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[54] INFLATABLE SURGICAL CAST

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[52] **U.S. Cl.** .....**128/90**, 128/91 A, 128/DIG. 20

[51] **Int. Cl.** **A61f 5/04**

[58] **Field of Search** .....128/90, 87, 89, 83, 83.5, DIG. 20; 3/19, 20

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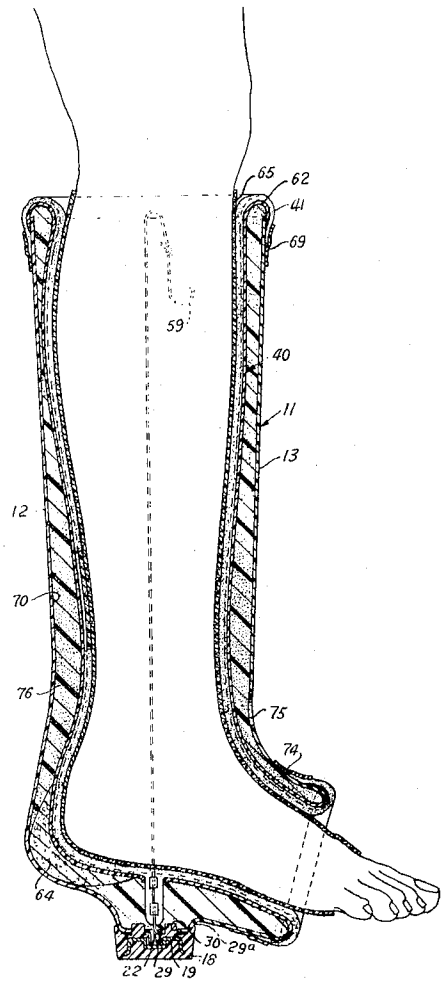
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[57] **ABSTRACT**

A water-impervious cast having a rigid tubular outer wall or shell and a flexible tubular inner wall which form a substantially cylindrical chamber about a body portion, such as a leg, arm, torso and the like, to be immobilized by the cast and a foamed-in-place rigid plastic filling the chamber and causing the inner surfaces of the flexible wall to contact the body portion and assume the configuration of the body portion to hold immobile the body portion. A method of forming a cast about a body portion by forming a substantially cylindrical chamber about a body portion by forming a substantially cylindrical chamber about a body portion closed at both ends and having an inner flexible wall movable into engagement with the body portion and introducing a foam-producing substance into the cylindrical chamber to cause it to foam and expand and move the flexible wall into engagement with and to conform to the shape of the body portion while the body portion is immobile.

10 Claims, 7 Drawing Figures



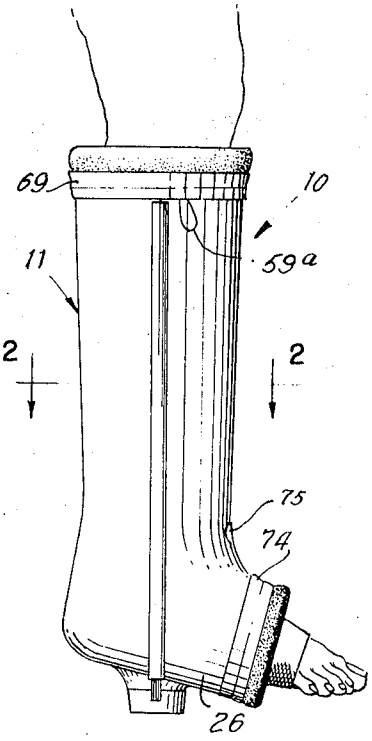


Fig.1

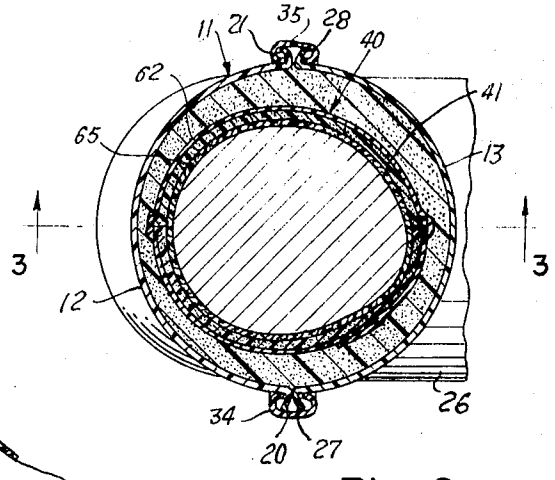


Fig. 2

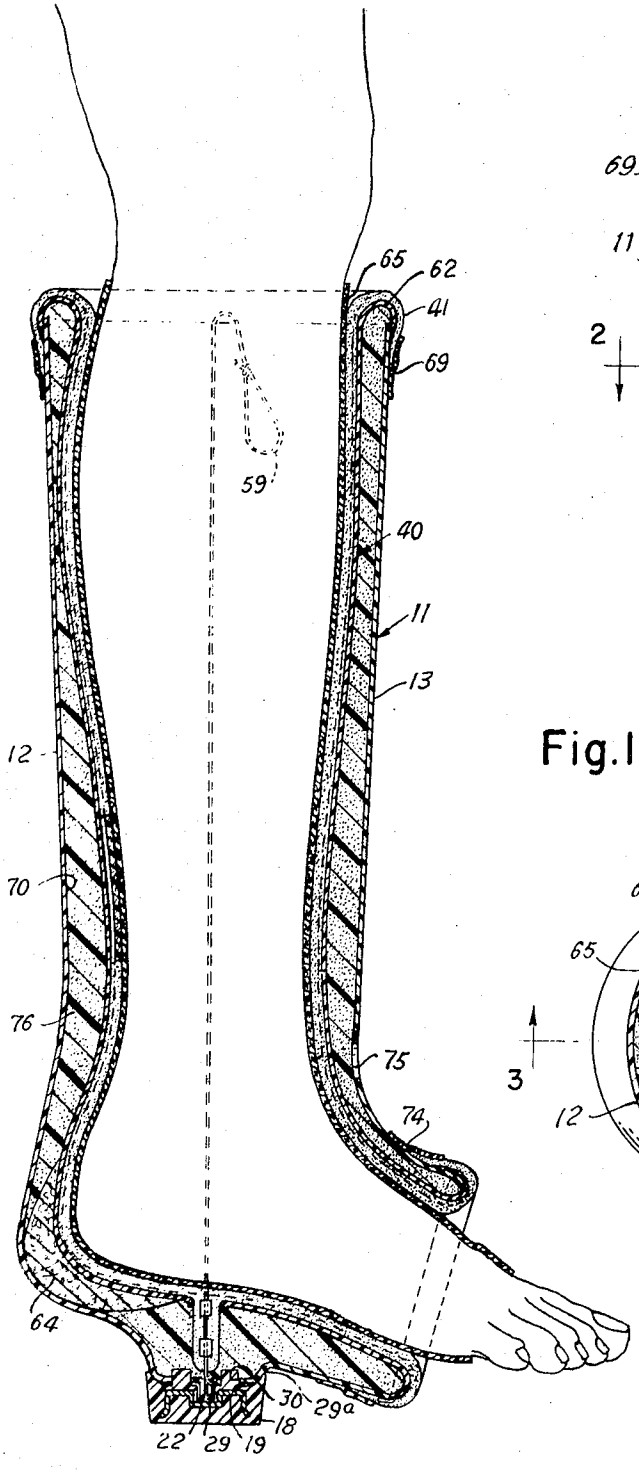


Fig.3

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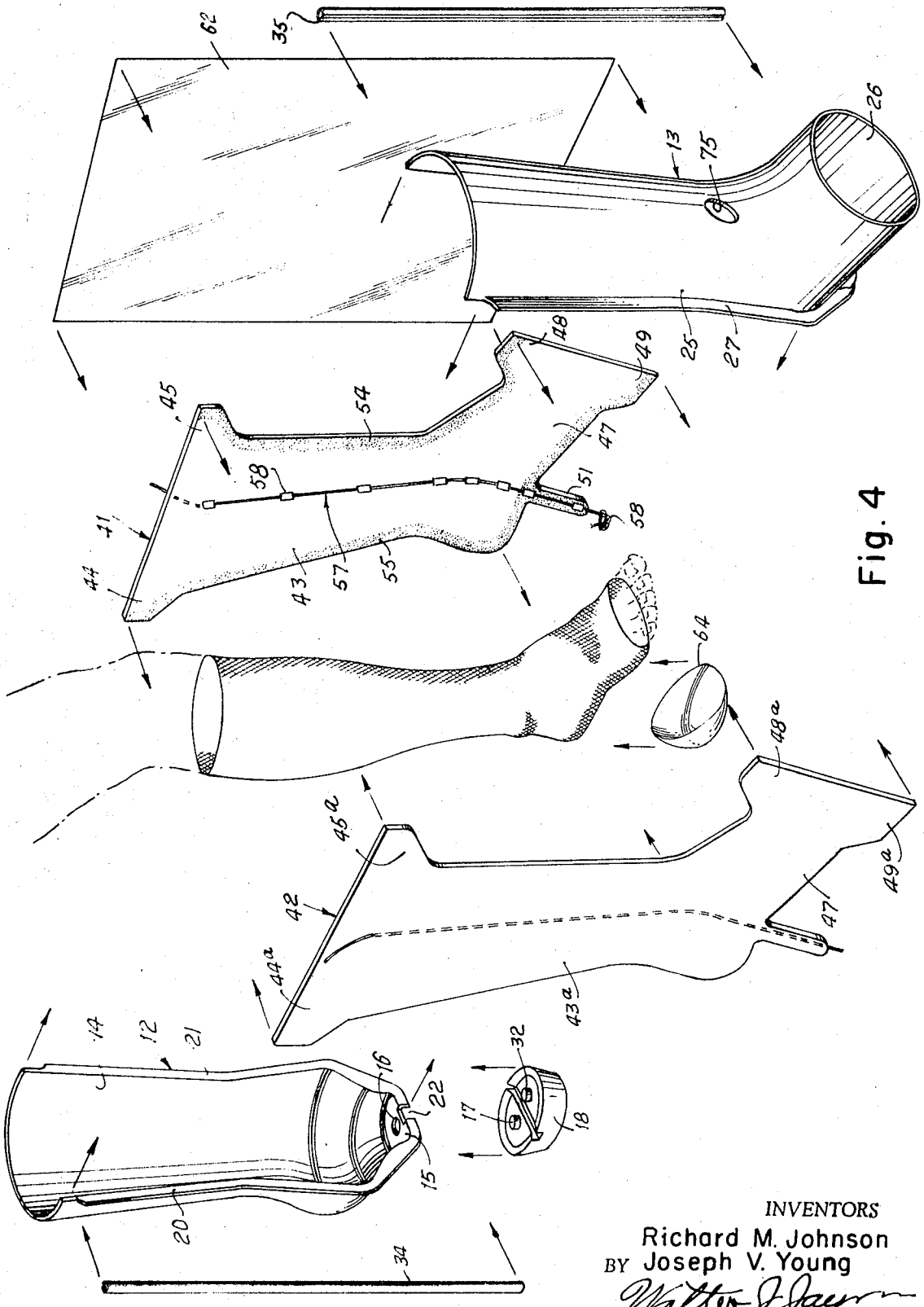


Fig. 4

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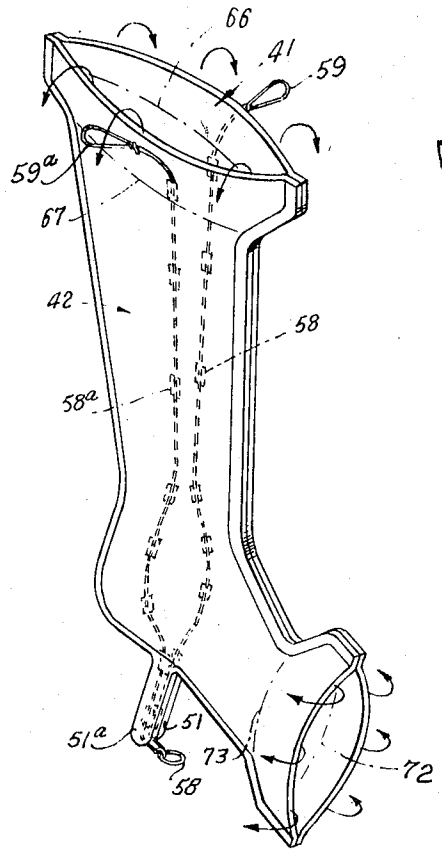


Fig.5

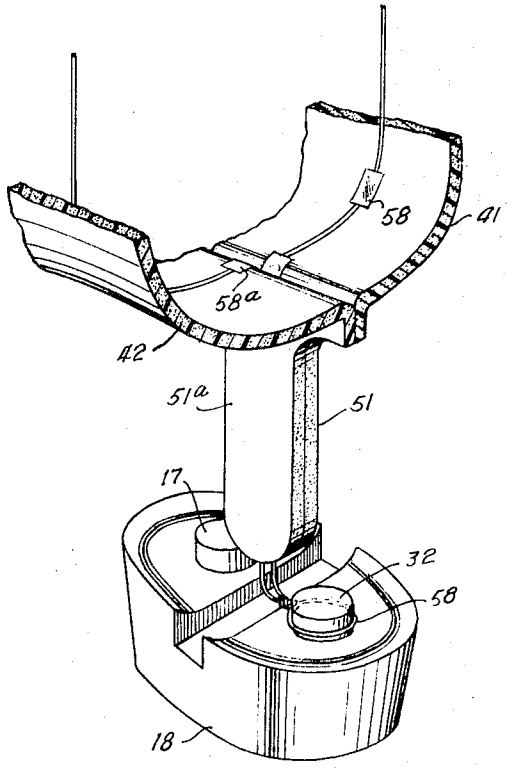


Fig.6

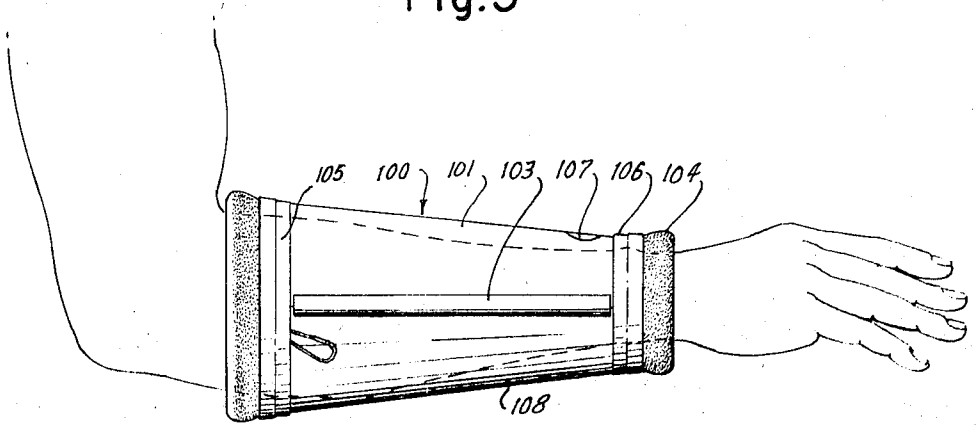


Fig.7

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INFLATABLE SURGICAL CAST

This invention relates to casts for immobilizing body portions.

An object of this invention is to provide a new and improved cast which can be easily and quickly disposed about a body portion to immobilize the body portion.

Another object is to provide a cast which is of relatively great strength, but light in weight.

Still another object is to provide a cast, but whose inner surface conforms exactly to the contours or configuration of the body portion which it encloses.

A further object is to provide a cast which permits circulation of fluids, such as air or liquids, about the body portion enclosed thereby.

An important object is to provide a cast which has an outer rigid substantially cylindrical shell or wall formed of two connectable sections in which a body portion such as a leg, arm or the like, may be positioned, the shell having such internal configuration at substantially all locations as to permit the outer shell to be spaced from and out of contact with the body portion, an internal wall formed of a flexible means which is movable inwardly into engagement with the body portion and connectable at its opposite ends to the outer shell to form therewith a substantially cylindrical chamber, and a foamed-in-place substance filling the cylindrical chamber and causing the inner flexible means to conform to the shape of the body portion positioned in the case and engage the body portion.

Another object is to provide a cast wherein a flexible cutting member as disposed within the cast and is usable to cut through the cast when it is desired to remove the cast.

Still another object is to provide a cast formed of a substance which permits the X-raying of the body portion while the cast is in place on the body portion.

Still another object is to provide a cast wherein the inner wall is formed of a resilient open-celled or porous substance to permit circulation of fluids about the body portion in the cast.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

FIG. 1 is a side view of a cast embodying the invention adapted for use on a leg and showing the cast in place on the leg;

FIG. 2 is a sectional view taken on line 2—2 of FIG. 1, the thicknesses of the components forming the inner flexible wall being exaggerated for clarity of illustration;

FIG. 3 is a sectional view taken on line 3—3 of FIG. 2, the thicknesses of the components forming the inner flexible wall being exaggerated for clarity of illustration;

FIG. 4 is a perspective exploded view of all components of the cast except the foamed-in-place plastic substance;

FIG. 5 is a perspective view of the flexible inner wall;

FIG. 6 is a fragmentary enlarged perspective view showing the manner in which a cast-cutting wire is connected to a heelpiece of the cast; and,

FIG. 7 is a view of a cast embodying the invention adapted for use on the forearm and showing the cast in place on the forearm.

Referring now to FIGS. 1 through 6 of the drawings, the cast **10** embodying the invention for use on the leg and foot includes a rigid outer wall or shell **11** formed of two sections **12** and **13**. The rear shell section **12** has a substantially semicylindrical wall **14** which is provided at its bottom end with a downward protuberance **15** provided with an aperture **16** in which is receivable the lug **17** of a heelpiece **18**. The heelpiece may be formed of a somewhat resilient plastic substance reinforced by a metal reinforcing member **19** embedded therein.

The left edge of the wall **14** of the shell is provided with an outwardly extending flange **20** and similarly the right edge of the cylindrical wall is provided with an outwardly extending flange **21**. The bottom ends of the flanges **20** and **21** are spaced to provide a downwardly opening slot **22** for a purpose to be described.

The front shell section **13** similarly has a cylindrical wall **25** and a tubular foot-receiving portion **26**. The left-hand edge of the cylindrical wall has an outwardly extending flange **27** and its right-hand edge has an outwardly extending flange **28**. The bottom portion of the front shell section is provided with a downward protuberance **29***a* having an aperture **30** in which is receivable the front lug **32** of the heelpiece **18**. The lowermost substantially horizontally extending portions of the edge flanges of the two shell sections are receivable in the vertical upwardly opening recess **33** of the heelpiece. The bottom ends of the flanges **27** and **28** are spaced to provide a downwardly opening slot **29** which is aligned with the slot **22** when the heelpiece is positioned on the two shell sections with its lugs extending through the apertures **16** and **30**.

The two shell sections **12** and **13** may be secured to one another by any suitable means such as a strip of adhesive tape or by clamp strips **34** and **35** which are adapted to resiliently extend about the aligned flanges **20** and **27**, and **21** and **28**, respectively, of the two shell sections. The two shell sections are also held together by the heelpiece **18** since the lower ends of the flanges of the two shell sections are received in the groove or recess **33** of the heelpiece and the lugs **17** and **32** of the heelpiece are received in the apertures **16** and **30** of the sections **12** and **13**, respectively.

The two shell sections are formed of a rigid plastic substance, such as acrylonitrile-butadiene-styrene, polycarbonate or high-impact polystyrene, which is relatively lightweigt, water impervious and strong.

The cast includes an inner substantially tubular flexible wall **40** comprising two sheet sections **41** and **42** formed of an open-cell foam substance, such as polyurethane commercially available under the mark "Scott Foam" which because of its open-cell structure permits passage of fluids therethrough. For example, the sheets may be one-eighth inch thick and have 80 pores per linear inch.

The wall section **41** has a longitudinal body portion **43** provided at its upper end with the oppositely extending tabs **44** and **45** and a foot portion **47** which extends angularly from the lower end of the perpendicular portion and is provided with oppositely extending tabs **48** and **49** at its outer end portion.

The wall section **41** also has a downwardly extending tab **51** which is adapted to extend downwardly (see FIG. 3) through the aperture provided by the aligned slots **22** and **29** of the shell sections **12** and **13**, respectively. The inner surfaces of the inner wall section **41** are provided with layers **54** and **55** of a suitable pressure-sensitive adhesive so that the sections **41** and **42** may be secured to one another along their opposite side portions.

The inner wall section **42** being identical in structure to the inner wall section **41**, its various portions have been provided with the same reference numerals, to which a subscript "*a*," has been added as the corresponding portions of the inner wall portion **41**.

A cutter or cast stripper member **57** is secured to the inner surfaces of the inner wall sections **41** and **42** by means of adhesive strips **58** and **58***a*, respectively. The cutting member **57** may be a stainless steel cable. The middle portion of the cutting member **57** extends downwardly of the lower ends of the bottom tabs **51** and **51***a* and is formed into a loop which is positionable about the lug **32** of the heelpiece. The opposite end portions **59** and **59***a* of the cutter member extend outwardly through apertures in the inner wall portions **41** and **42**, respectively, and may be formed into loops as is illustrated in FIGS. **1**, **3** and **5**.

The inner wall may also include a sheet **62** of a plastic substance, such as is commercially available under the name "Saran Wrap," which may be wrapped about the sections **41** and **42** after they have been placed about the leg of the wearer. Alternatively, the sheet **62** may be in the form of two sections, not shown, of the same configurations as the sections **41** and **42** and be bonded thereto prior to the placement of the sections **41** and **42** about the leg. The impermeable sheet **62** is used to prevent a foaming liquid, as will be explained below, from coming into contact with the leg of the wearer.

The cast may include, FIG. 3 and 4, a heel support or block 64 which may be used to hold the heel and the rear outer wall shell section 12 in proper spaced relation to the leg of the wearer during the forming of the cast. The heel support may be made of polyurethane foam.

In use, a woven stocking 65 may be placed about the foot and lower leg of the leg which is to be immobilized by the cast 10. The rear layers 55 of adhesive on the inner surfaces of the two sections then secure the rear and bottom portions of the inner wall sections 41 and 42 to one another and these two sections are then placed about the leg. The forward portions of the sheets are then secured to one another by the front layers 54 of adhesive on the inner surfaces, as illustrated in FIG. 5. The impermeable sheet 62 is then wrapped about the inner wall sections 41 and 42 to form a liquidtight covering therefor with the sections 41 and 42 held in somewhat loose engagement with the leg and foot. If the sheet is in the form of two sections bonded to the sections 41 and 42, the impermeable sheet obviously is disposed about the leg at the same time as the sections 41 and 42. The sheet 62 is wrapped around the tabs 51 and 51*a* or is perforated to permit them to pass downwardly thereof. The two tabs 51 and 51*a* which are now secured to one another, as illustrated in FIG. 6 and extend downwardly through the aperture formed by the aligned slots 22 and 30 of the shell sections 12 and 13 of the outer wall.

The rear shell section 12 is then disposed as illustrated in FIG. 3, about the rear portions of the leg, heel and foot of the wearer while the heel support prevents the heel from engaging the rear shell section 12. The bottom edges of the flanges 20 and 21 are inserted in the recess 33 of the heel while the heelpiece lug 17 is positioned in the aperture 16.

The middle loop portion 58 of the cutting member is disposed about the lug 32 of the heelpiece and the front shell portion 13 is placed over the foot of the wearer and the bottom portions of its flanges 27 and 28 are inserted into the recess 33 of the heelpiece. The lug 32 is received in the aperture 30.

The loop 58 as illustrated in FIGS. 3 and 6 is then held against displacement off the heelpiece lug 32 by the bottom inner portion of the front shell section 13.

The two rigid shell sections 12 and 13 are then secured to one another by the clamp strips 34 and 35 or alternatively by surgical adhesive tape and the like.

The upper portions of the tubular inner wall formed by the inner wall sections 41 and 42 defined by the broken lines 66 and 67, FIG. 5, which now extend upwardly of the top edges of semicylindrical wall portions 14 and 25 of the shell sections 12 and 13, respectively, are folded downwardly over the shell sections as illustrated in FIGS. 1 and 3. A strip of adhesive tape 69 is then wrapped about the folded-down portions and lapped over the shell sections to secure the folded-down portions to the shell sections and close the upper end of the chamber 70 formed by and between the inner and outer walls.

The portions of the inner wall sections 41 and 42 extending forwardly of the lines 72 and 73 extend forwardly of the front edge of the tubular foot portion 26 of the shell section 13 and are similarly folded back thereon, as illustrated in FIG. 3, to close the bottom end of the tubular chamber and secured to the foot portion by an adhesive tape 74.

The leg is then supported in a horizontal position and a liquid mixture of polyurethane, freon and a catalyst, the freon being in solution in the polyurethane or the catalyst, is poured in the chamber 70 through an aperture 75 in the front shell section in sufficient quantity that as the freon vaporizes, the freon-blown polyurethane foam 76 will fill the tubular chamber and cause the flexible inner wall to move inwardly at all locations therealong to expand the tubular chamber and to conform to the shape of the leg and foot. When the chamber is fully expanded any excess foam produced therein will flow out through the aperture 75 so that the body portion is not compressed or placed under pressure at any location. The foamed-in-place polyurethane forms a rigid closed-cell foam when it sets or hardens.

The leg is now held notionless relative to the outer wall for a period of time which is relatively short, for example, approximately 5 minutes, until the substance 76 hardens or sets. The polyurethane bonds to the shell sections 12 and 15 and to the inner wall sections 41 and 42 as it hardens.

The inner surfaces of the cast now conform exactly to the configuration of the leg and foot enclosed by the cast and, at the same time, immobilize the leg.

The thickness of the inner wall sections 41 and 42 and of the impermeable sheet 62 have been exaggerated in FIGS. 2 and 3 for clarity of presentation. The inner wall sections may, for example, be one-eighth of an inch thick while the sheet 62 may be five ten-thousandths of an inch thick.

The stocking 65 and the inner wall sections 41 and 42, which are of an open-cell foam substance, permit air to circulate to some extent through the cast and about the leg encased thereby. In addition, if desired, liquids may be allowed to flow through the cast and about the leg through the inner wall sections 41 and 42 and the stocking 65 to wash the leg or to apply medications thereto. The foam substance 76, however, which fills the chamber is not permeable to liquids.

Since the substance 76 and the shell sections 41 and 42 are not liquid permeable, even if the cast is submerged in a liquid, no appreciable amount of liquid will be absorbed thereby. In addition, the various substances of which the various components of the cast are formed are not water soluble so that the cast may be washed and desired liquids circulated through the cast and about the leg.

It will now be seen that the cast 10 embodying the invention comprises a tubular chamber means formed, for example, of the two inner wall sections 41 and 42 and the outer wall shell sections 12 and 13 which provides a substantially cylindrical chamber which is closed at both ends.

It will further be seen that the chamber means includes a nonexpansible outer wall formed by the rigid channel members 12 and 13 and a flexible inner wall, formed of the inner wall sections 41 and 42, which is movable inwardly toward the body portion until its inward movement is limited by the body portion which the cast encloses and the inner wall conforms to the configuration of the body portion.

It will further be seen that the inner wall is moved inwardly to engage and to conform to the outer surfaces of the body portion when a liquid is introduced into such chamber and such liquid foams and expands to fill such tubular chamber and move the inner wall sections inwardly.

It will also be seen that the flexible inner wall may include a liquid-impermeable sheet 62 disposed about the inner wall sections 41 and 43 to prevent the liquid introduced into the chamber from contacting the leg itself.

It will further be seen that the method of making a cast on a body portion, such as a leg, includes disposing a substantially tubular chamber means formed of such elements as the outer wall and the inner flexible wall 40, and introducing a foam-forming liquid into the chamber to fill the chamber and cause the inner wall to move inwardly until its inward movement is limited by the body portion, and holding the cast and the body portion against movement relative to one another until the produced foam hardens or becomes rigid.

It will be apparent that the cast is of very lightweight and that it may be washed or subjected to liquids unlike the usual heavy liquid-absorbing and liquid-soluble plaster cast, and that is permits flow of liquids between the leg and the cast which may be desired if medication or washing of the skin is required or desirable.

The foregoing description of the invention is explanatory only, and changes in the details of the construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. A cast for immobilizing a body portion, said cast including: chamber means positionable about a body portion provid-

ing a substantially cylindrical chamber closed at both ends, said chamber means including a nonexpansible substantially tubular outer wall and an inner flexible wall adapted to move inwardly and away from said outer wall until its inward movement is limited by a body portion about which said means is disposed and to conform to the configuration of the body portion, said outer wall having an open aperture; and a rigid foamed-in-place closed-cell substance introduced in fluid state into the chamber through said aperture filling said chamber and holding said inner wall against outward movement, said inner wall means comprising a sheet of open-cell foam substance and a sheet of liquid-impermeable substance disposed about said sheet of open-cell foam substance, said outer wall means comprising a pair of opposed substantially semicylindrical rigid sections and means for rigidly securing said sections to one another.

2. The cast of claim 1, and flexible cutter means disposed within said inner wall means and having opposite end portions extending outwardly of said cast.

3. The cast of claim 2, wherein said outer wall sections are provided with external flanges, said cutter means being movable between said flanges to cut through said inner wall means and said rigid foram substance to permit removal of said cast from a body portion.

4. The cast of claim 1, wherein said shell sections are adapted to be disposed about a leg and foot to be immobilized, the outer of said shell sections having a tubular foot-receiving portion, said inner wall means extending through said tubular foot portion of said front shell section and being secured thereto.

5. The cast of claim 4, and a heelpiece rigidly secured to said shell sections.

6. The cast of claim 5, wherein said heelpiece is provided with a transversely extending groove, said shell sections having edge flanges, said flanges of said shell sections being received in said groove.

7. The cast of claim 6, wherein said heelpiece is provided with a pair of upwardly extending lugs and said shell sections are provided with apertures in which said lugs are received.

8. The cast of claim 7, and a flexible cutter member disposed inwardly of said inner wall and having a middle loop portion disposed about one of said lugs and between said heelpiece and the bottom end of one of said shell sections.

9. The cast of claim 8, wherein said inner wall sections are of open cell polyurethane foam substance.

10. The cast of claim 9, wherein said foam substance in said chamber is a low-density, freon-blown polyurethrane. polyurethane.

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