March 15, 1949. C. V. GANOE ET AL 2,464,443

PROSTHETIC LIMB SOCKET FOR AMPUTEES

Filed Nov. 17, 1947

Fig. 1.

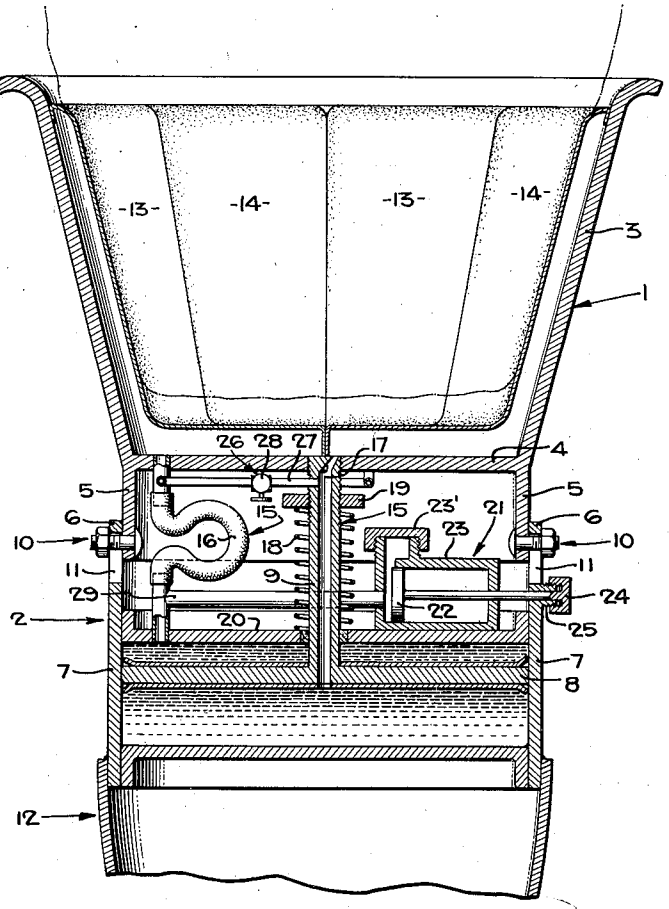
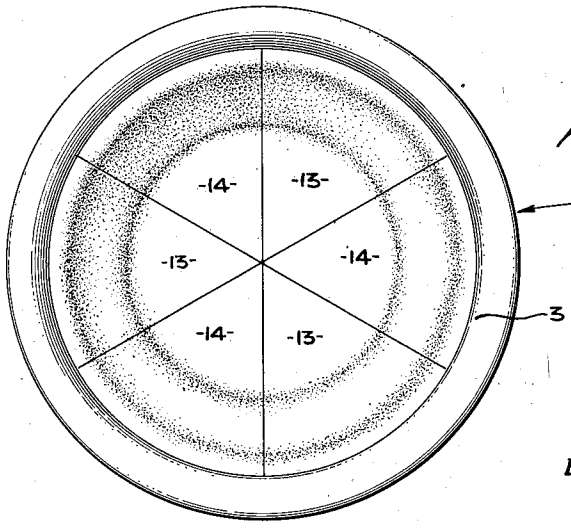


Fig. 2.



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Patented Mar. 15, 1949 2,464,443

UNITED STATES PATENT OFFICE

2,464,443

PROSTHETIC LIMB SOCKET FOR AMPUTEES

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Application November 17, 1947, Serial No. 786,422

16 Claims. (Cl. 3—3)

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This invention relates generally to prosthetic appliances and more particularly to an improved means for fastening a prosthetic limb to an amputee's limb stump.

Numerous types of prior art devices for attaching prosthetic limbs to limb stumps have been developed heretofore. However, all of said prior art devices have numerous disadvantages, most thereof arising from unsuccessful attempts to solve the major problem existing in attaching and fitting such a prosthetic limb to a limb stump. The problem is how to attach the prosthetic limb to the stump in such a manner as to obtain the maximum possible mobility and effectiveness of the prosthetic limb without causing deleterious or various types of undesirable effects on the limb stump by reason of the mode of fastening the prosthetic limb thereto.

Generally speaking, the prior systems employ a hollow socket adapted to receive the limb stump therein. Certain of the prior art systems employ a harness connected to the socket or prosthetic limb for connecting the prosthetic limb to the stump. These harnesses are rather bulky and uncomfortable.

Certain other prior art systems employ a vacuum or sealed system, wherein the stump is fitted into the socket with an extremely close fit and the air is removed from the socket below the stump, thus causing the stump and the socket to be connected by reason of the vacuum seal. This is undesirable in that it has a tendency to inhibit the return venous blood circulation and also lymphatic circulation, with all of the serious effects resulting therefrom.

Certain other prior art systems attempt to fasten the socket to the leg stump frictionally by having same in very tight engagement with the stump or by providing suitable harness means which is fastened very tightly around the limb stump. This system impedes arterial circulation primarily by inhibiting the flow of blood from the heart to the limb stump. The results of both types of blood circulatory inhibition are in a general way similar and unsatisfactory.

Another type of system employed for upper leg amputees provides an edge on the socket which extends up to and in contact with the buttock muscle of the amputee for transmitting load. This type of system is often used in conjunction with a frictional load bearing system wherein the side areas of the limb stump in contact with the inside surface of the socket transmit load through frictional contact therebetween. This type of system also causes severe irritation and

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often leads to ulcers and surface lesions of all types.

Generally speaking, the apparatus of the present invention comprises a hollow socket member of a cross section virtually conforming to, but slightly larger than, a limb stump over which it is to be fitted, open at the top and closed at the bottom. A plurality of separate, relatively thin, large surface area, flexible, hollow, closed cells are carried by the inside of the bottom and side walls of the hollow socket and are arranged to engage a limb stump inserted thereinto to prevent relative motion of the stump and socket. The hollow socket member is arranged to be effectively connected to a prosthetic limb in a manner whereby limited relative longitudinal movement thereof may occur. Hydraulic pump means is operably effectively connected between the socket member and the prosthetic limb whereby said relative longitudinal movement in either direction actuates said pump in a corresponding direction, one side of which is operatively connected to the interiors of a first set of said cells and the other side of which is operatively connected to the interiors of a second set of said cells, whereby hydraulic fluid is pumped to the corresponding set of cells, thereby increasing the pressure therein and from the other set of cells, thereby decreasing the pressure therein.

It can be seen from the above general description that when employing the apparatus of this invention, any longitudinal movement of the prosthetic limb with respect to the amputee's limb stump will result in altering the pressurized contact of the cells within the socket with the limb stump and relative longitudinal movement in the opposite sense will act in the opposite manner, thus effectively producing a pumping action on the amputee's limb stump during such relative longitudinal movement of the prosthetic limb with respect to the limb stump.

Differently stated, longitudinally directed motion of the stump or any variation in the load carried by the prosthetic limb causes a change in the distribution of pressure around the stump, some spaced areas being subjected to grasping pressure from the cells when the load is high and other spaced or intervening areas being subjected to grasping pressure from the cells when the imposed load is low or of opposite sense.

Relative longitudinal movement between stump and socket, of minor amplitude, will occur every time the load carried by the prosthetic limb is varied, such as, for example, in walking. Merely standing and shifting the weight from one leg to

the other would have this effect, and, in fact, almost any use of the limb has this effect. This alternate grasping and pumping action greatly increases the flow of blood and lymphatic circulation through the stump, thus avoiding the hereinbefore-mentioned prior art defects arising from inhibited circulation and, furthermore, since the portions of the socket in contact with the limb stump are flexible and resilient and do not slip with respect to the limb stump, no chafing or surface irritation and resultant debility occur.

With the above points in mind, it is an object of this invention to provide a new and improved means for fastening a prosthetic limb to a limb stump wherein circulation through the stump is not impaired by the device and wherein no chafing and surface irritation of the stump occur.

It is also an object to provide new and improved means for fastening a prosthetic limb to a limb stump wherein the circulation through the limb stump is not impaired.

It is a further object of this invention to provide a new and improved means of fastening a prosthetic limb to a limb stump wherein chafing and surface irritation of the stump do not occur.

It is a further object to provide a new and improved means of fastening a prosthetic limb to a limb stump whereby varying pressure is alternately applied to different surface areas of the limb stump within the socket whenever a longitudinal load component is applied to the prosthetic limb for effectively producing a massaging and pumping action on the limb adapted to improve circulation therethrough.

Other and allied objects will be apparent to those skilled in the art upon a careful study and examination of the illustrations, specification, and appended claims. To facilitate understanding, reference will be had to the following drawings, in which:

Fig. 1 is a diagrammatic vertical section of one illustrative embodiment of the invention.

Fig. 2 is a plan view of an illustrative embodiment of the invention of Fig. 1.

Referring to the figures, a hollow socket member, indicated generally at 1, is provided with means, indicated generally at 2, for attaching same to a prosthetic limb, a portion of which is indicated generally at 12. The hollow socket member 1, in the example illustrated, is of frustoconical shape, including the conical side wall 3 and the flat bottom wall 4. The fastening means 2 for fastening the hollow socket member 1 to the prosthetic limb 12 includes pump means and is arranged for limited, longitudinal, relative movement for actuating said pump means.

More specifically, the fastening means 2 includes a downwardly projecting circular lip 5 connected to the bottom of the hollow socket member 1 and adapted to cooperate with a similar, upwardly projecting, circular lip 6 carried by a hollow, shallow cylinder 7 in which a piston 8 is reciprocably mounted. The cylinder 7 is closed at the bottom. The prosthetic limb 12 is affixed to cylinder 7 in any suitable manner.

The piston 8 and cylinder 7 constitute the hereinabove-mentioned pump means, in the example illustrated. The piston 8 is connected by a rod or tube 9 to the bottom wall 4 of the hollow socket member 1. The downwardly directed lip 5 and the cooperating, upwardly directed lip 6 are connected together by suitable fastening means, allowing limited, relative, longitudinal movement of the lips 5 and 6 with respect to one another. Such means may comprise bolts 10, carried by circular

lip 5 and vertical slide slots 11 cooperating therewith and formed in circular lip 6. Since the piston 8 is fixed to the lower wall 4 of the hollow socket member 1 by means of the tube 9, and the cylinder 7 in which the piston 8 is contained, is adapted to be mechanically connected at its lower end to the prosthetic limb, indicated at 12, limited, relative, longitudinal movement between said prosthetic limb 12 and the hollow socket member 1 will cause similar relative movement of the piston 8 with respect to the cylinder 7, thus actuating the pump formed thereby in a direction depending upon the direction of said limited, relative, longitudinal movement.

Means 15 are provided for hydraulically connecting opposite sides of the piston 8 to different sets of hollow, flexible cells, indicated generally at 13 and 14, carried within the socket 1 against the walls 3 and the bottom 4, whereby pump actuation resulting from relative, longitudinal movement of the prosthetic limb 12 and the socket member 1 causes hydraulic fluid contained in the pump means or cylinder 7 to be pumped to and increase the pressure in one of said sets of cells and to be pumped from and decrease the pressure in the other of said sets of cells.

The set of spaced cells, indicated at 13, will be called herein "tension" cells for purposes of clarification in the description, and the intervening set of cells, indicated at 14, will be called herein "compression" cells for the purpose of simplifying the description. When the prosthetic leg 12 and the socket member 1 are relatively moved in an elongating direction, such as would occur when applying tension to the leg or when lifting the leg, where the weight of the prosthetic leg would apply tension, the piston 8 and cylinder 7 are relatively moved in the same sense, pumping hydraulic fluid through the hydraulic connecting means 15 in a manner tending to increase the pressure in the tension cells 13 and to decrease the pressure in the compression cells 14. In such case, the tension cells 13, which are of flexible construction, tend to grip the stump of the amputee firmly for causing the socket 1 to be firmly retained on the amputee's leg stump. The opposite action occurs when compressive load is put on the prosthetic limb 12 and the fastening means 2, causing the piston 8 and cylinder 7 to relatively move in the opposite sense and pump hydraulic fluid in the opposite direction, increasing the pressure in the set of compression cells 14 and decreasing the pressure in the set of tension cells 13. Thus the compression cells 14 will firmly grip the amputee's leg stump and prevent relative movement between said stump and said socket 1.

The cells 13 and 14 are preferably of thin, flat, large surface area construction and composed of a flexible, thin, compliant, sheet material impervious to hydraulic fluid and which may be resilient and elastic, if desired. Polyvinyl resins, rubber and various other materials may be employed. In the example shown, the tension and compression cells are alternately arranged so as to provide equi-angular segments about the central vertical axis of symmetry of the socket member 1, and each cell extends from a point high up on the conical wall 3 down to the bottom wall 4 and thence to the center of the bottom of the bottom wall 4, the edges thereof being in contact with adjacent cells. However, various other arrangements may be employed.

Hydraulic connecting means 15 in the example shown comprise a flexible conduit 16 connecting

the chamber on the upper side of the piston 8 with a manifold leading into the interiors of tension cells 13, and a bore or channel 17 in the piston rod 9 communicating the chamber on the lower side of the piston 8 with ports connected to the interior of compression cells 14. Since the chambers, cells and conduits are filled with a suitable liquid, it can be seen that relative movement of the prosthetic limb 12 and the socket member 1 causes similar relative movement of the piston 8 and cylinder 7 and creates a decrease or increase of pressure in the compression or tension cells.

Means is provided for normally biasing the pump in one direction. In the example shown, this comprises a coil compression spring 18, the upper end of which abuts an adjustment nut 19 and the lower end of which abuts the top wall 20 of the cylinder 7, thus normally tending to move the piston 8 to the extreme upper position within the cylinder 7, which pumps hydraulic fluid to the tension cells 13 and from the compression cells 14. Thus, the biasing spring means 18 tends to increase the pressure of the tension cells 13 for maintaining firm contact between same and the leg stump within the socket when no compressive load is applied to the prosthetic leg 12. When such compressive load is applied to the prosthetic leg 12, the spring 18 is overridden and the device operates as hereinbefore described. The spring adjustment nut 19 is threadably engaged with the exterior of the tube 9 and may be adjusted for varying the tension of the compression spring 18.

Means is provided for manually adjusting the volumetric capacity of the hydraulic system for effectively engaging or disengaging the cells with a leg stump. This is indicated generally at 21 and comprises a pressure release piston 22 reciprocably mounted in a pressure release cylinder 23 which is connected to the hydraulic system; in the example shown, to the conduit 16, by means of a conduit 29, and is adapted to be manually actuated by a cap 24 which may be threadedly engaged with a threaded boss 25. It can be seen that when the manual adjusting cap 24 is disengaged from the boss 25 and placed in an extended position, the volumetric capacity of the system is increased, and the pressure exerted by cells 13 and 14 is reduced sufficiently to enable an amputee to insert or remove his leg stump into or out of the socket 1. After inserting the leg stump into the socket 1, the cap 24 may be engaged with the threads 25 for reducing the volumetric capacity of the hydraulic system sufficiently to cause positive engagement of the tension cells and the exterior of the amputee's limb stump. Hydraulic fluid may be added to the system through a removable cap 23' on cylinder 23.

Hydraulic fluid control means, indicated at 26, may be provided, if desired. In the example shown, the hydraulic fluid control means includes a conduit 27 connecting the conduit 16 and the bore 17, although it may be connected in any suitable manner between opposite sides of the pump means. It also includes a control valve, indicated at 28, which may be a needle valve or the like, or any variable orifice or shut-off valve.

This hydraulic fluid control means may operate in two distinct manners. In the first system the needle valve 28 is adjusted to allow a limited flow of hydraulic fluid in either direction through the conduit 27 between the conduit 16 and the bore 17. This causes the pressure in the tension set of cells and the compression set of cells

to equalize a short period of time after the prosthetic limb 12 and the socket member 1 have become relatively longitudinally immobilized with respect to one another. In other words, the hereinbefore described gripping of the leg by either the tension cells or the compression cells, corresponding to the direction of load applied to the leg, whether tensile or compressive, still operates as described at the time the load is applied. However, subsequently the pressure within the two sets of cells equalizes and they apply an even grip around the entire area of the leg, whereas during either of the hereinbeforementioned rapid rate of change of load conditions, a somewhat greater grip has been applied to one-half of the area of the leg stump within the socket.

The second mode of operation of the hydraulic fluid control means 26 is where it is merely used for allowing hydraulic fluid to pass from one side of the pump means to the other side for varying the normal relative position of the piston 8 with respect to the cylinder 7, after which the valve 28 may be closed.

Numerous modifications and variations of this invention within the spirit and scope of the claims appended hereto will occur to those skilled in the art and all such are intended to be comprehended and included therein.

The examples described and illustrated herein are exemplary only and are not intended to limit the scope of this invention, which is to be interpreted in the light of the prior art and the appended claims only.

We claim:

1. An improved prosthetic limb-attaching apparatus for amputees, the lower end of which is adapted to be connected to a prosthetic limb and the upper end of which is adapted to receive and controllably, resiliently engage and retain a limb stump therein, comprising: a hollow socket member of circular cross section of a size slightly larger than a limb stump over which it is to be fitted, open at the top and closed at the bottom thereof; a plurality of separate, relatively thin, large surface area, hollow, closed cells of flexible composition in surface contact with the inside of the bottom and side walls of the hollow socket and adapted to controllably engage the end and sides of a limb stump inserted thereinto for providing suitable, resilient, load-carrying, bearing surface and also for retaining the limb stump therein; said cells being arranged in the form of adjacent, equiangular segments around the vertical axis of symmetry of a socket, the lower end of said socket being provided with downwardly extending, fastening lip means; a closed cylinder provided with upwardly extending, fastening lip means adapted to be connected to the downwardly extending, fastening lip means carried by the socket in a manner allowing limited relative vertical movement therebetween, the opposite end of said cylinder being arranged to be connected to a prosthetic limb; a piston reciprocably positioned in said cylinder provided with a rod connected to said socket member, whereby relative vertical movement of the socket member and the prosthetic limb causes the piston to change position within the cylinder; means for hydraulically connecting the interiors of alternating cells to the cylinder on one side of the piston and the interiors of the remaining cells to the cylinder on the other side of the piston, whereby relative, longitudinal movement of the piston and cylinder in one sense pumps hydraulic fluid contained therein into one of the sets of cells, thereby in-

creasing the pressure therein, and out of the other set of cells, thereby decreasing the pressure therein, thus causing the first set of cells to positively engage the limb stump and second set of cells to release the limb stump, and whereby such relative longitudinal movement of the piston and cylinder in the opposite sense causes the first set of cells to release the limb stump and the second set of cells to positively engage the limb stump; and means for manually adjusting the volumetric capacity of the hydraulic system for controllably, selectively causing the engagement or disengagement of the cells and limb stump.

2. Apparatus of the character stated in claim 1, wherein hydraulic fluid equalizer valve means is effectively connected between the two sets of cells and is adapted to adjustably limit the rate of flow of hydraulic fluid between said two sets of cells, whereby the pressure within both sets of cells will reach an equilibrium value a short time after relative vertical immobilization of the socket member and the prosthetic limb occurs.

3. An improved prosthetic limb-attaching apparatus for amputees, the lower end of which is adapted to be connected to a prosthetic limb and the upper end of which is adapted to receive and controllably, resiliently engage and retain a limb stump therein, comprising: a hollow socket member of a cross section virtually conforming to but slightly larger than a limb stump over which it is to be fitted, open at the top and closed at the bottom thereof; a plurality of separate, relatively thin, large surface area, hollow, closed cells of flexible construction in surface contact with the inside of the bottom and side walls of the hollow socket member and adapted to engage the end and sides of a limb stump inserted thereinto to prevent relative motion between the stump and the socket; said cells being arranged in the form of adjacent surface areas, sub-tending equal angles about the vertical axis of the socket member; means for effectively fastening the lower end of said socket member to the upper end of a prosthetic limb in a manner whereby limited, relative, vertical movement may take place therebetween, said means including a cylinder containing a piston, whereby said limited, relative, vertical movement causes limited, relative, vertical movement between the piston and the cylinder; means for hydraulically connecting the interiors of certain of the non-adjacent cells to the cylinder on one side of the piston, and the interiors of certain of the rest of the cells, which are also non-adjacent, to the cylinder on the other side of the piston, whereby relative, vertical movement of the piston and cylinder in one sense pumps hydraulic fluid contained therein to one of the sets of cells, thereby increasing the pressure therein and from the other set of cells, thereby decreasing the pressure therein, thus causing the first set of cells to positively engage the limb stump and the second set of cells to release the limb stump, and whereby such relative, vertical movement of the piston and cylinder in the opposite sense causes the first set of cells to release the limb stump and the second set of cells to positively engage the limb stump; and means for manually adjusting the volumetric capacity of the hydraulic system for controllably, selectively causing the engagement or disengagement of cells and limb stump, said piston and cylinder being normally effectively spring biased toward one extremum position.

4. Apparatus of the character stated in claim 3,

wherein hydraulic fluid equalizer valve means is effectively connected between the two sets of cells and is adapted to adjustably limit the rate of flow of hydraulic fluid between said two sets of cells, whereby the pressure exerted by both sets of cells will reach an equilibrium value a short time after relative vertical immobilization of the socket member and the prosthetic limb occurs.

5. An improved prosthetic limb-attaching apparatus for amputees, the lower end of which is adapted to be connected to a prosthetic limb and the upper end of which is adapted to receive and controllably, resiliently engage and retain a limb stump therein, comprising: a hollow socket member of a cross section virtually conforming to but slightly larger than a limb stump over which it is to be fitted, open at the top and closed at the bottom thereof; a plurality of separate, relatively thin, large surface area, hollow, closed cells of flexible construction in surface contact with the inside of the bottom and side walls of the hollow socket member and adapted to engage the end and sides of a limb stump inserted thereinto to prevent relative motion between the stump and the socket; said cells being arranged in the form of adjacent surface areas, subtending equal angles about the vertical axis of the socket member; said fastening means including pump means operably connected between the socket member and the prosthetic limb, whereby said relative vertical movement of the socket member and the prosthetic limb actuates said pump means in a direction corresponding to the direction of said relative vertical movement; means for hydraulically connecting one set of cells to one side of the pump and another set of cells to the other side of the pump, whereby actuation of the pump in one direction or the other pumps hydraulic fluid contained therein into one of the sets of cells, thereby increasing the pressure therein, and out of the other set of cells, thereby decreasing the pressure therein, thus causing the set of cells into which the hydraulic fluid is pumped to positively engage the limb stump and the set of cells from which the hydraulic fluid is pumped to release the limb stump; and means for manually adjusting the volumetric capacity of the hydraulic system for controllably, selectively causing the engagement or disengagement of cells and limb stump.

6. Apparatus of the character stated in claim 5, wherein hydraulic fluid equalizer valve means is effectively connected between the two sets of cells and is adapted to limit the rate of flow of hydraulic fluid between said two sets of cells, whereby the pressure exerted by both sets of cells will reach an equilibrium value a short time after relative vertical immobilization of the socket member and the prosthetic limb occurs.

7. An improved prosthetic limb-attaching apparatus for amputees, the lower end of which is adapted to be connected to a prosthetic limb and the upper end of which is adapted to receive and controllably, resiliently engage and retain a limb stump therein, comprising: a hollow socket member of a cross section virtually conforming to but slightly larger than a limb stump over which it is to be fitted, open at the top and closed at the botom thereof; a plurality of separate, relatively thin, large surface area, hollow, closed cells of flexible construction in surface contact with the inside of the bottom and side walls of the hollow socket member and adapted to engage a limb stump inserted thereinto to prevent

relative motion between the stump and the socket; said cells being arranged in the form of adjacent surface areas, subtending equal angles about the vertical axis of the socket member; said fastening means including pump means operably connected between the socket member and the prosthetic limb, whereby said relative vertical movement of the socket member and the prosthetic limb actuates said pump means in a direction corresponding to the direction of said relative vertical movement; means for hydraulically connecting one set of cells to one side of the pump and another set of cells to the other side of the pump, whereby actuation of the pump in one direction or the other, pumps hydraulic fluid contained therein into one of the sets of cells, and out of the other set of cells; and means for manually adjusting the volumetric capacity of the hydraulic system for controllably, selectively causing the engagement or disengagement of cells and limb stump.

8. Apparatus of the character stated in claim 7, wherein hydraulic fluid equalizer valve means is effectively connected between the two sets of cells and is adapted to limit the rate of flow of hydraulic fluid between said two sets of cells, whereby the pressure exerted by both sets of cells will reach an equilibrium value a short time after relative vertical immobilization of the socket member and the prosthetic limb occurs.

9. An improved prosthetic limb-attaching apparatus for amputees, the lower end of which is adapted to be connected to a prosthetic limb and the upper end of which is adapted to receive and controllably, resiliently engage and retain a limb stump therein, comprising: a hollow socket member of circular cross section of a size slightly larger than a limb stump over which it is to be fitted, open at the top and closed at the bottom thereof; a plurality of hollow cells of flexible composition in the hollow socket and adapted to engage a limb stump inserted thereinto for retaining the limb stump therein; the lower end of said socket being provided with downwardly extending, fastening lip means; a closed cylinder provided with upwardly extending, fastening lip means adapted to be connected to the downwardly extending, fastening lip means carried by the socket in a manner allowing limited relative vertical movement therebetween, the opposite end of said cylinder being arranged to be connected to a prosthetic limb; a piston reciprocably positioned in said cylinder provided with a rod connected to said socket member, whereby relative vertical movement of the socket member and the prosthetic limb causes the piston to change position within the cylinder; and means for hydraulically connecting the interiors of alternating cells to the cylinder on one side of the piston and the interiors of the remaining cells to the cylinder on the other side of the piston, whereby relative, longitudinal movement of the piston and cylinder in one sense pumps hydraulic fluid contained therein into one of the sets of cells, thereby increasing the pressure therein, and out of the other set of cells, thereby decreasing the pressure therein, thus causing the first set of cells to positively engage the limb stump and second set of cells to release the limb stump, and whereby such relative longitudinal movement of the piston and cylinder in the opposite sense causes the first set of cells to release the limb stump and the second set of cells to positively engage the limb stump.

10. An improved prosthetic limb-attaching apparatus for amputees, the lower end of which is adapted to be connected to a prosthetic limb and the upper end of which is adapted to receive and controllably, resiliently engage and retain a limb stump therein, comprising: a hollow socket member of a cross section virtually conforming to but slightly larger than a limb stump over which it is to be fitted, open at the top and closed at the bottom thereof; a plurality of hollow cells of flexible construction in the hollow socket member and adapted to engage a limb stump inserted thereinto to prevent relative motion between the stump and the socket; means for effectively fastening the lower end of said socket member to the upper end of a prosthetic limb in a manner whereby limited, relative, vertical movement may take place therebetween, said means including a cylinder containing a piston, whereby said limited, relative, vertical movement causes limited, relative, vertical movement between the piston and the cylinder; means for hydraulically connecting the interiors of certain of the non-adjacent cells to the cylinder on one side of the piston, and the interiors of certain of the rest of the cells, which are also non-adjacent, to the cylinder on the other side of the piston, whereby relative, vertical movement of the piston and cylinder in one sense pumps hydraulic fluid contained therein to one of the sets of cells, thereby increasing the pressure therein and from the other set of cells, thereby decreasing the pressure therein, thus causing the first set of cells to positively engage the limb stump and the second set of cells to release the limb stump, and whereby such relative, vertical movement of the piston and cylinder in the opposite sense causes the first set of cells to release the limb stump and the second set of cells to positively engage the limb stump.

11. An improved prosthetic limb-attaching apparatus for amputees, the lower end of which is adapted to be connected to a prosthetic limb and the upper end of which is adapted to receive and controllably, resiliently engage and retain a limb stump therein, comprising: a hollow socket member of a cross section virtually conforming to but slightly larger than a limb stump over which it is to be fitted, open at the top and closed at the bottom thereof; a plurality of hollow cells of flexible construction in the hollow socket member and adapted to engage a limb stump inserted thereinto to prevent relative motion between the stump and the socket; means for effectively fastening the lower end of said socket member to the upper end of a prosthetic limb in a manner whereby limited, relative, vertical movement may take place therebetween, said fastening means including pump means operably connected between the socket member and the prosthetic limb, whereby said relative, vertical movement of the socket member and the prosthetic limb actuates said pump means in a direction corresponding to the direction of said relative vertical movement; means for hydraulically connecting one set of cells to one side of the pump and another set of cells to the other side of the pump, whereby actuation of the pump in one direction or the other pumps hydraulic fluid contained therein into one of the sets of cells, thereby increasing the pressure therein, and out of the other set of cells, thereby decreasing the pressure therein, thus causing the set of cells into which the hydraulic fluid is pumped to positively engage the limb stump and the set of cells from which the hydraulic fluid is pumped to release the limb stump.

12. An improved prosthetic limb-attaching apparatus for amputees, the lower end of which is

adapted to be connected to a prosthetic limb and the upper end of which is adapted to receive and controllably, resiliently engage and retain a limb stump therein, comprising: a hollow socket member of a cross section virtually conforming to but slightly larger than a limb stump over which it is to be fitted, open at the top and closed at the bottom thereof; a plurality of hollow cells of flexible construction in the hollow socket member and adapted to engage a limb stump inserted thereinto to prevent relative motion between the stump and the socket; means for effectively fastening the lower end of said socket member to the upper end of a prosthetic limb in a manner whereby limited, relative, vertical movement may take place therebetween, said fastening means including pump means operably connected between the socket member and the prosthetic limb, whereby said relative vertical movement of the socket member and the prosthetic limb actuates said pump means in a direction corresponding to the direction of said relative vertical movement; and means for hydraulically connecting one set of cells to one side of the pump and another set of cells to the other side of the pump, whereby actuation of the pump in one direction or the other pumps hydraulic fluid contained therein into one of the sets of cells, and out of the other set of cells.

13. An improved socket for an amputee's stump, comprising: a substantially rigid socket having side walls and a bottom; a piston cylinder attached to the socket for axial limited movement and arranged to carry a prosthetic appliance; a plurality of separate cells on the internal surfaces of the socket, each of said cells being provided with a pliant, flexible surface; a piston in said cylinder; a rod connecting said piston to the socket; a chamber on each side of the piston in each cylinder; conduit means connecting one of said chambers with a set of spaced cells; and separate conduit means connecting the other chamber with another set of spaced cells.

14. An improved socket for an amputee's stump, comprising: a substantially rigid socket having side walls and a bottom; a piston cylinder attached to the socket for axial limited movement and arranged to carry a prosthetic appliance; a plurality of separate cells on the internal surfaces of the socket, each of said cells being provided with a pliant, flexible surface; a piston in said cylinder; a rod connecting said piston to the socket; a chamber on each side of the piston

in each cylinder; conduit means connecting one of said chambers with a set of spaced cells; separate conduit means connecting the other chamber with another set of spaced cells; and means for manually adjusting the volumetric capacity of the hydraulic system for controllably, selectively causing the engagement or disengagement of cells and limb stump.

15. An improved socket for an amputee's stump, comprising: a substantially rigid socket having side walls and a bottom; a piston cylinder attached to the socket for axial limited movement and arranged to carry a prosthetic appliance; a plurality of separate cells on the internal surfaces of the socket, each of said cells being provided with a pliant, flexible surface; a piston in said cylinder; a rod connecting said piston to the socket; a chamber on each side of the piston in each cylinder; conduit means connecting one of said chambers with a set of spaced cells; separate conduit means connecting the other chamber with another set of spaced cells; means for manually adjusting the volumetric capacity of the hydraulic system for controllably, selectively causing the engagement or disengagement of cells and limb stump; and hydraulic fluid equalizer valve means effectively connected between the two chambers and arranged to limit the rate of flow of hydraulic fluid therebetween, whereby the pressure exerted by sets of cells will reach an equilibrium value a short time after relative, vertical, immobilization of the socket member and the prosthetic appliance occurs.

16. Means for attaching a prosthetic appliance to a stump including: a substantially rigid socket; a plurality of cells on the internal surface of the socket, said cells being provided with pliant, flexible surfaces arranged to contact a stump; a connection between the socket and a prosthetic appliance, said connection permitting limited movement between the socket and said appliance in a direction virtually axial with respect to the socket; and a closed hydraulic system including a piston member movable upon relative movement of the appliance and socket and operatively connected to said cells for decreasing and increasing the pressure of fluid in adjacent cells simultaneously upon relative movement of the socket and appliance.

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No references cited.