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METHOD OF MAKING LINER FOR ARTIFICIAL LIMB

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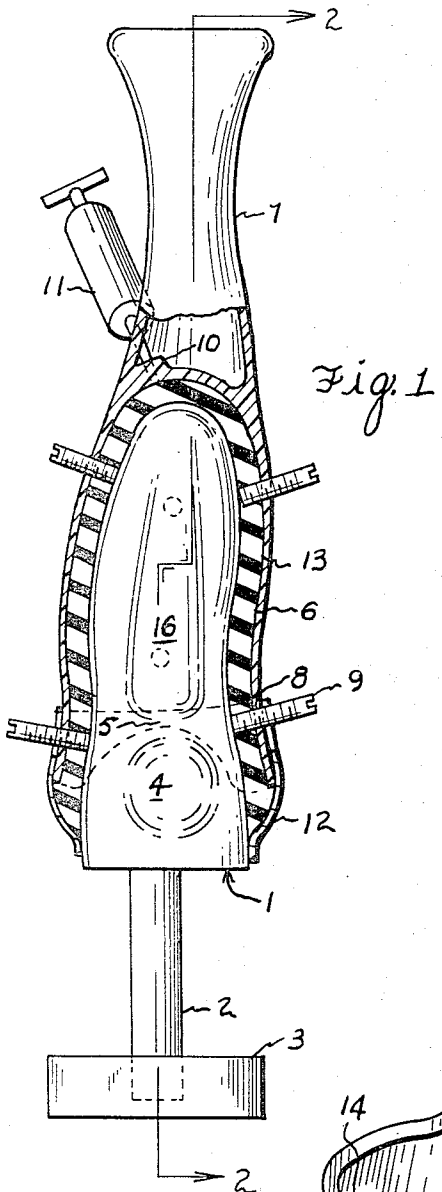

Fig. 1

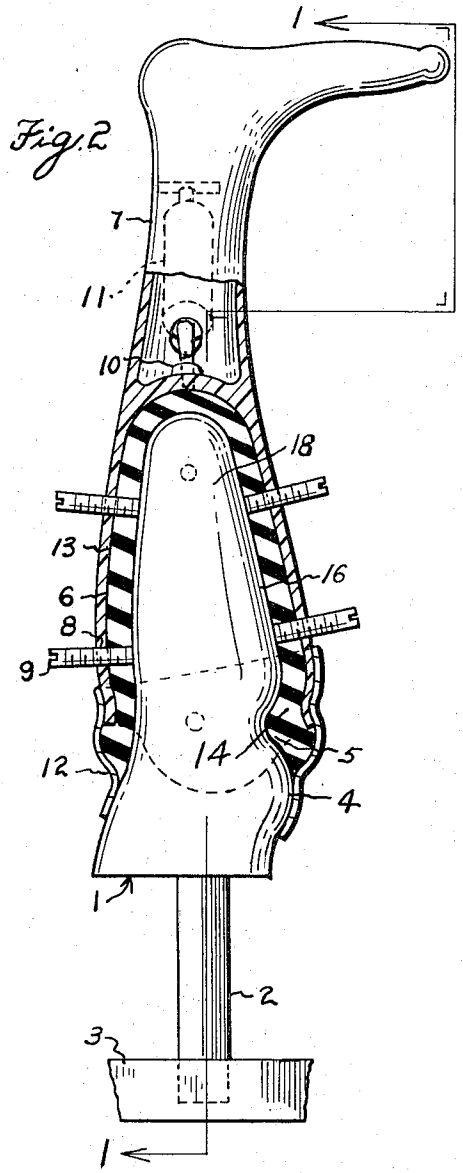

Fig. 2

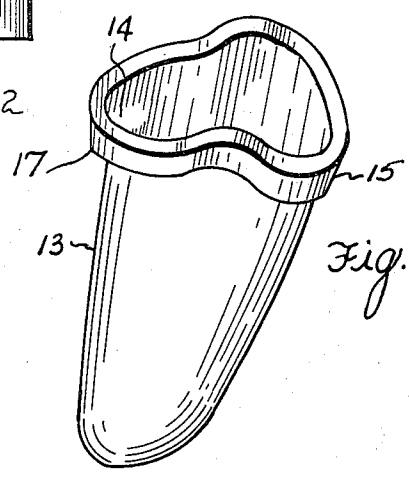

Fig. 3

INVENTOR.
EDWARD J. KANDEL
BY
Allan J. Murray
ATTORNEY

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METHOD OF MAKING LINER FOR ARTIFICIAL LIMB

Edward J. Kandel, 28466 Kendalwood Drive, Farmington, Mich. 48024

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ABSTRACT OF THE DISCLOSURE

A method for making a liner for the socket of an artificial limb, which method includes making a cast of the contours upon which said limb is to be fitted, disposing said cast in a spaced relationship to the inner surface of a socket in an artificial limb, providing means to maintain said spaced relationship, and filling the space between said cast and said socket with a yieldably resilient material which will set to form a cohesive unit bearing on its exterior surface the countours of said socket and on its interior surface the contours of said cast or model.

This invention relates to improvements in liners for sockets or artificial limbs and particularly liners designed to be replaceable without replacing all or any part of the artificial limb.

An object is to contour the liner to derive maximum support from bony surface areas of a stump as well as the fleshy areas.

A further object is to form the liner with a protuberance, disposed to engage the lower area of the knee cap, or patella, to derive further support therefrom when the liner is in use.

Still a further object is to provide a method of making a liner, including the steps of forming a mold by positioning a model of a stump within a socket, so that the surface of the stump occupies a desired spaced relationship to the interior surface of the socket, and of filling the resultant space with the liner material, and allowing a predetermined period for curing, or setting, of the material, and of removing the liner from the mold.

Prior practice has entailed such complications as piecing strips of materials, such as sponge rubber, horsehide, fiber glass, or various plastics upon a model of a stump and sewing or otherwise securing them together.Use of sponge rubber is unsatisfactory as it tends to resiliently collapse under pressure, and while so collapsed, its resiliency is minimal.

Said prior practice, too, frequently entails expensive replacement or reworking of an entire limb rather than replacing only the liner, because obtaining a comfortable fit with a new liner in the socket of a used limb is quite difficult. These and other objects are attained by the construction and method hereinafter described, and illustrated in the accompanying drawings, wherein:

FIG. 1 is a vertical, elevational view in partial section line 1—1 of FIG. 2.

FIG. 2 is a vertical, elevational view in partial section on line 2—2 of FIG. 1.

FIG. 3 is a perspective view of the liner.

In these views, the reference numeral 1 designates generally a cast, or model, of the stump remaining from a below-the-knee amputation. Such cast may be made in a manner well known to those skilled in the art, and may have imbedded therein a pipe or bar 2 which may serve as a stand for supporting the cast. The numeral 3 designates a block apertured to receive the lower end portion of the bar 2. Beneath the knee cap 4, as simulated on the cast, is a substantial indentation 5.

Encompassing the cast up to the area of the knee cap, is a socket 6 of an artificial limb 7. Said limb, like

the cast, is formed in a manner well known in the art. The limb 7 is formed with a plurality of holes 8, located thereon in accordance with the configuration of the stump to be received in the shell, as hereinafter explained. Said holes receive threaded studs 9, which are threadedly adjustable in the holes to afford precise positioning of the cast within said shell. As is clear from the drawings, the inner end faces of the studs engage the surface of the cast to support it in a desired position in the socket 6. The outer end portions of the studs, while shown simply slotted, may, of course, terminate in any form suitable to afford leverage to rotate the studs, for example multifaceted, or slotted heads.

Formed on the shell 7 at any convenient portion thereof is a boss 10, apertured to receive the nozzle of a pump 11, which may take the form of a conventional caulking gun. Any suitable means may be used to obstruct the opening of the limb 7: masking tape is preferred because it allows escape of air from the mold, either through the tape, or at slight areas of the tape which yield slightly under pressure. Some air escapes through the holes 8, as the studs 9 are not an airtight fit in said holes.

The liner 13 then, as shown in the drawings, is formed in the following manner. The cast 1 is disposed within the socket 6, and is precisely positioned by manipulation of the threaded studs 9 to leave a desired spacing between the outer surface of the cast 1 and the interior surface of the socket 6. The opening of the socket is then obstructed as aforesaid by tape 12, or the like. The pump 11 is loaded with a resilient material, such material being in a form in which it will "set" into a cohesive unit, and said material is then injected into the socket 6 until the space between the socket wall and the cast 1 is filled.

The material is then allowed to set, as aforesaid, for a predetermined period of time. The limb is then removed, and the liner 13 formed into what is now a cohesive element of resilient material is removed from the cast.

It is preferred to use room temperature vulcanizing (R.T.V.) rubber, and this is commercially available in a semi-liquid, or heavy paste-like state of substantial viscosity. Several advantages obtain from the use of materials and the characteristics of this type of rubber. Unlike sponge rubber, R.T.V. rubber may distort and displace, but it retains its resiliency. Sponge rubber collapses upon itself, and when this occurs it loses resilience and may be uncomfortable for the wearer of an artificial limb. Yet sponge rubber is widely used in current practice.

Further, the threaded studs may be removed after a predetermined period of time, at which point the rubber has partially set, and will not flow out the holes, but retains sufficient viscosity to flow into and close the holes left in the liner may be removal of said studs. Too, the finished liner may be cut and carved easily where desired, as for example to square off the lip 17, and additional rubber may be applied if needed and allowed to set, and will cohere with the liner.

An advantage of the method lies in the precise adjustment afforded by the studs 9. That is, if experience shows that more material in the liner at a given area would make it more comfortable, the cast may be positioned in the shell 7 to afford more material in that area.

The method is sufficiently uncomplicated, and the materials sufficiently readily available, that having acquired a cast and a shell, an amputee can with little experience prepare new liners when needed at substantial savings in expense of professional services. Because the rubber will stretch, the liner may be removed without damage to or destruction of the cast or limb, which may then be used repeatedly.

It has been found desirable to coat the exterior surface of the cast 1, and the interior surface of the socket 6 with

a release agent to resist adherance of the rubber to these surfaces. Common household detergent in liquid form has proven satisfactory for this purpose. The entire assembly may be immersed in warm water, and the limb **7** is manipulated to allow water to seep between the socket wall and liner, which facilitates removal of the sheel. The same procedure then frees the liner from the cast **1**.

The rubber may be poured into the socket **6** at the opening of the shell, by omitting the tape **12** and obstructing the hole in the boss **10**, and this will produce a liner of comparable quality. However, this entails using a solvent to make the purchased rubber more fluid, and this increases the time and expense involved. It will be recognized, of course, that any material having the desired characteristics in its original and its finished form will serve the purpose of my invention.

An advantage of the liner itself is that it is formed with an inwardly protruding contour **14**, which embraces the lower contour of the kneecap, and affords a measure of support to the wearer, by applying an upwardly directed reaction to the knee cap responsive to any downwardly directed force, from weight of a wearer of the device. The present practice produces liners designed to obtain maximum support by reaction below the knee cap, inwardly and upwardly directed responsive to weight of a wearer. This practice creates sore and tender areas, due to excessive pressure against the patellar tendon, below the knee cap. My invention utilizes both the lower surface of the knee cap (to which the patellar tendon attaches) and the area just below it. But so much support is obtained from the entire stump surface that no excessive force is applied to the knee cap or the area below it. Consequently, my improved liner does not cause the extreme discomfort occasioned by present devices. Full advantage is derived from the shin bone (**18** on the mast) as it displaces material to each side, where the displaced material affords support of the fleshy areas of the leg.

It will be realized that a shell may be formed by means well known, to simulate the interior contours of the socket **6**. Thus, one may make a new liner when desired without being deprived of the use of the artificial limb while said liner is being made.

What I claim is:

1. A method for making a liner of resilient material for use with the socket of an artificial limb, such method including the steps of

(a) making a cast, or model, of which the outer surface approximates the contours of the portion of the body to be received in such socket,

(b) making an artificial limb having a socket, said socket having an opening,

(c) forming one or more holes in the wall of said limb to open into said socket,

(d) applying a release agent to the inner surface of the socket and to the surface of the cast,

(e) disposing said cast within said socket to form a mold,

(f) applying supporting elements through said one or more holes, said supporting elements being adapted to support the cast with its said surface in a desired spaced relation to the inner surface of said shell, said cast being adapted for such support,

(g) filling said space with said resilient material,

(h) allowing said material to cure for a predetermined period of time,

(i) removing the cured liner,

2. A method for making the liner as set forth in claim **1**, where the further step of

(j) forming said socket with an entrance hole to admit said resilient material,

3. A method for making liner as set forth in claim **2**, with the further step of

(k) obstructing said opening as recited in (b) to resist escape therethrough of said resilient material admitted through said hole.

4. A method for making a liner as set forth in claim **1**, in which said resilient material is applied in flowable form, and progressively sets into non-flowable form during a predetermined period of time.

5. A method for making a liner as set forth in claim **2**, in which the material is injected into the mold through said entrance hole under pressure.

6. A method for making a liner as set forth in claim **1**, with the further step of

(j) withdrawing said supporting elements after a predetermined period to afford the partially set resilient material to flow into the space occupied by said supporting elements.

7. A method for making a liner set forth in claim **1**, with the further step of

(j) adding resilient material to, or removing resilient material from said liner as indicated from results of use of said liner.

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JAMES A. SEIDLECK, *Primary Examiner.*

DONALD J. ARNOLD, *Examiner.*

J. R. THURLOW, *Assistant Examiner.*