

[54] **FLUID PRESSURE CLAMP FOR PROSTHETIC APPLIANCE**

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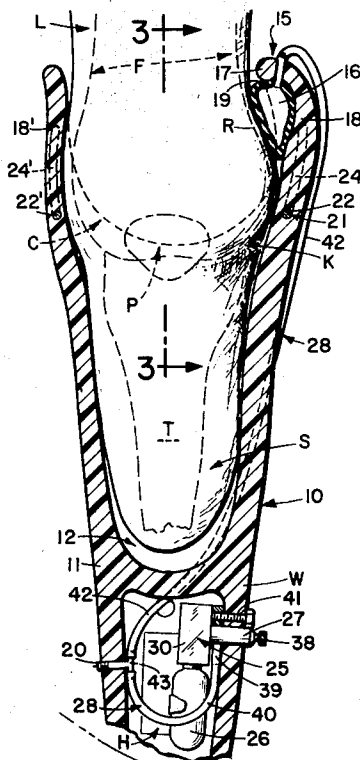
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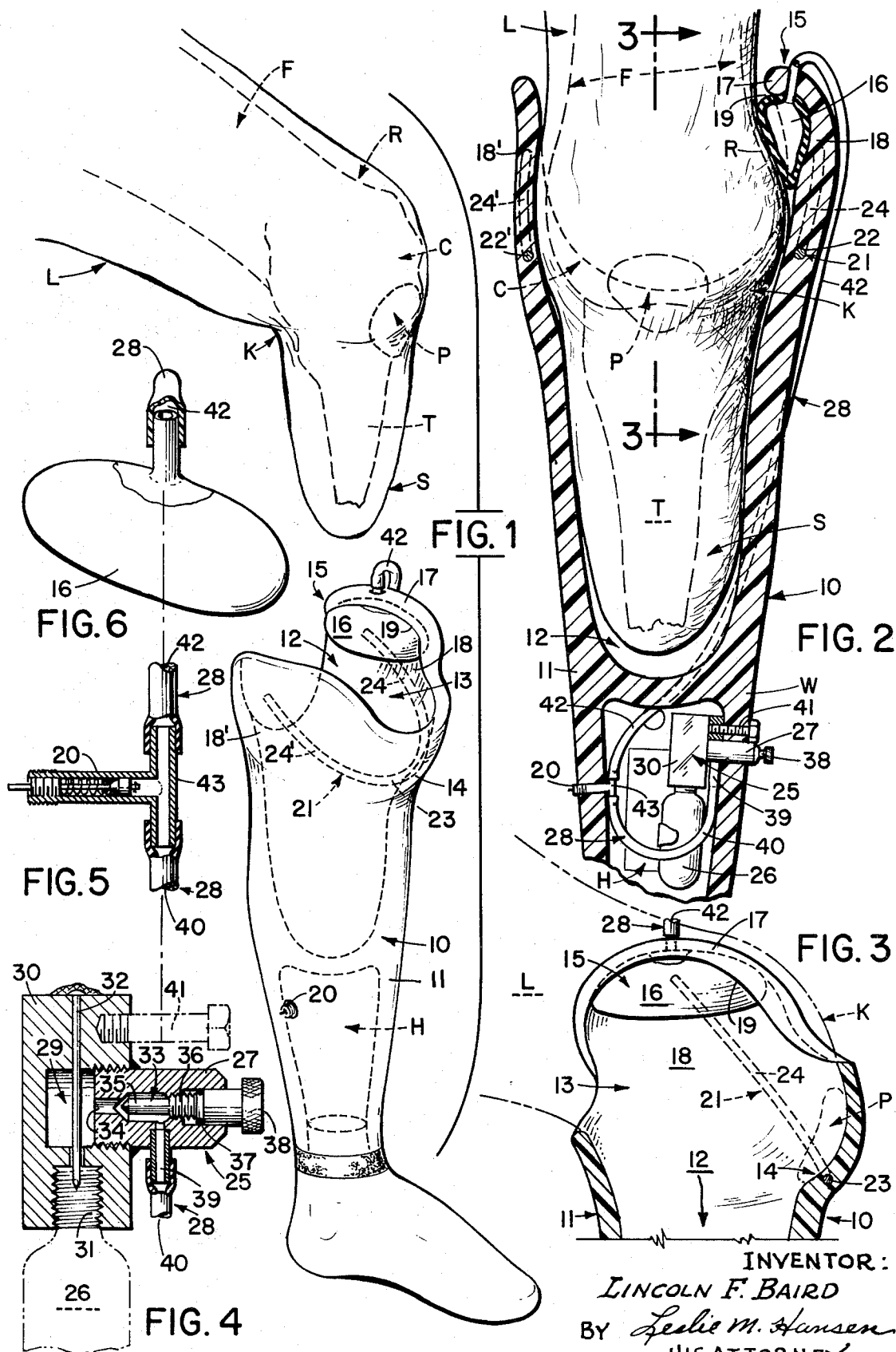
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[57] **ABSTRACT**

The securing of an artificial limb to an amputated limb by means of a yieldable binding between the artifice and the amputated limb, affording freedom of articulation of a condylar joint therein without chafing of the skin or exerting painful pressures thereto; the yieldable binding being a self-contained built-in fluid pressure wedge with a source of compressible fluid and control means therefor.

9 Claims, 6 Drawing Figures





FLUID PRESSURE CLAMP FOR PROSTHETIC APPLIANCE

BACKGROUND

This is a continuation in part of my application Ser. No. 59,480 filed July 30, 1970 on the same subject and now abandoned.

The present invention relates to prosthesis and more particularly to means for securing a prosthetic appliance to an amputated limb. Environmentally the present invention has its embodiment in means for releasably securing a prosthetic appliance to the stub of a human limb in a manner to achieve greater freedom of movement of such limb, less burdensome, abrasive, painful and deteriorating effects from the wearing of the same.

Artificial limbs are usually provided with a socket into which the stub of an amputated limb is inserted. Heretofore means for securing the artificial limb to the stub consisted of a harness extending from a corset or a belt to the prosthetic appliance. In the wearing of such harness I have experienced not only a piston action between the stump and socket but chafing of the skin and a cutting off of circulation in the limb stump. When the corset type harness is used around the upper leg the thigh thereof atrophies and deteriorates to about half its normal size. When an elastic belt was worn it exerted a constant forward pull on the wearer's torso and affects the posture noticeably toward a forwardly leaning attitude. Such belt also pressed inward on my intestines, dug into my sides and tended to restrict peristaltic action.

A more recent development in a support for and means for securing an artificial limb to an amputated stump has been a rigid plastic wedge which is forcibly inserted into the open end of the socket and against the condylar bone joint when the stump is in place in the socket. This too has been tried and found wanting. It was found that the hard wedge scraped the leg, especially during articulation and caused an excessive amount of pain. Moreover, if the leg was made comfortable while in a sitting position excruciating pain was experienced upon straightening of the leg to a standing position, the bones and tissue of the knee having moved relative to the wedge and socket. When the wedge was changed to make the leg comfortable while in a standing position the same pain was caused for the same reasons when the knee was bent to a sitting position relative to the socket of the artificial limb or prosthesis.

STATEMENT OF INVENTION

The present invention was developed to overcome the foregoing defects and harmful attributes of prior type securing means for prosthetic appliances. It is a principle object of the present invention to provide a yieldable pressure applying binding between the prosthesis and a portion of the amputated limb wearing the same.

It is another object to provide such yieldable securing means that will maintain a reasonably even pressure to effect a binding action yet change its shape in accordance with change of the position of a condylar joint with respect to the prosthesis. More particularly it is an object of the present invention to provide a built-in system for pressurizing a yieldable pressure applying binding between the open end of the socket in the prosthesis and the enlarged condylar bone adjacent the same. This object further contemplates an expandable binding in such system whereby the stump may be inserted with the depressurized binding in place and the latter thereafter pressurized to secure the binding.

This invention further contemplates the provision of a fluid pressure type clamp including an overlying lip or rim at the open end of the socket formed in the prosthesis for lodging the expandable binding in a region adjacent the normal location of the condylar bone of a leg stump inserted into the prosthetic appliance. In this connection means for reinforcing the open end of the socket of the prosthesis is provided to assure a hugging relation without actual physical contact relative to the condylar bone other than against the yieldable pressurized binding.

It is a still further object to provide means for pressurizing the binding member. This object further contemplates the provision of a source of compressible fluid within the prosthesis and a system for controlling pressurizing and release of pressure of the binding within the fluid pressurizable clamping means.

These and other objects and advantages of the present invention will become apparent from a reading of the following description and claims in the light of the drawing transferred from my earlier filed application Ser. No. 59,480 in which:

FIG. 1 is a perspective view of a prosthetic appliance constructed to include the embodiments of the pneumatic clamp of the present invention;

FIG. 2 is an enlarged vertical cross section through the appliance of FIG. 1 with an amputated leg stump in place therein;

FIG. 3 is a fragmentary section through FIG. 2 taken along line 3—3 thereof with the human leg removed;

FIG. 4 is an enlarged detail section through a control means and mounting for an air supply medium shown in FIG. 2;

FIG. 5 is an enlarged section through a T-fitting and release valve shown in FIG. 2; and

FIG. 6 is an enlarged perspective view of a flexible rubber sack employed in the pressure type clamp as illustrated in FIGS. 1, 2 and 3.

GENERAL DESCRIPTION

Referring to FIGS. 1, 2 and 3 of the drawing a prosthetic appliance 10 is shown as an artificial limb 11 having a socket 12 adapted to receive the stump S of an amputated limb L. The socket 12 has an open end conforming to the shape of a condylar bone structure C above the stump S and to embrace the enlarged condylar bone structure while allowing articulation of the joint formed thereby. In the present disclosure I have illustrated the prosthetic appliance as of the type worn as an artificial leg. It will be appreciated, however, that the inventive embodiment has equal application to other types of artificial limbs and like prosthetic appliances.

In FIGS. 1 and 2 the stump S includes a part of the tibia T of an amputated leg L cut off below the knee K or condylar C which is an enlarged ball-like end of the femur F. In such a condylar structure the patella or knee cap P projects forwardly as a part of the ball-like joint C. By reason of this configuration of the condylar joint C the open upper end 13 of the socket 12 in the artificial leg 11, conforming in shape, is provided with a shelf-like recess 14 (FIGS. 1 and 3) upon which the patella projection P of the knee is adapted to rest and transmit body weight to the artificial leg 11.

DETAILED DESCRIPTION

The present invention comprises a clamp 15 comprising an inflatable rubber or other form of elastic bag or bladder 16 disposed within the rim 17 formed on the side wall 18 of the open upper end 13 of the socket 12 of the artificial limb 11. In accordance with the present invention the rim 17 on the side wall 18 of the socket 12 has an intumed lip 19 adjacent one side, preferably the outer side, of the knee joint K and above the enlarged condylar ball-like bone C therein.

This forms a triangular gap between the receding upper surface R of the ball-like bone C and the side wall 18 of the socket wherein the inflatable bag 16 is disposed and confined by the overlying lip 19 of the rim 17. In its simplest form the clamp 15 includes means in the form of a one way pneumatic valve 20 communicating with the inflatable bag 16. By this arrangement the bag 16 is adapted to receive air under pressure from a hand pump or the like in a conventional manner for inflating the bag to thereby form a yieldable wedge or binding between the side wall 18 of the artificial limb 11 and the surface R of the condylar bone C. In this manner the ball-like knee joint K is clamped in place within the conforming upper end 13 of the socket 12 to secure the prosthetic appliance 10 to the amputated limb L.

The inflatable bag 16 being yieldable and somewhat pliable will conform to changes in disposition of the knee joint K relative to the wall 18. Therefore no abrasive action takes place between the yieldable wedge 16 and the flesh surrounding the condylar bone C. Consequently the clamp 15 functions completely and effectively during articulation of the knee joint and greater comfort afforded during walking and/or between change of position from standing to sitting and vice-versa.

To strengthen the plastic material from which such artificial limbs 11 are usually constructed and to assure against excessive flexing of the side wall 18 during change of position of the amputated limb L relative to the artificial limb 11 suitable reinforcement 21 may be provided in the latter. Such reinforcement 21 in the present disclosure is shown as a U-shaped metal member 22 embedded in the material from which the limb 11 is formed. The U shaped member 22 has its bight portion 23 disposed to partially circumscribe the shelf-like recess and its leg portions 24-24' extending diagonally upwardly therefrom within the side walls 18 and 18', respectively. The reinforcing member 22 thus embraces the pressure zone in which the knee bone K rests and articulates relative to the open upper end 13 of the socket 12 in the artificial limb 11.

A self-contained source of pressurizable fluid and control means therefor 25 is provided in combination with the clamp 15 of the present invention. The combined relationship is shown in FIG. 2 and the details thereof more specifically in FIGS. 4, 5 and 6. One form of self-contained source of pressurizable fluid 26 is shown as a CO² bulb connected to a control valve 27 and the latter communicating with the inflatable bag 16 by suitable conduits 28.

Referring to FIG. 4 the control means 27 comprises a fluid-tight chamber 29 formed within a body 30 having threading 31 conforming to that on a conventional CO² bulb. In alignment with this threading 31 is a pin 32 fixedly mounted on the body 30 such that when a charged CO² bulb is threaded against the pin the bulb cap will be pierced thereby to admit the pressurized fluid within the bulb into the chamber 29. Laterally of the body 30 a hand operated valve 33 has a ported end 34 thereof communicating with the chamber 29. This valve 33 has a needle 35 threadably mounted as at 36 therein for screw type movement toward and from the port 34 to open and close the same as desired. A suitable seal in the form of an O ring 37 is provided between the threading of the pin and a knurled knob 38 exteriorly of the valve 33. Between the threading 36 and the port 34 the valve has an outlet nipple 39 connected to one end 40 of the conduits 28.

Referring to FIG. 2 the body 30 of the control means 27 is confined within a hollow cavity H formed within the artificial limb 11 below the socket 12 therein. The body 30 is secured to a wall W of the limb 11 by means of a bolt 41 and so disposed as to extend the valve portion 33 through such wall to expose the knurled knob 38 exteriorly thereof.

The conduits 28 as depicted in the present disclosure in addition to the end 40 includes a section 42 both of which are connected to and through the head of a T fitting 43. The stem of the fitting houses the pneumatic valve 20 previously mentioned to be in communication with the inflatable bag 16 and as shown in FIG. 2 via the section 42 of the conduits 28. By this arrangement the inflatable bag can receive pressurized fluid from the source 26 by opening of the valve 33. For purposes of convenience the T fitting 43 is housed in the cavity H of the prosthesis and with the valve stem portion extending through the wall W for access to the valve 20 exteriorly of the leg 11. If the CO² bulb happens to be exhausted, air under pressure may be supplied by a small hand pump via the pneumatic valve 20. To release the pneumatic clamp 15 the stem of the valve 20 need only be depressed thereby relieving the pressure within the bag 16 so that the amputated limb can be detached from the prosthetic appliance 10.

It should here be noted that the back wall of the artificial limb 11 is provided with an access opening to the cavity H (FIG. 2). This enables the user to replace the source of pres-

surizable fluid 26. As already explained the source of pressurizable fluid 26 may be a CO² bulb connected to the control valve 27.

In accordance with the present invention the source of pressurizable fluid 26 may also be a pliable plastic bag similar 16, filled with a suitable fluid such as water and the like, connected to the control valve 27 on that side thereof opposite the conduit 28 communicating with the expandable wedge or bag 16. In this arrangement the pliable bags are in a closed fluid system having the control valve 27 interposed between them.

When the source of pressurized fluid 26 is a pliable plastic or rubber bag filled with, for example water, the fluid will be stored in the source 26 upon squeezing of the bag 16 when the valve 27 is open. By the same token when the stump S of an amputee is inserted into the socket 12 of the artificial limb 11 and the valve 27 open, the wearer merely presses his finger against the reservoir 26 to discharge the fluid therefrom. The fluid from the pliable reservoir 26 is thus transmitted through the system of conduits 28 into the expandable bag 16. When the bag 16 is thus filled and the fluid therein thus pressurized, the valve 33 of the control means 27 may then be closed by manipulation of the knob 38 to retain the pressurized fluid up in the bag 16. In this manner the artificial limb 11 is secured to the amputated limb therein by the fluid pressure clamp 15 in accordance with the present invention.

Although a section 42 of the pneumatic conduits 28 is shown exteriorly of the artificial leg 11 it will be appreciated that all of the conduits 28 may be built into such prosthetic appliance at the time of its manufacture to conceal all piping and guard the same against accident.

The fluid pressure clamp 15 of the present invention is convenient and simple to operate, affords chafe free articulation of the condylar joint to which the prosthetic appliance is attachable; the expandable wedge conforming to variations in position of the condylar joint and movement of the skin around the same. The amputated limb L is thereby prevented from deteriorating from atrophy and becomes more a living thing by development of the muscles and tissues therein during use of the artificial limb in a natural way.

Having thus described my fluid pressure clamp as applied to a Patella Tendon Bearing artificial leg in specific detail it will be appreciated by those skilled in the art that the same applies equally to other forms of condylar prosthetic appliances including variations in construction and modifications or alterations within the embodiment of the scope of the present invention.

What I claim as new and desire to protect by Letters Patent is:

1. In combination with a prosthetic appliance of the type having a socket formed therein for receiving the stump of an amputated limb and having side walls adjacent the open end of such socket for embracing a portion of a condylar bone in the limb connected to such stump; a fluid pressure clamp comprising:

1. a triangular space formed on the inner side of one side wall of the prosthetic appliance in relation to a receding surface above the condylar bone of an amputated limb adapted to be disposed in said socket;
2. an expandable bladder mounted in said triangular space and adapted upon receipt of pressurized fluid to have bearing relation against a portion of the condylar bone of the amputated limb adapted to have its stump inserted in such socket;
3. an interned lip on the rim of the open end of such one side wall overlying said expandable bladder; and
4. means for admitting fluid under pressure to said expandable bladder for expanding the latter to provide a pliant pressurized wedge between the condylar bone and such one side wall and adapted to yield in conformity with movements of the condylar bone upon articulation thereof relative to the prosthetic appliance.

2. The pneumatic clamp in accordance with that of claim 1 wherein such prosthetic appliance is for the stump of a leg amputated below the knee and has a shelf-like recess formed within the open end of such socket for receiving and supporting the patella of the condylar bone of the knee.

3. The pneumatic clamp in accordance with that of claim 1 wherein such prosthetic appliance is for the stump of a leg amputated below the knee and has a shelf-like recess formed within the open end of such socket for receiving and supporting the patella of the condylar bone of the knee, and reinforcing means embedded within the walls of such socket comprising a U-shaped metal member having its bight portion partially circumscribing such shelf-like recess and its leg portions extending into the side walls thereof for maintaining the latter substantially rigid against deflection during articulation of the knee of the amputated leg therein and pressure of the condylar bone against said pneumatic wedge.

4. The pneumatic clamp in accordance with that of claim 1 including a self-contained source of pressurizable fluid, a conduit for communicating said source of pressurizable fluid with said expandable bladder, and control means in said conduit for controlling the flow of pressurizable fluid to and from said bladder.

5. The pneumatic clamp in accordance with that of claim 4 in which said self contained source of pressurized fluid and control means comprises:

1. a closed fluid system including said expandable bladder;
2. a pliable plastic bag reservoir arranged in said prosthetic appliance and accessible to manual squeezing;
3. a conduit communicating said expandable bladder with said pliable plastic bag;
4. a supply of fluid confined within said pliable plastic bag reservoir for transmittal therefrom into said expandable bladder via said conduit upon manual squeezing and com-

pression of said pliable plastic bag reservoir; and

5. valve means in said conduit between said pliable plastic bag reservoir and said expandable bladder closable for maintaining fluid under pressure in said expandable bladder and openable for releasing pressurized fluid therefrom for return to said pliable plastic bag reservoir.

6. The pneumatic clamp in accordance with that of claim 4 in which said self-contained source of pressurized fluid and control means comprises:

- a. a needle valve mounted within such prosthetic appliance and having a manually operated knob protruding therefrom exteriorly of such prosthetic appliance,
- b. a charged bulb of pressurized fluid connected to one side of said needle valve within the prosthetic appliance, and
- c. a conduit having one end connected to the other side of said needle valve and the opposite end of said conduit communicating with said expandable bladder.

7. The pneumatic clamp in accordance with that of claim 6 including a T fitting having its head portion interposed between the ends of said conduit and its stem end protruding through the wall of such prosthetic appliance for exposure externally thereof, and

a manually operatable valve stem in the stem end of said T fitting and exposed externally of said prosthetic appliance for relieving pressurized fluid from said inflatable bladder.

8. The pneumatic clamp in accordance with that of claim 7 in which said charged bulb of pressurized fluid is a CO² bulb threadably connected to one side of said needle valve.

9. The pneumatic clamp in accordance with that of claim 8 including means within said needle valve for piercing said CO² bulb upon threading thereof onto said needle valve for admitting CO² gas into said one side of said needle valve.

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