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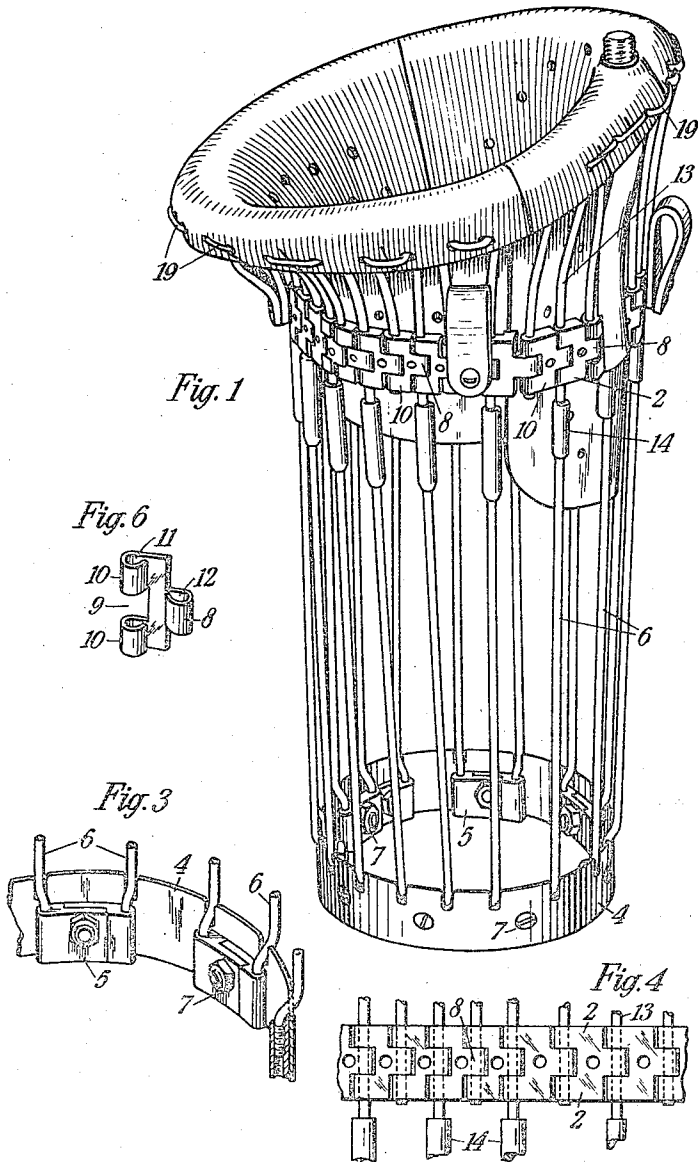
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ARTIFICIAL LIMB AND THE LIKE

Filed June 2, 1939

2 Sheets-Sheet 1



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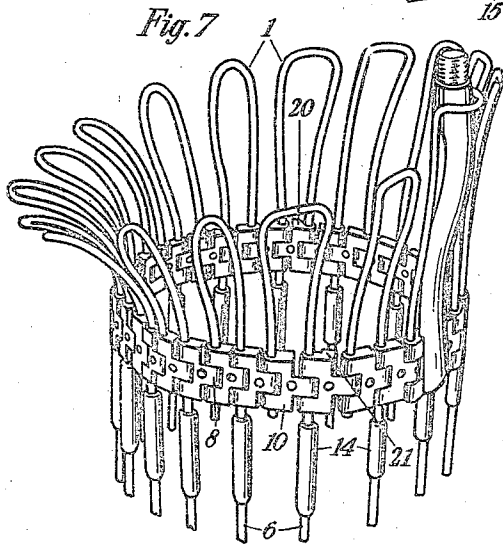
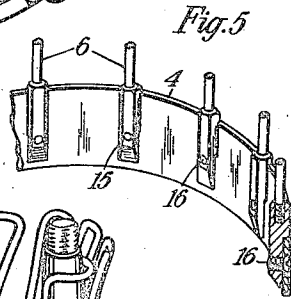
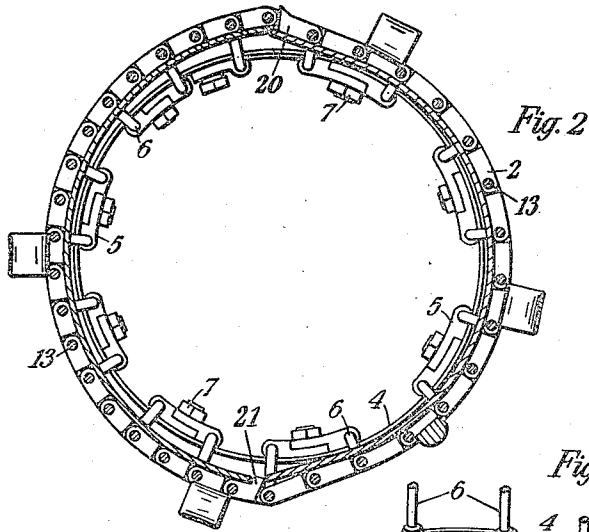
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2 Sheets-Sheet 2



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# UNITED STATES PATENT OFFICE

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## ARTIFICIAL LIMB AND THE LIKE

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In Great Britain June 17, 1938

11 Claims. (Cl. 3—2)

This invention is for improvements in and relating to artificial limbs and essentially to those sections of artificial limbs known as sockets for amputations which have been made either above or below the knee or elbow.

One method, employed commercially, of making such sockets of artificial limbs is to shape them from wood or metal to the configuration of the stump whilst it is in repose. Such a socket is rigid in its character and is formed so as to fit snugly around the stump while the limb is in repose but does not and cannot allow for the transient alterations of the stump when it is in use. It is recognized both by makers of artificial limbs and amputees alike that an ideal socket would be one which would offer a firm support for the stump of an amputee, take the full weight of his body without limiting in any way his complete freedom of movement or restricting the free access of air to the whole area of the stump, it being realized that any stump which is confined in a rigid socket will, apart from the great discomfort experienced by the amputee, reveal a condition of stasis which must cause a more or less rapid shrinkage of the stump.

It has hitherto been proposed to provide an artificial limb constructed with a socket of longitudinal wires secured to a base plate and capable of being compressed by straps around the exterior, which, however, do not positively hold adjacent wires in a spaced relationship to one another.

The object of the present invention is to provide as far as is practical the theoretical requirements of a perfect socket which virtually amount to the provision of a socket which offers lateral flexibility combined with longitudinal rigidity. Thus a band composed of fabric gives lateral support with flexibility but does not possess rigidity sufficient to support the downwardly directed pressure applied thereto, whilst a metal band will give rigidity sufficient to support downwardly directed pressure but has not that degree of flexibility sufficient to yield both laterally and longitudinally to transient alterations in a stump.

According to the present invention there is provided a socket for an artificial limb which comprises a framework which is securable at one end to the end of an artificial limb and at the other end over the stump of an amputated limb and which includes a series of longitudinal elements capable of resisting pressure applied in a longitudinal direction, the adjacent elements of the framework being positively held in the neighbourhood of the stump in spaced relationship to one

another and in such a manner that the said elements encircle the stump whilst at the same time permit the transverse configuration of the framework in the neighbourhood of the stump to conform to transient variations in the transverse configuration of the stump.

Further according to the present invention there is provided a socket for an artificial limb which comprises a series of longitudinal elements arranged to be secured at one end to an artificial limb and forming at the free ends thereof a socket for the stump of an amputated limb, the adjacent elements of the framework in the neighbourhood of the free ends thereof being pivotally linked to one another to permit the internal surface formed by the elements to conform to cross-sectional variations in the stump.

Again according to the present invention there is provided for a socket as set forth in either of the two preceding paragraphs in which there is connected to the elements in the region of the stump a band rigid in the direction of longitudinally applied pressure and deformable in the direction of the plane of the band to transient alterations in the configuration of the cross section of the stump.

Again there is provided according to the present invention a socket for an artificial limb as set forth in any one of the three preceding paragraphs wherein the elements which resist longitudinally directed pressure are constructed so as to yield slightly as the pressure is applied so as to prevent sudden shock between the socket and the limb.

A further object of this invention is to provide sockets and the like for artificial limbs with means for vertical and circumferential adjustments by which means the costly procedure of skilled personal fitting may be dispensed with; for example, a person fitted with a socket made and assembled in accordance with the present invention could, by adjustment and selection of and addition to the contemplated standardised parts adapt, unaided, a socket to meet his or her requirements.

The invention will be more particularly described with reference to the accompanying drawings in which:

Figure 1 illustrates in perspective a socket constructed in accordance with the present invention;

Figure 2 illustrates a sectional plan view of the socket illustrated in Figure 1, the section being taken just above the yieldable band mounted at the head of the socket;

Figure 3 illustrates a portion of the ring forming the base of the socket;

Figure 4 illustrates a portion of the yieldable band mounted at the head of the socket;

5 Figure 5 illustrates a portion of an alternative ring to that illustrated in Figures 1 and 3;

Figure 6 illustrates a link formed by a stamping operation and constitutes an alternative, merely 10 in the method of production, of the link illustrated in Figures 1, 2 and 4 which is employed for forming the yieldable band of the socket; and

Figure 7 illustrates the general form of the prongs forming the top of the socket.

The invention in its simplest form, as applied 15 to an amputation effected above the knee, may be regarded as a ring constructed so as to fit over the upper end of the artificial leg from which there are arranged to extend a series of upwardly directed longitudinal elements in the form of rods 20 which are held in correct spaced relationship to one another at the end thereof adjacent to the stump by a flexible band which permits the rods to conform to the configuration of a stump both when the stump is in repose and during any 25 transient changes in the configuration of the stump whilst it is in use.

Referring particularly to Figure 1 of the drawings the socket illustrated comprises four main sections, the first consisting of a frame (Figure 7) 30 built up of a series of inverted U-shaped prongs 1, the closed ends of which are, at least in the neighbourhood of the pelvis, flared outwardly and arranged to conform to the configuration of the pelvis where the weight of the amputee is taken, 35 the second section of the socket comprises a yieldable band (Figure 4) built up of a series of links 2 which are so arranged and connected to one another as to be rigid in the direction in which downwardly directed pressure is applied 40 whilst it is deformable in a lateral direction, the third section of the socket comprises a series of upwardly directed stays 6 which are rigid in an upward direction but flexible laterally and the 45 fourth section of the socket comprises a supporting ring 4 for the socket. The U-shaped prongs 1 together with the stays 6 constitute, in combination, the upwardly directed rods forming a framework which receives the stump of a limb and supports the downwardly directed pressure of the 50 amputee, whilst the series of links which form the yieldable band constitute the operative connection between adjacent rods which positively holds the adjacent rods in the neighbourhood of the stump in spaced relationship so as to permit 55 the internal configuration of the framework to conform substantially to the configuration of the stump both when in repose and during any transient changes in the configuration of the stump which produce lateral reaction between the encircling framework and the stump.

60 Referring to the drawings a ring 4 is constructed so as to fit upon the end projection of an artificial leg which carries the normal fitting to which the braces worn by the amputee are connected. The ring 4 is provided upon the internal 65 face thereof with terminal members 5 arranged to receive the ends of upwardly extending stays 6. The stays 6 are cranked at their lower ends so that the outer surface formed by the stays 6 70 has substantially the same radius of curvature as the ring 4. Preferably a resilient ring is mounted above the cranked portion of the stays 6 so as to hold them in position and the said ring is anchored at suitable points around its periphery 75 to the ring 4, for example by being clamped be-

tween the nut 7 and the terminal members 5. The stays 6 are mounted in the terminal members 5 so as to permit a small movement of the stays 6 in a direction substantially in line with the outer surface of the ring 4. The terminal 5 members 5 are built up of two overlapping sections which are connected to the ring by a nut and bolt 7. By arranging the sections of the terminal members 5 in the overlapping relationship a certain predetermined movement between 10 the terminal members 5 is permitted thereby enabling the stays 6 carried by the terminal members 5 to find their correct alignment relatively to the ring and also permit a predetermined circumferential displacement of the stays to overcome the torsional shocks, strains and vibrations 15 produced by the foot movement in the artificial leg.

The stays 6 at their upper ends are connected 20 by a screw union to the pivot pins of a series of links 2 which constitute a band and permit the upper ends of the stays 6 to conform to the configuration of the stump of the limb which is inserted therein.

The links 2 comprise an element provided with 25 a tongue 8 and recess 9 (Figure 6) and is constructed in such a manner that the tongue 8 constitutes the male member of the recess 9 of the next adjacent link. Each adjacent limb 10 of the recess 9 is provided with a bearing 11 and the tongue 8 is provided with a bearing 12. The 30 links 2 are arranged to be connected together by inserting a pin through the bearings 11 of one link and the tongue 8 of the next adjacent link in the manner clearly indicated in Figures 1, 2, 4 35 and 7. The links 2 illustrated in Figures 1, 2, 4 and 7 are cast and drilled but it will be appreciated that they may be formed by stampings in the manner illustrated in Figure 6. The links 2 are preferably connected together not by separate 40 pins but by the free end of U-shaped prongs 13 which extend through the bearings hereinbefore referred to, and one limb of a prong is made longer than the other so as to permit it to be connected to the upwardly extending stays 6 45 by a screw union 14. The screw unions 14 on the pelvis side of the socket are illustrated as being longer than those on the opposite side because it is found in practice that larger amounts of adjustment are necessary on the pelvis side. 50 The U-shaped prongs 13 are flared outwardly (Figure 7) at the ends thereof which engage with the pelvis, the outward flare providing a certain degree of longitudinal yield at this section of the 55 cage.

The interior of the upper end of the cage is 60 lined with a flexible material for example leather, against which the limb of the amputee bears. The leather lining is connected to the U-shaped prongs 13 by means of a leather lace 19 threaded 65 through holes in the leather and around the prongs 13. Due to the fact that the prongs 13 and the stays 6 are separated from one another the leather lining will be formed in the course of time, or may even be formed during the course 70 of manufacture, into corrugations which facilitate ventilation around the stump.

In the example of the band illustrated in Figure 2, it will be observed that one portion of the band conforms to a circle of larger diameter than 75 the other portion of the band and this is preferably effected in the neighbourhood of the pelvis, and permits additional lining to be inserted over this area which naturally takes up most of the pressure whether it be lateral or longitudinal, but

it will be appreciated that the portion of the band which conforms to a circle of larger diameter can be located at any desired section and can be made of any desired length. This simple adjustment enables a fitter to form a recess in the band of sufficient size to prevent any pressure being applied to a sore or wound not sufficiently healed to stand pressure and in general to relieve any tender part of the stump from pressure.

When the stump is normal the diameter of the band can be made uniform at all points.

In order to enable the band to be formed with a portion thereof of different radius of curvature to the remainder two links 20 and 21 are inserted into the band at the desired section of the band which has to be maintained out of contact with the stump and the section between the links 20 and 21 is completed by a further link or links. The links 20 and 21 are so constructed as to ensure that the portion of the band extending between them is of a radius of curvature greater than the remainder of the band and that the enlarged portion of the band is maintained a sufficient distance from the stump as to relieve any sore portion of undue pressure. In the preferred embodiment of the construction outlined above, there is disposed between the two links 20 and 21 a single link extending the whole distance between the links 20 and 21 and constructed so as to relieve the flesh disposed between the links 20 and 21 from any exterior pressure. Such a link preferably extends for the width of the portion of the flesh which has to be so relieved and preferably constitutes an arcuate member.

The screw unions 14 employed for adjusting the lengths of the rods can be employed to fulfill a further function. In some cases where the stump is comparatively long and the amputee wishes to feel a comparatively large area of lateral support, it is found according to this invention that by increasing the length of the lining sufficient lateral support is provided by the screw unions in conjunction with the lining to give the effect of a series of hinged links of greater depth than the actual links employed.

Figure 5 illustrates an alternative form of ring to that illustrated in Figure 3 in which cut-away portions are formed in the ring arranged to receive terminal members 15 into which stays 6 extend. The terminal members 15 are connected to the ring 4 by pivot pins 13 and a certain predetermined amount of play is provided between the cut-away portions of the ring and the terminal members to provide for the movement hereinbefore referred to.

In some cases it may prove desirable for the means which positively hold the adjacent rods of the framework in spaced relationship, that is the band illustrated and described in the embodiment hereinbefore specified, to be disconnected at a predetermined point in its length to enable the framework to be opened out to an extent sufficient to enable a stump to be inserted therein and to be thereafter re-connected so that the socket snugly embraces the stump. Any catch which can be easily operated and which will readily effect both the connection and disconnection hereinbefore referred to, may be employed.

Secured to the band built up by the links hereinbefore referred to, is an upwardly extending rod 13 which is disposed on the side of the framework constituting the socket which is remote from the side arranged to be engaged with the pelvis, and the said rod is screw-threaded at

its upper end so as to engage with the fitment secured to a waist band, where such is employed in conjunction with the socket of an artificial leg. Further, the band which is formed by the pivoted links 2 is provided at four points around the length thereof with loops 17 arranged to receive the portions of the braces which extend inside the cage and engage with the fitment mounted on the upper end of the artificial limb. The loops 17 are provided in order to keep the portions of the braces in correct position relatively to the socket.

Thus it will be seen that according to the present invention there is provided a socket for an artificial limb which is simple in its construction, efficient in its operation and cheap to manufacture and maintain. It will be readily appreciated by any one skilled in the art that the socket, besides providing numerous advantages over the solid wall socket, will give added comfort to the amputee and also possess means of adjustment both in a longitudinal and lateral direction. Thus the screw union between the stays 6 and the ends of the U-shaped prongs permits longitudinal adjustment and owing to the band being formed by the links 2, the circumference of the band may be varied by substituting a link of one length by a longer or shorter link. Again the rigidity of the frame built up of the prongs 8 may be increased by employing one prong for each link in which case an additional hole would have to be formed in each link to receive the two ends of a prong.

What I claim as my invention and desire to secure by Letters Patent of the United States is:

1. A socket for artificial limbs comprising a substantially circular series of circumferentially spaced rod-like elements each capable of resisting pressure applied in a longitudinal direction, one end of said series being attachable to an artificial limb and the opposite end of said series being open to receive therein the stump of an amputated limb, and a substantially circular band connected to said rod-like elements near the open end of said series, said band being rigid in the direction of the length of said elements but deformable in the direction of the plane of the band whereby said elements are conformable to the configuration of the cross-section of the stump inserted in said circular series of elements.

2. A socket for artificial limbs comprising a substantially circular series of circumferentially spaced rod-like elements each capable of resisting pressure applied in a longitudinal direction, one end of said series being attachable to an artificial limb and the opposite end of said series being open to receive therein the stump of an amputated limb, and a laterally flexible and longitudinally rigid member connecting the elements of said series together near the open end of said series to maintain said elements in spaced, substantially parallel relation about a stump inserted within said series of elements, said member effectively resisting pressure applied in a direction normal to the plane of said member but permitting the transverse configuration of said series to conform to transient variations in the transverse configuration of the stump inserted therein.

3. A socket for artificial limbs comprising a substantially circular series of circumferentially spaced rod-like elements each capable of resisting pressure applied in a longitudinal direction, one end of said series being attachable to an artificial limb and the opposite end of said se-

ries being open to receive therein the stump of an amputated limb, and a substantially circular flexible band composed of a series of pivotally connected links connecting the elements of the series together in a plane substantially normal to the length of the elements to maintain said elements in spaced, substantially parallel relation about a stump inserted within said series of elements, said pivotally connected links permitting the transverse configuration of said series to conform to transient variations in the transverse configuration of the stump inserted therein.

4. A socket for artificial limbs comprising a substantially circular series of circumferentially spaced rod-like elements each capable of resisting pressure applied in a longitudinal direction, one end of said series being attachable to an artificial limb and the opposite end of said series being open to receive therein the stump of an amputated limb, and a substantially circular, flexible band composed of a series of pivotally connected links connecting the elements of the series together in a plane substantially normal to the length of the elements to maintain said elements in spaced, substantially parallel relation about a stump inserted within said series of elements, said links pivoted on axes substantially parallel to the length of the rod-like elements to resist pressure applied in a direction normal to the plane of the band but permitting the transverse configuration of said series to conform to transient variations in the transverse configuration of the stump inserted therein.

5. A socket for artificial limbs as set forth in claim 1, wherein the free ends of the rod-like elements beyond the substantially circular band are flared outwardly.

6. A socket for artificial limbs as set forth in claim 3 wherein the band is composed of a series of corresponding links each having a tongue and a recess both disposed circumferentially of the band, and means for pivotally connecting the

tongue of one link within the recess of an adjacent link.

7. A socket for artificial limbs as set forth in claim 3 wherein the band is composed of a series of links each having a tongue provided with a transverse passage extending substantially parallel to the length of the rod-like elements and each link having a recess defined by opposed walls each having alined passages extending substantially parallel to the length of the rod-like elements, and means for pivotally connecting the tongue of one link within the recess of an adjacent link, said means passing through the transverse passage in the tongue and through the alined passages in the walls defining the recess in the adjacent link.

8. A socket for artificial limbs as set forth in claim 3 wherein certain links in the band are of greater length than others, the longer links relieving the adjacent portion of the stump of pressure to which it would be otherwise subjected by the rod-like elements adjacent said portion.

9. A socket for artificial limbs as set forth in claim 3 wherein a portion of the circular series of rod-like elements is disposed on one radius and wherein the remainder of the circular series of rod-like elements is disposed on a different radius, two of the links of the band between the sections of different radii being modified to permit one section of the band to be of a different radius than the other section.

10. A socket for artificial limbs as set forth in claim 1, wherein the rod-like elements are adjustable in length.

11. A socket for artificial limbs as set forth in claim 1, wherein a flexible lining is disposed within the socket and has portions thereof bent into the spaces between the spaced rod-like element to provide longitudinally extending ventilating channels between the inserted stump and the inner surface of the socket.

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