United States Patent

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[54] **ELECTRICAL CONTACT MEANS FOR HAIR CURLER HAVING ELONGATED ANNULAR HEATER**
4 Claims, 3 Drawing Figs.

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[51] Int. Cl. A45d 2/36, H05b 1/02, H05b 3/12
[50] Field of Search 219/221–226, 241, 242, 504, 505, 300, 301, 210; 132/33, 36, 39

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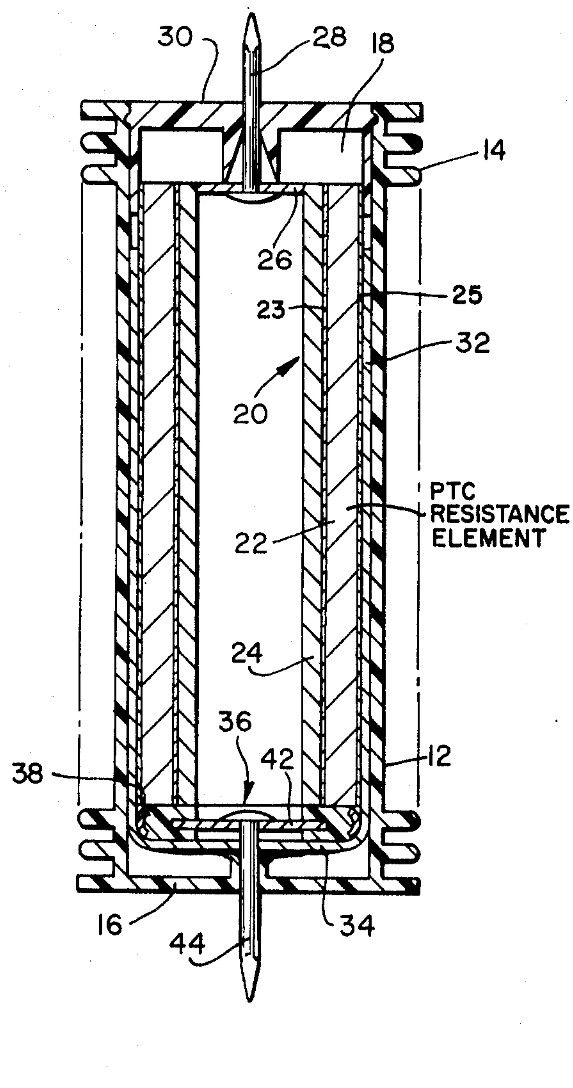
ABSTRACT: A hair curler employing a heater element formed of a conductive crystalline polymer is disclosed. The polymer, loaded with conductive particles, such as carbon black, has a positive temperature coefficient (PTC) of resistance characteristic and combines a fast warmup time with a slow cooldown time due to the phase change of amorphous polymer to crystalline polymer upon cooling, yet does not become molten due to the sharp rise in resistance at temperatures above an anomaly temperature which limits the heat generation at elevated temperatures. Since the polymer retains its shape, no special sealing means is required to confine it as in prior art, fusible wax devices. An elongated annular PTC heating element is employed with conductive coatings placed on the inner and outer peripheral surfaces thereof. Tubular elements are placed in biased relationship to the conductive coatings with terminals attached to the tubular elements extending from opposite ends of the curler.



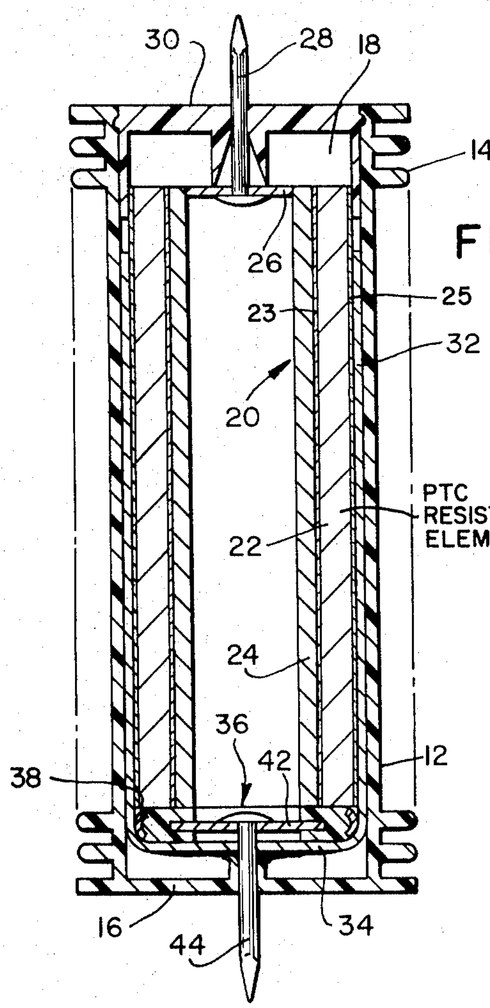


FIG. 1

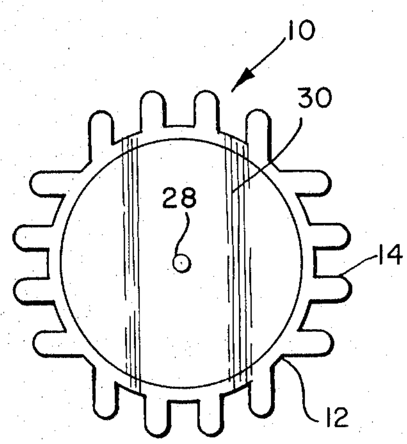


FIG. 2

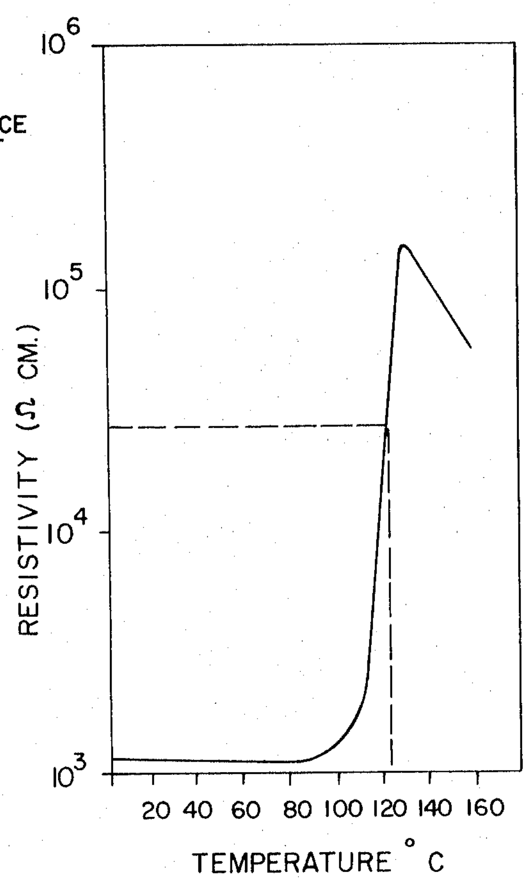


FIG. 3

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ELECTRICAL CONTACT MEANS FOR HAIR CURLER HAVING ELONGATED ANNULAR HEATER

BACKGROUND OF INVENTION

The invention relates to hair curlers, and more particularly, to electrically heated hair curlers.

Electrically heated hair curlers have found wide market acceptance in recent years. In general, these curlers comprise an outer cylindrical shell of a suitable polymer provided with a plurality of fingers extending outwardly from the outer peripheral surface of the shell for grasping hair wound about the shell. These curlers are heated to a desired temperature, then taken by the user who trains hair about the periphery. The hair is generally kept in contact with the curler for a short period of time to effect curling of the hair. Various ways have been used to heat the curlers but all have certain disadvantages. One type of curler employs, mounted within the shell, a housing which contains a fusible wax. The curler is placed in heat-transfer relation with a heating element until the wax melts and is then removed from the heat source and is ready for use. However, since the wax is changed to a liquid, special precautions must be taken to insure a good seal. Further, the time which is required for the curler to be heated is longer than desirable due to the relatively low heat conductivity of the wax. The wax-filled device does, however, offer the advantage of being an excellent heat-storage means due to the latent heat released during phase change of the wax from liquid to solid upon cooling. Attempts have been made to avoid the above disadvantages by using a resistance element in the curler both as the heater and as the heat-storing means. This avoids the liquid sealing problem but the warmup time for the device time is still excessive since a relatively massive resistance element must be employed in order to store the heat for the required time after deenergization. Still another disadvantage is that both of the above types require current-controlling devices, such as thermostats. Further, heat distribution along the surface of the curler for both types is relatively nonuniform with a concomitant nonuniform degree of curling for different sections of hair.

Thus it is an object of the invention to obviate the disadvantages of the prior art curlers mentioned above.

Another object of the invention is the provision of a hair curler heater which combines the functions of various components used in prior art devices.

Yet another object is the provision of a simple, reliable, rugged hair curler device, one which provides uniform heating with no hot or cold spots. Another object is the provision of a hair curler heater which has an extremely fast warmup time along with the characteristic of maintaining its heat for a prolonged period. Yet another advantage is the provision of a hair curler device which needs no thermostats yet provides close temperature control. Another object is the provision of electrical-contact structure for use with a heater shaped as an elongated annulus and made of polymer material.

Other objects and features will be in part apparent and in part pointed out hereinafter.

The present invention meets the above objects by providing a hair curler which employs an elongated annulus of electrically conductive polymeric material placed within the curler shell. An electrically conductive coating is located on both the inner and outer surfaces of the annulus electrically insulated from each other. An electrically conductive tubular member is pressed into the bore to effect electrical connection to the coating on the inner surface as well as provide physical support thereto while a sleeve of electrically conductive material is placed around the outer-surface coating. To afford electrical connection to this annulus, terminal means in the form of pins are attached to the tubular member and the sleeve and extend outwardly from opposite ends of the curler shell.

In the accompanying drawings, in which one of the various possible embodiments of the invention is illustrated:

FIG. 1 is a cross section of a hair curler device made in accordance with the invention;

FIG. 2 is top plan view of the FIG. 1 device; and

FIG. 3 shows a curve of resistivity plotted against temperature for a heater element made in accordance with the invention.

Dimensions of certain of the parts as shown in the drawings may have been modified and/or exaggerated for the purposes of clarity of illustration.

The invention accordingly comprises the elements and combinations of elements, features of construction, and arrangements of parts which will be exemplified in the structures hereinafter described, and the scope of the application of which will be indicated in the following claims.

The heater of the present invention is made out of conductive-filled polymer having a positive temperature coefficient of resistance above an anomaly or threshold temperature. The heater is connected to line voltage so that current flows therethrough causing I^2R heating. When the temperature rises above the anomaly point, there is a sudden and marked increase in resistance to effectively cut off the current through the heater. Thus, this self-limiting of current eliminates the need for a thermostat or similar control employed by prior art devices. Among the other advantages the present invention offers is that extremely fast warmup time is obtained while storing the heat for an extended period of time since the polymer acts as a heater, heat exchanger and heat sink or heat-storage means. Not only does the PTC characteristic serve to limit current but it offers another unexpected advantage. The prior art teaches that a PTC characteristic in conductive polymers is caused by a difference in thermal expansion between the polymer material and the conductive filler, that is, if the polymer has a greater thermal coefficient of expansion than the conductive-filler particles, this would give rise to a PTC effect. As the temperature is raised, the polymer expands more than the conductive particles, thus spreading the conductive particles apart. See, for instance, U.S. Pat. Nos. 2,978,665 and 3,243,753. However, this is not a complete explanation since many materials, such as polyvinylchloride and polystyrene do not exhibit a marked PTC effect even though the thermal coefficient of expansion of the polymer is greater than that of the conductive material.

In the present invention material is utilized in which, rather than being primarily dependent upon rates of thermal expansion, the PTC effect appears related to the phase change in polymers having crystalline structure. When a crystalline-type polymer, such as polyethylene, is loaded with carbon particles, such as carbon black, the carbon black is distributed unevenly in the polymer even with extensive mixing. Such material also includes amorphous regions and it happens that most of the carbon particles are found in these amorphous regions. The carbon particles form large aggregates separated by crystalline regions with the separation being in the order of several hundred angstroms. Thus the polymer contains a few chains of carbon particles forming a continuous chain through the material but the bulk of such chains will be broken up by crystalline regions of polyethylene. Electron tunneling can occur fairly readily through thin films of crystalline polymer so that carbon chains broken up by crystalline regions can have conductivities approaching those of uninterrupted carbon chains. As temperature rises, the carbon-black masses separate due to the greater thermal expansion coefficient of the polymer, increasing the difficulty of electron tunneling between carbon masses which offsets the increased electron tunneling effect due to temperature rise while the crystalline regions remain intact. At temperatures below roughly 90° C., the resistance level is relatively flat. When the temperature rises to the crystalline melting point, the carbon masses become separated by amorphous regions in which electron tunneling is very limited, thus causing high resistance of the material, as seen in the roughly 90–130° C. range of FIG. 3. Further increase of temperature causes the polymer to become semimolten which permits the strained carbon masses to expand in the polymer and form a partial network of carbon through the material resulting in an increase in conductivity, as seen in FIG. 3 at temperatures above roughly 130° C.

Thus use of PTC polymeric resistance material not only permits combining of several functions mentioned above but also utilizes the extra heat storage capabilities associated with the phase change. That is, changing of the crystalline polymeric composition to the amorphous phase upon heating stores latent heat associated with the phase change which is released upon cooling to make a very efficient heat storage device.

Referring now to the drawings, numeral **10** indicates generally a hair curler made in accordance with the invention and comprises an outer, generally cylindrical, shell **12** of any suitable synthetic resin having a plurality of fingers **14** distributed over the outer peripheral surface of the shell and extending therefrom to facilitate holding of hair thereon. Shell **12** is formed with a closed end **16** and an open end **18** to permit passage therethrough of a heater assembly **20**. Assembly **20** includes an elongated annular heating element **22** formed of a conductive-filled polymer having a positive temperature coefficient of resistance above an anomaly or threshold temperature. In order to provide optimum and reliable electrical contact with this polymeric composition, the inner and outer peripheral surfaces of element **22** are coated with a conductive material, layers **23** and **25** respectively, such as electroless nickel and electroplated tin, are electrically insulated from one another and cooperate with sleeve members in close physical connection therewith. Reference may be had to coassigned and copending application Ser. No. 6,093, filed Jan. 27, 1970 for further details on the method used to apply the conductive coatings to the polymer. Sleeve **24**, formed of a good electrically conductive material, such as copper, and being of a size and sufficiently thick so that when inserted into the bore of element **22**, is firmly biased against the inside surface thereof. This serves both to make electrical contact with the conductive coating and also to support the coating and prevent it from pulling upon continued cycling of energization. A cap **26** is attached to sleeve **24** at one end thereof by conventional means, such as by soldering, and a pin **28**, attached as by soldering, extends therefrom. It will be understood that cap **26** could be formed integrally with sleeve **24** if so desired. Pin **28** extends through an aperture provided in cap **30** which is received in and closes the open end of shell **12**. Sleeve **32**, also of good electrically conductive material, is placed about the outer periphery of element **22** in tight physical contact therewith and is formed over at **34** as by crimping to enclose header **36**. Header **36** comprises an outer rim **38** of any convenient material, such as aluminum, surrounding an annulus **40** of dielectric material such as a polymer, which in turn supports shelf **42**. Pin **44** extends from shelf **42** and is attached thereto by any convenient means, such as welding. To enhance the electrical connection between pin **44** and sleeve **32**, solder may be placed on surface **34** around the pin location or alternatively, shelf **42** could be electrically connected to rim **38** (not shown).

Element **22** is formed from a polymer material filled with conductive particles and having a PTC effect. The polymer is of a type having crystalline structure, such as a polyolefin, which gives rise to the PTC characteristic as well as providing the heat storage capabilities associated with the phase change from the crystalline phase to the amorphous phase. A unique advantage that this material offers is that the current, and hence heat generation, is limited by the marked increase in resistance before the material melts. That is, the elongated annulus **22** still maintains its configuration so that there is no need for providing elaborate sealing means as in the case of devices using fusible waxes. Yet the advantages derived from the phase change are utilized. The material is chosen so that using line voltage, resistance will approach the level shown in FIG. 3 by the dashed lines. At this point, heat generation matches heat dissipation with very little change in temperature. Reference may be had to coassigned and copending application Ser. No. 6,086, filed Jan. 27, 1970 for further details on the composition of the polymer material and how it is made.

Combining the heating and heat storing functions by means of the PTC polymeric element results in a very fast warmup time along with the slow-cooling characteristics of the wax-filled devices.

Thus the use of a polymer PTC hair curler provides a very fast warmup time, yet has a very favorable cool-down time. It further obviates the need for additional thermostats to limit the current since the PTC characteristic effectively limits the current flow when the operating temperature has been reached. Additionally, the polymer is rugged and not subject to damage upon dropping, is extremely uniform in heating along its surface, and is readily shaped using conventional polymer forming techniques. The invention also provides for making electrical connection to an elongated annulus of polymer and for supporting the conductive coatings placed on the annulus.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

It is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

As many changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings, shall be interpreted as illustrative and not in a limiting sense, and it is also intended that the appended claims shall cover all such equivalent variations as come within the true spirit and scope of the invention.

We claim:

1. An electrically heated hair curler comprising a generally cylindrical outer shell, a plurality of hair-engaging fingers distributed over the outer peripheral surface of the shell and extending outwardly therefrom, an elongated annulus constructed of conductive polymeric resistance material placed within the shell in good heat-transfer relationship thereto, conductive coatings on the inner and outer peripheral surfaces of the annulus, the coatings being electrically insulated from each other, a tubular member of electrically conductive material pressed into the bore of the annulus and extending along at least a portion of the length thereof, the tubular member applying a bias against the inner conductive coating to effect electrical connection and provide physical support to the coating, a sleeve of electrically conductive material placed around the outer conductive coating in close physical and electrical connection therewith, the sleeve being electrically insulated from the tubular member, and terminal means attached to the tubular member and sleeve to effect electrical connection to the annulus.

2. A hair curler according to claim 1 in which the terminal means includes two pins, one of the pins electrically connected to the sleeve, the other pin electrically connected to the tubular member, the pins electrically insulated from each other, and extending outwardly from opposite ends of the curler shell.

3. A hair curler according to claim 2 further including a header located at one end of the annulus, the header mounting one of the terminal pins in electrical isolation from the other pin.

4. A hair curler according to claim 1 in which the electrically conductive tubular member extends substantially along the whole length of the annulus.