FROSTHETIC LEG WITH A HYDRAULIC KNEE CONTROL

Fig. 1

Fig. 2

Fig. 3

Fig. 4

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This invention relates to artificial legs and more particularly to a means for controlling the knee action of a leg prosthesis adapted to be used by above-the-knee amputees. This prosthesis may be used in conjunction with an independent articulated foot and ankle prosthesis.

Leg prostheses are often costly and complex and the most affected by many devices now in use is awkward and does not closely approximate a natural walking movement.

Many of the devices in use include variable controls which are needed by only a small percentage of amputees. The prosthesis of this invention is of simple construction and there are no adjustments for its few moving parts. Thus, the unit may be preset at the factory.

It is an object of this invention to provide a light, simple and inexpensive leg prosthesis.

Another object of this invention is to provide a hydraulically operated leg prosthesis which will enable an amputee to walk at a desired speed in a more natural manner.

It is a further object of this invention to provide a hydraulic knee control for a leg prosthesis which may be used in conjunction with an independent articulated foot and ankle prosthesis device.

A further object of this invention is to provide a knee control for a leg prosthesis which offers little resistance to the initial flexing movement of the knee but increases resistance to the flexing motion as speed and force of the movement increases.

A hydraulic control of this invention is to provide a knee control in a leg prosthesis which will allow a rapid but controlled movement, with less resistance during the extension cycle of the prosthetic leg movement than during the flexing cycle.

Another object of this invention is to provide a hydraulic knee control which is essentially tamper proof and has no need for periodic adjustments, since hydraulic action is consistent.

Since variable controls are needed by only a small percentage of amputees, a further object of this invention is to provide a knee control for a leg prosthesis which has no variable controls.

Further objects and advantages of this invention will become apparent from the following description referring to the accompanying drawing, and the features of novelty which characterize this invention will be pointed out with particularity in the claims appended to and forming a part of this specification.

In the drawing:

FIG. 1 is a sectional view of the knee control device of the present invention;
FIG. 2 is a sectional view of the knee control installed in a leg prosthesis;
FIG. 3 is a rear view of the knee control installed in a leg prosthesis; and
FIG. 4 is a sectional view of the poppet valve used in conjunction with the knee control device.

Numerals 12 indicates a lower thigh portion of a leg prosthesis to which a lower leg or shank member 20 is hinged by a knee bolt 14.

The shank portion 20 and the thigh portion 12 pivot relative to each other about knee bolt 14. Knee action is controlled by the knee control device of FIG. 1 which is indicated generally at 114 in FIG. 2.

A tubular member 116 is divided by a fixed partition 38 into an upper hydraulic cylinder 30 and a lower hydraulic cylinder 28. The partition 38 is held in position by dimples 70. Fluid passages between cylinders 28 and 30 are provided by poppet valve 40 and orifice 50. Floating piston 66 is disposed within cylinder 30, thus dividing the cylinder into chambers 32 and 34. O-ring 102 provides a seal between chambers 32 and 34, thus preventing the passage of fluid from one chamber to the other.

Piston 60 is disposed within cylinder 28 and connected to piston rod 18 which extends through a piston rod bearing 74. The piston rod bearing 74 and O-rings 106 and 108 provide a fluid tight seal at the lower end of the piston. The cylinder 28 is divided into chambers 62 and 64 by piston 60. Fluid passage between chambers 62 and 64 is provided by orifice 58 which extends through piston rod 18, or which may be adapted to pass through piston 60. The upper end of the piston member 116 is closed by cylinder head 10. A fluid tight seal is provided by O-ring 100.

The cylinder head 10 and the lower end 68 of piston rod 18 are each provided with rubber or resilient members 24 into which bearings 26 are pressed.

Cylinder head 10 is pivotally attached to thigh member 12 rearwardly of knee bolt 14 by means of pin 16. Piston rod 18 is pivotally attached to shank portion 20 by means of pin 22. Resilient members 24 serve to retain the bearings 26 in such a manner as to prevent binding if shafts 16 and 22 are not parallel with knee bolt 14 and to provide quieter action.

Cylinder 28 and the lower chamber 32 of cylinder 30 are filled with a hydraulic fluid 36. Chamber 34 of cylinder 30 is partially filled with a compressible fluid such as air.

The poppet valve 40 disposed in partition 38 includes a casing 42 having shoulders 44 and 45 thereon and being threaded as at 46 on its upper portion. The poppet valve is further composed of a valve stem 48 having orifice 59 therethrough, a spring 52, a retainer collar 54 pressed on valve stem 48, and a valve closing member 56. The poppet valve is normally biased to a closed position by spring 52. If desired, orifice 50 may pass through the partition 38 instead of poppet valve stem 48.

At the beginning of the knee flexing cycle the piston 60 is forced upwardly into cylinder 28. This action causes hydraulic fluid 36 to be forced from chamber 64 into chambers 62 and 32 through orifices 58 and 50. The poppet valve 40 which is biased to a closed position remains closed during the flexing cycle.

The size of orifice 50 regulates the flow of fluid from chamber 64 to chamber 32 to determine the resistance to the knee flexing motion. The most desired action is obtained when orifice 50 is smaller than orifice 58.

Fluid forced into chamber 32 urges floating piston 66 upwardly, thus compressing the compressible fluid such as air which partially fills chamber 34. The compressed fluid acts as a fluid spring, helps stop the flexing movement and serves to aid in the return of the prosthesis to an extended position. Momentum and gravity supply the remaining force to return the prosthesis to the extended position.

During the extension cycle the piston 60 moves down in cylinder 28, thus forcing the hydraulic fluid out of
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3. Chambers 62 and 32 and into chamber 64. The reduced pressure in chamber 64 during the extension cycle causes poppet valve 50 to open, thus allowing little resistance to fluid movement from chamber 32 to chamber 64. The orifice 58 thus controls the rate of fluid flow from chamber 62 to chamber 64 and thereby controls the rate of travel of piston 60. By controlling the travel of piston 60 orifice 58 also controls the resistance to the extension cycle of the prosthesis. It can be seen from the above that any change in the size of either one or both of the orifices 50 and 58 may be made to regulate the knee action to suit the wearer of the prosthesis. Full extension is reached when tubular member 116 contacts resilient member 72 on the lower thigh member 12.

4. Throated portion 46 of poppet valve casing 42 is screwed into partition 38 until shoulder 44 abuts against the partition. The valve stem 48 extends through casing 42 and is held in place by collar 54 and valve gate 56. The collar 54 also holds spring 52 and serves to permit correct valve opening travel. The spring 52 which normally urges the valve to a closed position is adapted to yield to the relatively high pressure in chamber 32 during the extension cycle, thus allowing the valve gate 56 to move away from casing 42 to open the valve. At the end of the extension cycle the pressure in chamber 32 causes it to be relatively greater than that in chamber 64. Thus, the valve stem and gate are moved upward by spring 52 to close the valve. An important feature of this invention is the pivotal connection of the cylinder end 10 of the pneumatic knee control device to the lower portion of thigh member 12. This makes possible the presence of hydraulic fluid 36 on both sides of floating piston 66. This gives better lubrication and also prevents the passage of compressible fluid from chamber 34 into other chambers, as air in other chambers would tend to cause noise in the mechanism. O-ring 102 provides a fluid seal for piston 66 and O-ring 104 provides a fluid seal for piston 60.

5. Rivet 110 is press fitted for holding head 10 in place, and may be removed for servicing of chamber 34. Rivets 112 which are press fitted and hold piston rod bearing 74 in place may be removed to facilitate service of the knee control device.

While a particular embodiment of this invention has been illustrated and described, modifications thereof will occur to those skilled in the art. It is to be understood, therefore, that this invention is not to be limited to the particular details disclosed, and it is intended in the appended claims to cover all modifications within the spirit and scope of this invention.

What is claimed is:

1. In a leg prosthesis an upper thigh member, a lower thigh member, a hinged connection of said members to form a knee joint, means to control said knee joint, said means being comprised of a tubular member closed at one end and divided by a fixed partition, a first cylinder and a second cylinder formed by said fixed partition, a poppet valve in said partition, an orifice through said poppet valve, a floating piston in said first cylinder, a piston in said second cylinder, a piston rod connected to said piston in said second cylinder, a piston rod bearing in the other end of said tubular means through which said piston rod passes, a pivotal connection between said thigh portion and said closed end of said tubular member, said pivotal connection located rearwardly of said knee joint, and a pivotal connection between said piston rod and said shank.

2. A claim according to claim 1 wherein said thigh member includes a stop along its lower portion, and said tubular member contacts said stop to terminate the extension movement of said prosthesis.

3. A claim according to claim 1 wherein said pivotal connections include a bearing member and resilient retainer member, said bearing member being pressed into said resilient retainer member.

4. A fluid chamber knee control device for a leg prosthesis comprising a tubular member closed at one end, a piston rod bearing in the other end through which a piston rod passes, a fixed partition, a tubular member dividing it into an upper and a lower cylinder, said partition having a poppet valve therethrough, an orifice connecting said upper and lower cylinders, a floating piston in said upper cylinder, a piston in said lower cylinder connected to said piston rod, said floating piston dividing said upper cylinder into an upper and a lower chamber, the other said piston dividing the lower cylinder into an upper and a lower chamber, means to control said knee joint, said means being comprised of a tubular member closed at one end and divided by a fixed partition, a fluid chamber being filled with a compressible fluid which acts as a fluid spring.

5. A claim according to claim 4 wherein said lower cylinder and said lower chamber of said upper cylinder are filled with hydraulic fluid and the upper chamber of said upper cylinder is partially filled with said hydraulic fluid, the remainder of said upper chamber of said upper cylinder being filled with a compressible fluid which acts as a fluid spring.

6. A leg prosthesis which includes an upper thigh member, a lower thigh member, a knee joint pivotally connecting said thigh member, means for control of said knee joint, said means comprising a tubular member closed at one end, said piston rod bearing through which a piston rod passes sealing the other end, said closed end of said tubular member being pivotally connected to said thigh member behind said knee joint, said piston rod being pivotally connected to said shank member, a fixed partition in said tubular member dividing said tubular member into an upper and a lower cylinder, a poppet valve through said fixed partition, a floating piston in said upper cylinder dividing said cylinder into upper and lower chambers, means to control the passage of fluid between said chambers, a lower piston connected to said piston rod in said lower cylinder dividing said lower cylinder into upper and lower chambers, said upper and lower chambers of said lower cylinder and said lower chamber of said upper cylinder containing a hydraulic fluid, said upper chamber of said upper cylinder being partially filled with said hydraulic fluid, the remaining portion of said upper chamber of said upper cylinder containing a compressible fluid, an orifice through said poppet valve to allow controlled passage of fluid therethrough, and an orifice through said lower piston to allow controlled passage of fluid therethrough.

7. A leg prosthesis as described in claim 6 wherein said thigh member includes a stop along its lower portion, and said tubular member is adapted to contact said stop to terminate the extension movement of said prosthesis.

8. A claim according to claim 7 wherein said stop is a resilient bumper.

9. A prosthesis according to claim 6 wherein said orifice in said piston is relatively larger than said orifice in said poppet valve.

10. A leg prosthesis comprising an upper thigh member, a lower thigh member, a knee joint pivotally connecting said members, means pivotally connecting said members for control of said knee joint comprising, a tubular member sealed at each end, a partition in said tubular member, an upper cylinder and a lower cylinder formed by said partition, said upper cylinder containing a hydraulic fluid, said lower cylinder containing a hydraulic fluid, a valve means joining said cylinders, a non-valve means allowing continuous fluid communication between said cylinders, fluid spring means in said upper cylinder, a piston in said lower cylinder, an upper chamber and a lower chamber in said lower cylinder, said piston being driven by said piston, an orifice joining said upper and lower chambers of said lower cylinder, and a piston rod connected to said piston.

11. A claim according to claim 10 wherein one end
of said tubular member is pivotally attached to a thigh member of a leg prosthesis, and said piston rod is pivotally attached to a shank member of said leg prosthesis.

12. A claim according to claim 11 wherein said thigh member includes a stop along its lower portion, and said tubular member contacts said stop to terminate the extension movement.

13. A leg prosthesis according to claim 10, wherein said valve means is a poppet valve disposed in said fixed partition, said poppet valve comprising, a casing, a threaded portion on said casing, a valve stem, said valve stem extending through said casing, a passageway extending through said valve stem, a shoulder on said casing, a collar on the upper part of said valve stem, a spring disposed between said shoulder and said collar and between said casing and said valve stem, and a valve gate disposed on the lower part of said valve stem, said valve gate normally being urged to a closed position by said spring.

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