Enclosing Therapeutic Microwaveable Heat Transfer Device

Abstract

Therapeutic garments or devices for enclosing appropriate body parts, such as a mitten (50), a bootie (80), an elongated strip (130) and the like, are fashioned with polysiloxane layers (52, 54, 82, 86) having particles dispersed therein which absorb microwave energy and emanate heat in response. The silicone rubber layers (52, 54, 82, 86) are enclosed in respective cloth covers (56, 64, 102, 104, 110) and are stitched together along their lateral margins (106, 112, 120) to form a body part enclosure. The covering elements are made of materials which are substantially non-absorptive of microwave energy.
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ENCLOSING THERAPEUTIC
MICROWAVEABLE HEAT TRANSFER DEVICE

TECHNICAL FIELD OF THE INVENTION

The present invention relates generally to therapeutic devices for the treatment of localized injury or pain and specifically to a microwaveable, enclosing therapeutic microwaveable heat transfer device.
BACKGROUND OF THE INVENTION

It is well known that, for a therapeutic effect, both human and animal muscle tissue should be heated in some circumstances and chilled in others. For instance, sprained or strained muscle tissues are generally chilled to reduce swelling and further damage. Small, specialized ice packs are known which are designed for application of cold to localized areas.

Similarly, a variety of devices are known in the prior art for applying heat to localized areas of pain. Such devices include hot water bottles, which are ordinarily made of flexible rubber, and which can also include insulated coverings for conserving heat when the hot water bottle is filled with hot water. For instance, see United States Patent No. 2,072,564, issued March 2, 1937, to May, entitled Hot Water Bottle Cover. Other heating devices include electric heating pads in which a plurality of resistive heating elements are electrically actuated to provide a source of heat for treating localized areas of pain.

The prior art hot water bottle suffers from a variety of disadvantages. The device is cumbersome to use since it is necessary to fill the interior of the bottle with hot water from a tap. Even with an insulated covering, the device lacks the ability to retain a significant amount of heat for a prolonged period of time. The electric heating pad, while more efficient in operation and heat transfer ability, suffers from various limitations including the encumbrance which results from being attached to a power source by wires. Also, the electric pad can constitute a hazard from electrical voltage if used around water, such as in a bath area.

U.S. Patent Nos. 4,756,311 and 4,920,964 are related patents which both show thermal compresses which contain a cold pack gel material. The gel material is laminated by an envelope made of a film of synthetic resin. U.S. Patent No. 4,671,267 shows a body of gel which is encased within a heat permeable stretch fabric and applied to a body part. The reference also teaches applying the gel material directly to the injured skin to create a temporary skin with improved air permeability. The patent does not teach the inclusion of an electromagnetic absorptive
agent to render the material microwaveable, however.

U.S. Patent No. 4,596,250 issued to Beisang, III et al. discloses a cooling/heating therapeutic device based on an aqueous solution of propylene glycol, polysaccharide and plant gum, and including metal particles for absorption of microwave energy. The Beisang structure is capable of functioning as a moldable heating pack. However, since the Beisang structure contains a metallic lining that makes it unsuitable for microwave applications, and requires a separate, water impermeable envelope to contain the aqueous suspension, Beisang's structure has a less than optimum total specific heat and resistance to breakdown due to oxidation, ozone attack and general use, as well as biological attack.

A need therefore exists for an improved device and method for applying heat to localized areas of both human and animal bodies for relief of pain and for the prevention and/or treatment of injury.

A need also exists for such a device which is heat actuable without the presence of electric wires and which retains its heat transfer properties for a prolonged time period.

A need also exists for such a device to substantially enclose the body part, such that moist heat is entrapped thereby and such that a heat-irradiating member of the device substantially surrounds the body part.
SUMMARY OF THE INVENTION

According to one aspect of the invention, a microwaveable garment is provided which is adapted to surround a predetermined body part to effect heat transfer between the body part and the garment. The garment includes at least one matrix layer of microwaveable polymer, microwave energy-absorbing matter disposed within the matrix layer, and a flexible cover enclosing the matrix layer. Preferably, the polymer comprises polydiorganosiloxane. The microwave energy-absorbing matter disposed in the matrix is preferably selected from the group consisting of metals and those metallic compounds capable of absorbing microwave energy and translating same into heat.

The flexible cover enclosing the layer consists essentially of material which is substantially non absorptive of microwave energy.

According to further aspects of the invention, the garment may be formed as a hand covering, such as a glove or mitten, for effective heat transfer to the hand, a slipper or bootie for effecting heat transfer to the foot, a torso garment or an elongated strip for wrapping around an affected body member.

The various body part enclosing devices disclosed herein are operable to surround the affected body part with therapeutic heat. This produces a measure of pain relief, as from arthritic conditions which exceeds that of a simple non-enclosing pad. It is thought that the microwaveable, body-part enclosing devices of the invention are better able to retain moist heat because they form largely water impermeable enclosures. A further technical advantage inheres from the rugged construction of these therapeutic devices, since they are based upon polydiorganosiloxane or silicone rubber matrices. Silicone rubber is impervious to most forms of chemical attack and to oxidation, and to biological attack as well. Thus, therapeutic devices made according to the invention can be expected to endure many more heating cycles than the devices disclosed by the prior art. The devices according to the invention are also capable of being cooled and being used as enclosing cold compresses to reduce inflammation due to injury.
BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention, and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a perspective view of a mitten incorporating a polydiorganosiloxane matrix and fabricated according to the invention;

FIGURE 2 is an exploded perspective view of the mitten shown in FIGURE 1 with parts broken away, showing details of its construction;

FIGURE 3 is a perspective view of a slipper or bootie incorporating the microwaveable polydiorganosiloxane matrix of the invention, with phantom lines showing placement of internal components;

FIGURE 4 is a magnified elevational sectional view taken substantially along line 4-4 of FIGURE 3;

FIGURE 5 is a perspective view of an elongate moldable microwaveable strip according to the invention, shown wrapped around an arm of a user;

FIGURE 6 is a graph of temperature and humidity versus time illustrating a first humidity retention experiment using a mitten according to the invention; and

FIGURE 7 is a graph of temperature and humidity versus time illustrating a second humidity retention experiment using a second mitten according to the invention.
DETAILED DESCRIPTION OF THE INVENTION

The preferred embodiment of the present invention and its advantages are best understood by referring to FIGURES 1-59 of the drawings, like numerals being used for like and corresponding parts of the various drawings.

FIGURES 1 and 2 illustrate an embodiment of the invention wherein two matrix layers of polydiorganosiloxane have been incorporated into a mitten indicated generally at 50. Mitten 50 is sized to be slipped onto a patient's hand. The internal structure of mitten 50 is better illustrated by the exploded perspective view shown in FIGURE 2. Matrix layers 52 and 54 are provided in which are incorporated suitable microwave energy-absorbing matter, such as metallic particles, ferrite, a bendable wire mesh or the like.

Layers 52 and 54 each comprise a very flexible matrix material having blended therein an electromagnetic absorptive material to produce a homogenous matrix composition which is heatsable by exposure to microwave energy. The matrix material can comprise any of a number of commercially available flexible, elastomeric materials; for instance, the matrix material could be formed from a natural rubber, a synthetic rubber, a styrene butadiene rubber, ethylene propylene rubber, chloroprene, nitrile rubber or a silicone rubber. The criteria for selecting a candidate material are its heat stability and its ability to be easily compounded or blended with an electromagnetic absorptive material. The material is preferably water impermeable. The preferred material is a cured silicone rubber because of its heat stability and its superior resistance to embrittlement due to oxidation, ozone attack and general use.

The preferred matrix material for the microwaveable layers 52 and 54 can be manufactured by blending together a polyorganosiloxane gum with a particulate electromagnetic absorptive material to produce a homogeneous silicone rubber composition which is heatsable by exposure to microwave energy. The polyorganosiloxane polymers or gums employed in the preferred matrices of the invention are well known materials that can be made by standard methods known
in the art. The preferred polymer is a polyorganosiloxane gum which contains methyl, vinyl, phenyl and/or 3,3,3-trifluoropropyl radicals attached to the silicon atoms of the polymeric siloxane. Examples of polyorganosiloxane gums are those polymers, copolymers and mixtures thereof wherein the siloxy units can be dimethylsiloxane, phenylmethylsiloxane, 3,3,3-trifluoro propylmethylsiloxane, diphenylsiloxane, methyl vinylsiloxane, and phenylvinylsiloxane. A discussion of the preparation of such organic compounds can be found, for example, in: Eaborn, D., Organosilicone Compounds, Academic Press, New York, 1959; Montermos, J.C., Silicone Rubbers, Morton, E.D., Introduction To Rubber Technology, Reinhold Publishing Corp., New York, 1959; and Rochow, E.G., An Introduction To The Chemistry of Silicones, John Wiley and Sons, New York, 1951.

In order to provide a matrix composition which is microwave-heatable, a particulate, electromagnetic absorptive material is blended with the matrix material. A number of such materials are commercially available, including ferrites, powdered iron, powdered aluminum, and zinc oxide. Preferred materials include zinc oxide and powdered aluminum which, when blended in the range from about 5 to 30 parts per 100 parts polydiorganosiloxane gum, produce a silicone rubber blend which is heatable in the range from about 160°-180°F by exposure to a 700 watt microwave oven for one to five minutes. The matrix composition should require on the order of 40-50 minutes to return to 60°F.

The polydiorganosiloxane gum can contain any several filler materials. The preferred material is a reinforcing silica filler or a mixture of a reinforcing silica filler and a siliceous or calcareous extending filler. Examples of silica filler which can be used to reinforce the polydiorganosiloxane elastomer are fumed silica, precipitated silica, silica aerogel, etc. The filler material, including reinforcing and non reinforcing fillers, is preferably used in the range of about 1-260 parts of filler per 100 parts of polyorganosiloxane gum or elastomer, most preferably in the range from about 20 to about 80 parts of filler.

The microwaveable rubber composition is further
characterized by the presence of a polymerization catalyst, thereby permitting the composition to cure upon application of heat. Suitable curing compounds include various peroxides, such as benzoyl peroxide or dicumyl peroxide, and platinum. These catalysts are present in small amounts; benzoyl peroxide, for example, can be employed at concentration of about 0.6 parts per 100 parts by weight of the polydiorganosiloxane gum. A platinum catalyst would be used in much smaller amounts. In an alternative embodiment, omission of the catalyst will cause the matrix layers not to cure and to thereafter be moldable or malleable, thereby allowing the garment of which they are a part to closely conform to the affected body part.

In addition to the above described ingredients, the rubber matrix compositions which are preferred in the invention can contain heat stability additives, anti crepe hardening additives, compression set additives, additives to improve handling properties, dyes or coloring additives and other additives conventionally used in heat cured silicone elastomers and also room temperature cured (RTV) elastomers.

The preferred microwaveable silicone rubber matrix is made by blending or milling together the various constituents. The order of adding the elastomer, filler and electromagnetic absorptive material is not critical. The following example is intended to be illustrative of the invention:

40 Duro silicone Base* 100 parts
Vinyl dimethyl end-stopped
polydimethylsiloxane polymer 50 parts
Aluminum powder 10 parts
Benzoyl peroxide 0.6 parts

* Siloxane polymer with added filler, either fumed silica or precipitated silica such as Hi-Sil 233.

The area of coverage of the polysiloxane matrix layers 52 and 54 are preferably almost coincident, or at least cover a large part of, the area of coverage provided by the mitten or other garment over the hand or other body part.

Layer 52 is enclosed by a flexible cover 56 which is
substantially non-absorptive of microwave energy. Cover 56 consists of an outer sheet or piece 58 and an inner piece 60, which may be stitched together along their respective lateral edges on stitch line 62, and which may be fabricated of cloth. Layer 54 is likewise provided with a cover 64 which may be constructed of a cloth material similar to that of cover 56. Like cloth cover 56, cloth cover 64 may have an inner sheet or piece 66 which is stitched along a stitch line 68 to a lower, outer sheet or piece 70 to complete the containment of the gum layer 54. 

In the embodiment illustrated in FIGURES 1 and 2, once the mirror-image silicone layers 52 and 54 are covered, they are mated along their respective lateral edges and stitched together (not shown). Of course, no such stitching takes place along lateral margins 68 or 70, so as to leave an opening for the insertion of the hand. After stitching together, the halves of the construction are covered by an exterior cover indicated generally at 72. Cover 72 may consist of, for example, a top half 74 and a bottom half 76, which are stitched together at all lateral margins except for the hand opening. Like sheets 58, 60, 66 and 70, layers 74 and 76 should be constructed of a material which is substantially non-absorptive of microwave energy, such as cloth. The completed mitten 50 may include an elastic band indicated by phantom lines at 78 in FIGURE 1, to retain the mitten 50 on the hand. Device 50 may also take a glove form rather than the mitten shown. Device 50 may also include a sponge layer (not shown) or the like, affixed interiorly of the polysiloxane matrix layers 52 and 54 within the hand enclosure, to provide a moisture source for moist heat. Such a sponge layer may also be incorporated into the devices illustrated in FIGURES 3-5. Mitten 50 may also incorporate a number of further insulative layers (not shown) to be interposed between polysiloxane layers 52 and 54 and the hand to produce a more gradual, drawn-out heating effect at the hand surface. Mitten 50 may also incorporate insulative layers (not shown) between the polysiloxane layers 52 and 54 and the exterior to slow down the radiation of heat into the environment. In one preferred embodiment, one insulative layer is disposed between layers 52 and 54, and the hand, while an insulative layer of double thickness (or,
alternatively, two layers of single thickness) are placed between layers 52 and 54 and exterior covers 74 and 76. This causes the heat to radiate preferentially inwardly into the hand. These additional insulative layers should be substantially microwave-transparent and could be constructed of or filled with fiberfill or the like and would take the same silhouette as that of layers 58, 60, 66, 70, 74 and 76. These additional insulative layers would be joined to the other layers using conventional techniques such as stitching. Insulative layers may be added in a similar fashion to other enclosing garments according to the invention, such as those illustrated in FIGURES 3-5.

FIGURE 3 illustrates a device according to the invention for the enclosure of another part of the body, namely the foot. A slipper or bootie indicated generally at 80 incorporates three layers of microwaveable polysiloxane polymer, each indicated in FIGURE 3 by phantom lines: a layer 82 for one side of the foot, a layer 84 for an opposed side of the foot, and a sole layer 86. Layer 82 extends from the toe to the heel of the foot and generally over a respective half of the dorsum of the foot. Layer 84 is disposed in mirror image to layer 82. A heel margin 86 of the layer 82 is disposed adjacent a heel margin 88 of the layer 84. Similarly, a toe margin 90 of the layer 82 is disposed adjacent a toe margin 92 of the layer 84. Layers 82 and 84 together form an opening 94 for the insertion of the foot. A lateral margin 96 of the sole layer 86 is disposed to be adjacent bottom margins 98 and 100 of side layers 82 and 84, respectively, so as to complete the foot enclosure.

The details of construction of the bootie 80 are better shown in FIGURE 4, which is a detailed schematic sectional view taken substantially along lines 4-4 of FIGURE 3. The polysiloxane matrix layers 82 and 86 are enclosed in respective cloth covers. Layer 82 has an outer cloth cover piece 102, and an inner cloth cover piece 104. The lateral margins of cover pieces 102 and 104 are stitched together at 106. Similarly, the sole polysiloxane matrix layer 86 has an inner cloth cover piece 108 and an outer cloth cover piece 110. The lateral margins of cover pieces 108 and 110 are stitched together at 112. The stitched
lateral margins 106 and 112 are disposed to be in close association with each other to suitably enclose the foot with a heat-transferring layer but yet allow articulation of the two layers.

All materials used in the bootie 80, with the exception of the polymer layers 82, 84 and 86, are preferably constructed of a material which is substantially non-absorptive of microwave energy, such as cloth, foam rubber and the like. To complete the bootie 80, an exterior cover member 114 may be provided. Cover member 114 may be constructed of any of various conventional materials, including for example terry cloth. The cloth cover 114 may be glued or stitched to a cushionable midsole member 116. Alternatively, the terry cloth exterior cover 114 may be attached to a lower exterior skirt (not shown) which in turn would be stitched to the foam rubber midsole 116 at line 118. Also included are a durable outsole layer 120 that may be glued or otherwise affixed to the foam rubber layer 116 and the bottom skirt portion of the exterior terry cloth layer 114. A comfortable inner layer 122, which may be constructed of terry cloth or the like, is disposed across the top of the sole polysiloxane layer 86 as enclosed by cover pieces 108 and 112. A dorsal interior lining member 124 is disposed along the interior cover 104 of the polysiloxane matrix layer 82. A bottom lateral margin of the interior lining 124 is glued or stitched to a lateral margin of the bottom lining 122 at margin 126.

FIGURE 5 is a perspective illustration of another embodiment of the invention, which consists of an elongate strip indicated generally at 130. Strip 130 is preferably many times longer than it is wide, such that it may be wrapped around an arm, leg, neck, trunk or the like. Here, the strip 130 is shown wrapped around a forearm. The strip 130 includes a polysiloxane matrix layer as suitably enclosed by a cloth cover or the like, further preferably including an exterior cover 132. Both the interior cover (not shown) and exterior cover 132 are once again fabricated of a material which is substantially non-absorptive of microwave energy, such as cloth. These cover layers are so specified so that they will not be a barrier to the absorption of microwave energy by the polysiloxane matrix layer (not shown in
FIGURE 5). Suitable closure devices, such as VELCRO hook and loop closures, may be provided on the ends of or along the length of the strip 130 to affix it in place.

FIGURES 1-5 illustrate various embodiments of the invention where various body parts are enclosed by garments which include at least one polysiloxane matrix layer that has dispersed therein a particulate material capable of absorbing microwave energy and subsequently emanating heat. It has been found that fashioning the polysiloxane matrix layer(s) into enclosing garments confers an additional benefit to the wearer, as the suffering hand, foot, etc. is enclosed by a heat-sourcing layer. It has been discovered that the therapeutic value is enhanced over providing a simple nonenclosing layer of polyorganosiloxane. It is thought that the enclosure formed by the devices of the invention act to trap moist heat. While embodiments suitable for the hand, foot, and arm or other limb are shown, the invention also includes such embodiments as larger strips, leggings, tops, pants, torso wraps, shorts and the like.

The heat- and moisture-retaining advantages of the invention are demonstrated in the following examples.

Example 1

A mitten was fashioned in accordance with the invention and generally as shown in FIGURES 1 and 2. Two polysiloxane layers were used, each having a composition as specifically recited above. The polysiloxane matrix layers were .160 inches thick. In the first experiment, a mitten was used with double insulation on the outside and none on the inside.

This mitten was heated in a 700-watt conventional kitchen microwave oven for two minutes and ten seconds, and then removed. FIGURE 6 is a graph of temperature and humidity versus time as taken from probes inside the mitten, with temperature (in degrees F.) and humidity (as a percentage of maximum atmospheric moisture content), using the same scale. The portions of the temperature and humidity curves to the left of dashed line 200 should be disregarded as experimental artifacts. Without any layer of insulation on the interior of
the hand, the mitten proved uncomfortably warm (in excess of 140 degrees F.). The humidity data nevertheless show that for about the first ten minutes, 100 percent humidity was retained inside the mitten. Thereafter, the humidity dropped off to ambient atmospheric humidity with most of the drop taking place within the first 30 minutes. These data were recorded without having a hand inside the mitten.

**Example 2**

A second experiment was conducted similar to Example 1. This time, a mitten was fabricated to have two layers of insulation on the outside and one layer of insulation on the inside. This mitten was heated in the 700-watt microwave oven for two minutes and ten seconds, and the temperature and humidity data were recorded with the hand present in the mitten. The temperature and humidity results over time are graphed in FIGURE 7. Data to the left of line 202 should be disregarded as an experimental artifact.

As FIGURE 7 shows, the increased rate of drop in humidity indicates acceptance of the entrapped moisture by the hand. This in turn also indicates the transference of moist heat to the hand in a desirable fashion. Also, note that after approximately ten minutes, there is a gradual increase in humidity inside the mitten, indicating the retention of hand-generated moisture therein because of the enclosed, water-impermeable nature of the polysiloxane layers and the garment in general.

FIGURE 7 also indicates that with one insulative layer on the inside of the mitten, the apparatus is suitable for the placement of the hand therein, with temperatures peaking at about 130 degrees F. at ten minutes and gradually falling thereafter.

**Example 3**

In a further experiment, a non-enclosing polysiloxane matrix layer was fabricated to take a non-enclosing pad configuration. The pad was subjected to a microwave oven for two minutes and ten seconds, as in the previous experiments. However, no humidity in excess of the atmospheric ambient was noted at any time during the recording period. These data show the importance of having an enclosing garment for the
transference of moist heat to the affected body part.

An invention has been provided with several advantages. The enclosing, heat-transferring device of the invention can be used for a variety of medical applications without the encumbrance of being attached to a power source by wires. Also, the device of the invention does not represent a hazard from the electric source, even if water is present. The device is simple and economical to manufacture and is not easily damaged in use. The illustrated embodiments are suitable for enclosing various body parts, thus enhancing the therapeutic value of the invention.

Although the present invention and its advantages have been described in detail, it should be understood that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the invention as defined by the appended claims.
I CLAIM

1. A microwaveable garment adapted to surround a predetermined body part to effect heat transfer between the body part and the garment and to trap moist heat, comprising:
   at least one substantially water-impermeable microwaveable flexible matrix layer having a polydiorganosiloxane matrix extending to substantially surround the predetermined body part;
   microwave energy-absorbing matter distributed throughout said matrix layer; and
   a flexible cover consisting essentially of material which is substantially non-absorptive of microwave energy, said cover enclosing said layer.

2. The garment of Claim 1, wherein said microwave energy-absorbing matter comprises particulate matter dispersed in said matrix layer.

3. The garment of Claim 1, wherein said microwave energy-absorbing matter is selected from the group consisting of metals and metallic compounds capable of absorbing microwave energy.

4. The garment of Claim 1, wherein said matrix layer has a width and a length many times said width, such that said garment may be wrapped around a body part.

5. A microwaveable garment adapted to surround a predetermined body part to effect heat transfer between the body part and the garment and to trap moist heat, comprising:
   a plurality of flexible, substantially water-impermeable matrix layers each having a polydiorganosiloxane matrix, with microwave energy-absorbing matter distributed throughout each said matrix;
   for each matrix layer, a flexible cover consisting essentially of material which is substantially non-absorptive of microwave energy, each said flexible cover enclosing its respective matrix layer;
each flexible cover disposed adjacent at least one other flexible cover, said flexible covers having lateral margins, at least one lateral margin of each flexible cover joined to a lateral margin of an adjacent flexible cover; and

said garment having an area of coverage over said body part, said matrix layers extending over at least most of said area of coverage so as to substantially enclose the body part.

6. The garment of Claim 5 wherein said flexible cover have exterior sides facing away from the body part, said garment further including a flexible outer cover covering said exterior sides.

7. The garment of Claim 5 wherein said flexible covers have interior sides facing toward said body part, said garment further including a flexible inner cover covering said interior sides and for disposal between said interior sides and said body part.

8. The garment of Claim 1, wherein said flexible covers are joined together to form pockets for retaining said matrix layers.

9. A microwaveable therapeutic device for effecting heat transfer with respect to the hand and to trap moist heat, comprising:

first and second substantially water-impermeable flexible layers each comprising a polydiorganosiloxane matrix, a microwave-absorbing material distributed throughout each of said first and second layers, said first layer sized and shaped to be disposed adjacent a palm side of a hand, said second layer sized and shaped to be disposed adjacent a dorsal side of said hand;

a first flexible cover formed of a material which is substantially nonabsorptive of microwave energy and formed to enclose said first layer;

a second flexible cover formed of a material which is substantially nonabsorptive of microwave energy and formed to enclose said second layer;
said first and second covers having lateral margins, means for affixing lateral margins of said first cover to respective lateral margins of said second cover to form a hand enclosure, such that said first and second layers substantially surround the hand.

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10. The device of Claim 9, and further comprising a flexible outer cover formed of a material which is substantially nonabsorptive of microwave energy, said first and second covers having exterior sides facing away from said hand enclosure, said outer cover covering said exterior sides.

11. A microwaveable therapeutic device for effecting heat transfer with respect to the foot and to trap moist heat, comprising:

a plurality of flexible microwave-absorbing layers disposed adjacent to each other so as to substantially enclose the foot, said layers including first and second layers each comprising a polydiorganosiloxane matrix, a microwave-absorbing material distributed throughout each of said microwave-absorbing layers, said first layer disposed adjacent the inner side of the foot, said second layer disposed adjacent the outer side of the foot;

a first flexible cover formed of a material which is substantially nonabsorptive of microwave energy and formed to enclose said first layer;

a second flexible cover formed of a material which is substantially nonabsorptive of microwave energy and formed to enclose and second layer; and

said first and second covers having lateral edges, said edges disposed adjacent each other along at least some of their respective lengths to form a foot enclosure.

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12. The device of Claim 11, and further comprising a third microwave-absorbing layer comprising a substantially water-impermeable polydiorganosiloxane matrix, a microwave-absorbing material disposed in said third layer, said third layer conforming in shape
to the sole of the foot; a third cover formed of a material which is substantially nonabsorptive of microwave energy and formed to enclose said third layer;

said first and second covers having bottom, dorsal and heel edges, an endless lateral edge of said third cover disposed adjacent said bottom edges of said first and second covers, said dorsal edges of said first and second covers disposed adjacent each other, said heel edges of said first and second covers disposed adjacent each other, such that said first, second and third layers substantially enclose the foot.

13. The device of Claim 12, wherein said third cover has a bottom surface facing away from said foot enclosure, said device further including a sole affixed so as to be disposed adjacent said bottom surface.
FIG. 6

FIG. 7
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

<table>
<thead>
<tr>
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<th>US CL</th>
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<td>A61F 7/00</td>
<td>607/111, 114, 101 219/10.55M</td>
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**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

| U.S. | 607/111, 114, 101 219/10.55M |

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

Please See Extra Sheet.

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

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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<td>&amp;</td>
<td>US, A. 4,914, 717 (Gibbon) 03 April 1990</td>
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<td>Y</td>
<td>US, A, 5, 070, 223 (Colasomte) 03 December 1991 (see column 9, lines 50-65.)</td>
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<td>US, A, 2, 403, 676 (Modlinski) 09 July 1946 (see whole document).</td>
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<td>A</td>
<td>US, A, 2, 515, 298 (Feldman) 18 July 1950 (see whole document).</td>
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<td>A</td>
<td>US, A, 4, 920, 964 (Francis, Jr.) 01 May 1990 (see whole document).</td>
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[X] Further documents are listed in the continuation of Box C.  

See patent family annex.

- **A** document defining the general state of the art which is not considered to be part of particular relevance
- **E** earlier document published on or after the international filing date
- **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)
- **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
- **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
- **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
- **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
- **&** document member of the same patent family

**Date of the actual completion of the international search**

24 August 1993

**Date of mailing of the international search report**

01 Nov 1993

Name and mailing address of the ISA/US

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Mark S. Graham

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Facsimile No. NOT APPLICABLE

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<td>US, A, 4, 938, 222 (Bier, Jr.) 03 July 1990 (see whole document.)</td>
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<td>Y</td>
<td>GB, A, 2, 158, 936 (Matthews 20 November 1985 (see whole document).</td>
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B. FIELDS SEARCHED
Documentation other than minimum documentation that are included in the fields searched: