June 20, 1967 J. N. LOGUE ETAL 3,326,211

REUSABLE CAST-LIKE APPLIANCE

Filed March 31, 1964 2 Sheets-Sheet 1

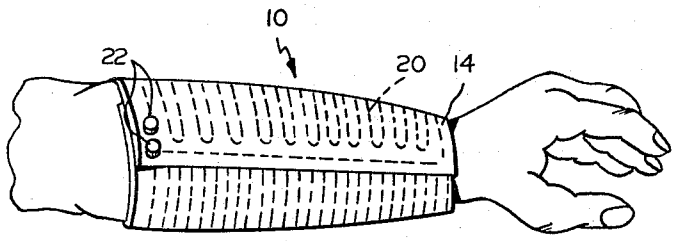


FIG. 1

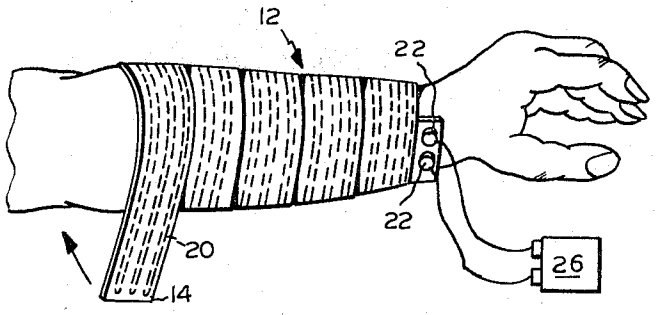


FIG. 2

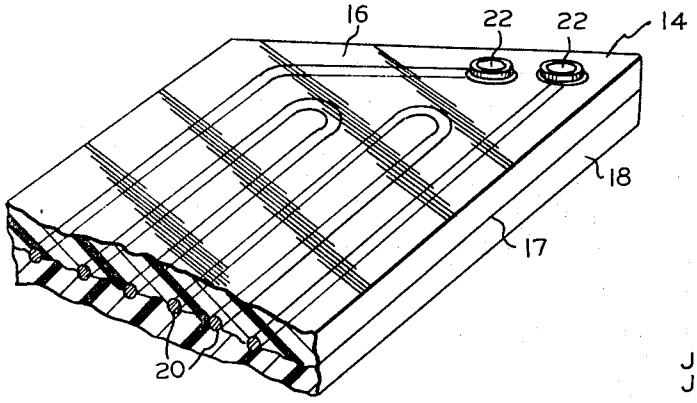


FIG. 3

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REUSABLE CAST-LIKE APPLIANCE

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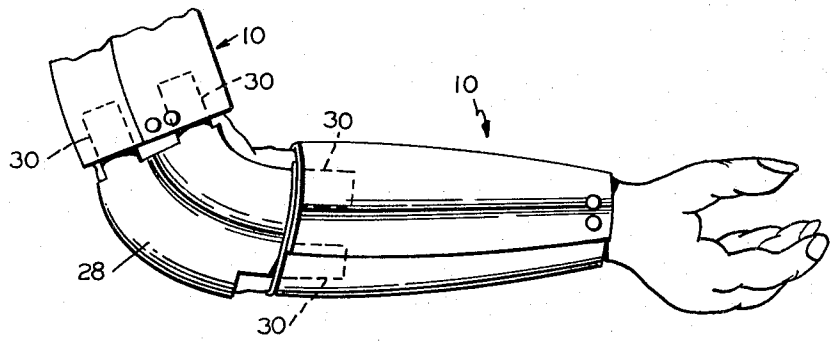


FIG. 4

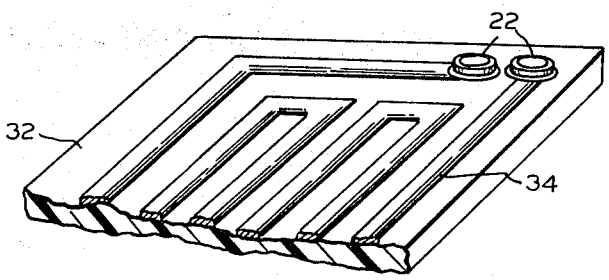


FIG. 5

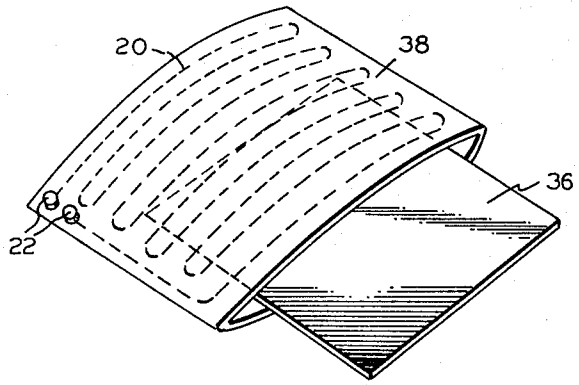


FIG. 6

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REUSABLE CAST-LIKE APPLIANCE

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2 Claims. (Cl. 128—90)

This invention relates to a surgical cast, and more particularly to a light-weight cast of plastic material which may be quickly applied to an injured member, readily removed therefrom, and reused when and as desired.

The conventional plaster cast universally employed is characterized by a number of disadvantages, including excessive and often uncomfortable bulk and weight, the necessity of time-consuming preparation and application techniques, as well as inefficient and uneconomic single-service use thereof as the cast must be destroyed in removing the same from the limb or other member undergoing treatment. Despite these and other undesirable attributes all too familiar to the medical profession, the conventional plaster cast, substantially unaltered throughout the years, continues in universal service in the absence of an effective, simple substitute therefor.

Efforts have been made in the past to overcome one or more of the disadvantages of plaster casts, but without material success. Thus, it has been suggested for example, that a plaster cast be made in two C-shaped sections connected by zippers, as in U.S. Patent 3,085,569. While such construction facilitates removal of the cast and access to the encased body member, the cast otherwise retains is objectionable bulk and weight, may still only be employed once and then discarded, and is rendered appreciably more complex and expensive in the provision of zippers and related structural components. A different tack is taken by U.S. Patent 2,483,715, which contemplates the provision of a length of thermoplastic material helically wound about the body member wherein overlapping edges of adjacent windings are fused together to form an integral sleeve. Such a cast partially reduces the bulk and weight disadvantages of the usual plaster cast, but nonetheless cannot be removed from the member for interim treatment thereof without destroying the cast, thereby requiring fabrication of a new plastic cast upon the limb after treatment thereof.

Many other approaches hitherto suggested are likewise deficient in one or more significant practical or medical respects, including undue complexity and attendant increased expense as compared to plaster casts.

It is therefore a principal object of our invention to provide a surgical cast or comparable appliance which successfully overcomes the many disadvantages of the conventional cast, and which is likewise superior in major practical respects to other unsuccessful cast forms.

It is a further object of our invention to provide a cast which may be quickly and easily applied without time-consuming preparation techniques normally required with plaster of Paris casts, whereby the cast of our invention may readily be employed in the field or under emergency conditions, as well as under relatively ideal conditions found in a hospital or doctor's office.

It is another object of our invention to provide a surgical cast which is of light weight and may easily be provided in a variety of standard sizes and forms for off-the-shelf usage in hospitals and the like, as well as being incorporated as a standard component of first-aid equipment for emergency use by civilian or military units.

It is an additional important object of our invention to provide a novel cast which may be speedily removed when necessary for interim treatment of the encased body member, and thereafter readily reapplied to the body member for continued support following treatment.

As a corollary thereto, it is a significant object that our plastic cast may be readily reused upon the same or successive patients, thereby effecting material economies in supplies and labor, and contributing to the minimization of expense for the benefit of the medical profession and the public at large.

An important object of our invention resides in the provision of a rigid plastic cast or like restraining device which incorporates therein means for rendering the same flexible when desired, whereby the cast may be applied, removed and reapplied with facility, requiring only an external power source in any of the several forms of the invention.

Another object of our invention resides in the provision of a reusable cast-like device which without altering the principles thereof, may be employed in related supporting, restraining and packaging applications whether animate or inanimate.

These and other objects and advantages will become clearly apparent from the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is perspective view of one form of a cast of a preferred construction as applied to a body member.

FIG. 2 is a perspective view of a second form of cast of a preferred construction as applied to a body member.

FIG. 3 is an enlarged fragmentary perspective view of a preferred construction of cast material.

FIG. 4 is a perspective elevation illustrating the use of a splint or like support member as cooperatively associated with the cast of our invention.

FIG. 5 is an enlarged fragmentary perspective view of a second modified form of cast construction.

FIG. 6 illustrates a further modified form of our cast.

Referring to the drawings, the cast **10** of FIG. 1 and the cast **12** of FIG. 2 are formed from a composite laminated sheet **14** shown in greatly enlarged detail in FIG. 3. The sheet structure comprises substantially coextensive upper and lower thermoplastic sheets **16** and **18**, which may be heat sealed or otherwise laminated together throughout substantially their entire area. Sandwiched between the sheets at their bonded faces **17** is an elongated, sinuously wound electrical resistance element **20**. The resistance element **20** in any given form of the invention preferably comprises a single elongated wire which terminates at its end in adjacent electrical contacts **22** secured to the surface of the upper laminated sheet **16**.

The electrical resistance element **20** in the preferred form of the invention constitutes a length of wire or a comparable etched copper conductor which being sinuously disposed substantially throughout the entire length and span of the laminate **14** will thus, when energized from a battery or other suitable electrical power source **26** (FIG. 2) substantially uniformly heat the normally relatively rigid plastic laminate **14** throughout its area so that the same is rendered soft and flexible, without becoming molten or heated to a temperature in excess of that reasonably comfortably withstood when applied to the injured limb of a patient. We have found that a power supply providing approximately 2 watts per square inch of laminate in still air at 70° F. is satisfactory for proper manipulation of the cast in a preferred form thereof. The current and voltage required to approach this power density for any given laminate will of course vary and is readily predetermined for any given size or shape of laminate **14**, depending upon, also of course the length, gauge and type of wire therein, thickness of the plastic sheets, particular plastic material employed, etc. as will be readily understood by those skilled in the art.

In one working embodiment of the invention, we have successfully employed laminated Vinylite sheets each $\frac{1}{32}$"

thick and between which is bonded enameled 30-gauge copper wire in a closely spaced zig-zag pattern.

In more detail, a preferred range of thickness for polyvinyl chloride sheets **16**, **18** resides between .020–.075" for each sheet, wherein the conductor element embedded therebetween is preferably of copper of a size approaching .020" x .0014". This exemplary laminate, as is apparent, is clearly characterized by almost negligible bulk and weight as compared to the conventional plaster cast.

While for the sake of clarity in the drawings, we have shown adjacent turns or laps of the resistance element **20** as being relatively widely spaced, it will be understood that the resistance element will have successive loops or other weave pattern thereof in quite closely spaced relationship on the order of .10", and indeed with insulated fine wire, adjacent turns may even be in contact at several points throughout the laminated sheet **14** as required to achieve uniform heating and softening thereof throughout its span and avoid cold spots or relatively unheated areas which would lack the necessary flexibility for proper contouring as required.

Thus, with respect to the convolutely wrapped cast **10** of FIG. 1, a laminated sheet **14** of the character described would have a substantially square or broad rectangular outline. In the form shown, the blank **14** is of sufficient length to encompass the length of a forearm and having a span sufficient to permit partial lapping of the ends of the sheet thereby to completely enclose the arm member. Obviously for greater strength or support as determined by the medical practitioner, the sheet **14** may have a length sufficient to form a plurality of convolutions in forming the cast **10**.

In forming the slightly modified cast **12**, FIG. 2, the laminate **14** is in the nature of an elongated relatively narrow strip having the button-like electrical terminals **22** at one end thereof on the exterior sheet **16**. In applying the same to the injured limb, the heated and flexible laminate is helically wound about the member with successive adjacent marginal edges of the strip in slightly overlapping relation so as to thereby completely encompass and encase the member within the cast **12** when the same rigidifies. Depending upon the extent of the injury as determined by the attending physician, the strip **14** may be of sufficient length to effect a plurality of helical windings traversing back and forth across the limb in thus forming the cast **12**.

Inasmuch as the cast material is non-absorbent as well as relatively rigid when cooled, it is desirable and indeed preferable to initially wrap the injured member with a padding material of gauze, cotton or the like prior to application of the cast as above described. The use of padding thus absorbs perspiration, prevents localized pressure points of the plastic cast with the flesh which may develop sores, and also insulates the skin, which may be quite tender, from direct contact with the relatively hot softened plastic.

Should the injured encased member require a further or subsequent treatment of an area or portion thereof within the cast as is often the case with flesh-wound fractures, or skin irritation, it is only necessary to connect a source of electrical energy as at **26** to soften the plastic laminate **14**, permitting the same to be readily unwound or unwrapped from the injured member. It is important to note that following treatment of the wound, dressing or other work, the cast may then be reformed upon the body member using the same laminated sheet **14**.

This facet of our invention is especially significant as compared with present day practice, for example, in conjunction with compound fractures which involve contaminated wounds. After the bones have been set and in traction, our cast may be opened or unwrapped and the wound treated. Thereafter the cast could be promptly reformed to again rigidify the limb. As is apparent, such facility of treatment and immediate recasing of the limb in the cast utilizing the same cast material cannot possibly be accomplished with present plaster casts, entirely apart from the highly advantageous economic aspects of our cast as compared therewith.

Further utility of our invention is exemplified by FIG. 4. As seen therein, a pair of casts **10** rigidifying and encasing an injured limb, may also be employed in beneficial conjunction with a complexly contoured splint-like element, such as the elbow element **28** of FIG. 4. The element **28** is illustrative of a class of comparable complexly contoured members, for knees, shoulders, etc., and comprises an unheated, pre-shaped sheet member which is in lapped relationship with one or more adjacent casts **10**, thereby forming in effect an elongated rigid cast for supporting irregular body portions. The preformed element **28** illustrated in FIG. 4 may be provided with projecting tab portions as at **30** of a shape as desired for the particular application contemplated. Thus, the element **28** will be applied to an elbow, knee, etc., after which the cast or casts **10**, **12** are formed. While we have shown the tab-like portions **30**, it is readily apparent that full width terminal ends of a preshaped member **28** could be encased within adjacent casts to cooperate therewith to readily support the member in lieu of the tab-like portions shown. The portions **28** of course need not be preformed, but may comprise in-stock flat sheets of plastic which may be softened by infrared or other comparable means to permit shaping of the same to the contour of the affected part. After cooling thereof to the desired contour, the same would be cooperatively associated with the casts of our invention to form the elongated rigid cast assembly required. Likewise, member **28** may be of other deformable relatively rigid material, such as aluminum in the manner of the splint in U.S. Patent 2,958,325. It is of course apparent that a supporting member **28** may also be employed with the helically wrapped cast **12** of FIG. 2.

A modified form of plastic sheet from which casts **10** or **12** may be formed is shown in FIG. 5. In this form of the invention there is employed only a single non-laminated sheet of thermoplastic **32**. On the exterior surface thereof, the sheet **32** is provided with a flexible conductive coating **34** arranged in a pattern comparable to that of the embedded wires **20** in FIG. 3. The conducting coating **34** terminates in suitable external contact buttons **22** as before. In this form of the invention manufacture thereof is simplified in eliminating the necessity for laminating superposed sheets. In using the surface-conductive sheet **32** in forming a cast as at **10** or **12**, it is of course apparent that the surface conductors **34** should be on the exterior surface of the cast as wrapped in order that access may be had to contacts **22**, as well as to prevent direct contact of the conductive coating with the flesh. While the construction is thus simplified, the heating effect is relatively less efficient inasmuch as a portion thereof is lost to the atmosphere as compared with the preferred laminate **14** wherein the embedded resistance element **20** radiates all generated heat to the surrounding plastic laminate without appreciable loss.

FIG. 6 illustrates a further modified form of our invention wherein a single thin sheet of thermosoftenable plastic **36** is disposed within an envelope of cloth or the like **38**, the cloth envelope having the resistance element stitched or otherwise secured to the layers of the same. Thus, the plastic sheet **36** is inserted within the envelope **38**, and the open end or ends of the envelope if desired may be zippered or snapped shut by means of suitable conventional fasteners. Thereafter electrical energy is supplied to the envelope-mounted contacts **22** to thereby heat the element **20** and cause softening of the sheet **36** therewithin. After sufficient heating, the envelope **38** with the sheet **36** therewithin as a whole are wrapped or encased around the affected member, the electrical current discontinued when desired, and the sheet **36** permitted to cool and rigidify to form the cast.

Thus while employing certain of the principles of the instant invention, the modification of FIG. 6 differs in

certain respects from other forms thereof in that the plastic sheet is not provided with a self-contained heating element, but requires in cooperative association therewith the encasing electrically heated envelope, the two together thus forming a two-part cast embracing the advantages and utility of our invention as above set forth.

In removing the cast of FIG. 6, the encasing blanket or cloth **38** will be heated to thereby soften the sheet, permitting unwrapping and removal of the two-part cast, which as before may be reapplied or reused when necessary.

While we have described our cast-like appliance in connection with the application thereof to a body member such as an arm, it is readily apparent that cast-like supporting and protecting members according to the teachings herein may be utilized in conjunction with other portions of the anatomy, such as the back, torso, neck, etc., and indeed the invention can find use as a restraining garment or blanket. Likewise the applicance of our invention may be employed with animals, or in other environments where a supporting or protecting member having a self-contained heating element which may be rendered flexible when desired but which becomes relatively rigid upon cooling, is desirable. The invention lends itself to fabrication in a variety of shapes and sizes to accommodate all reasonably conceivable applications for off-the-shelf usage as will be apparent.

While Vinylite is a material which has been successfully employed, it is apparent that any thermosoftenable plastic material may be employed which upon limited heating thereof becomes sufficiently flexible to be contoured without distension, wound, or wrapped around an injured member, and which returns to a substantially rigid and inflexible state upon cooling of the plastic material to ambient temperature.

While in the preferred embodiment a single resistance element is disposed throughout the cast material, it is within the scope of our invention to provide two or more separate resistance elements associated with a given laminate, each element having its own terminals **22**, and thus each being arranged to heat only a portion of the cast material either simultaneously or successively as required. The provision of a plurality of resistance elements in a single plastic cast can be advantageous with relatively larger-area laminates, or those of irregular configuration, as H or T-shaped.

The nature and uses of our invention are believed clearly apparent from the foregoing, wherein the laminate **14** may be fabricated according to our teachings by any of several processes comprehended by those familiar with the art. For the sake of further understanding, another successful techinque by which the cast laminate may be formed is set forth in some detail as follows:

A one-ounce sheet of clean, dry cold rolled copper is laminated under heat and pressure to a sheet of clean, dry polyvinyl chloride. A suitable temperature is 325° F. at a pressure of 20 p.s.i. Pressure is maintained for about one minute under heat, after which the pressure platens are cooled to approximately 100° F. The composite sheet is then removed and coated, as by spraying, with "Kodak" photoresist, following which the coated sheet is oven-dried for 15 minutes at 140° F. The sensitized surface of the sheet is covered with a negative of the pattern to be etched and exposed to ultraviolet light for one minute. The exposed copper pattern is developed in trichloroethylene, after which a heated ferric chloride solution is employed to dissolve out the unexposed copper. Following removal of the photoresist coating the composite sheet thus is provided with a copper resistance element pattern of desired design, to the ends of which lead-out wires are soldered. Thereafter, a second polyvinyl chloride sheet is laminated thereover to finish the cast laminate with the conductor pattern disposed and imbedded in the median plane thereof.

What we claim is:

1. A removable and reusable cast-like appliance for body members, comprising a sheet of thermosoftenable plastic material which is relatively rigid at ambient temperatures, an envelope having a wall of flexible insulating material, said envelope enclosing said sheet, and a flexible electrical resistance element secured to said wall of the envelope for heating said sheet therewithin to thereby render said sheet flexible for contouring of said sheet, envelope, and resistance element as a unit to said body members.

2. The appliance of claim **1** wherein said envelope is provided with fastening means around an opening therein for closing the opening to retain said sheet in the envelope.

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