May 2, 1967 LA VAUGHN L. MORTENSEN 3,316,558

PROSTHETIC LEG WITH A HYDRAULIC KNEE CONTROL

Filed Nov. 12, 1963

FIG. 1

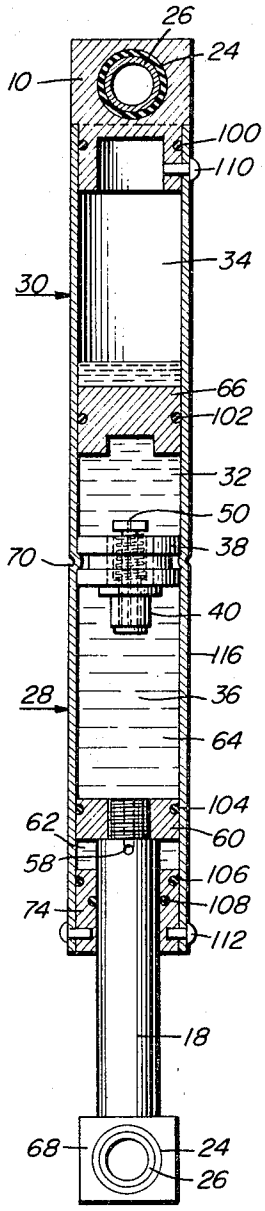


FIG. 4

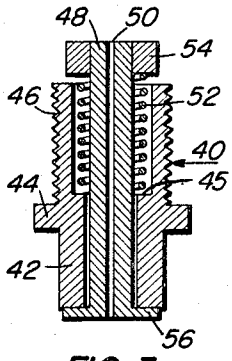


FIG. 3

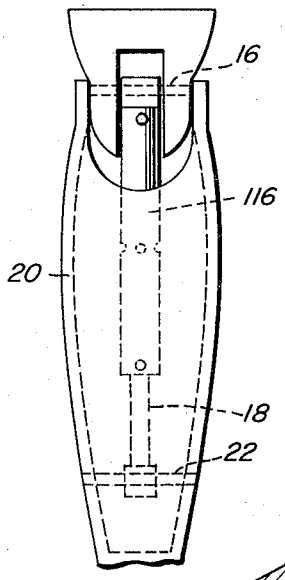
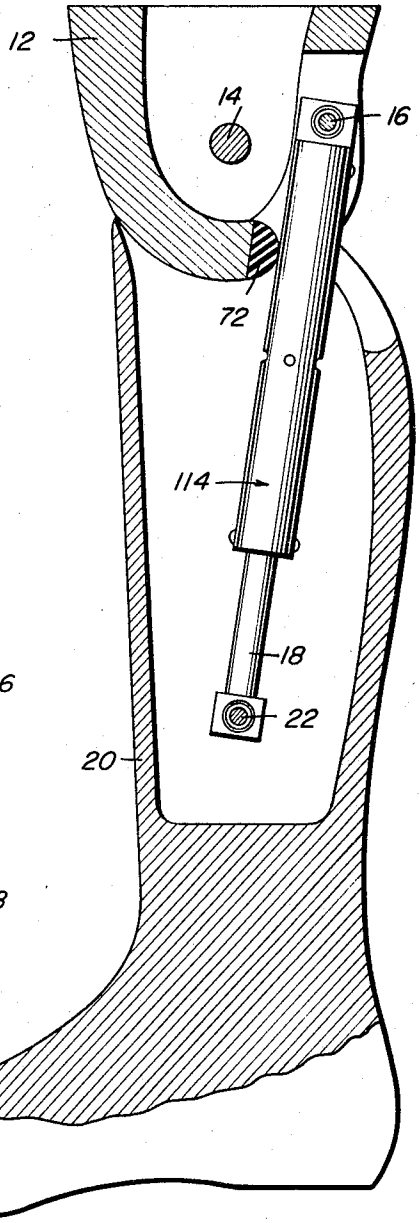


FIG. 2



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PROSTHETIC LEG WITH A HYDRAULIC KNEE CONTROL

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13 Claims. (Cl. 3—1.2)

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 motion effected 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 prosthetic 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.

Another object 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.

Numeral **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 tubular member **116**. 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 tubular 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 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 said hydraulic fluid and 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 **50** 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 upward 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

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.

Threaded 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 ceases 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.

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 shank 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 extention movement.

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 cmprising a tubular member closed at one end, a piston rod bearing in the other end through which a piston rod passes, a fixed partition in said 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 prevent passage of fluid around said floating piston, means to prevent the passage of fluid around said other piston, an orifice through said other piston to allow controlled passage of fluid therethrough, and an orifice through said poppet valve to allow controlled passage of fluid therethrough.

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 shank member, a knee joint pivotally connecting said members, means for control of said knee joint, said means comprising a tubular member closed at one end, a 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 prevent 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 shank member, a knee joint pivotally connecting said members, means pivotally connected between 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, hydraulic fluid in both said cylinders, 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 formed 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.

References Cited by the Examiner

UNITED STATES PATENTS

909,859	1/1909	Apgar	3—2 X
2,489,291	11/1949	Henschke et al.	3—24
2,859,451	11/1958	Mauch	3—22
3,147,966	9/1964	Axthammer et al.	267—64

FOREIGN PATENTS

316,515	12/1919	Germany.
31,662	12/1926	France. (1st addition)
474,290	9/1952	Italy.

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