May 9, 1933. C. H. DAVIES 1,907,511

COMPOSITION SOCKET FOR ARTIFICIAL LEGS

Filed July 3, 1931

Fig. 1.

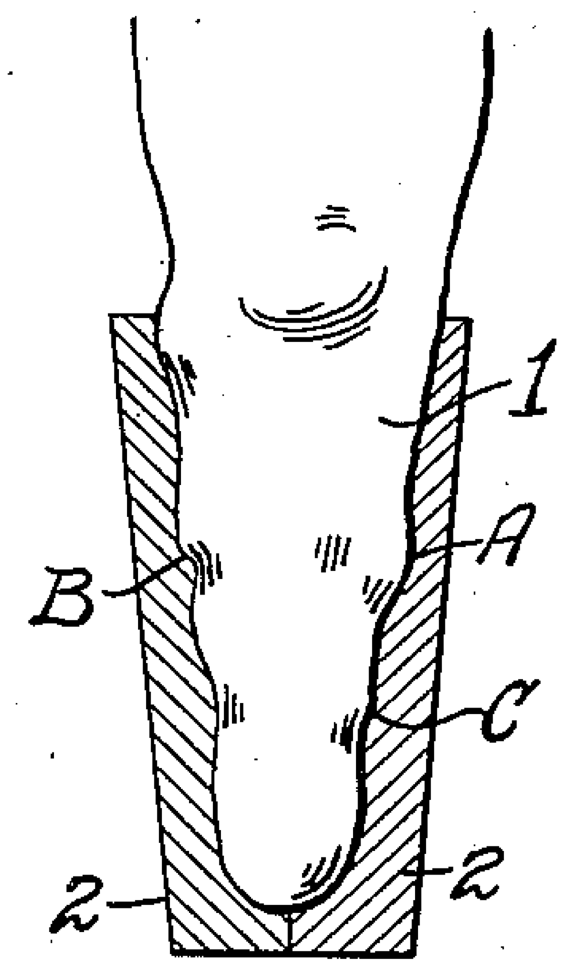


Fig. 2.

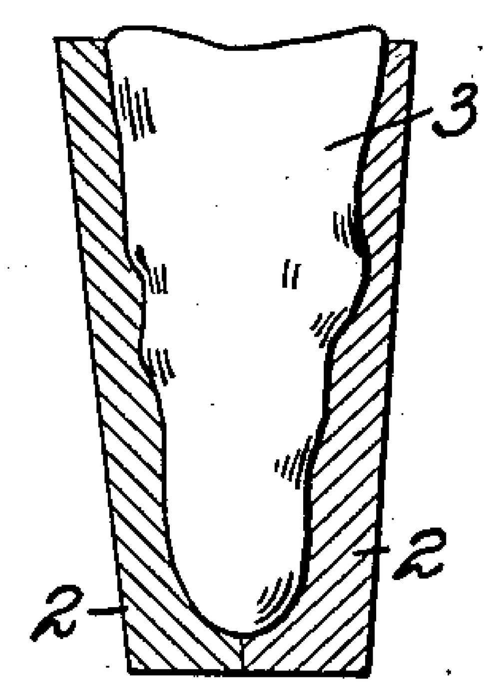


Fig. 3.

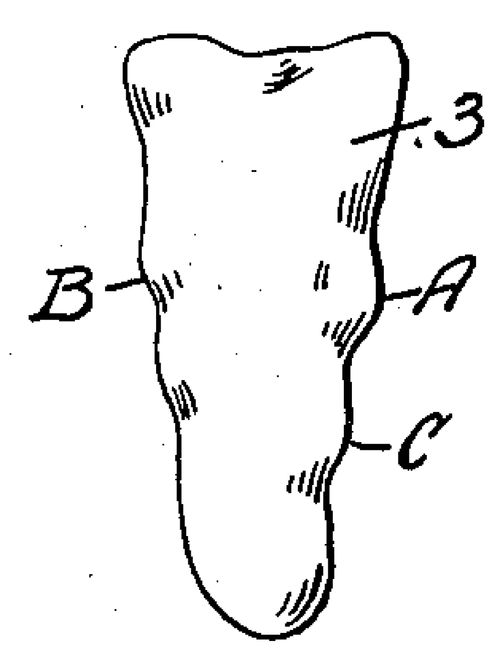


Fig. 6.

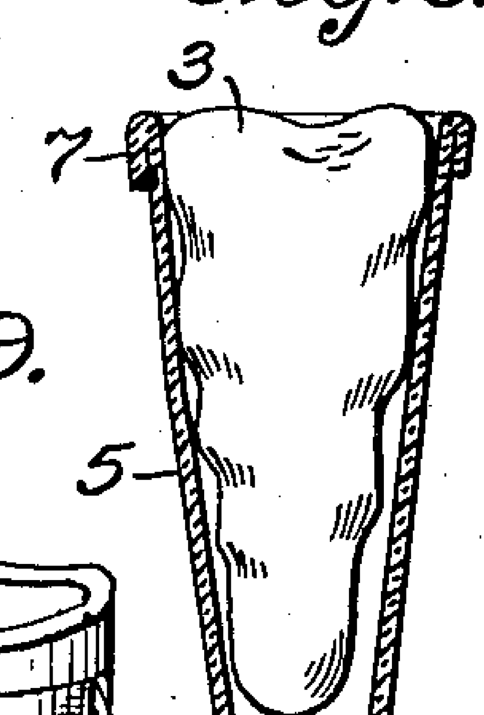


Fig. 4.

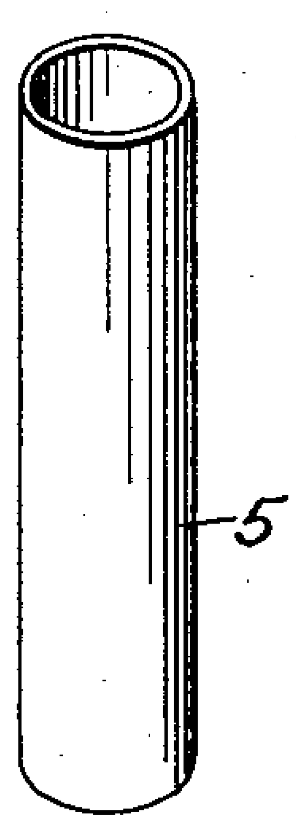


Fig. 5.

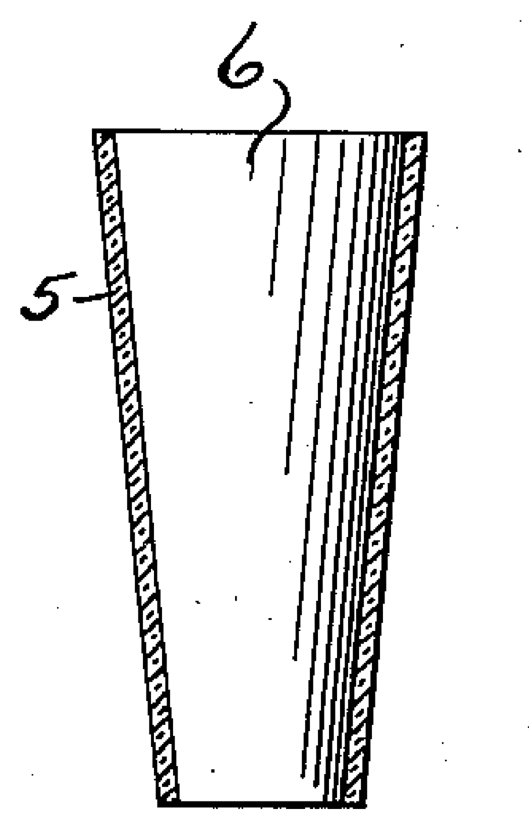


Fig. 9.

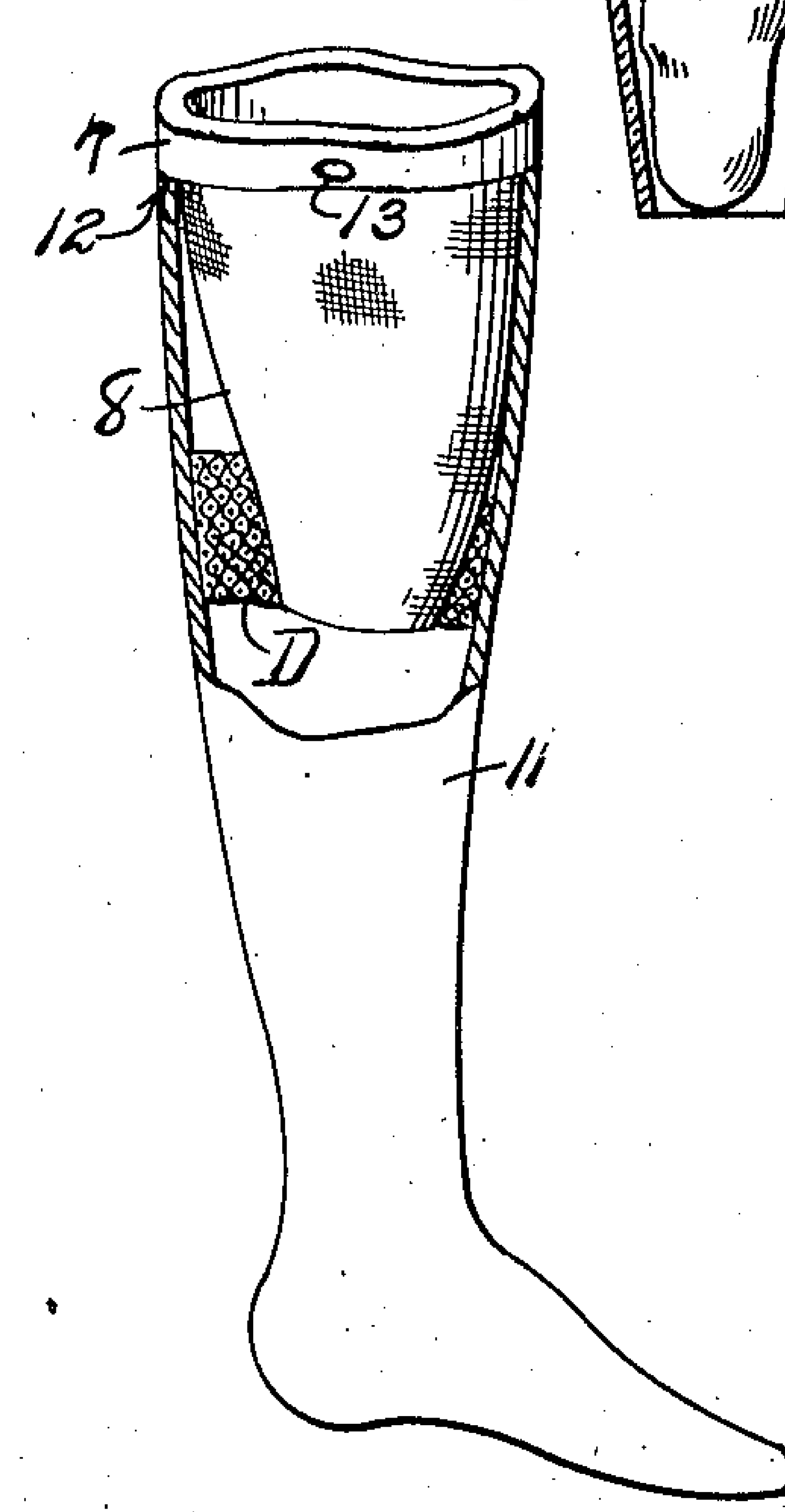


Fig. 7.

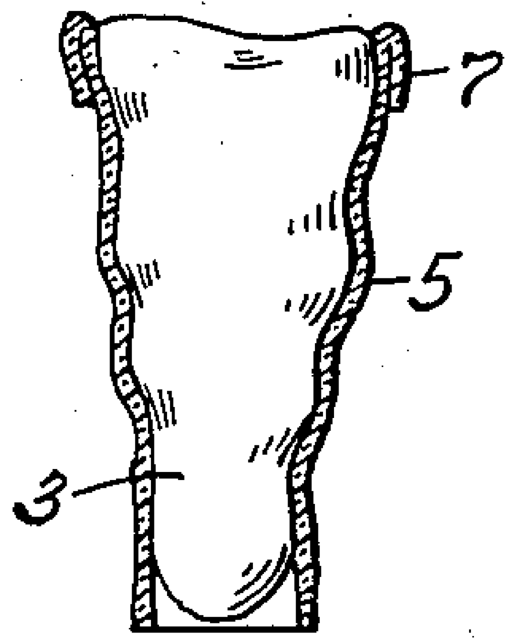
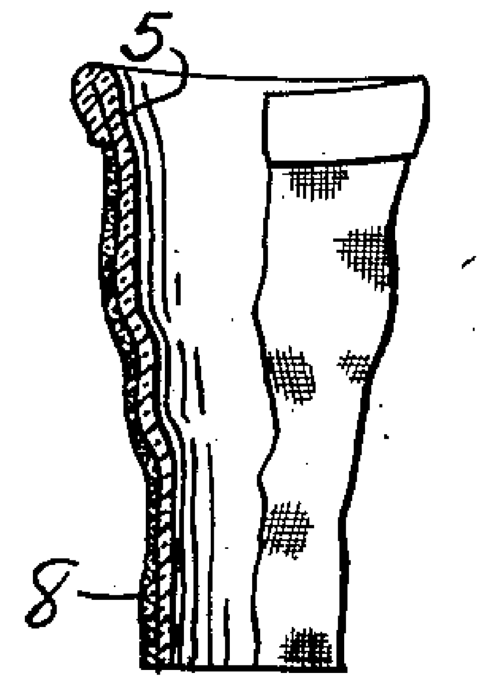


Fig. 8.



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WITNESS:

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UNITED STATES PATENT OFFICE

CHARLES H. DAVIES, OF PHILADELPHIA, PENNSYLVANIA

COMPOSITION SOCKET FOR ARTIFICIAL LEGS

Application filed July 3, 1931. Serial No. 548,642.

This invention relates to accurate and perfect fitting composition sockets for artificial limbs for use especially in those cases where the amputations are below the knee, although the essential features may also be employed in cases where the amputation is above the knee.

In the construction of wooden sockets, empiricism is, most unfortunately, evident, chance and guess work being constant. The socket builder accepts a shell cast of the amputated stump and tries to duplicate this shell by carving out of a solid block of wood various bone projections, and also attempts to provide sufficient room for the irregular and tender stump. The results obtained depend solely upon his judgment.

The task outlined is laborious and the results are always in question. Several fittings are necessary, frequently painful to the patient. After several hours of fitting, the patient is then obliged to tell the wood socket builder what result has been obtained, and whether or not the fit is comfortable. Obviously it is difficult if not almost impossible for the wood socket builder to duplicate the shell cast of the amputated limb with its various indentations, bone projections and irregular shape, and to construct a comfortable fitting socket to which the patient is justly entitled.

In the construction of leather sockets, a shell plaster of paris cast is taken of the stump. This cast is then removed from the stump and filled with liquid plaster of paris. After hardening, the outer shell is removed from the plaster cast, leaving the solid cast, which is a duplicate of the stump of the amputated limb.

The bone projections are built up according to the mechanic's skill. Empiricism is again evident, and the fit of the leather socket also depends upon the judgment of the socket builder. The leather is saturated with water and stretched around the cast, and thereafter hammered around the projections, the hammering being done to bring out more prominently indentations essential to the fit. The leather is now dried, and in drying contracts and provides a socket that fits the stump fairly well. This socket is then attached to the shin piece of the limb and a second layer of leather is built around the first to reinforce it.

The disadvantages of the leather socket are its flexibility, the absorption of perspiration, the excessive weight, and an occasional secretion of matter from the leather which becomes a serious irritant to the stump. When a leather socket becomes wet, the fit is quite naturally affected.

My invention relates to a perfect fitting composition socket for artificial limbs, which socket is absolute and positive in securing an accurate reproduction of the cast, thereby providing a comfortable fit without depending upon the skill of the operator. Empiricism is eliminated, and the operator performs his work in a scientific and accurate manner. A comfortable and accurate fitting socket can be built by this method by the average laborer and in one-fifth of the time required to construct a wooden socket, or one-third of the time required to construct a leather socket, and in addition eliminates one-half of the weight and material, and is surprisingly economical. Due to its strength, apertures or "health holes" may be perforated in the composition perfect fitting socket, to permit air to get to the stump. Moreover, the article is extremely light, a most acceptable feature to the limb wearer.

The material used has a nitrocellulose base, and is sanitary, waterproof, and empervious to perspiration. Due to its remarkable strength, it can be inserted into the metallic shin or attached to a wooden shin of an artificial limb and is permitted to hang freely as illustrated in the accompanying drawing.

Should it become necessary for the bone projections already provided for in the cast, and built up by felt pads, to give more room, concentrated steam under a pressure of 30 pounds is applied by flexible tubular means to the exact spot where relief is necessary. As the steam is applied to the spot, the action is the same as when the hot water heated to 212 degrees F. is applied as described below, for softening the tube. The operator presses the socket out at this point, thereby giving sufficient room to warrant immediate relief without cutting the material and thereby weakening the socket.

In the drawing,

Figure 1 is in section and elevation, and shows the mold being formed on the stump.

Figure 2 is in section and elevation and shows the mold filled with plaster of paris.

Figure 3 represents the element thus cast in elevation.

Figure 4 illustrates in perspective a composition tube to be shaped in forming the socket.

Figure 5 shows a tapering mandrel in elevation, the tube after being moistened and heated and stretched, being in section and surrounding the mandrel.

Figures 6, 7, 8, partly in vertical section, show further steps described below.

Figure 9 shows the completed socket applied within the upper portion of the limb.

The procedure for the construction of this composition perfect fitting socket for the amputated limb is as follows:

In Figure 1 the projections A. B. C. of the bone 1 are assumed to be built up with small felt pads caused to adhere to the stump. Then a sock is drawn over the stump, and plaster of paris is applied as shown at 2 and is built up to one-fourth of an inch in thickness. Figure 2 shows the mold filled with liquid plaster of paris 3 and this is permitted to harden and constatutes an exact duplicate of the stump including the projections. The outer material is cut away, leaving the element 3, in solid form.

A composition tube 5 including nitrocellulose as its base material, is shown in Figure 4. The characteristics of this material and the advantages for using it in the building of sockets for artificial limbs are that when immersed in hot water and heated to 212 degrees F., it will soften, so that it may be stretched, and after having been stretched it is permitted to cool. When again inserted into hot water, it will contract to its original size.

Figure 5 shows a tube nitrocellulose stretched around a tapering mandrel 6. The end of the tube is smaller in diameter than the end of the cast element 3. The tube 5 is inserted into hot water, heated to 212 degrees F., and is gradually stretched over the tapering mandrel 6 which mandrel is larger at the top than element 3.

After the tubing is stretched over the mandrel, it is taken out of hot water and permitted to cool. The mandrel is then taken out of the tubing, and the element 3 is inserted as in Figure 6. The upper end of the tubing has been lapped at 7 to provide a shoulder to rest on the top of the metal shin 11 at point 12. The assembled elements of Figure 6 are then re-inserted into hot water and heated to 212 degrees F. The characteristic of the material when heated a second time is to shrink back to its original size (Figure 4). The tube then becomes an exact duplicate of the cast element 3 and the latter is then broken and taken out of the shell 5 (Figure 7). The shell 5 is re-enforced with celastic, a cloth material 8 impregnated with pyralin and softened with a mixture of alcohol and camphor. When this celastic cloth is permitted to dry, it becomes extremely hard and does not shrink. The shell 5 having the covering 8 provides a perfect fitting composition socket and is then inserted into the metallic shin 11 and rests on the seat 7 Figure 9, at the point 12.

In most instances the atrophied stump is smaller than the good limb. The artificial limb being constructed to match the shape of the good limb would leave a space at D in the calf of the limb. In order to secure the close fit of the socket at this point, and eliminate all possible lost motion, vertical movement or friction, celastic is wrapped around the shell 5 as in Figure 9, to fill in this portion of the limb. The shell is now riveted to the metal or wooden shin at point 13 and the structure is complete.

It may be observed that the essential properties of the cellulosic composition to form the socket 5 are, first, that it is hard at atmospheric temperatures; second, capable of being rendered temporarily soft and pliable and elastic by suitable treatment, and, third, has a tendency to contract to its original size and hardened condition when relieved from the effects of the sofening means.

Therefore, I do not desire to limit myself to the precise details of construction or arrangement or method of procedure herein set forth, as it is obvious that various modifications may be made therein without departing from the essential features of my invention, as defined in the appended claims.

What I claim is:

1. The method of forming a socket of hardened plastic cellulosic material for lining an artificial limb, to fit the tapered atrophied natural stump of an amputated limb; which consists in making a cast of plastic material around said stump and thereby forming a matrix conforming to the irregular conical form of said stump; removing said matrix from the stump and casting plastic material in said matrix to form an artificial stump, resembling the natural stump; removing the matrix from the artificial stump of plastic material; rendering plastic a primarily cylindrical tube of cellulosic material which is hard at atmospheric temperature, by heating it to

approximately 212° F.; stretching said cylindrical tube to a conical tubular form, large enough to receive said artificial stump; turning down the edge of said tube at its larger end to overlap the outside of the tube and form a shoulder; causing said conical tube to harden in such distended form; inserting the artificial stump in that hardened tube of conical cellulosic material; again heating said tube of cellulosic material to approximately 212° F., and allowing it to cool, shrink, and harden upon said artificial stump, to form a socket which will fit the natural stump; removing the artificial stump from said hard cellulosic socket; fitting said socket of cellulosic material in an artificial limb of rigid material; and securing it in said artificial limb, so positioned that when the natural stump is inserted therein said artificial limb is presented in proper relation with said stump to resemble the amputated limb.

2. The method of forming a socket of hardened plastic cellulosic material for lining an artificial limb, to fit the tapered atrophied natural stump of an amputated limb; which consists in forming a matrix conforming to the irregular conical form of said stump; casting plastic material in said matrix to form an artificial stump, resembling the natural stump; rendering temporarily plastic a tube of cellulosic material which is hard at atmospheric temperature; stretching said tube to a conical tubular form, large enough to receive said artificial stump; turning down the edge of said tube at its larger end to overlap the outside of the tube and form a shoulder; causing said conical tube to harden in such distended form; inserting the artificial stump in that hardened tube of cellulosic material; again rendering said tube of cellulosic material temporarily plastic, and allowing it to shrink and harden upon said artificial stump, to form a socket which will fit the natural stump; and securing said hard socket of cellulosic material in an artificial limb of rigid material, so positioned that when the natural stump is inserted therein said artificial limb is presented in proper relation with said stump to resemble the amputated limb.

3. A socket of hardened plastic cellulosic material for lining an artificial limb, to fit the tapered atrophied natural stump of an amputated limb; consisting of an irregular conical tube, open at both ends, with its inner surface shaped to substantially the same configuration as the outer surface of said stump; the larger end of said socket shaped to fit, in contact with, the wall of said limb, and means for holding the smaller end of said socket spaced from said wall.

4. A structure as in claim 3, wherein the means for holding said socket spaced from the wall of the limb includes means for preventing lost motion of the socket in the limb.

5. A socket of hardened plastic cellulosic material for lining an artificial limb, to fit the tapered atrophied natural stump of an amputated limb; consisting of an irregular conical tube, open at both ends, with its inner surface shaped to substantially the same configuration as the outer surface of said stump; the larger end of said socket having an external shoulder overhanging and resting upon the adjacent end of said artificial limb; said shoulder being formed by and in unitary relation with the cellulosic material of the socket.

6. A method as in claim 1, including the step of providing the socket with a covering formed of fabric before inserting it in the artificial limb; whereby, said fabric covering is interposed between said socket and the inner surface of the limb.

In testimony whereof I affix my signature.

CHARLES H. DAVIES.