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(71) Applicant *(for all designated States except US)*: PERFECT IMPRESSION FOOTWEAR COMPANY [US/US]; Key Tower, Suite 3010, 127 Public Square, Cleveland, OH 44114–1216 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: WEBER, William, H. [US/US]; 8283 Fairmount Road, Novelty, OH44072 (US). HOOVER, James, W. [US/US]; 4587 Ridgedale Drive, Akron, OH 44319 (US). MOORE, Dan, T., III [US/US]; 2626 Fairmount Boulevard, Cleveland Heights, OH 44106 (US). TUFTS, Lindsey, Jr. [US/US]; 4792 Walford Road, Warrensville Heights, OH 44128 (US).

(74) Agents: MURTAUGH, John, P. et al.; Pearne, Gordon, McCoy & Granger LLP, 1200 Leader Building, Cleveland, OH 44114–1401 (US).

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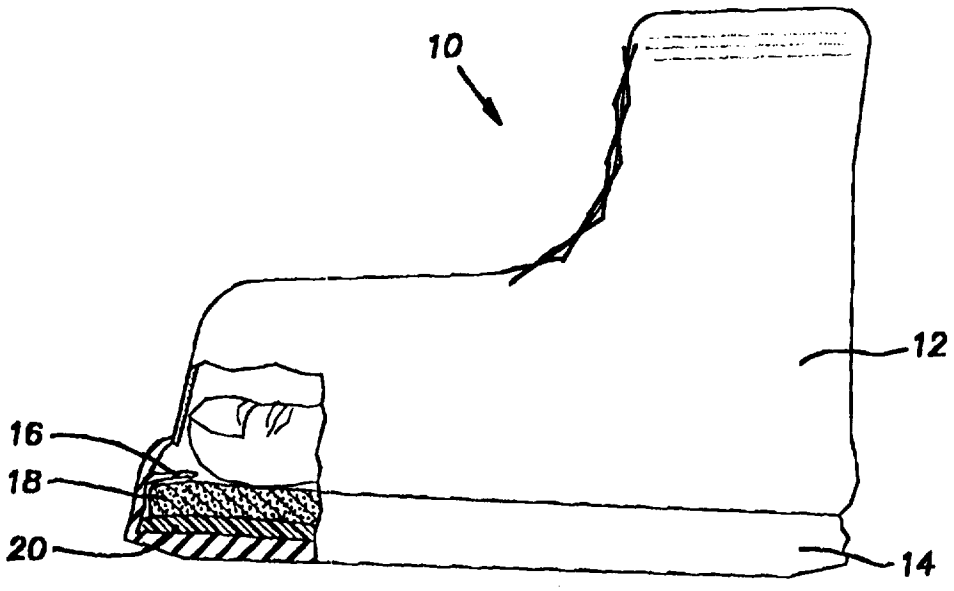

(57) Abstract

Footwear (10) such as a shoe or boot having an upper (12), an outsole (14) and an insole (18). The insole comprises a layer of thermoplastic (24) and a heater member (20).

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CUSTOM-FITTING FOOTWEAR

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. Provisional Application No. 60/027,175, filed October 1, 1996. This application is a continuation-in-part of U.S. Patent Application Serial No. 08/777,471, filed December 30, 1996.

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates generally to custom-fitting footwear and more specifically to a conformably moldable thermoplastic insole in footwear which is heat-softenable by a built-in electric heater member.

DESCRIPTION OF RELATED ART

For many years removable and non-removable insoles for footwear have been produced to simulate the bottom contour of the human foot in an effort to provide the wearer with a greater degree of comfort, supporting the arches and reducing the shock of impact while walking, running or jumping. A number of approaches have been taken to provide insoles which have a shape custom-fitted to the individual shape of the underside of a particular wearer's foot. In one approach, different chemicals are mixed and a chemical reaction is initiated in an insole, the person then steps into the footwear having the insole therein and forms an impression and the material is allowed to cure before the footwear is used. See U.S. Patent Nos. 4,520,581; 4,128,951; 2,838,776; and 4,888,225. U.S. Patent 3,968,577 discloses a

similar system where the curing may also be via heating. However, in these processes if the fit is not right the first time, the insole cannot be remolded and must be discarded.

Other references disclose an insole having a layer of a thermoplastic material. The thermoplastic material is heated, thus softening it. The person steps into the footwear and makes an impression in the insole. The material then cools, retaining the impression of the foot. A custom-fitting insole is produced.

There is a need for a preferably full length and full width insole sized to accommodate the entire undersurface of a person's foot which is preferably built-in or non-removable from footwear, having a thermoplastic material layer which is heat-softenable by a built-in electric heater or heater member. There is a need for such footwear so that a purchaser can heat-soften the built-in insole, try on the footwear, form the impression, and then let the impression cool so as to provide custom-fitting footwear in a convenient and efficient manner.

SUMMARY OF THE INVENTION

Footwear is provided which comprises an upper, an outsole, and an insole. The insole comprises a layer of thermoplastic material and a heater member, the heater member being capable of generating heat by being energized by electrical energy by connection to an electrical power source. The heater member is capable upon being energized of effectively heating and softening the thermoplastic material so that the insole may be conformed to the shape of the underside of a foot of a person.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an elevational view of a hiking boot incorporating the present invention with part of the toe portion of the boot cut away showing part of the toe portion of the boot in cross section.

Fig. 2 is a cross sectional view, lengthwise, of the outsole of the boot of Fig. 1.

Fig. 2A is a cross sectional perspective view of the toe portion of the outsole of the boot of Fig. 1.

Fig. 3 is an exploded view of an insole of the present invention.

Fig. 4 is a perspective view of an insole of the present invention being made.

Fig. 5 is a partially-exploded view of an insole of the present invention.

Fig. 6 is a partially-exploded view of an insole of the present invention with an outsole and power source.

Fig. 7 is a perspective view of a half insole of the present invention in an outsole.

Fig. 8 is a plan view of a heater of the present invention.

Fig. 8A is a sectional view taken along line 8A-8A of Fig. 8.

Fig. 9 is a plan view of an insole incorporating the heater of Fig. 8.

Fig. 10 is a plan view of an alternative embodiment of a heater.

Fig. 11 is a plan view of an alternative embodiment of a heater.

Fig. 12 is a perspective view, with the front half cut away, of an insole.

Fig. 13 is a plan view of a heater.

Fig. 14 is a perspective view of a removable insole according to the invention, with part of the cover pulled away.

Fig. 15 is a perspective view of a shoe incorporating an

embodiment of the invention, with portions of the shoe in outline.

Fig. 16 is an exploded view of a shoe of the present invention.

Fig. 17 is an elevational view of the rear or back end of an outsole.

Fig. 18 is a perspective view of an electric plug that plugs into the back end of the outsole.

Fig. 19 is a perspective view of a cap which snaps into the opening at the back end of the outsole.

Fig. 20 is a plan view of the rear or back end of an outsole.

Fig. 21 is a bottom view of the back end of a heater showing a plug tab folded in position.

Fig. 22 is a schematic illustration of an electrical power source for energizing the heater.

Fig. 23 is a plan view of the front end of an alternative embodiment of a heater.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

With reference to Figs. 1-15, and more particularly Fig. 1, there is shown a boot or hiking boot 10 having an upper 12 and a flexible outsole 14, and an insole comprised of a thermoplastic material layer 18 and a heater or heater member 20. The outsole is flexible, that is, it bends when the wearer walks, and is made of materials known in the art such as injection molded polyurethane. With reference to Fig. 2, the outsole 14 is shown lengthwise in cross section, having a toe end 15 and a heel 17. The outsole has a lip 16 around its entire interior perimeter. When the insole is heated by the heater as described hereinafter, the thermoplastic material in the insole is softened and stepped on by the person. This tends to squeeze the softened

plastic and tends to force it around the person's foot and possibly up into the shoe or boot. The lip 16 overhangs the insole and functions to prevent any soft plastic from escaping or being forced into the upper part or interior of the shoe or boot. Fig. 2A further illustrates lip 16 being integrally molded around the interior perimeter of the outsole 14.

Fig. 3 illustrates the insole 22 which is flexible and resilient at 72°F and which is preferably built-in and non-removable from the footwear, less preferably removable. The insole 22 is comprised of a thermoplastic material layer 24, a second thermoplastic material layer 26, and a heater or heater member 28 sandwiched therebetween. As shown, these three layers are in the shape of an insole of a shoe or boot. When these three layers are pressed or attached or sealed together, they have a thickness of 1/32 to 1/4, more preferably 1/16 to 1/8, inch. The thermoplastic material layers are of a thermoplastic material which is heat softenable so that the insole is moldable or conformable to the shape of the underside of a foot of a person when the person stands on the heat-softened insole. Alternatively, only one of the two layers 24, 26 may be utilized, preferably layer 24. A preferred thermoplastic material for use in the present invention includes several components, the first component being selected from the group consisting of ethylene copolymers, ethylene terpolymers and mixtures thereof; the second component being selected from the group consisting of ethylene terpolymers which are ethylene vinyl acetate modified by the addition of carbonyl groups; the third component being weight reducing fillers such as glass or plastic bubbles or microspheres or microbubbles or microballoons (these being preferred), ground cork, ground foam rubber, Cabosil, and rice hulls, and a fourth component being process oil or plasticizers such as epoxidized soybean oil or from the phthalate family. These latter two components modify the material with relation to weight, processing and/or hardness. Preferred thermoplastic materials are described more specifically as follows.

The thermoplastic material, which is solid at 80°F, is preferably the following formulation:

1. 45-95, more preferably 50-90, more preferably about 75-85, more preferably about 78, weight percent ethylene vinyl acetate (EVA)

2. 10-40, more preferably 15-25, more preferably about 17.5, weight percent modified EVA

3. 0.5-15, more preferably 1-5, more preferably about 2, weight percent polyoctenamer rubber.

4. 0.5-3, more preferably about 1.5, weight percent dry expanded thermoplastic microspheres, such as Expancel 091DE from Expancel, Inc. of Duluth, GA. (Alternatively nonexpanded expandable thermoplastic microspheres such as Expancel 551DU may be substituted for the expanded microspheres; in this case the process oil is not needed and the expandable microspheres, which expand at about 250-300°F, expand during the extrusion process).

5. 0.25-1.5, more preferably about 1.0, weight percent process oil such as paraffinic process oil, which is used to pre-wet the expanded plastic microspheres.

Less preferably the formulation is:

1. 45-95, more preferably 50-90, more preferably about 75-85, weight percent EVA

2. 10-40, more preferably 15-25, more preferably about 18, weight percent modified EVA.

3. Effective amounts of weight-reducing filler and process oil, such as noted above. Less preferably, about 0.25-1.5 weight percent plasticizer such as epoxidized soybean oil may be used instead of the process oil.

Component No. 1 above (EVA) is preferably Product AT 2850M from AT Plastics Inc., Brampton, Ontario, Canada, is preferably 28% vinyl acetate, less preferably 24 to 33% vinyl acetate, preferably has a relatively low molecular weight (approximately 14,000 to 26,000 weight average), preferably has a relatively high melt index (preferably 850, less preferably 400 to 1000, dg/min.), preferably has a ring and ball softening point of about

150-170°F, more preferably 160°F, and preferably has a specific gravity of 0.96 or less. It can be in pellet or powder form. Product AT 2850M has a tensile strength of 200 psi, 190% elongation at break, a flexural modulus 1% secant of 1060 psi, a Shore A hardness of 67, a ring and ball softening point of 169°F, a melt temperature of 149°F, and a specific gravity of 0.944. One advantage of EVA is its low cost.

The modified EVA is preferably Elvaloy 741, less preferably Elvaloy 742. Both are an ethylene terpolymer and both are ethylene vinyl acetate modified by the addition of carbonyl groups, said carbonyl groups being incorporated as part of the main chain. The phrase ethylene terpolymers which are ethylene vinyl acetate modified by the addition of carbonyl groups as used herein includes Elvaloy 741 and 742. Elvaloy 741 is compatible with EVA, lowers the softening point of the EVA, increases and controls viscosity, increases flexibility, and enhances resistance to perspiration, body oils, and microbial growth. It is available from DuPont and has a molecular weight of greater than 250,000, a specific gravity of 1, tensile strength of 860 psi, 950% elongation at break, an elastic modulus of 1150 psi, a melt index of 35-40, a ring and ball softening point of 106°C, a crystalline melting temperature of 151°F, and a Shore A durometer hardness of 70. It can be used in pellet or powder form. Sufficient modified EVA is added to lower the softening point to the desired range but also to provide a thermoplastic material in which an effective impression can be made while not detrimentally affecting the other desired performance characteristics. Ethylene vinyl acetate modified by the addition of carbonyl groups is believed to have unique properties as described above which make it particularly useful in the present invention.

The polyoctenamer rubber is preferably trans-polyoctenamer rubber, available as Vestenamer 6213 from Huls America Inc., Piscataway, New Jersey. It has a whole polymercyclic structure. It has a melting point of approx. 86°F, specific gravity of 0.89,

an average molecular weight of 120,000 with a very broad molecular weight distribution, a viscosity at 23°C of 120-140 ml/g, a Mooney viscosity ML (1+4) 100°C of less than 10, and a melt index MFI 190°C/2.16 kg of 3.5. It enhances the heat stability of the thermoplastic material and also enhances extrusion of the product.

The weight-reducing fillers and process oils or plasticizers are as described above.

So long as a sufficiently low softening point for the overall thermoplastic material is achieved, other ethylene copolymers and/or terpolymers or mixtures thereof can be substituted, in whole or in part, for the ethylene vinyl acetate, including ethylene methyl acrylate, ethylene ethyl acrylate, ethylene butyl acrylate, and ethylene vinyl acetate acid terpolymer such as ELVAX 4310 from DuPont.

As used herein, non-foam means non-blown. Preferably, the thermoplastic material has a ring and ball softening point of more than 140°F and less than 200°F, more preferably 165-190°F, more preferably about 175-190°F, has a melting point of 155 to 170°F, has a melt index of 1.5 to 5, preferably about 2.6, g per 10 min. (90°C, 1082 g load), has a consistency at 160°F approximately like masticated chewing gum so that an effective impression of the foot can be made, and has the following physical characteristics at 72°F or other standard conditions: Shore A hardness of 50-80, more preferably 55-70, more preferably 60-70, more preferably about 65, tensile strength of 200-600, more preferably 300-500, psi, flexibility of 3-7, more preferably 4-6, more preferably about 5 (measured at room temperature on a flexometer having a scale of 0 to 10 and operating at 300 cycles per minute), elongation at break of 300-700, more preferably 400-600, percent, and for lightness a specific gravity of less than 1, more preferably less than 0.8, more preferably less than 0.7, more preferably about 0.6. It is non-foam with microspheres or microbubbles or microballoons as weight-reducing filler and is non-blown and can be softened and remolded multiple times without

loss or significant or substantial loss of its function or physical characteristics and preferably can be conformed to the underside of a person's foot while at 140-200°F, more preferably 150-180°F, more preferably 150-170°F, more preferably 160-170°F, more preferably about 165-170°F or about 165°F. It resists compression. Low density and light weight are desirable characteristics for insoles and footwear. To provide sufficient structural support at stress points under the person's foot and to avoid permanent compression and resist compression, the thermoplastic material has a specific gravity of at least 0.25, more preferably at least 0.3, more preferably at least 0.4, more preferably at least 0.5, more preferably at least 0.55.

With reference to Figs. 8 and 8A, a heater or heater member 20 is shown, having an etched foil heating element 60 sandwiched between top and bottom layers 62 and 63 of insulation or insulating sheath material. Alternatively the top layer 62 is not employed. The etched foil heating element 60 is preferably provided by acid etching a circuit in a 0.001 to 0.003 inch thick nickel resistance alloy or aluminum (such as aluminum 1100 or 1145) foil. The etched foil element has excellent circuit pattern repeatability and superior heat transfer, which results from greater area coverage of the element. The sheath material layers 62 and 63 are preferably 3-5 mil Mylar brand of polyester film or Kapton, a thin lightweight transparent material from DuPont. A preferred heater or heater member 20 may be obtained from Watlow, St. Louis, Missouri. Less preferably, the sheath material layers 62, 63 may be silicon rubber or neoprene. Less preferably, the heating element may be a wire-wound element, such as is created by spiraling fine resistance wires around a fiberglass cord. The wire-wound element is laid out in a pattern to provide effective heat distribution. These heaters are also available from Watlow. An alternative heating element includes a nichrome or copper wire heating element available from Watlow. Less preferably, the heater or heater member 20 may be an electrically conductive polymeric layer, such as with carbon

black, having sufficient electrical resistance to generate an effective amount of heat.

The heater 20 may be embedded into or adhered onto the thermoplastic material layer in a variety of ways. A diecut layer of thermoplastic material may be laid into a cavity, having a thickness of 1/16 inch on top of which is placed the heater which is in the same shape as the thermoplastic material layer and another identical thermoplastic material layer laid on top of the heater creating a sandwich as shown in Fig. 3. Alternatively, a single layer of thermoplastic material may have the heater on top or underneath the thermoplastic material layer. Alternatively, as shown in Fig. 4, the heater 20 may be placed into a die 32 and molten thermoplastic polymer material 34 is placed into the die on top of the heater 20; conversely, molten thermoplastic material can be pumped into a die and the heater placed on top of the molten polymer. A preferred insole 36 is shown in Fig. 5, comprised of a combination thermoplastic material/heater layer 38 over which is provided a layer 40 of closed cell urethane foam, such as available from Rogers Corporation in East Woodstock, CT. A top cover layer 42 is then provided to cover the entire component upon which the foot would rest, the top cover being preferably a moisture wicking fabric such as available from Faytex in Weymouth, MA. The closed cell urethane foam is provided for cushioning and to insulate the foot from the heat of the thermoplastic material.

As shown in Fig. 6, a premolded outsole or outsole/midsole combination 46 (shown without lip 16) has a recess into which is placed an insole 44 of the present invention having an electrical connection plug 48 connected to the heater in the insole by a wire 50. The plug 48 is adapted and constructed so that it may be electrically connected to an electrical power source by receiving an electrical connector 56 which is connected to a power box/controller 52 which may be plugged into an electric outlet by plug 54. Plug 48 snap fits in a recess or plug port 49 molded into the back of the outsole 46. Alternatively the

plug 48 can be placed at other locations along the perimeter of the outsole, preferably near the heel or instep or on the outside opposite the instep.

Similarly to Fig. 6, Fig. 7 shows a half insole 58 for the heel portion only laid into an outsole 46.

With reference to Fig. 8, the heater 20 is preferably provided with a plug tab 64 so that the etched foil heating element 60 may be electrically connected through the plug tab to the electrical connection plug 68, which is similar or identical to plug 48. Thus, electrical energy can flow through plug 68, through electrical conductors or foil strips (from the etching process) or wires in plug tab 64 to the etched foil heating element 60. The plug tab 64 exits adjacent to the heater 20 so that the etched foil heating element can heat right up to the edge of the insole. A crease or fold 66 is provided so that when the heater 20 is embedded in or adhered between or on or under the thermoplastic material layer(s) such as 24, 26, the plug tab 64 may be folded underneath the insole, as shown in Fig. 9. With the plug tab 64 being attached in the instep or medial arch area 71 (at the waist 69, 69 of the heater as shown in Fig. 8) and folded underneath the insole 70, the insole 70 may be much more easily assembled into the boot or shoe. The plug tab 64 provides 3 or 4 inches of extra loose extension material so that during assembly of the footwear, the plug 68 may be snap fit into a recess in the outsole and the insole 70 may be placed within the outsole. Having three or four inches of plug tab material makes it easier to bend the insole and assemble it into the outsole. Thermocouple or temperature sensor 65 is attached to the heater 20 on the outside of layer 62 or layer 63, or is located between layers 62 and 63, or is embedded in the thermoplastic material layer, and is connected by wire 67 through plug tab 64 to plug 68. Thermocouple 65 measures or senses the temperature of the thermoplastic material which is being heated by heater 20 and operates through an appropriate control in plug 68 or power box 52 to cut off or reduce electric power to heater 20 when a

preselected softening temperature (such as 165°F) of the thermoplastic material is reached. Other means known in the art may be used to monitor the temperature of the thermoplastic material and to reduce or turn off the electric power at an appropriate temperature. For example, HISS technology may be used, which controls the heater without use of a thermocouple. It sends an electric signal or pulse through the foil circuit and measures electrical resistance which is a function of temperature and thereby can control the temperature through a control unit connected to the power source. The heater 20 is preferably in close or physical contact with the adjacent thermoplastic material layer or layers.

With reference to Fig. 10 a heater 20 is shown having slices 74 and slices or cuts 76 cut through the insulating sheath material layers 62, 63. Slices, cuts and holes are all perforations. These slices or cuts will permit heat-softened thermoplastic material to flow or squeeze therethrough or be forced therethrough when the person is standing on the insole, to more effectively flow towards and reach the plug area so that the plug may more effectively flow be sealed in the plug port of the outsole into which it is snap-fit. This will help keep moisture out of the footwear. Heat activated glue may also be used to seal the plug in the plug port. In Fig. 11, holes 72 are shown through layers 62, 63 and also through heating element 60; melted polymer may flow through these holes for the same purpose that melted polymer flows through the slices or cuts in Fig. 10. If the insole has a covering enclosing the thermoplastic material, similar slices, cuts or holes through the cover may be provided for the same purpose.

Fig. 16 shows in exploded view a preferred embodiment of the invention. The footwear includes an outsole 108 having an inner bottom surface 110, an inner sidewall 112, and a perimeter 114 having holes for sewing the upper 147 and retaining layer 145 in place. The inner sidewall 112 does not have a lip 16. The back or heel portion or end 109 of the outsole 108 has a connector

channel or trough 116 shaped to receive via snap-in fit or friction fit the electrical connector or plug 132. The heater or heater member 124, preferably an etched foil heating element 128 on a Mylar film substrate 126, is bonded to surface 110 by pressure sensitive adhesive or heat activated (hot melt) adhesive (the heat to be supplied by the heater 124). In place of etched foil circuitry, one may substitute screen printed conductive ink circuitry on the Mylar substrate, a preferred conductive ink being a silver carbon blend from Murfin Industries, Columbus, Ohio. Alternatively the conductive ink circuitry may be applied to the Mylar substrate via laser jet printing or ink jet printing or other printing technique.

With reference to Figs. 16 and 21, the heater 124 has a plug tab 130 (which is also etched foil on a Mylar substrate) extending from the heater's heel portion to electrically connect the heating element 128 to the electrical connector or plug 132. Plug tab 130 is shown having first, second and third portions 137, 138 and 139, respectively, connected at folds 134 and 135, the tab 130 being connected to the main body of heater 124 at fold 136, where the tab 130 is folded onto the bottom side of the heater.

Thermoplastic material layer 142 (2-7, more preferably 3-6, more preferably 4-5, mm thick) is extruded onto about 1/8 inch closed cell polyurethane flexible foam layer 143; they adhere together since the thermoplastic material is hot. Layer 143 preferably has no fabric surface. After being die-cut, this thermoplastic material-foam bilayer (preferably 5-12, more preferably 7-10, more preferably 8, mm thick) is disposed in the outsole 108 over the heater 124 with the thermoplastic material 142 in contact with the heater 124 and the foam 143 on the top. The foam provides cushioning and insulates the foot from the hot plastic.

Then an overhanging flexible retaining layer 145, such as leather or ETC material or a lightweight synthetic moisture-wicking fabric, is applied and adhered to the foam layer 143 by

pressure-sensitive adhesive or other adhesive. Then the upper 147 is stitched through the retaining layer 145 into the holes in the perimeter 114 of the outsole 108. Preferably the retaining layer 145 is precisely die-cut to the finished dimensions before it is applied and stitched on so no trim is necessary; alternatively it may overhang the edge of the outsole and be trimmed after the upper 147 is stitched on. The retaining layer 145 functions to provide a suitable surface for the foot to contact, and also prevents hot thermoplastic material from oozing or flowing or squeezing up or penetrating into the inside of the shoe during the subsequent forming operation. As described previously, the back end of the heater has perforations so hot thermoplastic material may flow down during the forming operation into trough 116 to seal connector or plug 132 in place and seal port 148 against entrance of moisture or dirt. After the footwear is constructed, the heater may be energized for a short time to adhere the thermoplastic material to the heater and the heater to the outsole.

With reference to Fig. 20, there is shown a plan view of the trough 116 having a sloping surface 118 which slopes up from the bottom of the trough to the surface 110 of the outsole. This receives the portion 139 of plug tab 130. Trough 116 has arms 122 to receive wings 123 of connector or plug 132. Trough 116 has a mouth 120 which exits under the perimeter 114 and through the back 109 of the outsole 108 to create an aperture or opening or plug port or connector port 148 at the back of the outsole. As shown in Fig. 21, the plug tab 130 is folded in a preselected manner to prevent any exposed circuitry from physically contacting any other exposed circuitry (to prevent shorting), aligning portion 139, and aligning connector or plug 132 so that male connector or tip 150 can be inserted into mouth 120 and be disposed in connector port 148, communicating with the outside of the outsole, available to be plugged into female connector or plug 151.

With reference to Fig. 22, there is shown two plugs 151 (so

that a pair of shoes can be heat-softened simultaneously) connected via wires 156 to power box/controller 161 which may be plugged into an electric outlet by plug 162. With reference to Figs. 17-19, plug 151 has four female connector openings 152-155 for electrical connection to four corresponding male connectors or prongs in tip 150. Two of these prongs can be used to power the etched foil element 128; the other two prongs can be used to communicate with a temperature sensor in the thermoplastic material. Plug 151 plugs into tip 150 of connector or plug 132 at or through port 148. The back 109 of the outsole has a recessed area or recess 149 adjacent or surrounding the port 148. Cap 158 (preferably plastic) has (a) a shield 159 shaped like the recess 149 and as thick as the recess is deep (for flush mounting) and (b) a mounting snout or projection 160 to frictionally fit into and engage the port 148. After the forming process and after plug 151 is removed the cap 158 is fixed in place, optionally with adhesive, to keep dirt and moisture out. A logo or trademark can be displayed on the exterior surface of cap 158.

When the customer walks in the shoe store, the two plugs 151 from the electric power source or power box 161 are plugged into the tip 150 through port 148 of each of a pair of shoes. The heater is energized to soften the thermoplastic material to its softening point, preferably 150-180°F, more preferably 160-170°F, more preferably 165-170°F or about 165°F, within less than 5 minutes, preferably 3-4 minutes. This temperature can be reached, maintained, and controlled via the temperature sensor or thermocouple in the thermoplastic material and the power box/controller 161. Optionally the controller can be programmed to apply full power for four minutes to soften the plastic, then apply 1/10 power for eleven minutes to maintain the temperature (to permit a time window to try on the shoes), then automatically shut off. The shoes are then unplugged, the customer puts them on and walks around, preferably for 1-7 minutes, forming the impression. The impression becomes set as the plastic cools.

The plastic may be reheated and a new impression made if the first impression is not right. If the customer doesn't want the shoe, the plastic is heated and smoothed and the shoes restocked.

Optionally each size of etched foil heater (such as shoe size 9 or size 11) has a different heating value or resistance so that, if the power source supplies a uniform or fixed or unvariable amount of energy or current, less heat will be delivered to the small shoe and more heat will be delivered to the large shoe, but since the large shoe has more thermoplastic material to heat up, they will both be heated up and softened in about the same amount of time.

As shown in Fig. 12, the thickness and shape of the thermoplastic material layer can be varied to accommodate formability options, for example, a thicker portion or layer 80 of thermoplastic material in insole 78 in the medial portion may be provided to aid a pes planus pronation. Similarly, the construction of the heater can be modified to adapt to similar situations. More heat can be applied to a specific region to allow for a deeper impression in a shorter period of time by concentrating the etched foil heating element in one area, such as the heel area 82 of heater 20 shown in Fig. 13. This would be appropriate in the case of forming a deep heel cup to aid in calcaneal cushioning.

The insole may less preferably be removable, as shown in Fig. 14, where removable insole 84 is shown with the heater encased in thermoplastic material 86 being covered on the top and bottom with urethane coated fabric 90 and sewn around the perimeter with coated nylon bias 88 such as available from National Bias Company in Cleveland, Ohio. Thus the sewn covering may hold the heater in contact with the thermoplastic material layers; alternatively, the heater may be adhesively attached or otherwise attached or sealed to or within the thermoplastic material layer or layers. As shown in Fig. 14, the heater of a removable insole may be provided with a flexible wire 92 connected to a plug 94 for connection to an electrical power

source; the cord or wire is approximately 6 inches in length attached at the rear of the insole so as not to hinder the normal gait of the wearer and to increase the comfort level. If the wire and/or plug are uncomfortable, the wire may be snipped where it emerges from the insole after the insole has been molded to the shape of the person's foot. Alternatively the heater may be combined with a thermoplastic material layer above and/or below the heater, which combination may be combined with a flexible foam layer above and/or below the thermoplastic material layer(s) to provide a removable insole or orthotic. The insole may be trimable, that is, the front and/or rear and/or side portions of the insole may be trimmed off, such as with scissors or a knife, to provide a smaller insole for a smaller shoe size. In this way, only one large size insole need be made and sold, and the customer can measure his foot and trim off the excess insole to provide the correct size insole. The exterior of the insole can be marked with cut lines to indicate the different shoe sizes. To accommodate this feature, the front end of the etched foil heater 163 as shown in Fig. 23 can have an etched foil heating element 164 having or defining a circuit and having a circuit arrangement, a portion of the circuit arrangement being arranged or wired in parallel as shown rather than in series to permit portions to be trimmed off without breaking the circuit. The back and/or sides of the heater can be wired in a similar parallel manner to permit trimming at those locations.

Fig. 15, which shows a less preferable construction, shows a shoe 96 having a conforming member 98 in the heel box surrounding the sides of the heel of the wearer. For electrical connection, the conforming member 98 has a wire 102 connected to an electrical connection plug 104. The conforming member 98 is constructed as described above. In a similar manner, a conforming member 100 may be provided in the tongue of the shoe. These members can be sewn or otherwise attached in the appropriate places of the footwear.

The present invention is preferably utilized in a shoe or

boot intended for ambulatory locomotion, such as walking and hiking shoes and boots, preferably a walking shoe, an athletic shoe, a dress shoe, a casual shoe, an outdoor shoe, a work/duty shoe, and a women's shoe, less preferably a hiking boot. The invention can even less preferably be used in a sandal or an inline skate or even less preferably in a ski boot. The invention can be used to adjust to the unique contours of the structure of the foot in the various places where the foot contacts the footwear, preferably the bottom of the foot.

To provide custom-fitting footwear, such as a boot, according to the invention, the heater is energized with electric power so that electrical resistance materials in the heater will generate heat, which softens the adjacent thermoplastic material. The person then steps into the footwear or boot and steps down on the insole to conform the insole to the shape of the underside of their foot. The person may also walk around to more accurately set the impression. The thermoplastic material is then permitted to cool and harden, thus providing a custom-fitting footbed and a flexible, resilient insole custom-fitted to the underside of the person's foot. If the person wants to change the fitting, the thermoplastic material may simply be reheated and re-conformed.

The electric power source and thermocouple are controlled so that the thermoplastic material is heated up by the heater to a temperature preferably in the range of 130°F-180°F. In addition, the power source provides sufficient energy to bring the thermoplastic material up to temperature within a preselected time frame, preferably less than 10 minutes, more preferably less than 5 minutes. The final preselected temperature is then maintained by use of the built-in thermocouple, the thermocouple controlling the electrical power so as to maintain the preselected temperature.

The insole with heater assembly can less preferably be utilized in specified areas within the sole of the shoe, for example, the arch area only or the heel portion only.

Optionally, a battery pack can be attached to the person or the footwear, the battery pack being electrically connected to the plug 48 or connector 32 or the heater 20 or 124 and equipped with a controller and/or thermocouple to control the amount of electrical power supplied to the heater, a sufficiently small amount of DC electric power being supplied so that the insole is merely warmed but not softened. By this way, the footwear can warm the foot of the wearer during cold weather. If in a ski boot, the foot can be warmed; after skiing the heater can be energized or warmed to dry the boot.

Although the preferred embodiments of this invention have been shown and described, it should be understood that various modifications and rearrangements of the parts may be resorted to without departing from the scope of the invention as disclosed and claimed herein.

WHAT IS CLAIMED IS:

1. Footwear comprising an upper, an outsole, and an insole, said insole comprising a layer of thermoplastic material and a heater member, said heater member being capable of generating heat by being energized by electrical energy by electrical connection to an electrical power source, said heater member being capable upon being energized of effectively heating and softening said thermoplastic material so that said insole may be conformed to a shape of the underside of a foot of a person.

2. The footwear of claim 1, wherein said heater member is disposed between said layer of thermoplastic material and said outsole, said outsole being flexible.

3. The footwear of claim 1, wherein said heater member comprises an etched foil heating element.

4. The footwear of claim 3, wherein said etched foil heating element comprises nickel resistance alloy foil or aluminum foil.

5. The footwear of claim 1, wherein said outsole includes a lip which overhangs said insole.

6. The footwear of claim 1, said insole further comprising a thermocouple unit capable of controlling electric energy supplied to said heater member and capable of controlling the temperature to which said heater member may heat said thermoplastic material.

7. The footwear of claim 1, said heater member having a heel end and being connected to a plug in a plug port, said heater member having perforations near said heel end to facilitate softened thermoplastic material flowing towards said

plug in said plug port.

8. The footwear of claim 1, said footwear having a footwear heel portion, said heater member having a heater heel portion and having a plug tab extending from said heater heel portion, said plug tab terminating in a plug located in said footwear heel portion.

9. The footwear of claim 8, said plug tab having first, second, and third portions, said plug tab having a fold between said first and second portions, said plug tab having a fold between said second and third portions.

10. The footwear of claim 1, wherein said footwear is selected from the group consisting of walking shoes, athletic shoes, dress shoes, casual shoes, work/duty shoes, and hiking boots.

11. The footwear of claim 10, wherein said footwear is selected from the group consisting of walking shoes.

12. The footwear of claim 1, wherein said layer of thermoplastic material comprises weight-reducing filler.

13. The footwear of claim 1, further comprising a battery pack electrically connected to said heater member and being capable of supplying electrical energy to said heater member so as to effectively warm said insole without materially softening said thermoplastic material.

14. The footwear of claim 1, wherein said thermoplastic material is non-foam.

15. The footwear of claim 14, said thermoplastic material having a specific gravity less than 0.8.

16. The footwear of claim 1, said outsole having a heel portion, said heel portion having a trough effective to receive a plug for electrical connection to said electrical power source.

17. The footwear of claim 2, said insole further comprising a layer of flexible foam, said thermoplastic material layer being disposed between said flexible foam layer and said heater member.

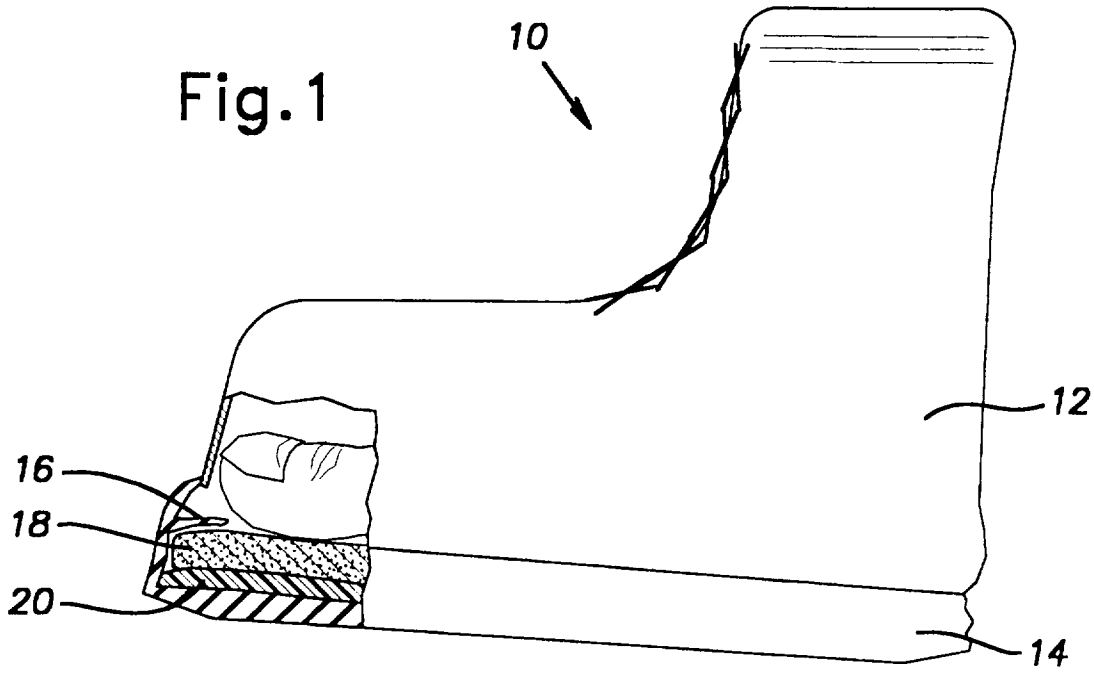
18. The footwear of claim 17, said footwear further comprising a flexible retaining layer, said flexible foam layer being disposed between said flexible retaining layer and said thermoplastic material layer.

19. The footwear of claim 1, said outsole having a heel end, said heel end having in a plug port a first plug adapted to receive a second plug for electrical connection to said electrical power source.

20. The footwear of claim 19, further comprising a cap fixed in said plug port.

21. The footwear of claim 3, said insole being removable, said etched foil heating element defining a circuit and having a circuit arrangement, a portion of said circuit arrangement being arranged in parallel so that a front portion of said heating element may be trimmed off without breaking said circuit.

Fig.1



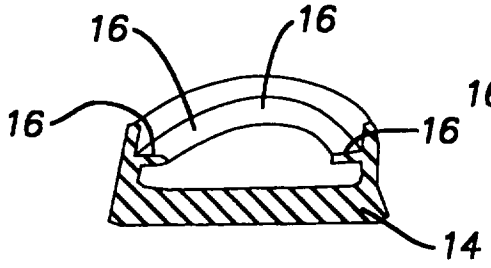


Fig.2A

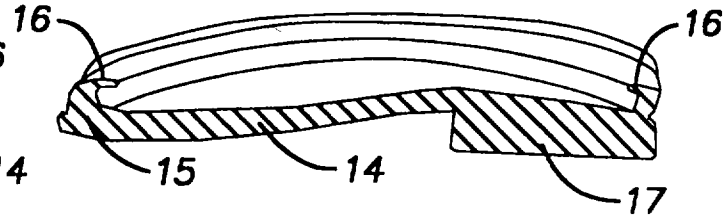


Fig.2

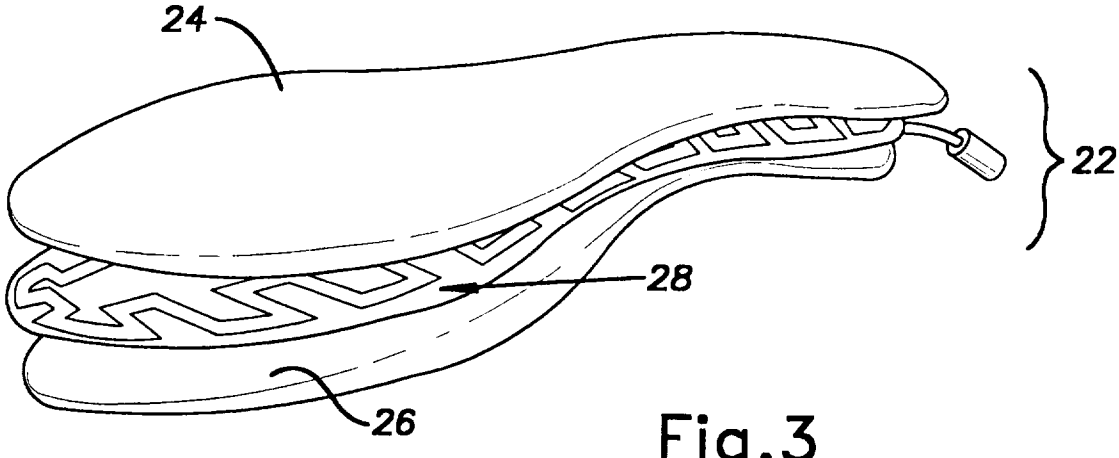
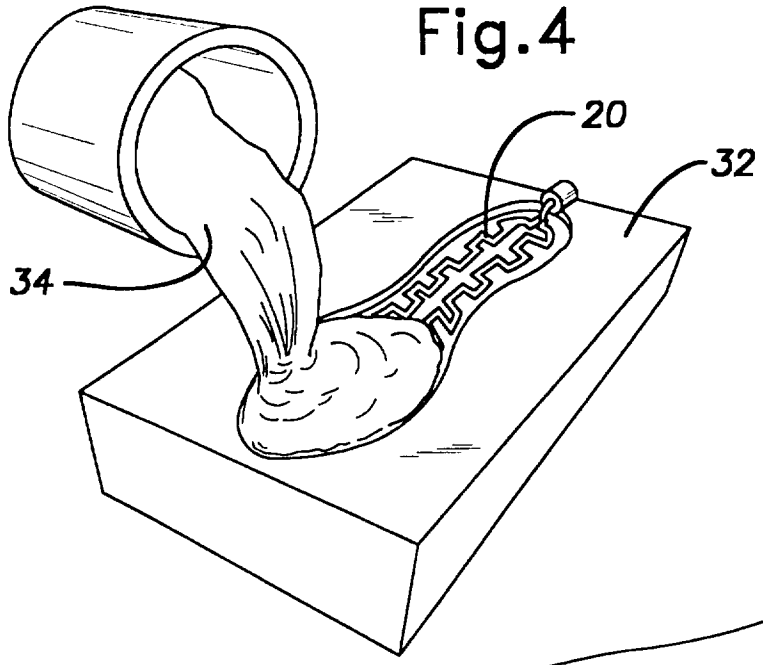


Fig.3

Fig.4



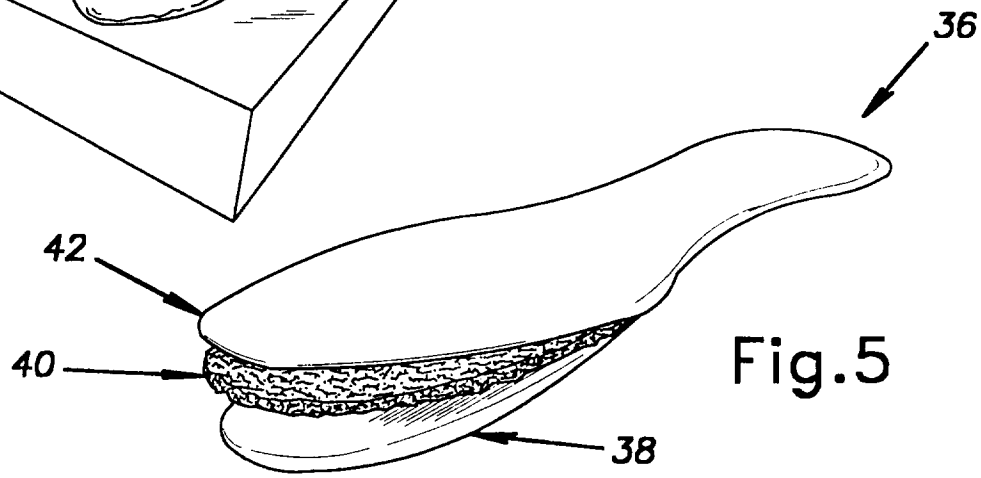
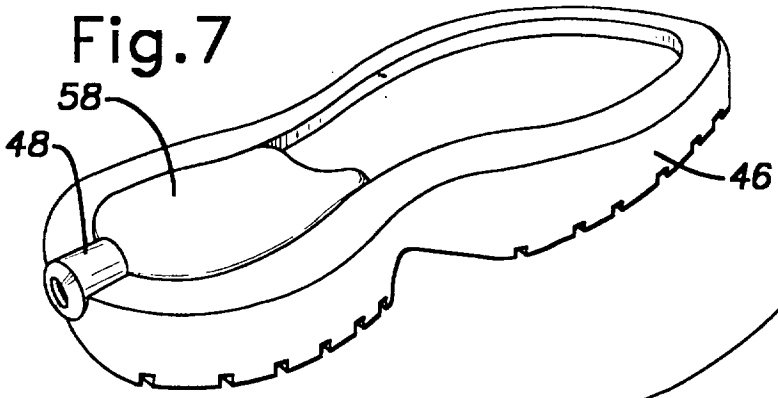


Fig.5

Fig.7



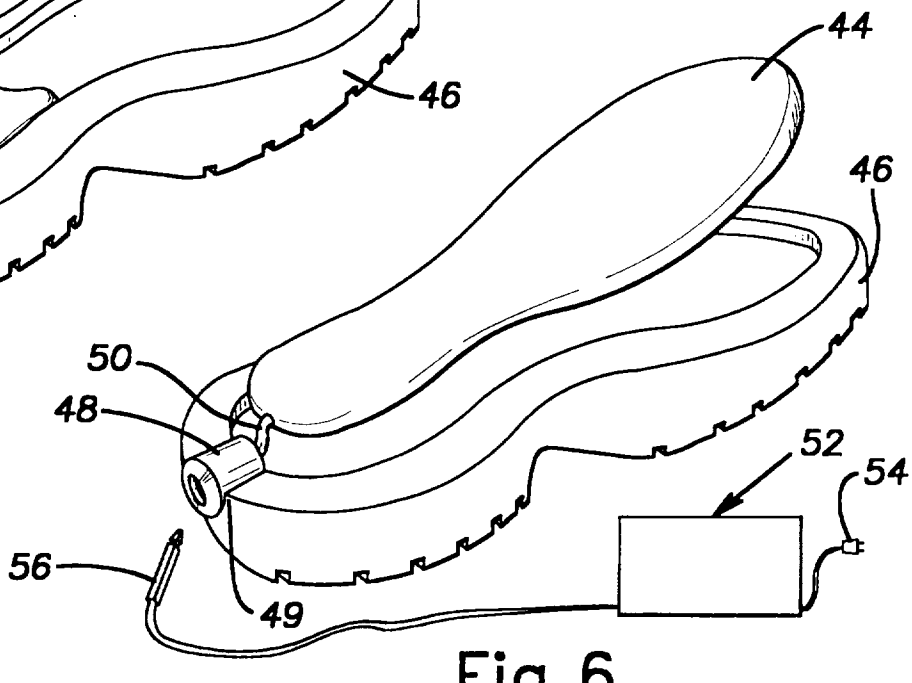


Fig.6

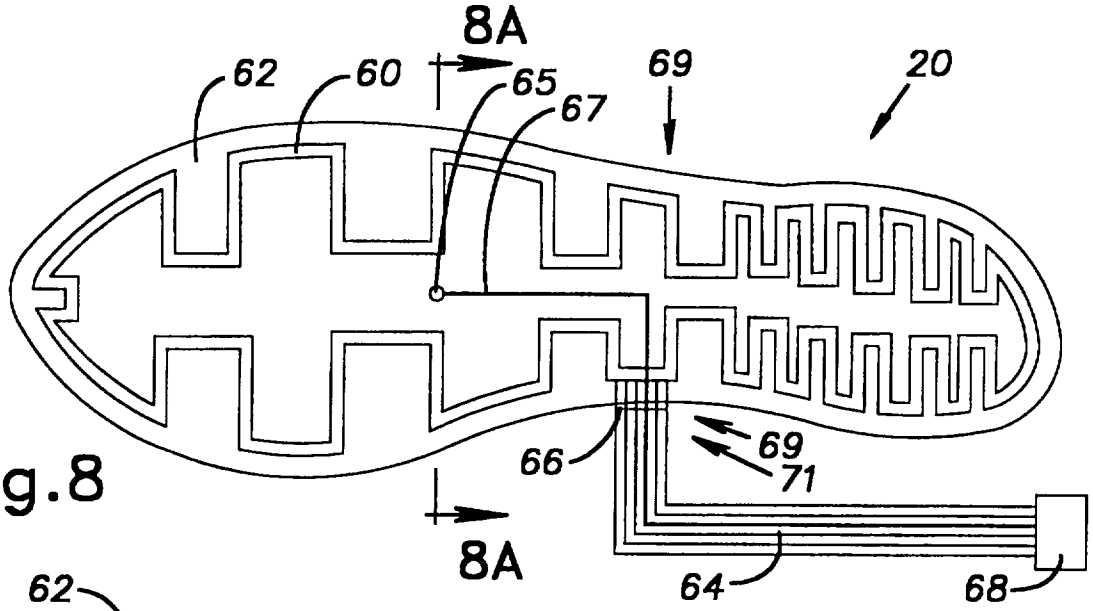


Fig.8

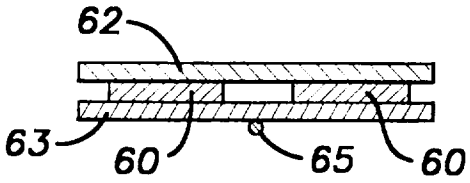


Fig.8A

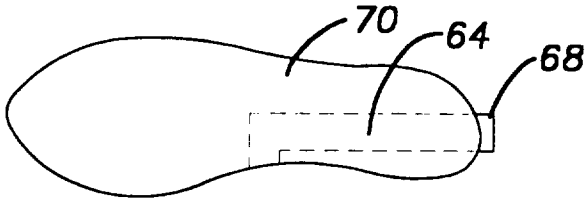


Fig.9

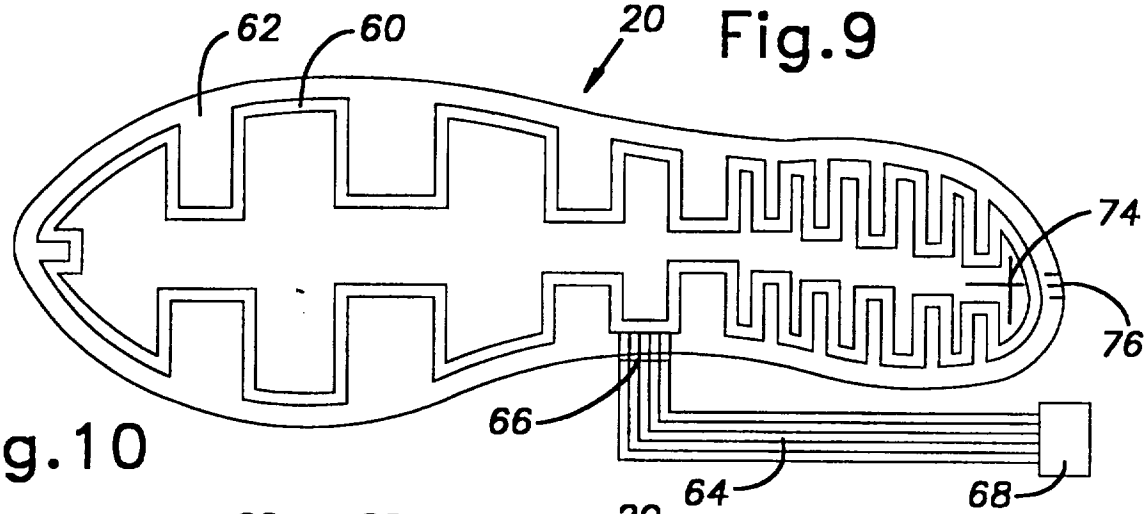


Fig.10

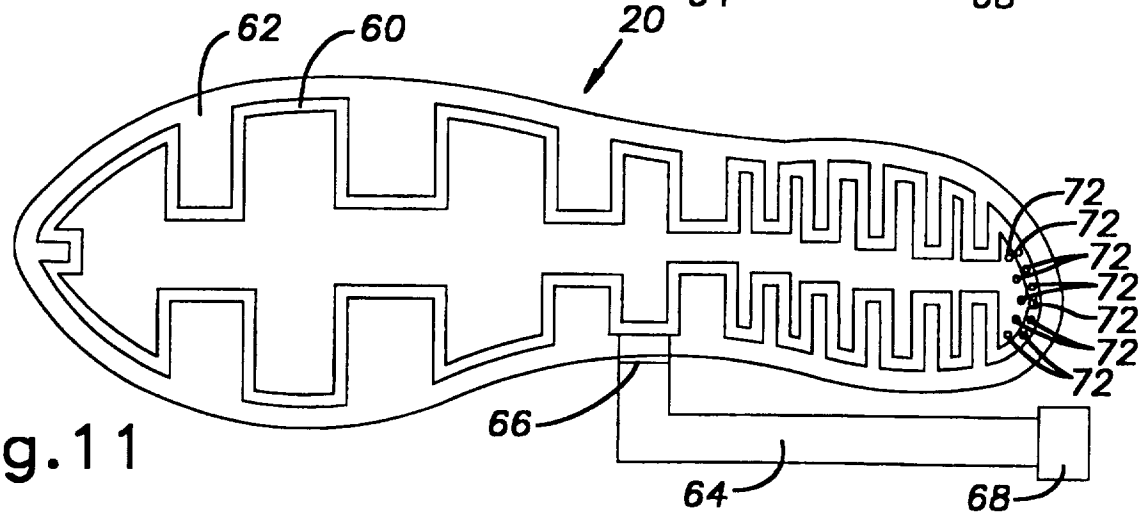


Fig.11

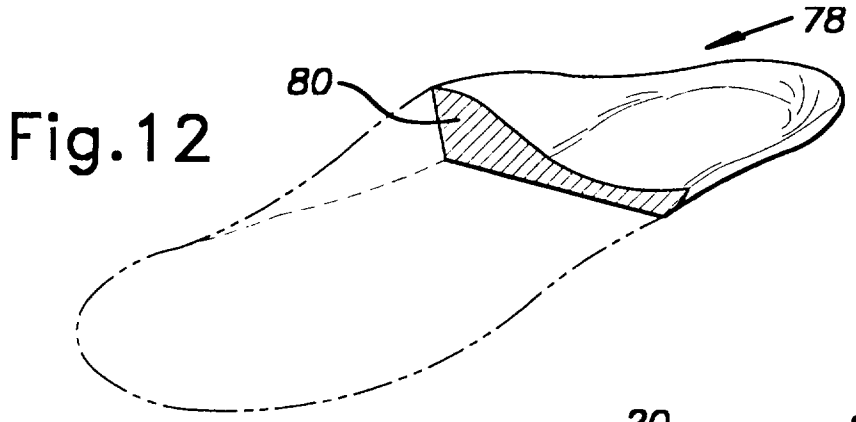


Fig.12

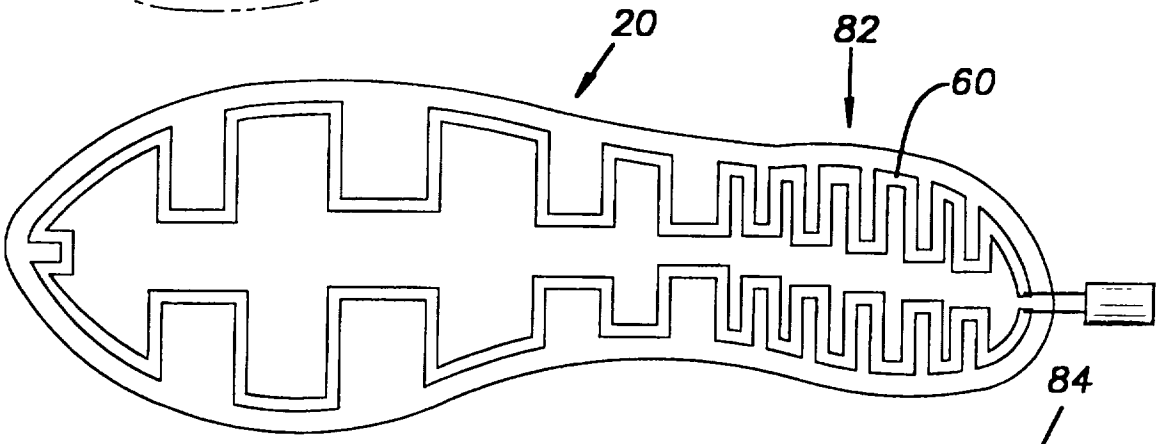


Fig.13

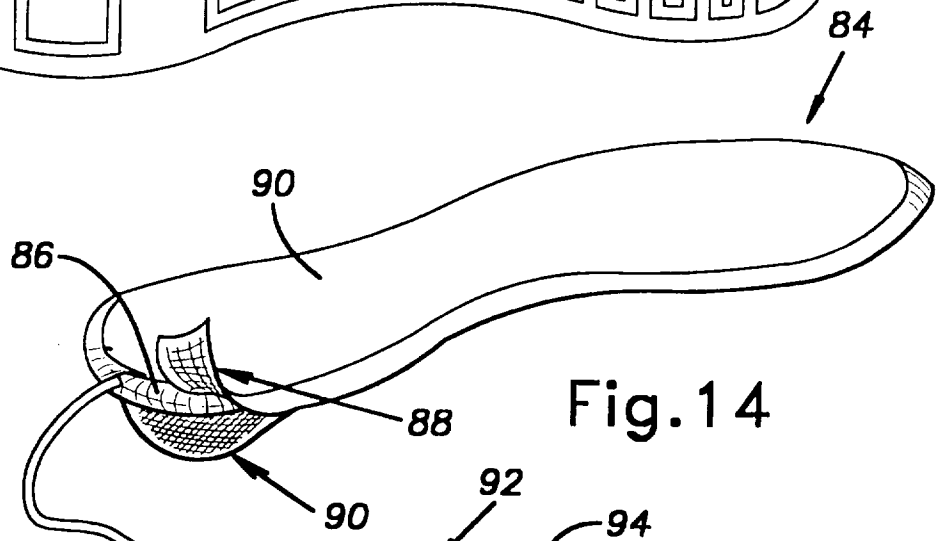


Fig.14

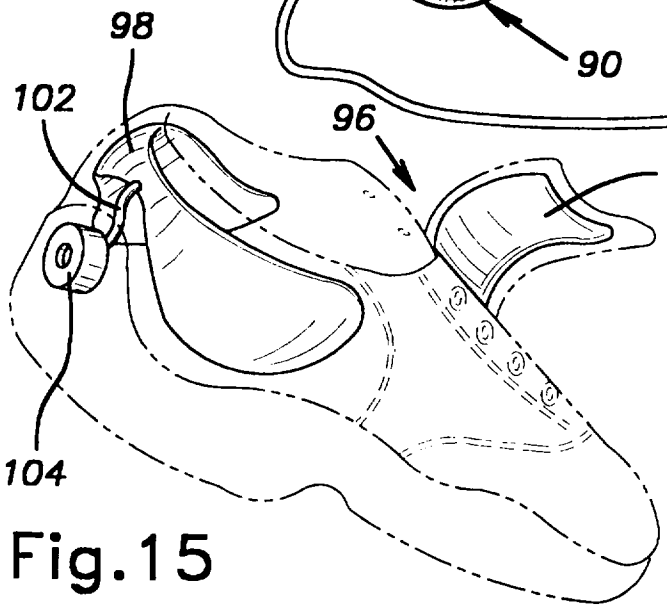


Fig.15

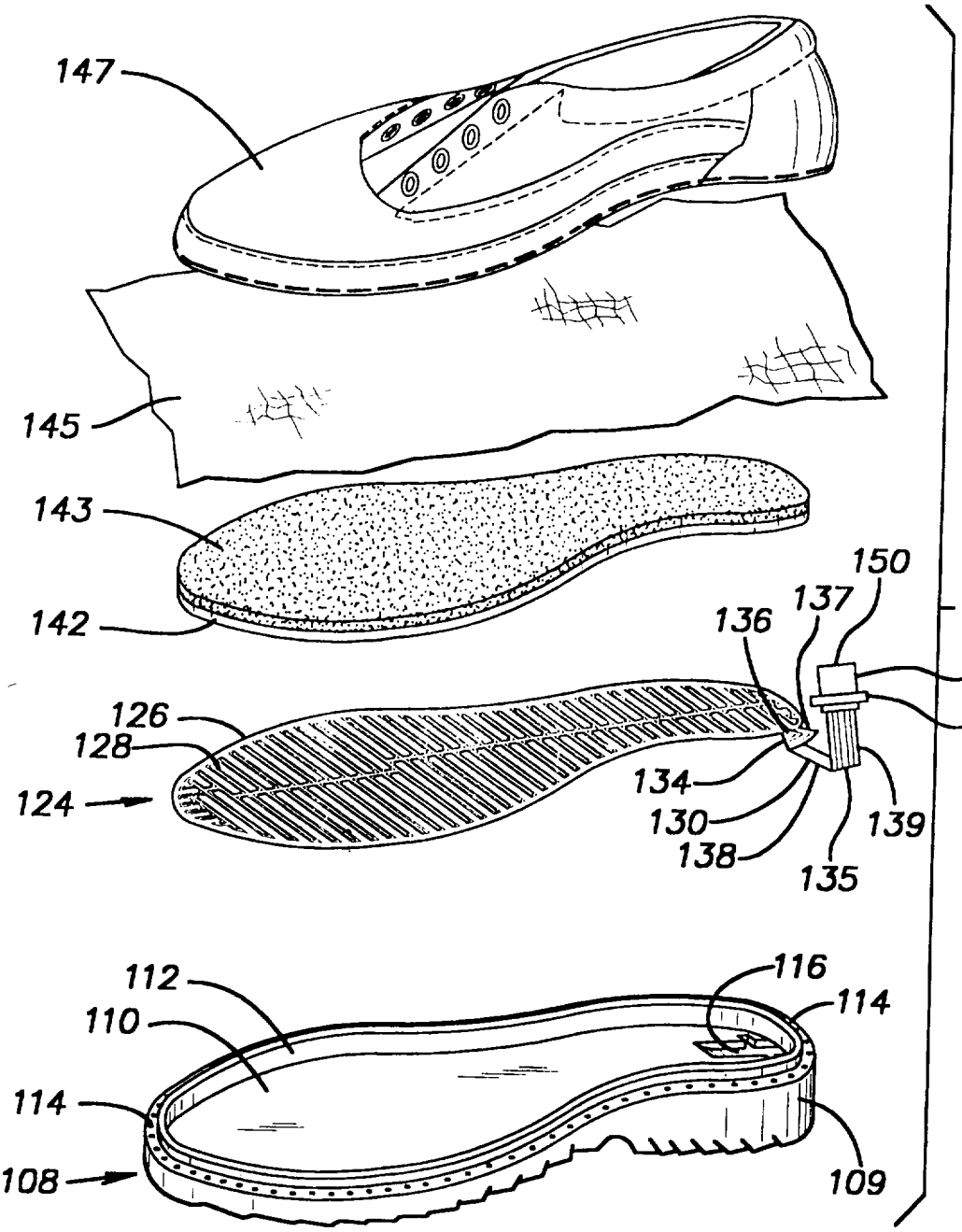

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Fig.16

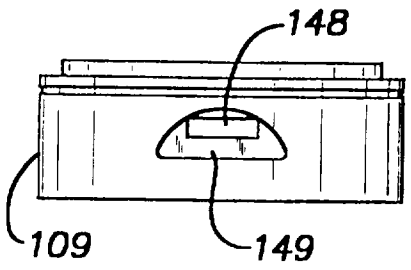

Fig.17

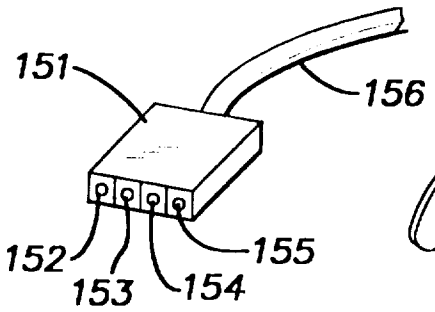

Fig.18

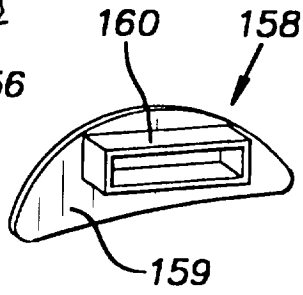

Fig.19

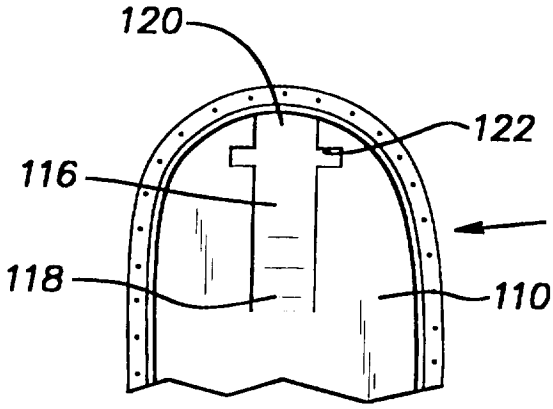

Fig.20

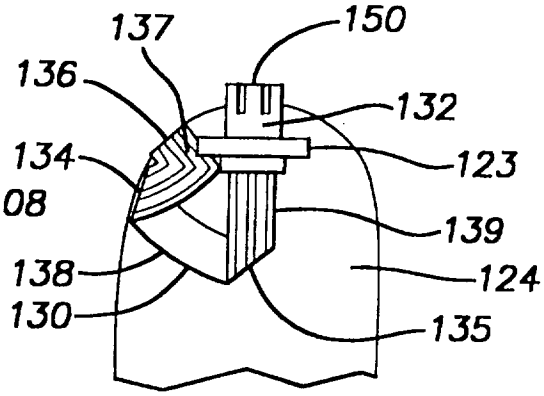

Fig.21

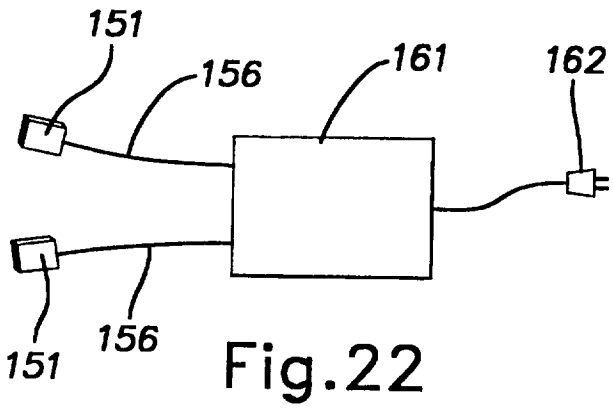

Fig.22

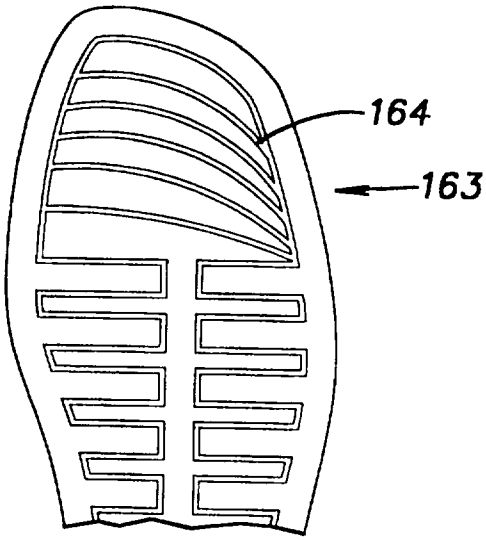

Fig.23

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/17427

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A43B 7/14, 7/02, 13/38
US CL : 36/93,2.6,44

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 36/93,2.6,44,153,154

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ---- Y	US 3,641,688 A (VON DEN BENKEN) 15 FEBUARY 1972, SEE THE ENTIRE DOCUMENT	1,10,11,14 --------- 2-6,8-9,12-13,15-21
Y	WATLOW CATOLOG, "FLEXIBLE HEATERS", PAGES 143-144, DATED PRIOR TO OCTOBER 1996	3,4,21
Y	US 4,433,494 A (COURVOISIER et al) 28 February 1984, SEE THE ENTIRE DOCUMENT	2,17
Y	US 5,203,793 A (LYDEN) 20 APRIL 1993, SEE COL. 19, LINES 49-66	12
Y	US 3,599,353 A (MAGIDSON) 17 AUGUST 1971, SEE LIP 16.	5

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search
05 NOVEMBER 1997

Date of mailing of the international search report
28 NOV 1997

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231
Facsimile No. (703) 305-3230

Authorized officer
For TED KAVANAUGH
Sheila Veney
Paralegal Specialist
Group 3200
Telephone No. (703) 308-1148

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/17427

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2,025,950 A (KURTZ) 31 DECEMBER 1935, SEE THE ENTIRE DOCUMENT.	13
Y	US 1,275,451 A (LILLARD) 13 AUGUST 1918, SEE THE ENTIRE DOCUMENT.	16,19,20
Y	US 4,055,699 (HSIUNG) 25 OCTOBER 1977, SEE THE ENTIRE DOCUMENT.	17,18