

No. 708,685.

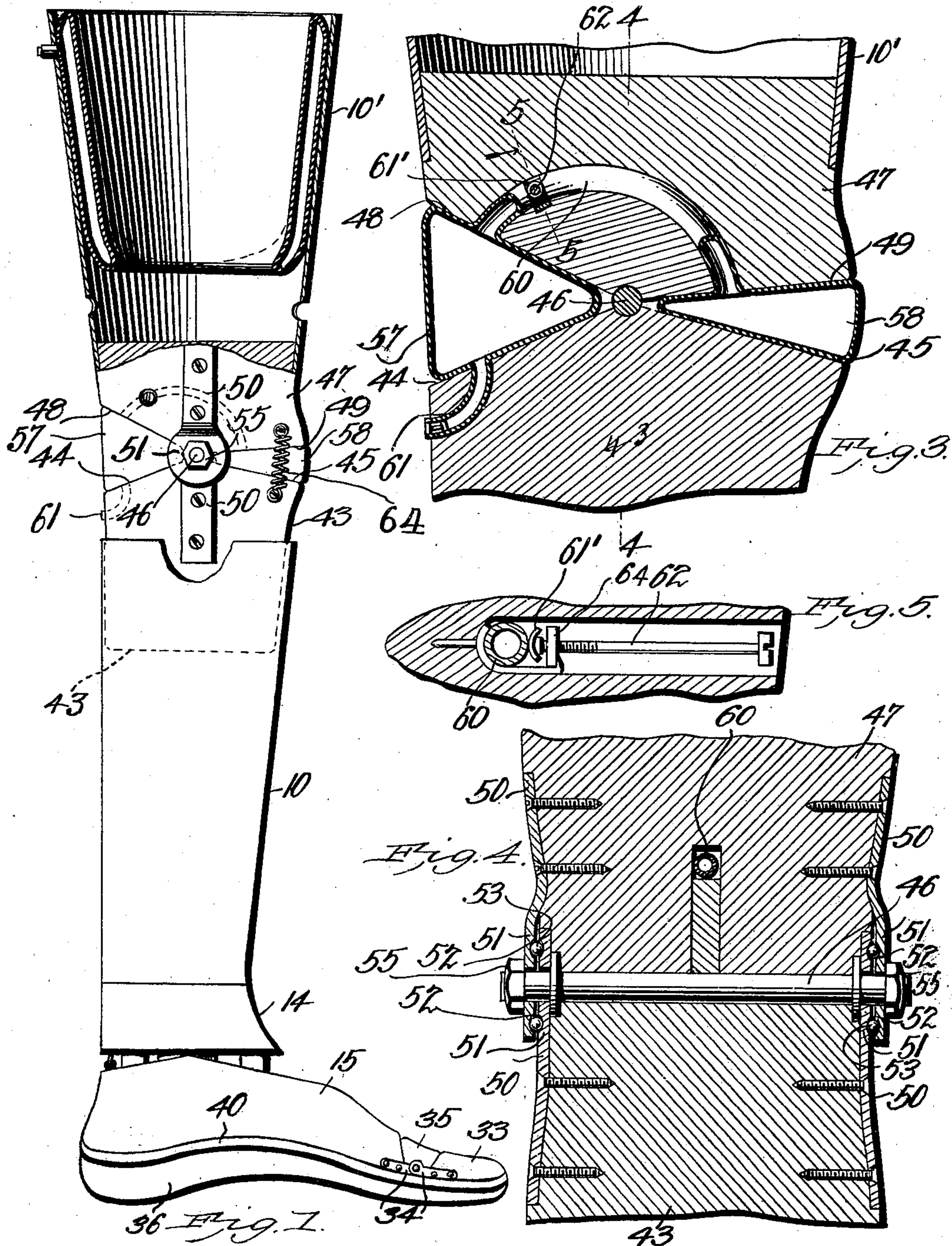
Patented Sept. 9, 1902.

C. P. WHITE.
ARTIFICIAL LIMB.

(Application filed Jan. 28, 1902.)

(No Model.)

2 Sheets—Sheet 1.



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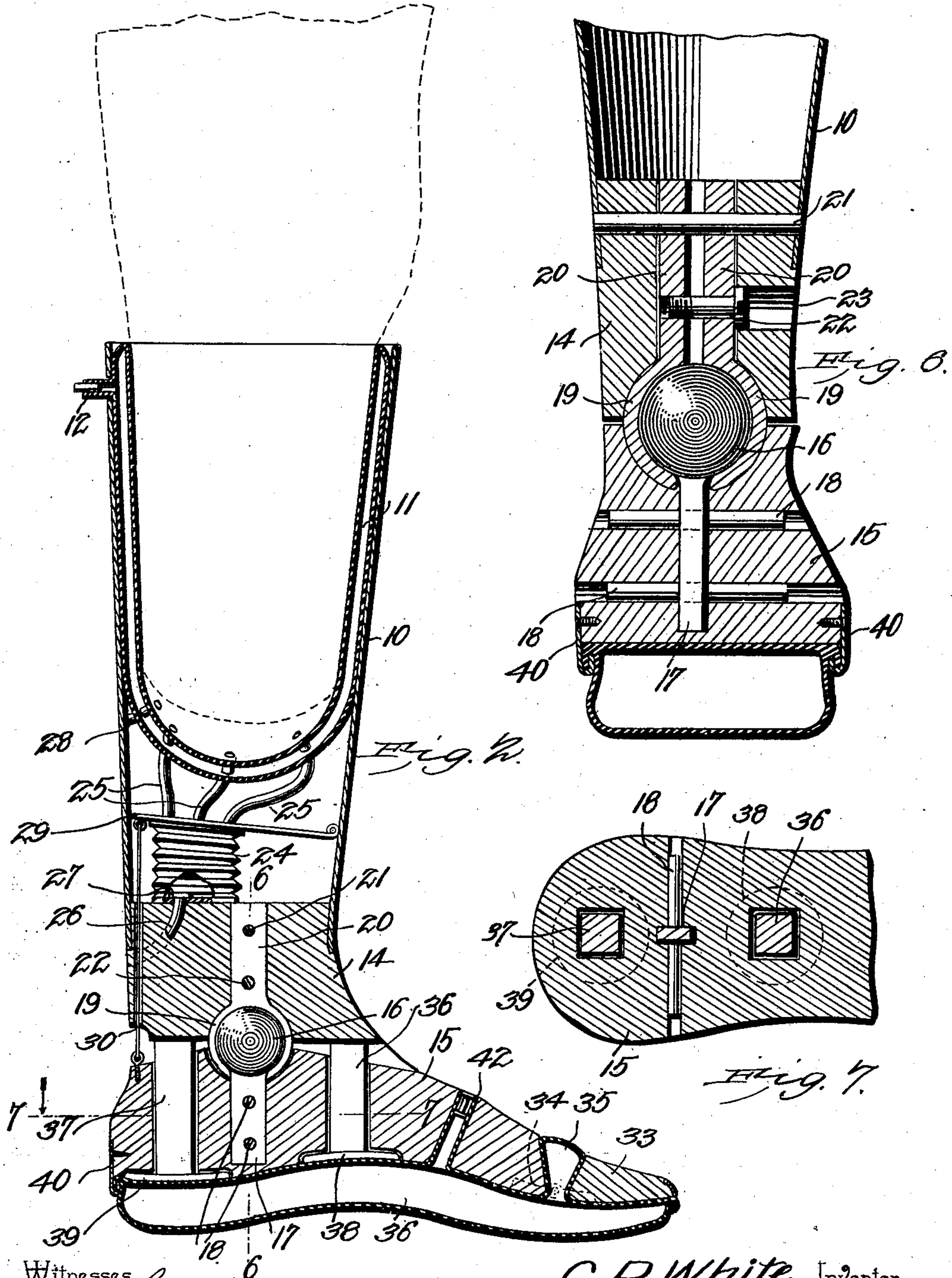
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2 Sheets—Sheet 2.



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UNITED STATES PATENT OFFICE.

CHARLES P. WHITE, OF SPENCER, NORTH CAROLINA.

ARTIFICIAL LIMB.

SPECIFICATION forming part of Letters Patent No. 708,685, dated September 9, 1902.

Application filed January 28, 1902. Serial No. 91,631. (No model.)

To all whom it may concern:

Be it known that I, CHARLES P. WHITE, a citizen of the United States, residing at Spencer, in the county of Rowan and State of North Carolina, have invented a new and useful Artificial Limb, of which the following is a specification.

My invention relates to certain improvements in artificial limbs, and has for its principal object to provide an improved device of the class in which the weight will be reduced to a minimum and in which a series of pneumatic cushions and compensating devices are employed in order to enable the limb to be readily attached or removed, to reduce the shock and jar incident to the employment of rigid structures, and in which the operation of the connected parts will closely resemble that of natural joints.

A further object of the invention is to provide compensating air-cushions on each side of the connected points of a joint, the cushions being connected and provided with a suitable regulating device to govern the passage of air or other fluid from one cushion to the other.

A still further object of the invention is to provide an improved support or bearing for connecting the natural to the artificial limb, said support being of such nature as to automatically conform to the contour of the natural limb, affording a yielding bearing having equal pressure at all points.

A still further object of the invention is to provide for the proper ventilation of the end of the natural limb, so that the artificial limb may be constantly worn without personal inconvenience.

A still further object of the invention is to provide the foot portion of the limb with a pneumatic cushion so constructed and connected that in use the movements of the wearer will cause different portions of the sole to receive differing pressures as the results of such movement and cause an operation and movement resembling that of the muscles of the natural foot.

With these and other objects in view the invention consists in the novel construction and combination of parts hereinafter described, illustrated in the accompanying

drawings, and particularly pointed out in the appended claims.

In the drawings, Figure 1 is an elevation, partially in section, illustrating an artificial limb constructed in accordance with my invention. Fig. 2 is a sectional elevation of an artificial limb, illustrating a construction adapted for application to a natural limb amputated below the knee-joint. Fig. 3 is a sectional view, on an enlarged scale, illustrating the construction and arrangement of the connected compensating cushions employed at the knee-joint. Fig. 4 is a transverse sectional elevation of the same on the line 4 4 of Fig. 3. Fig. 5 is an enlarged detail sectional view on the line 5 5 of Fig. 3, illustrating a construction of regulating-valve which may be employed in the connecting-tube of the compensating cushions. Fig. 6 is a transverse sectional elevation on the line 6 6 of Fig. 2, illustrating the detail construction of the ankle-joint. Fig. 7 is a sectional plan view of a portion of the foot member on the line 7 7 of Fig. 2.

Similar numerals of reference are employed to indicate corresponding parts throughout the several figures of the drawings.

Referring first to Fig. 2, 10 indicates a casing, which may be made of a contour similar to that of the natural limb, said casing being formed of aluminium, wood, or other suitable material of sufficient strength for the purpose. In this casing is placed a tubular air-cushion 11, having a suitable inflating-nipple 12 for attachment to an air-pump. This cushion is adapted for the reception of the stump of the amputated limb, and its lower portion may be closed, as indicated in Fig. 2, or may be open, as indicated in Fig. 1, to permit of natural ventilation, the casing in such cases being preferably provided with one or more ventilating-openings to permit of the free circulation of air. The stump is inserted within the cushion for a suitable distance, and then air is pumped in, inflating the cushion between the stump and the casing 10, the pressure exerted being sufficient to firmly hold the stump in place under all normal conditions of use and affording a yielding support which automatically conforms to the shape of the stump, exerting an

equal degree of pressure on all parts of the surface with which it is in contact and serving to hold the artificial limb in position without the employment of straps or other
 5 securing devices and without any inconvenience or pain to the wearer.

The stump-supporting cushion may be made of any desired shape and size to accommodate the limb, and in the drawings I
 10 have illustrated two forms of cushion, one for application to a stump formed by amputation above the knee, as in Fig. 1, and the other for the reception of a stump formed by amputation below the knee, as illustrated in
 15 Fig. 2. The structure may be modified in various ways in accordance with the size and shape of the stump and may also be employed as a means for securing an artificial arm in position, if desired.

20 In the lower portion of the casing 10 is secured a wooden or other block 14, terminating at the median line of the ankle-joint and forming a support for the upper portion of the ball-and-socket joint used at the ankle.
 25 The major portion of the foot member is formed of a suitably-shaped block 15 of wood, metal, or other substance, and carries the remaining member of the ball-and-socket joint. The ankle-joint comprises a ball 16,
 30 secured to or formed integral with a stem or plate 17, preferably polygonal in cross-section and adapted to a suitably-shaped recess in the foot-block 15, being confined in place in said block by suitable pins or bolts 18.
 35 The socket member, which embraces the ball, is formed of two approximately semispherical plates 19, having shank portions 20, adapted to a suitable recess in the upper block 14 and held in place by a pin or bolt 21 at a
 40 point near their upper ends. Between the socket members and the securing-pin 21 the shanks carry an adjustable screw 22, which passes loosely through an opening in one of the shanks and is adapted to a threaded
 45 opening in the opposite shank, there being a suitable opening 23 formed in the block for the insertion of a screw-driver in order to adjust the plates and increase or decrease their degree of frictional contact with the
 50 ball 16, this adjustment being desirable in the event of the joint working loose from continued use.

In devices of this class one of the principal objections to their use is the improper ventilation of the stump, the close confinement of the stump resulting in free perspiration and proving an annoyance and inconvenience to the patient, while at the same time the absence of fresh air from a wound or unhealed
 60 stump will to a considerable extent retard healing. To overcome these difficulties and afford a free circulation of air, I provide on the upper portion of the block a bellows or other pumping device 24, from which leads
 65 one or more tubes 25 to the lower portion of the stump, the air-tube extending through the lower part of a closed cushion or being

carried by the lower edge of a cushion having an open bottom. Air is supplied in the bellows from without through a suction-passage 70 26, having a suitable valve 27, which opens to permit the entrance of air to the bellows and automatically closes as the bellows contracts to force the air through the tubes 25. Suitable outlet tubes or passages, as 28, are 75 arranged to permit the air to pass from the lower portion of the cushion to the outer air. The bellows may be connected for operation to any other movable member of the limb, a convenient method of accomplishing this result being illustrated in Fig. 2, wherein 29 80 represents a bar or plate connected to the upper bellows-disk and hinged at one end to the casing 10. At the opposite end of the plate or bar is secured one end of a cord or 85 rod 30, the lower end of which is connected to the rear portion of the foot-block 15, the movement of the block on the ball-and-socket joints serving to operate the bellows. This device may of course be modified by the em- 90 ployment of any form of bellows or pump, and in some cases an ordinary pump, such as that used for expanding bicycle-tires, may be employed for the purpose, the size of the pump being reduced in order that it may be 95 properly applied to the limb. Where artificial ventilation is to be carried out in connection with a stump formed by amputation above the knee-joint, the tubes 25 may be carried up through the interior of the limb 100 to the proper point, or a suitable pumping device may be attached at the knee-joint.

The block 15 is shaped to conform to the contour of the body portion of the foot, and at the forward end thereof is arranged a toe 105 member 33, the latter being connected to the block by hinged plates or strips 34, arranged at opposite sides of the foot. The adjacent edges of the blocks 15 and 33 are inclined to form a recess or opening, which when the 110 blocks are in normal position is much wider at the top than at the bottom, the recess or opening being substantially V-shaped in form and adapted for the reception of a section 35 of the pneumatic sole 36. The sole 115 36 extends for the full length of the foot member, and the portion 35 is integral and connected with the sole through the comparatively narrow or restricted mouth formed between the lower portions of the blocks 15 120 and 33, so that when the weight is thrown forward and rests on the toe the air in the portion 35 will be forced out into the main body of the pneumatic sole, and as the foot is then raised from the ground air will again 125 flow into the portion 35 of the cushion and return the toe-block to proper position. The block 15 is provided at suitable points in front and rear of the ball-and-socket members with vertical guiding-openings for the 130 reception of shanks 36 37, having at their lower ends disks or pistons 38 and 39, respectively, which rest in recesses formed in the lower portion of the blocks 15, so that the

lower surfaces of the disks or pistons will be in alinement with the bottom of the block 15 and present a comparatively smooth and continuous surface for the upper wall of the pneumatic sole. The upper ends of the shanks 36 and 37 normally project beyond the upper surface of the block 15 and rest against the undersurface of the block 14, being forced into contact with said block by the pressure of air in the pneumatic sole. In use the forward movement of the body will slightly raise the heel from the ground and result in a downward movement of the leg portion, with the ball 16 as a fulcrum. This movement depresses the disk or piston 38 and throws the weight directly on the pneumatic sole, excessive downward movement being prevented by the normal pressure of air within the sole augmented by the increased pressure due to the weight of the body. This movement will also force a portion of the air from the chamber 35 into the main body of the sole; but a considerable resistance is offered to the pivotal movement of the toe member by the cushion of air, the gradual yielding resulting in an easy movement resembling the action of the natural foot. On the forward step the preliminary contact of the heel portion will result in the weight being supported by the sole through the medium of the disk 39, shank 37, and block 14. The disks or pistons being situated both in front and in rear of the median line of the ankle-joint operate alternately to support a portion of the weight on the upper wall of a pneumatic sole and serve to return, through the expansive movement of the sole, the various parts to initial position after each movement. The pneumatic sole may be supported in position in any desired manner. In the drawings I have shown depending plates 40, carried by the blocks 15 and 33, said plates being substantially hook-shaped in cross-section and adapted to receive correspondingly-shaped portions on the edges of the pneumatic sole, although various other supporting devices may be employed for the purpose. The sole is provided with a suitable nipple 42, to which an air-pump may be attached for inflating purposes.

The structure thus far described is particularly adapted for application to a stump formed by amputation below the knee, and where the natural joint is missing I employ a knee-joint of the character best shown in Figs. 3 and 4. In this case the casing 10 is provided at its upper end with a filling-block 43, formed of wood or other suitable material, the upper face of said block being provided with opposite inclined seats 44 and 45, inclining downwardly and outwardly from the center of a bolt 46, which forms the pivot member of the knee-joint. The upper portion of the joint is formed by a block 47, having lower inclined faces 48 and 49, secured in the lower portion of a casing 10', which may form a thigh member and may be of

the construction similar to that of the casing 10 and provided with a supporting-cushion for the stump. To each side of each block 43 and 47 are secured plates 50, terminating in disk-shaped members 51, each provided with ball-races 52 for the reception of an annular series of antifriction-balls 53. Each disk is perforated for the reception of a pivot-bolt 46, having suitable adjusting-nuts 55, by which the disks may be adjusted to secure proper operation of the bearing-balls. In this joint the movement of the parts so far as regards the pivotal connections should be as free as possible and the friction reduced to a minimum. The joint is supported in proper position by a pair of compensating air-cushions 57 and 58, the cushion 57 being situated at the rear of the joint and being somewhat larger than the front cushion, owing to the greater range of movement which must be provided for in order to render the device as much like the natural limb as possible. The cushions are arranged between the blocks 43 and 47 in the substantially V-shaped recesses formed by the adjacent inclined faces of the blocks and are connected together by a tube or pipe 60, which may be formed of rigid or of flexible material, and one of said cushions is provided with an air-inlet tube 61, having a suitable nipple for attachment to the air-pump. When the knee bends in the natural direction, as when assuming a sitting position, the air will be forced from the cushion 57 through the tube 60 to the cushion 58, and when rising the air will flow in reverse direction. This flow occurs alternately in opposite directions during walking; but in the absence of the regulating device the air would pass too quickly from one position to the other, and the cushioning effect would be lessened to a very considerable extent. To regulate the pressure and the speed at which the air may pass from one cushion to the other, I employ a regulating device, which may be in the form of an ordinary metallic valve, or where a flexible tube is employed I may use a plate 61', carried by a threaded rod 62, adapted to a lug 63, the turning of the rod forcing the plate into contact with the tube and governing the area of said tube. In this manner the flow of air from chamber to chamber may be regulated in order to retain to the fullest extent the cushioning effect necessary at each movement and at the same time permitting the passage of air and avoiding undue pressure on the cushions. The movement of the joint may be restricted or retarded to some extent by the employment of a spring 64, connecting the blocks 43 and 47, as indicated in Fig. 1, and, if necessary, these springs may be employed between the members of the ankle-joint and the members of the foot-joint, as will be readily understood.

While the construction herein described, and illustrated in the accompanying drawings,

represents the preferred form of the device, it is obvious that various changes in the form, proportions, size, and minor details of the structure may be made without departing from the spirit or sacrificing any of the advantages of my invention.

Having thus described my invention, what I claim is—

1. In an artificial limb, the combination of the outer casing, with a stump-receiving pocket formed of a loosely-supported pneumatic cushion having a closed bottom and open top and located between the stump and casing, said cushion serving as the sole means of connection between the stump and casing.

2. In an artificial limb, the combination with a stump-receiving pocket, of a mechanically-operated pump operatively connected to a movable member of the limb and serving to artificially ventilate said pocket.

3. In an artificial limb, the combination with a stump-receiving pocket, of an air-pump having an outlet in said pocket and adapted to discharge a current of air thereinto to ventilate the pocket, and means for operating said pump.

4. The combination in an artificial limb, of the casing, a stump-receiving pocket arranged therein, an air-pump comprising a bellows located in the lower portion of said casing, a plate hinged to the casing and connected to a movable part of the bellows, a foot member, and a flexible connecting means between said foot member and said plate.

5. The combination in an artificial foot, of the pivotally-connected body and toe members, and a pneumatic sole having a connected portion forming an air-chamber between the two members.

6. The combination in an artificial foot, of the body member, a pivotally-connected toe member, a channeled plate carried by said members, and a pneumatic sole having an outer portion shaped to engage said plate.

7. The combination in an artificial limb, of two pivotally-connected members, a pneumatic cushion carried by one of such members, and a pair of disks adapted for contact with said pneumatic cushion and having guided shanks in operative contact with the second member, substantially as specified.

8. The combination in an artificial limb, of

the foot and leg members having a pivotal connection to form an ankle-joint, a pneumatic sole on the foot member, a pair of compression-disks carried by the foot member and adapted for contact with the pneumatic sole at the front and rear of the joint, said disks having shank members in operative contact with the leg member.

9. The combination in an artificial limb, of a pair of movable members, a ball, a rectangular shank secured to or formed with the ball and connected to one of the members, a pair of semispherical plates carried by the opposite member and adapted to embrace the ball, said plates being spaced to permit of the movement between them of the rectangular shank of the ball member, and a screw independent of the plate-securing devices for adjusting said plates.

10. In an artificial limb having two pivotally-connected members, a pair of connected fluid-containing chambers situated one on each side of the pivotal connection between the members.

11. In an artificial limb having two pivotally-connected members, a pair of connected fluid-containing chambers situated one on each side of the pivotal connection between the members, and means for regulating the flow of fluid between said chambers.

12. The combination in an artificial limb, of a pair of leg members having inclined faces to form approximately V-shaped recesses between them, a pivot connecting said members, a pair of triangular fluid-containing chambers situated within said recesses, a tube carried by one of the leg members and connecting said chambers, and means for regulating the flow of fluid through said tube.

13. In an artificial limb, a pair of leg members having a pivotal connection, compressible chambers situated between said members and an auxiliary tension-spring connecting said members, substantially as specified.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

CHARLES P. WHITE.

Witnesses:

JNO. E. PARKER,

FRANK S. APPLEMAN.