temperatures, glass, ceramic, asbestos or similar high temperature insulators may be used.

As discussed hereinbefore, it is very difficult to provide a printed resistance circuit having an even and accurately deposited cross-sectional area, and hence the wattage output obtained from a group of similar heaters will vary considerably. In accordance with this invention, the printed circuit is made with an overall circuit length

3

approximately 5% to 10% greater than required by the design specifications. That is to say, experience will show that a circuit having a particular resistance will usually have a given approximate length. The circuit is printed having a length at least 5% to 10% greater than the figure thus determined. The normal operating potential is then impressed upon the terminals 14 and 16 and the unit is allowed to heat up to its operating temperature. A wattmeter 18a is incorporated into the circuit and, with the 10%, more or less, extra resistance, the indicated wattage will be above the desired rating of the heating unit. Test prods joined by a low resistance lead are then pressed into contact with the circuit on adjacent portions of the parallel spiral circuit, for example at 18 and 20. As a portion of the resistance of the printed circuit will be shunted out or short circuited, the wattage output of a heater will be reduced a commensurate amount, and this change will be indicated on the wattmeter 18a which is interposed in the feed circuit. If, however, the reduction in the wattage does not bring the rating to the desired or specified output of the heater, the test prods may be moved further along the circuit to shut off or short circuit increasing portions thereof. If, for example, when the test prods reach the points 22, 24, the wattmeter indicates the desired or specified output of the heater, the proper location for a permanent shunt, as will be discussed hereinafter, may be considered to be determined. The voltage impressed upon terminals 14 and 16 is removed, and a short thick low resistance shunt 26 is printed or painted between these points. Excellent results have been obtained by painting one or more layers of a thick metallic solution with an ordinary paint brush, although it is within the contemplation of this invention to provide any low resistance shunt, such as a metal bar. It is desirable that the heater be again brought to its operating temperature and that the wattage output be given a final check, although the use of this method allows a very small chance of error or mistake.

As discussed above, one of the disadvantages of the use of printed circuits in the creation of electrical resistance heating elements has been that the conductive paints or inks used, such as copper, aluminum, or silver, all possess a high resistance-temperature coefficient. As the electrical heating units are rated by underwriters laboratories in terms of initial wattage output when cold, and as such heaters are frequently used for protracted periods, it will be readily seen that the full or rated output is achieved during a very small fraction of the total time in which a particular heating unit is in use. Thus it will be readily seen that the heating potential, or the total capacity to produce the desired quantum of heat, is being wasted during a major portion of a given normal operating period.

It is within the contemplation of this invention to provide means which will eliminate this useless waste of the full heating potential of the elements. This end is achieved by providing the circuit with a thermal operated relay interposed in a shunt which short circuits a portion of the resistance path of the element. When, for example, a printed aluminum heating element rated by the underwriters laboratories at 1300 watts is initially charged with an electrical potential, the wattage output will be at a level substantially equal to the full rated figure. However, as the element warms up, the resistance of the circuit rises due to the high resistance-temperature coefficient of the aluminum, and as the resistance rises the total wattage output will, the voltage remaining constant, diminish. After a very short operating period, the total wattage output of the heating unit will be reduced to the neighborhood of 1000 watts which is only 77% of the full rated capacity which might be expected from the apparatus and of which the apparatus is capable of producing.

In Figure 2, there is illustrated an exemplary electrical heating element having a resistance circuit printed with a conducting paint or ink upon a non-conducting base 32.

4

The circuit of the heater illustrated consists of dual paths disposed in a narrowly spaced parallel relationship, with each pair of paths formed to a diminishing square spiral at the end of which the paths are joined, at 34. The circuit is provided with a correlation correction shunt 36 painted across the dual parallel spaced paths as discussed hereinabove. The dual paths are also joined by a shunt 38 having a thermal-operated relay or thermostatic switch interposed therein. Such a relay 40 may consist of a bi-metal element formed of two plates of metal having dissimilar coefficients of heating expansion. Such thermal-operated relays are in themselves old and the details of its construction constitute no part of this invention. The relay 40, disposed on the shunt 38, will close the circuit of the shunt when the relay proper is heated to a predetermined level, and when it closes the remaining portion of the heating circuit, generally indicated at 42, is short circuited and rendered inoperative. The shunting out of portion 42 of the printed circuit results in an overall reduction in the total resistance of the heating unit, and thus, under a given fixed potential, the wattage output of the entire unit will be raised. In operation, the heating unit disclosed in Figure 2 will, when cold, provide a continuous circuit from terminals 28 around the spiral to the permanent shunt 36. The resistance to the flow of the current in the metallic paths will rapidly raise the temperature of the heating element to a point where the thermal-operated relay will close the circuit of the shunt 38, so that then the flow of the current will be restricted to the parallel paths between the terminals 28 and the relay operated shunt 38. The location of this relay may be selected by the trial testing with the low resistance test prod circuit and the wattmeter as discussed hereinabove.

In Figure 3, there is shown a heating panel formed with the heating units comprising resistance circuits printed upon a non-conducting base as described in the discussion of Figures 1 and 2. In Figure 4 there is shown a section disclosing the composite structure of the panels. The heating panel consists of paper or a glass paper base 50 having metallic resistance circuits 52 printed thereon. As best shown in Figure 3, the resistance circuit is arranged with resistance paths 54 extending in widely spaced parallel relationship along the full length of the panel to form bus lines. Disposed between the bus lines 54 are a plurality, for example, four, heating sections 56 which may be the equivalent of the heating units described hereinabove in the discussion of Figures 1 and 2. That is, the heating sections are formed of dual paths disposed in narrowly spaced parallel relationship with each set of paths formed to create a diminishing square spiral. Each of the heating sections 56 has one of these dual paths connected to a first bus line, and the other of its dual paths connected to a second bus line. Adjacent each heating section 56, there is disposed a broken printed circuit 58 extending between the bus lines 54. The break or void 60 in this circuit may be formed with tabs or wide strips 55 which may be used as bases for terminal posts, as described hereinafter. It will be seen that each of the heating sections 56 is spaced a substantial distance from its neighboring sections, so that the entire heating panel may be bisected or otherwise divided to provide a fraction of the total wattage output on the entire panel where circumstances dictate the provision of a heating panel having a reduced output wattage. For example, if each of the four heating sections 56 have a rated wattage output of 250 watts, the complete panel will serve as a 1000-watt heater. However, in certain applications, it may be desirable to provide a domestic or commercial establishment with a panel heater having a rated wattage output of 750 watts. Therefore, in accordance with this invention, the panel may be cut or sawed along line 62, to remove heating section 56', leaving three heating sections having a total wattage output of 750 watts.

Regardless of whether a panel carries one or more

5

heating sections 56, only one set of contact junctures or terminal posts need be provided as each of the tabs 55 is connected by a printed path or circuit with a bus line 54 which, in turn, is connected with each operative heating section.

Referring more particularly to Figure 4, there is shown an exemplary illustration of the composite panel in which the base sheet of glass paper 50 has the heating elements 52, comprising the various heating sections 56 and bus lines 54, printed thereon. A second or cover sheet 64 is disposed on the printed side of the base sheet 50, and a sheet of heat-reflecting material, such as aluminum foil 66, is disposed on the back of the base sheet. As discussed hereinabove, the base sheet and the cover sheet may be composed of paper, plastic, or plate glass, or any other non-conducting material, and the heating element may be composed of any metallic or non-metallic conducting ink or paint.

Still referring to Figure 4, the assembled panel, that is the superposed glass paper cover, printed base sheet, and heat-reflecting sheet, are molded or otherwise bonded into a flat unitary structure. This may be accomplished by dipping the composite structure in a varnish, such as a silicone varnish, or by impregnating the composite structure with a suitable plastic material and applying the necessary quantum of heat and/or pressure.

When the composite structure is so impregnated and molded, it is within the contemplation of this invention to form any of a variety of shapes. For example, hot cups or heated trays may be easily formed by the proper selection of a suitable mold.

In Figure 5, there is illustrated an exemplary utilization of the printed resistance heating panel. An ordinary panel of wall board of insulating material, for example, GYPROC, may be provided with niche 72 formed therein which is cut with a depth substantially equal to the thickness of the heating panel illustrated in Figures 3 and 4. This heating panel is disposed within the niche, with the aluminum foil heat reflecting barrier 66 next to the floor or bottom of the niche. As the niche has a depth substantially equal to the thickness of the heating panel, the exposed side of the wall board panel 70 will present a substantially smooth surface which, when painted or papered, will present an appearance virtually indistinguishable from the other ordinary wall board insulating panels. The heating panel may be glued into the niche, or may be secured therein by nails driven through the border or outer edge portions 55 of the heating panel, or it may be secured therein by brackets or any other suitable detent means.

6

It is within the contemplation of this invention to provide panels having heating sections 56, which are either of the ordinary printed resistance type or of the preferred examples illustrated in Figures 1 and 2 and discussed hereinabove.

Having described only a typical preferred form and application of the invention, it is not to be limited or restricted to specific details herein set forth, but I wish to reserve to myself any variations or modifications that may appear to those skilled in the art and falling within the scope of the following claims.

I claim:

1. An electrical heating panel comprising a base sheet of non-conducting material, a resistance circuit printed on a first side of said non-conducting material, a cover sheet of non-conducting material disposed on the printed side of said base sheet, an aluminum foil sheet disposed on the second side of said base sheet, said base sheet, said cover sheet and said foil being bonded together into a panel structure, and said printed circuit comprising a plurality of bus lines extending substantially the full length of said panel, and a plurality of heating sections disposed between said bus lines, the said heating sections being spaced apart so that the panel may be bisected by cutting it along a line extending between adjacent heating sections to reduce the wattage output of the panel by removing one or more heating sections therefrom.

2. A method of making an electrical element having accurately controlled resistance comprising printing the resistance circuit upon a non-conducting base, said circuit having a greater terminal-to-terminal length than required, shunting out increasing portions of the printed circuit until the correct resistance exists between said terminals, and establishing a permanent low resistance shunt about said portions by depositing a substantial strip of metallic liquid upon said base, and curing said liquid.

References Cited in the file of this patent

UNITED STATES PATENTS

1,696,684	Knopp	Dec. 25, 1928
2,100,327	Getchell	Nov. 30, 1937
2,205,543	Rideau	June 25, 1940
2,503,457	Speir et al.	Apr. 11, 1950
2,512,875	Reynolds	June 27, 1950
2,518,807	Musgrave et al.	Aug. 15, 1950
2,598,878	Ballou	June 3, 1952
2,613,306	Waltersdorf et al.	Oct. 7, 1952
2,641,675	Hannahs	June 9, 1953
2,660,659	Sarno	Nov. 24, 1953
2,683,673	Silversher	July 13, 1954