ABSTRACT

A brace for limiting a pair of limbs articulated to each other at a joint therebetween to swinging movement with respect to each other only about a single axis. Thus, the brace may be a knee brace for limiting upper and lower leg limbs for swinging movement relative to each other only about a single horizontal axis passing through the knee joint. A pair of limb-engaging components are shaped respectively to engage the limbs on one side thereof at locations spaced from the joint, and a pair of arms, which are fixed to these components, extend into overlapping relation at end regions of the arms which are pivoted to each other for limiting them to swinging movement about an axis which will coincide with the single axis about which the limbs will be free to turn. A joint-engaging components is adapted to engage the joint at the side of the limbs opposite from the limb-engaging components, and a pair of relatively stiff members extend from the pair of limb-engaging components around to the region of the joint-engaging components where the latter together with these relatively stiff members are pivoted to each other for free swinging movement with respect to each other about an axis which also will coincide with the above single axis. In this way, while the limbs will be free to swing with respect to each other about this single axis which passes through the joint, they are prevented from turning with respect to each other about any other axis.

12 Claims, 13 Drawing Figures
BRACE FOR ARTICULATED LIMBS

BACKGROUND OF THE INVENTION

The present invention relates to braces. In particular, the present invention relates to braces which are adapted to restrain a jointed pair of the human body to prevent injury thereto, particularly under conditions where the part of the body to which the brace is applied is prone to injury.

For example, in the case of a knee joint which articulates upper and lower leg limbs to each other, under ideal conditions these limbs should only swing one with respect to the other about a single horizontal axis which extends laterally, which is used to restrain from right to left. However, in certain individuals the knee joint is also undesirably prone to provide for swinging movement of the upper and lower limbs with respect to each other about an axis which may also be horizontal but which extends forwardly and rearwardly. Of course, this latter type of articulation is highly injurious and should be avoided under all circumstances. Thus, the present invention relates particularly to that type of brace which can be used by individuals prone to injuries, undesired joint articulation of this type.

Unfortunately, at the present time, ideal conditions of articulation between limbs at a joint interconnecting the same cannot be achieved with conventional braces. Such braces provide a highly undesirable degree of immobility not only preventing movement of the limbs about an undesired axis, but also preventing, to an undesired degree, movement of the limbs about a single desired axis. Thus, all of the presently known braces represent a compromise according to which the freedom of the limbs to swing about a desired axis is at least partially sacrificed in order to obtain prevention of turning about an undesired axis.

Moreover, conventional braces are relatively heavy, they are difficult to put on and take off, and they cannot readily be maintained at all times reliably in their proper positions.

SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to provide a brace of the above general type which will avoid the above drawbacks.

Thus, it is an important object of the invention to provide a brace which will provide almost unlimited freedom of swinging movement of a pair of jointed limbs one with respect to the other about a desirable single axis, while at the same time reliably preventing any movement of the limbs with respect to each other about any other axis.

In addition, it is an object of the invention to provide a brace composed of a relatively small number of simple components which can be used in a highly reliable manner to achieve the complete freedom of articulation about the one desired single axis.

Furthermore, it is an object of the invention to provide a brace of this type which can be readily put on and removed and which also can be very easily held in its proper position.

Furthermore, it is an object of the invention to provide a brace which at all times remains at all of its parts relatively close to the articulated limbs so that the brace will not be readily apparent through articles of clothing, for example.

It is in particular an object of the invention to provide a brace of the above general type which is especially adapted for use at the knee joint.

According to the invention, the brace has a pair of limb-engaging components respectively adapted to engage the articulated limbs at the same side thereof at locations spaced from the joint thereof. A pair of arms is fixed to and extends from these components, respectively, with the pair of arms terminating in end regions distant from these components. A first pivot means interconnects these end regions of the arms to limit them to swinging movement one with respect to the other about an axis which will coincide with the single axis to which the turning of the limbs is to be limited. A joint-engaging component is adapted to be located directly in engage-
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leg limbs at the same side thereof and at locations spaced above and below the knee joint, respectively. A pair of arms 16 and 18 are respectively fixed to and extend toward each other from the limb-engaging components 12 and 14. As is apparent from FIG. 7, these arms 16 and 18 respectively terminate in overlapping end regions 20 and 22 which may be of circular configuration and which are formed with aligned openings through which a single pivot pin 24 extends. If desired, a washer 26 may be situated between the overlapping end regions 20 and 22. The pivot means which is formed by the single pivot pin 24 provides a pivot axis which is perpendicular to the arms 16 and 18 and which coincides with the single axis to which swiveling of the upper and lower leg limbs is to be limited. This pivot pin 24 may, for example, take the form of a simple rivet extending through and having the head ends which respectively engage the outer surfaces of the arms 16 and 18, as indicated in FIG. 7.

As is also apparent from FIG. 7, the arms 16 and 18, which are in the form of relatively flat substantially straight bars are surrounded by relatively soft, yieldable coverings 28 and 30 in the form of an interior soft padding enveloped within an outer flexible plastic sheet or the like.

A pair of relatively stiff curved members 32 and 34 are respectively fixed to and extend form the pair of limb-engaging components 12 and 14. These relatively stiff members 32 and 34 are in the form of bars which are adapted to curve around the front of the upper and lower leg limbs. These curved portions at the front of the limbs are respectively connected with substantially straight elongated portions 36 and 38 which forms part of the members 32 and 34, respectively, and which terminate also in substantially circular end regions which overlap each other and are formed with aligned openings, as is particularly apparent from FIG. 6. It is to be noted that the straight portions 36 and 38 of the members 32 and 34 extend in the same general direction as the arms 16 and 18 while not necessarily being precisely parallel thereto.

A joint-engaging component 40 is adapted to directly engage the knee joint at the side of the upper and lower leg limbs opposite from the limb-engaging components 12 and 14. This component 40 is formed by a metal plate 42 having an inner surface carrying a soft layer of padding 44 which directly engages the joint. The components 12 and 14 are constructed in the same way, which is to say they include suitably curved metal strips carrying at their inner surfaces a soft yieldable padding which directly engages the upper and lower leg limbs. The plate 42 is formed with an opening which is aligned with the openings at the overlapping end regions of the members 32 and 34, and a single pivot pin 46 extends through these aligned openings to provide for the members 32 and 34, as well as for the component 40, a single turning axis which coincides with the axis of the pivot means 24. As is apparent from Fig. 6, the left end of the pin 44 is countersunk into the plate 42 while the right end has an enlarged head. Also, washers 48 and 50 may be located between the members 32 and 34, at their overlapping end regions, and between the component 40 and the member 32. Thus, the pair of pivot means 24 and 46 have a common pivot axis which will coincide with the single axis about which the turning movement of the upper and lower leg limbs is to be limited.

The brace 10 of the invention is very readily placed on the leg simply by situating the upper and lower leg limbs in the region of the knee joint within the relatively stiff brace members 32 and 34. The components 12 and 14 are respectively placed in engagement with the upper and lower limbs at the outer side thereof while the joint-engaging component 40 is placed directly in engagement with the joint at the inside of the limbs.

The brace is preferably retained in position by the structure shown in FIGS. 8–13 and described below. With the brace 10 positioned on the leg, there is a complete freedom to swing the leg position indicated in FIGS. 2 and 3 to the leg position indicated in FIGS. 4 and 5. Thus, there is freedom to swing about the single axis defined by the pair of pivot means 24 and 46. However, the substantially three-point engagement provided by the limb and joint engaging components and the interconnection therebetween through the relatively stiff brace members 32 and 34 will reliably prevent any movement of the upper and lower limbs with respect to the other about any axis other than that which coincides with the common axis of the pair of pivot means 24 and 46.

It is particularly to be noted that with the pivot means 46 not only is it possible for the pair of members 32 and 34 to freely swing one with respect to the other, but, in addition, the component 40 is free to turn about the axis of the pin 46 with respect to the members 32 and 34. Thus, all of the elements which are interconnected by the pivot 24 and 46 are completely free to turn with respect to each other about the common axis of these pivots, so that while a substantially complete freedom of turning with respect to the one, single desired axis is assured, the brace will nevertheless function very reliably to prevent turning about any other axis. If desired, the several washers 26, 48 and 50 may be made of a suitable antifiction material.

It is furthermore to be noted that the members 32 and 34 remain at all times close to the outer surfaces of the limbs while the arms 16 and 18 and the components 12, 14, 32 and 34 and also remain very close to the limbs. Therefore, when the brace of the invention is worn it is not readily apparent through an article of clothing. For example, with the illustrated leg brace, it is possible to wear on the leg trousers without the brace being particularly noticeable through the trousers.

Referring now to FIGS. 8–13, a structure is illustrated therein for releasably holding the brace 10 on a leg. Referring to FIG. 8 it will be seen that the upper, larger limb-engaging component 12 has fixed thereto, in any suitable way as by rivets or the like, for example, an elongated band 60 made of stretchable elastic webbing. This band 60 may be made of soft rubber, for example. It extends from its end which is fixed to the limb-engaging component 12 freely therefrom to a length sufficiently great to provide for wrapping of the band 60 around the upper limb above the knee. The band 60 is shown in FIG. 9 extending from the upper component 12 in the condition which the band 60 takes when it is wrapped around the upper limb above the knee.

In the illustrated example the band 60 is maintained in its wrapped-around condition by a releasable fastener in the form of well-known Velcro structure. This structure includes a layer of substantially stiff metal loop 62 fixed to the exterior of the band 60 and a coating layer of pile fabric 64 which simply is pressed against the looped loop 62 to reliably hold the components together until the layer 64 is separated from the layer 62. The band 60 is shown in a twisted condition in FIG. 8 so as to clearly illustrate the fastening elements 62 and 64. Thus while the element 62 is situated at the outside of the band the element 64 is situated at the inside of the band, and therefore is not visible in FIG. 9.

Thus, with respect to the upper, larger component 12 it is only necessary for the operator to wrap the band 60 in a somewhat stretched condition around the limb above the knee, placing layer 64 in engagement with layer 62 so as to hold the band in its wrapped condition.

The lower, smaller limb-engaging component 14 is maintained on the limb below the knee by a similar band structure 66. However, this stretchable elastic webbing which forms the band 66 is fixed intermediate its ends to the component 14. The part of the band 66 which extends to the left beyond the component 14, as viewed in FIG. 8, forms a wrap-around band which is constructed similarly to the one to operate in much the same way as the upper band 60. However, the band 66 has an extension 66 extending to the right beyond the component 14, as viewed in FIG. 8, for a purpose referred to below. The band 66 is also shown in FIG. 8 in a twisted condition so as to illustrate the section of relatively stiff loops 68 at the outside of the band and the end section 70 of pile which is to be pressed into the section 68 to provide the Velcro releasable
fastening of the band provide the Velcro releasable fastening of the band portion 66a in its wrap-around condition shown in FIG. 9.

As may be seen from FIG. 9, the extension 66b extends along a spiral or helix from the component 14 up to the upper band 60. At its free end, the extension 66b carries at its inside a pile section 74 adapted to be pressed against the section 76 of relatively stiff loops, to provide a releasable Velcro Connection between the top end of the extension 66b and the upper band 60. Thus, the fastening component 76 is inclined so as to extend along the spiral path occupied by the upper end region of the extension 66b which carries the fastening component 74 which coacts with the fastening component 76.

The above-described structure of FIGS. 8 and 9 is shown mounted on a left leg in FIGS. 10–13 which respectively illustrate the structure as seen at the inside of the left leg, at the front of the left leg, at the outside of the left leg, and at the rear of the left leg. Thus, FIG. 10 shows the joint-engaging component 40 at the inside of the leg with the relatively stiff brace member 34 shown extending forwardly along the inside of the leg and then around the front thereof (FIG. 11) to terminate at the lower component 14 which is visible in FIG. 12 at the outside of the leg below the knee thereof. It is to be noted that while the band portion 66a is wrapped around the lower leg region in the manner shown in FIGS. 10–13 with the component 14 situated between the layers of the band portion 66a, the extension 66b extends from the component 14 and remains directly in engagement with the leg between the latter and the bar 34, in the manner shown most clearly in FIG. 11.

Thus, in this case a part of the band 66 forms a leg-engaging surface for the component 14. In other words that part of the band 66 which is fixed to and overlaps the component 14 at the inside thereof directly engages the leg and forms part of the component 14. This is the part which is contained within the dotted area shown in FIG. 9 as the outline of component 14. As is apparent from FIG. 13, the wrap-around portion 66a of the band 66 terminates at the rear of the leg just beyond the component 14 at the outside of the left leg.

In contrast with the lower band portion 66a, the upper band 60 is connected to the outside of the component 12 and extends over the upper relatively stiff bar 32 of the brace so as to cover this bar as well as the component 12, and the band 60 is wrapped around the upper limb region and terminates at the location where the rear of the leg merges into the inside of the leg.

As a result the inclined fastening component 76 extends upwardly across the rear of the leg and then to the outside thereof, so that the extension 66b of the band 66 will be fastened to the upper band 60 in the manner shown in FIGS. 12 and 13 at the outside and rear of the leg respectively.

The joint-engaging component 40 as fixed to its upper and lower end regions, as by rivets or the like, a pair of encircling straps 80 and 82 which take the form of substantially non-stretchable webbing terminating in buckles for adjustable connection of the bands in a condition extending around the leg at the joint region thereof. The upper encircling band 80 shown in FIG. 8 has a portion 80a extending in one direction from the component 40 and a portion 80b extending in the opposite direction therefrom. In the same way the lower 82 has a portion 82a extending in one direction from the component 40 and a portion 82b extending in the opposite direction therefrom. The portions 80a and 82b respectively terminate in buckles 84 and 86 adapted to receive the free ends of the portions 83a and 84a of the bands 82 and 80, these portions being formed with openings through which the swingable pin of each buckle is adapted to extend. Thus, it will be seen that the band portion 80a is inclined downwardly around the joint region to be fastened to the buckle 86 carried by the band portion 82b, while the band portion 82a is inclined upwardly around the joint region to be fastened to the buckle 84. In the manner which is shown most clearly in FIGS. 12 and 13, in the illustrated arrangement the band portion 82a extends over the band portion 80a while crossing the latter.
the single axis, whereby the limbs will be free to swing about the latter single axis while being prevented from swinging about any other axis, said end regions of said arms overlapping each other and being respectively formed with aligned openings passing therethrough, and said single pivot pins including a single pivot pin extending through the latter openings.

3. A brace for limiting a pair of limbs which are articulated to each other at a joint therebetween to swinging movement at the joint only about a single axis, comprising a pair of limb-engaging components to be located on the same side of the limbs in engagement therewith beyond the joint therebetween, a pair of arms respectively fixed to and extending from said pair of components, said arms respectively terminating in end regions situated distant from said components, first pivot means interconnecting said arms at said end regions thereof for swinging movement one with respect to the other about an axis which will coincide with the single axis to which the swinging movement of the limbs is to be limited, a joint-engaging component for engaging the joint between said limbs at a side of said limbs opposite from the side thereof engaged by said pair of said components, a pair of relatively stiff, curved members respectively fixed to said pair of limb-engaging components to extend therefrom around the pair of limbs to the side of the latter opposite from said pair of components, said members respectively terminating in end regions located adjacent said joint-engaging component, and second pivot means interconnecting said joint-engaging component and said end regions of said members for free swinging movement relative to each other about said axis which is to coincide with the single axis, whereby the limbs will be free to swing about the latter single axis while being prevented from swinging about any other axis, said relatively stiff members having overlapping end regions which also overlap said joint-engaging component, and the latter component and said overlapping end regions of said members all being respectively formed with aligned openings passing therethrough, and a single pivot pin forming said second pivot means and extending through the latter openings.

4. The combination of claim 3 and wherein said arms terminate in overlapping end regions respectively formed with aligned openings passing therethrough, and said first pivot means including a single pivot pin extending through the latter openings and having an axis coinciding with the axis of the single pivot pin of said second pivot means.

5. The combination of claim 1 and wherein said arms are substantially straight, said relatively stiff members having in the region of said second pivot means elongated substantially straight portions which are respectively substantially parallel to said arms.

6. The combination of claim 5 and wherein said members include substantially U-shaped portions extending from said straight portions thereof to said pair of limb-engaging components, respectively.

7. The combination of claim 1 and wherein each of said components includes a plate having an inner surface and a pad carried by said inner surface.

8. The combination of claim 1 and wherein the brace is a leg brace, said limb-engaging components having shapes which are adapted to engage outer side surfaces of upper and lower leg limbs at locations spaced from a knee joint therebetween, and said joint-engaging component having a shape for engaging the knee joint at the inside of a leg.

9. The combination of claim 8 and wherein said relatively stiff members extend from said pair of limb-engaging components forwardly therefrom, then transversely, and then rearwardly to the region of said second pivot means, so that when the brace is worn, said relatively stiff members will extend around the front of the upper and lower leg limbs.

10. A brace for limiting a pair of limbs which are articulated to each other at a joint therebetween to swinging movement at the joint only about a single axis, comprising a pair of limb-engaging components to be located on the same side of the limbs in engagement therewith beyond the joint therebetween, a pair of arms respectively fixed to and extending from said pair of components, said arms respectively terminating in end regions situated distant from said components, first pivot means interconnecting said arms at said end regions thereof for swinging movement one with respect to the other about an axis which will coincide with the single axis to which the swinging movement of the limbs is to be limited, a joint-engaging component for engaging the joint between said limbs at a side of said limbs opposite from the side thereof engaged by said pair of said components, a pair of relatively stiff, curved members respectively fixed to said pair of limb-engaging components to extend therefrom around the pair of limbs to the side of the latter opposite from said pair of components, said members respectively terminating in end regions located adjacent said joint-engaging component, and second pivot means interconnecting said joint-engaging component and said end regions of said members for free swinging movement relative to each other about said axis which is to coincide with the single axis, whereby the limbs will be free to swing about the latter single axis while being prevented from swinging about any other axis, a pair of limb-encircling bands being respectively connected with said pair of limb-engaging components for encircling the limbs to maintain the brace thereon, one of said bands having an extension extending spirally to and releasably fastened to the other of said bands.

11. The combination of claim 10 and wherein all of said bands, including said extension of said one band, are made of a stretchable elastic webbing.

12. The combination of claim 11 and wherein said pair of limb-engaging components are respectively upper and lower components with said upper component being larger than said lower component, and the bands which is connected with said lower component having said extension which extends spirally up to said upper component and is releasably fastened therewith.