The present invention relates in general to the art of prosthetics and more particularly to artificial legs of the suction, socket type.

This type of prosthesis is usually provided with a spring closed relief valve acting as a pop valve arranged to be opened momentarily to permit release of air from the socket, when placing the shortened limb in the socket and then, to establish a suction by means of partial vacuum for holding the prosthesis in place. Such valves are also used to admit air at the will of the wearer to permit ready removal of the prosthesis, to which end the valve is provided with manually operated means for momentarily opening the same against the tension of its closing spring.

Some users of this type of prosthesis often experience a disconcerting disturbance of circulation in the limb on which the prosthesis is worn, due to what is believed to be the building up of an unduly high degree of partial vacuum during walking, particularly in warm humid weather.

It has been found that temporary relief from the above mentioned discomfort may be obtained by momentarily opening the valve by hand but with the annoyance of having to do so repeatedly at short intervals while walking, sometimes as frequently as every 50 feet. A further annoyance incidental to this expedient is that the sudden release through the valve of any difference of pressure between the interior of the socket and the outside atmosphere is accompanied by an unpleasant noise embarrassing to the wearer. Any attempt to remedy the situation by use of a pressure controlled valve for maintaining the degree of partial vacuum or sub-atmospheric pressure constant at all times during wear, is not desirable as the degree of sub-atmospheric pressure found comfortable for one condition of weather would not be the same under other conditions.

An object of the present invention is to provide a prosthesis of the suction, socket type in which the aforementioned objections are eliminated.

Another object is to provide a prosthesis of the present type in which the attainment of a satisfactory adjustment for a given operating condition may be discontinued for any length of time and reproduced with accuracy and without resort to trial and error procedure.

A further object is the provision of a prosthesis of the suction, socket type in which the reduced internal pressure during walking may be maintained substantially constant without sudden release or intake of air sufficient to produce undesirable noise.

Other objects and advantages of the invention will become apparent from a perusal of the following specification and the drawings accompanying the same.

In the drawings:
Fig. 1 is a side face view of a portion of a leg prosthesis incorporating the invention, showing an outside view of the valve control.

Fig. 2 is a vertical fragmentary cross section taken on the line 2—2 of Fig. 1.

Referring to the drawings in detail, the numeral 10 indicates a portion of the wall of the socket of a leg prosthesis of the suction socket type. It will be understood that as is customary in a prosthesis of the present type, the socket member is formed in any known or other suitable manner to have its inner side walls conform to the contour of the limb on which it is to be worn in a substantially upright fitting leaving a small enclosed free space at the bottom, and may be lined with suitable padding material as is customary in the art.

For the sake of simplicity and clearness of disclosure, such padded lining and other usual inside and outside wall coverings are omitted, the wall structure being here shown as of one material. It is also to be noted that for the sake of clearness, the parts are shown greatly enlarged to approximately four times the actual size so that while the free space appears large in the drawing, it is really quite small in relation to the size of the socket.

Mounted in the wall 10 of the socket near the bottom of the socket chamber is a valve casing 12 extending through from the outside of the wall to the interior wall face 13 of the socket chamber in the enclosed space below the space occupied by the end of the shortened limb 14 of a wearer. The valve casing is provided near its inner end with external threads 15 which engage internal threads in the circular opening 16 in the socket wall to hold the casing in place with the flange 17 seated in a rabbot at the outer rim of the opening against a sealing gasket 18. The valve body 19 of a valve designated as a whole at 20 is secured in the casing by means of a clamping nut 21 threaded on to the reduced end of the valve body, the latter extending through an opening 22 in the inner wall of the casing to receive the nut outside the casing wall whereby the nut bearing against the casing wall clamps the valve in place with the outer base portions 23 seated in a rabboted rim portion 24 at the outer open end of the valve casing. A bore or duct 25 extending through the reduced portion 26 of the valve body terminates in the enlarged portion of the valve body in a conical valve seat 27 from the face of which valve seat extends a duct 28 through to the outside of the socket body into communication with the interior of the valve casing 12.

Fitted into the conical valve seat is a complementary conical valve head 29 mounted for rotation in the valve seat by means of the attached valve shaft or stem 30 having bearing near the end remote from the head in a round bearing block 31. The round bearing block is threaded on its periphery to engage internal threads 32 in the inner wall of a cylindrical valve-spring chamber 33 formed in the enlarged portion of the valve body. A valve spring 34 in the form of a cylindrical coil compression spring surrounds the valve stem, bearing at one end against the bearing block 31 and at the other end against the valve head 29.

The valve head 29 has formed therein an axial bore or manifold duct 35 in constant communication with the duct 25 and a plurality of radial passages or ducts 36 which latter extend to the conical surface for communication with the valve seat duct 28 selectively as the valve head is turned. Venting ducts 46 in the valve body flange 23 serve to vent the valve casing to atmosphere. Turning of the valve stem 30 and head 29 is effected manually through a hand bar 37 mounted on the reduced squared end 38 of the valve stem and clamped thereto by a watch screw 39. A disk 40 integral with the bar 37 or otherwise arranged to move with the drawings extending index arm 41 cut free of the disk on each side as shown in Fig. 1. Indexing characters 42 in the form of numbers are applied to the flange 23 in any known or other suitable manner, as by engraving, to indicate the angular positions in which the index arm is to be placed for selectively bringing any one of the radial ducts 36 into communication with the duct 28 or for closing
off all the radial ducts as the case may be. In the present instance, the index characters take the form of numerals indicating the diameters of the ducts which they represent in thousandths of an inch, the index "0" indicating, that with the index arm pointing toward the index, there is no communication between the manifold duct 35 and the duct 28, or that the valve is in the off position.

Springing loaded detent means, for holding the index arm in any one of its indexed positions against light force, is provided in the form of indentations or sockets 43 in the outer face of the flange 23 to receive a downwardly projecting boss 44 stamped in the index arm 41. In the embodiment here shown there are five such indexed positions marked 0, 3, 6, 9, and 12, representing zero leakage, or connection of a leakage duct of 3, 6, 9 or 12 thousandths of an inch in diameter, respectively.

A positive stop for the index arm and consequently for the valve movement at the zero position is provided by a stop post 45 mounted in the flange 23 near the zero index character to project into the path of the index arm 41 at a point spaced slightly counterclockwise of the zero index character. Thus the valve adjustment can readily be brought to the zero position from any position, say that shown in Fig. 1, by turning the hand bar 37 counterclockwise until the arm strikes the stop post 45. This may be accomplished by manipulation of the device through the clothing of a wearer, and establishes a reference point from which adjustment of the valve may be made also through the clothing, to select any one of the predetermined rates of leakage. A quick venting of the socket chamber for release of either vacuum or pressure may be had by a slight outward pull on the hand bar 37 against the tension of the valve-seating spring 34 to temporarily withdraw the conical valve head from its seat to momentarily provide a direct connection between the ducts 25 and 28. Where it is desired to maintain the full venting for an indefinite length of time, the index arm in the raised position may be moved over and rested upon the stop post 45 to hold the valve head off the seat. This full venting is of course of special advantage in applying and removing the prosthesis.

With the prosthesis in use, in walking, there is a tendency to continuously increase the difference in pressure between the interior of the socket and the outside atmosphere to a point where the user experiences discomfort apparently due to circulatory disturbance, however with maintenance of a proper given slow leakage path between the socket chamber and the outside atmosphere this tendency is offset.

As the optimum degree of resistance to air flow required to substantially offset the above mentioned tendency to pressure change, varies with weather conditions such as temperature and humidity, adjustment to such variations is afforded by provision of the plurality of ducts of varying resistance to air flow. While in the present embodiment the different degrees of resistance to air flow is accomplished by use of ducts of different areas of cross-section, it will be understood that variation in resistance of the different ducts may be accomplished by any known or other suitable means as by packing with a porous filling such as steel wool or equivalent.

While a single preferred embodiment of the invention has been herein shown and described for the sake of disclosure, it is to be understood that the invention is not limited to such specific embodiment but contemplates all such modifications and variants thereof as fall fairly within the scope of the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for Governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. An artificial limb comprising a socket member formed with a chamber adapted to be fitted with a sub-

stantially air tight fit to the stump of a patient's limb, means providing a plurality of fixed leakage channels between the interior of the socket and the outside atmosphere, each of said channels having a different fixed resistance to the passage of air therethrough, and means for selectively maintaining any one of said channels open.

2. An artificial limb comprising a socket member adapted to receive the stump of a patient's limb, said socket member being formed with a chamber adapted to be fitted to the stump in a substantially air tight fit with the sides of the channel, and means providing a plurality of fixed leakage channels between the said free space and the outside atmosphere, said channels having different fixed resistances to air flow therethrough, and means for selectively maintaining any one of said channels open.

3. An artificial limb comprising a socket member adapted to be fitted with a substantially air tight fit to the stump of a patient's limb while leaving a relatively small space between the bottom of the stump and the bottom of the socket, means providing a plurality of normally closed air leakage channels of different diameters between the said small space and the outside of the socket member, and means for selectively maintaining any one of said channels open.

4. An artificial limb comprising a socket member adapted to be fitted with a substantially air tight fit to the stump of a patient's limb while leaving a relatively small space between the bottom of the stump and the bottom of the socket, means providing a plurality of air leakage channels of different diameters, and a distributing valve means selectively connecting any one of said channels between the said small space in the socket and the outside atmosphere to establish a predetermined leakage path between the said space and the outside atmosphere.

5. An artificial limb comprising a socket member adapted to be fitted with a substantially air tight fit over the end of the stump of a patient's limb while leaving a relatively small enclosed air space between the end of the stump and the bottom of the socket, means providing a plurality of circular leakage channels of different diameters ranging from approximately 3 thousandths to 12 thousandths of an inch, and selector valve means selectively connecting any one of said channels between said air space and the outside atmosphere.

6. An artificial limb comprising a socket member adapted to be fitted with a substantially air tight fit over the end of a patient's shortened limb while leaving a relatively small space between the end of the shortened limb and the bottom of the socket, means providing a plurality of leakage channels having different areas of cross-section approximately equal to those of circular channels of a diameter of 3 thousandths to 12 thousandths of an inch, and selector valve means selectively connecting any one of said channels between said small space in the socket and the outside atmosphere.

7. An artificial limb comprising a socket member formed with a chamber adapted to be fitted with a substantially air tight fit to the stump of a patient's leg, a conical valve seat member having openings therein one at the apex of the valve seat in communication with the interior of said socket chamber and the other in the side wall of the conical valve seat in communication with the outside atmosphere, the opening in the side wall lying in a given plane transverse to the axis of the conical valve seat, said seat being in said valve seat and having a manifold duct extending through the apex end of the conical valve seat in communication with the said valve seat opening at the apex of the seat, a plurality of leakage ducts in the valve head leading from the manifold duct each to a different point at the conical surface of the valve head in said given plane in which lies the said opening in the side wall of the valve seat, each of said leakage ducts having a differ-
ent resistance to fluid flow, spring means urging the valve head against the seat, and manually operated means accessible from outside the socket member mechanically connected with the valve head for rotating the head and for lifting the head clear of the seat to provide a space between valve head and valve seat in direct communication with both said pair of openings in the valve seat for quick equalization of pressure between the interior of the socket and the outside atmosphere.

8. An artificial limb comprising a socket member adapted to be fitted with a substantially air tight fit to the stump of a patient's limb, a spring-loaded relief valve connected to vent the interior of the socket member to the outside atmosphere, said relief valve having a rotatable valve head normally engaging a valve seat under spring pressure, and selective aperture means connecting the interior of the socket member with the outside atmosphere through the valve seat and valve head and selective with rotation of the valve head.

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