United States Patent [19]

Taylor

[11] 3,902,482

[45] Sept. 2, 1975

[54] **MECHANICAL JOINT FOR AN ORTHOPEDIC BRACE OR PROSTHESIS**

[76] Inventor: **George A. Taylor,** 976 Saunders Rd., Richmond, British Columbia, Canada, V7a 2B4

[22] Filed: **May 28, 1974**

[21] Appl. No.: **474,133**

[30] **Foreign Application Priority Data**

May 21, 1974 Canada 200442

[52] **U.S. Cl.** ..... **128/80 F;** 3/22; 3/26; 403/95; 403/116; 128/88

[51] **Int. Cl.** **A61f 5/00;** A61f 1/04

[58] **Field of Search** ..... 128/80 F, 80 C, 80 R, 88; 3/22, 24, 26, 27; 403/95, 116, 119, 113

[56] **References Cited**

UNITED STATES PATENTS

552,143	12/1895	Rankin	128/80 F
1,336,695	4/1920	Gromes	128/88
3,799,158	3/1974	Gardner	128/80 C

FOREIGN PATENTS OR APPLICATIONS

826,333	12/1951	Germany

Primary Examiner—Ronald L. Frinks

Attorney, Agent, or Firm—Fetherstonhaugh & Co.

[57] **ABSTRACT**

A mechanical joint for a leg brace having portions attachable to the leg above and below the knee joint and interconnected by a link. The spaced ends of the brace portions and the opposite ends of the link are shaped to provide bearing plates which are secured together by movable pivot means. This provides the mechanical joint with dual bearings having a combined pivotal movement closely simulating the flexing action of an anatomical knee.

9 Claims, 13 Drawing Figures

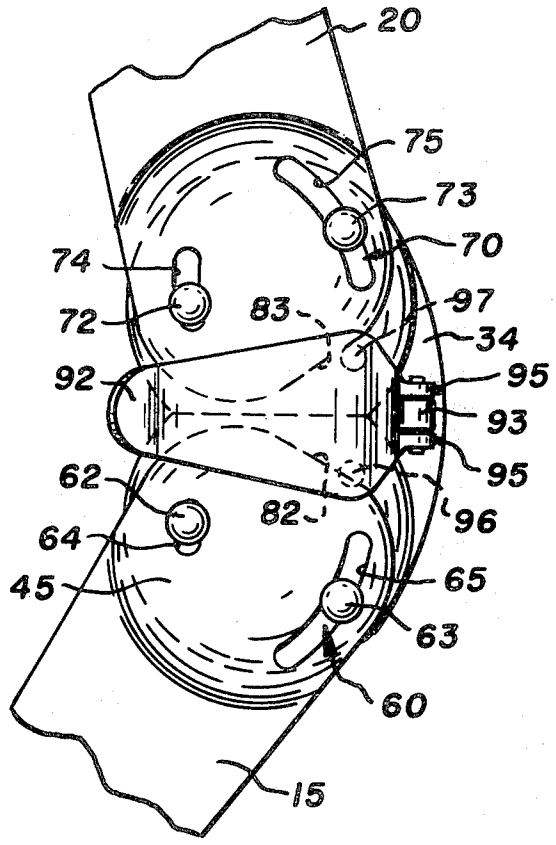


Fig. 1.

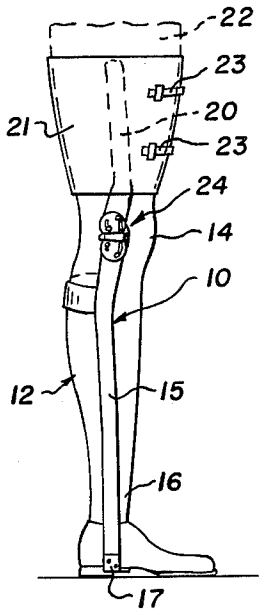


Fig. 2.

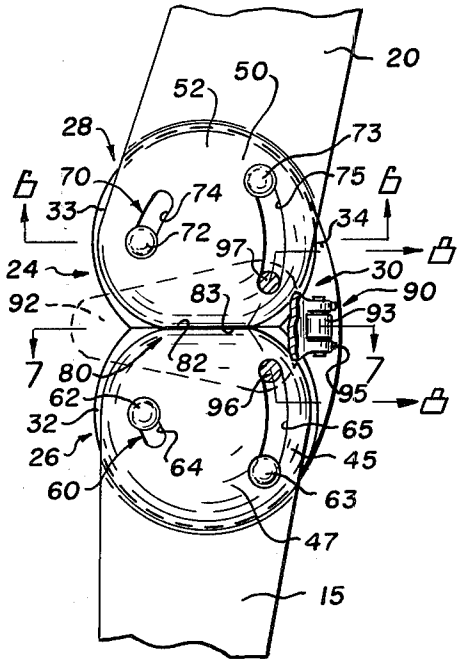


Fig. 3.

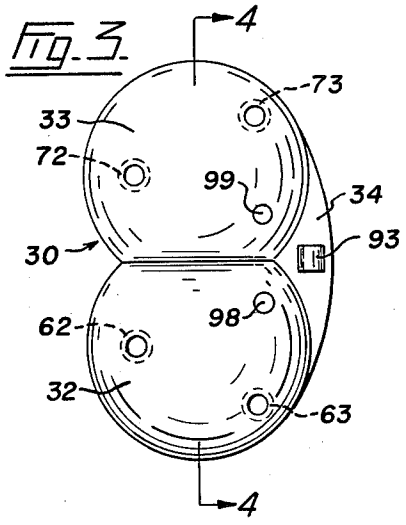


Fig. 4.

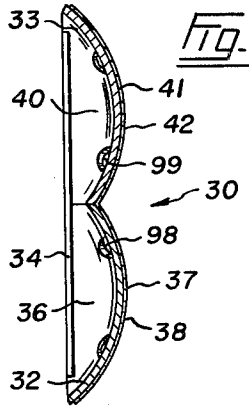


Fig. 5.

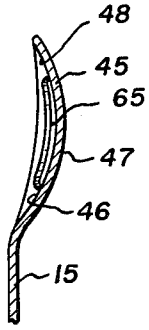


Fig. 6.

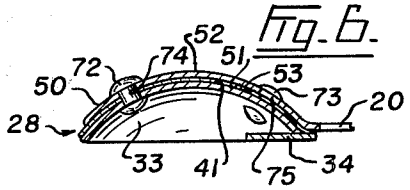


Fig. 7.

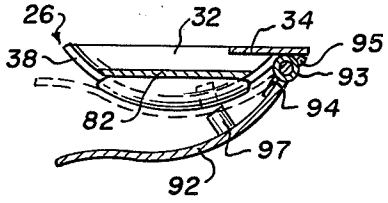


Fig. 8.

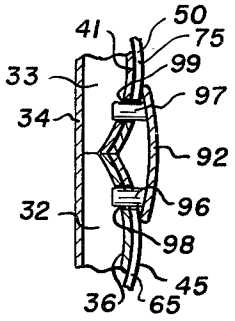


Fig. 9.

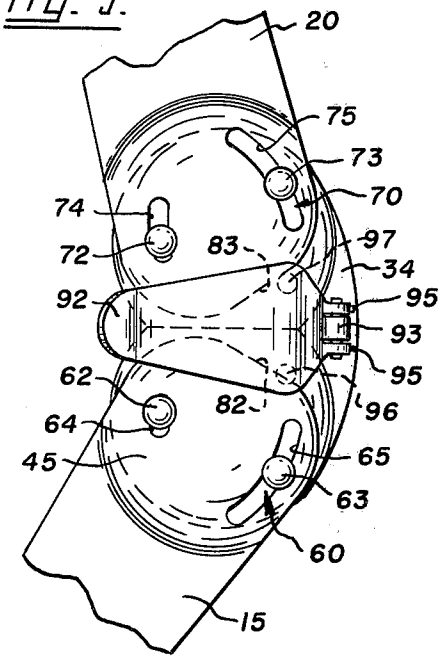


Fig. 10.

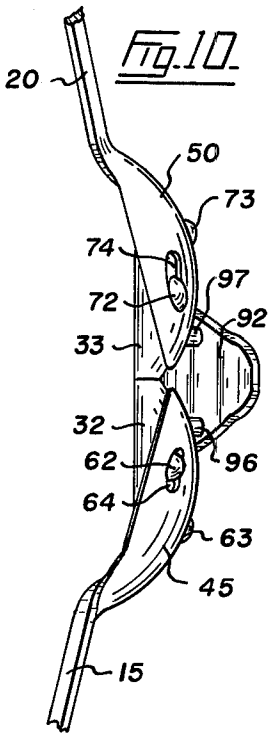


Fig. 11.

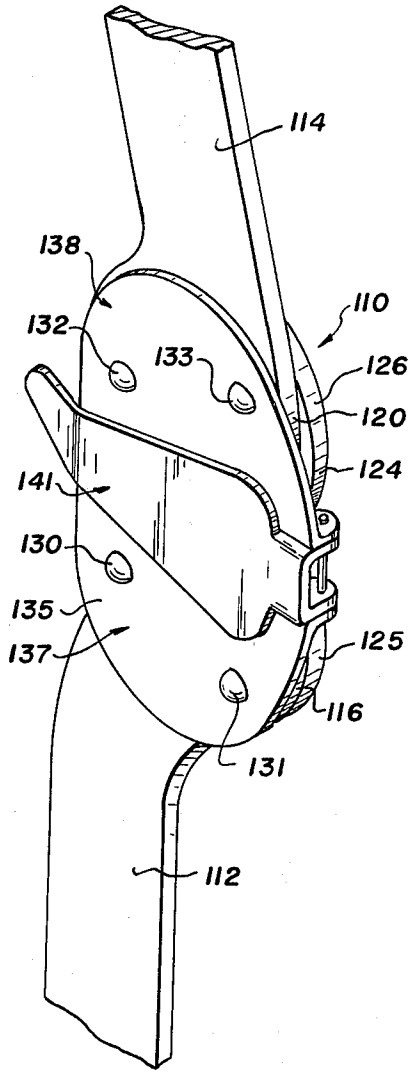


Fig. 12.

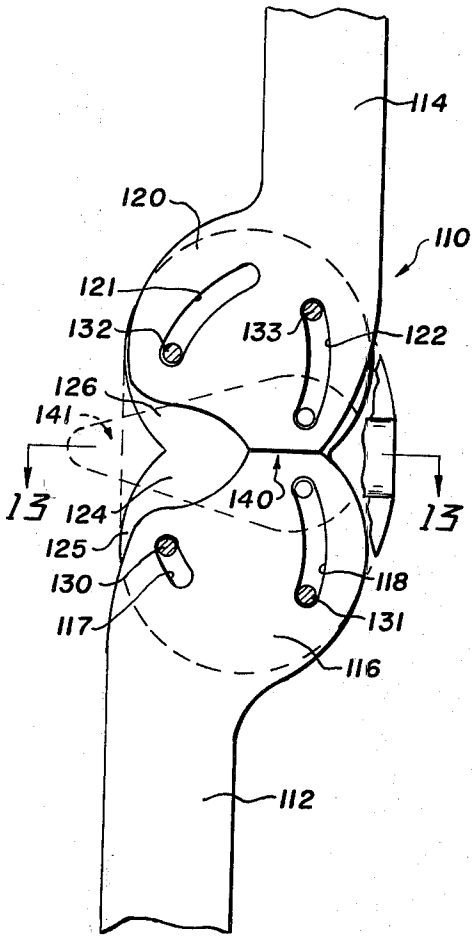
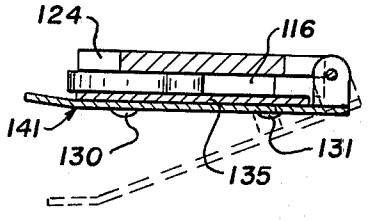


Fig. 13.



MECHANICAL JOINT FOR AN ORTHOPEDIC BRACE OR PROSTHESIS

My invention relates generally to joints for orthopedic braces or prosthetics and more particularly to a mechanical joint for a leg brace.

When a brace is worn to lend support to an injured or weakened knee, it is generally desirable that the properly supported limb be allowed to operate in as natural a manner as possible so that appropriate muscles and ligaments will become strengthened and eventually the support will no longer be required. Even if the injury or weakness is permanent, the brace wearer should not be hampered unduly by the device so that his inability to use his leg in a normal manner is more noticeable than would otherwise be the case.

A leg brace requires a mechanical joint which will take some of a medially or laterally applied load off the knee joint but the mechanical joint itself should not be heavy, bulky or complex otherwise the brace is awkward to wear and is noticeable through the wearer's clothing and is needlessly expensive. There are a number of artificial limbs which have mechanical joints designed to reproduce as closely as possible the flexing action of the human knee but such joints usually are of quite complex construction and furthermore they occupy a major portion of the space between the upper and lower parts of the artificial leg. This arrangement is unsatisfactory for use in a leg brace wherein the joint structure must lie alongside the anatomical knee joint and be flat and compact so as not to provide an unsightly projection sticking out from one side of wearer's leg.

I have found that the above mentioned as well as other disadvantages of conventional hinge structures can be overcome by providing a simply and inexpensively constructed brace with a mechanical joint which is designed to reproduce very closely the natural movements of a body joint. The mechanical joint is light in weight as well as strong and it has an overall thickness which is not much greater than the remainder of the brace which makes the device difficult to detect through the clothing of the wearer. An athlete, for example, who might have a knee injury such as a strained ligament, could wear the present invention to protect the knee from severe blows or stress which could quite easily further damage the knee and incapacitate him completely.

The mechanical joint for an orthopedic brace constructed in accordance with the present invention interconnects brace portions which are attachable to parts of a wearer's body on opposite sides of a body joint, the mechanical joint comprising a bearing plate on an end of each brace portion near the body joint, a link extending across the body joint and having a bearing plate on each opposite end thereof, said bearing plates of the link overlapping the bearing plates of the brace portions to provide dual bearings, and pivot means interconnecting the bearing plates of each of the dual bearings, said pivot means providing the dual bearings with transverse axes of pivot which are shiftable whereby the link is movable away from and towards the brace portions as the body joint is flexed and straightened.

In drawings which illustrate preferred embodiments of the invention,

FIG. 1 is a side elevation of a leg brace,

FIG. 2 is a detail side elevation of a mechanical joint of the leg brace,

FIG. 3 is a side elevation of a link which forms part of the mechanical joint,

FIG. 4 is a section taken on the line 4—4 of FIG. 3,

FIG. 5 is a vertical section showing a bearing plate of the mechanical joint,

FIG. 6 is a transverse section taken on the line 6—6 of FIG. 2,

FIG. 7 is a transverse section taken on the line 7—7 of FIG. 2,

FIG. 8 is a vertical section taken on the line 8—8 of FIG. 2,

FIG. 9 is a side elevation similar to FIG. 1 but showing the mechanical joint bent as a result of the wearer's knee being flexed,

FIG. 10 is a rear elevation of the mechanical joint as shown in FIG. 9,

FIG. 11 is a perspective view of a modified mechanical joint for a leg brace,

FIG. 12 is a detail side elevation of the modified joint with part of a link removed, and

FIG. 13 is a transverse section taken on the line 13—13 of FIG. 12.

This invention may be used to reinforce anatomical joints such as the shoulder, elbow, hip and ankle but, since the brace is especially designed to simulate the gliding, rocking and rotational movement of the human knee, it will be described herein as utilized exclusively for that purpose. A person's knee can be likened to a ball and socket joint having a rather unusual action for that type of mechanism. When the knee bends and straightens during walking or running, the ball of the upper leg and socket of the lower leg interact in such a way as to move away from and towards one another. The leg actually extends and contracts during locomotion and, when the parts of the knee joint are separated, the lower leg can twist slightly with respect to the upper leg. It is only when the leg is straightened and supporting the weight of the body that the knee joint is locked and the lower leg cannot twist as described. Thus, the natural knee joint has a point of pivot which moves about as the leg is alternately bent and straightened with the knee providing a restricted universal action unless firmly locked as described.

Referring first to FIG. 1 of the drawings, the numeral **10** indicates generally an orthopedic leg brace. The brace **10** is shown attached to a leg **12** so as to lend support to the knee joint **14.** This example of the brace **10** has a lower portion **15** which is a flat strip of metal shaped to extend alongside lower leg **16** with one end of the portion preferably being secured by a fitting **17** to the shoe of the wearer. Upper portion **20** of the brace is also a flat strip of suitably shaped metal which is secured to a stiffened leather band **21,** the longitudinally divided band being clamped to the thigh **22** of the wearer by means of straps **23.** The adjacent ends of the brace portions **15** and **20** are connected by a mechanical joint generally indicated at **24,** the joint being disposed alongside the knee joint **14** when the brace **10** is attached to the wearer's leg as described.

The mechanical joint **24** comprises bearings **26** and **28** (FIG. 2) which pivotally connect the brace portions **15** and **20** to a link **30.** The link **30** is shown separately in FIGS. 3 and 4 as being shaped to provide substantially circular bearing plates **32** and **33.** A flat web **34** extends between the plates **32** and **33** along the front

edge of the link. Plate 32 has an inner concave face 36 and an outer convex face 37. The outer convex face 37 is coated with a suitable plastic anti-friction material and preferably this coating 38 is the synthetic material known by the trade mark "Teflon." Similarly, the bearing plate 33 has a concave face 40 and a convex face 41 with the latter face having a plastic coating 42.

The lower portion 15 of the brace is provided with a bearing plate 45, see particularly FIGS. 2 and 5, which plate overlaps and closely fits the bearing plate 32 of the link thereby forming the bearing 26. Preferably, the bearing plate 45 is formed by a stamping process which shapes the upper end of the metal brace portion 15 into a dished configuration thus providing a concave inner face 46 and a convex outer face 47, see FIG. 5. Firmly bonded to the face 46 is a thin plastic coating 48. Thus, the plastic coated faces 37 and 46 when placed in sliding contact with one another provide the bearing 26 with a particularly smooth action which enables the brace portion 15 to rock on the link 30 in several directions.

Referring now particularly to FIGS. 2 and 6, the upper portion 20 of the leg brace will be seen to be shaped to provide a bearing plate 50 having concave and convex inner and outer faces 51 and 52. Face 51 has a plastic coating 53 which serves as anti-friction material. The plastic coated face 51 fits over the underlapping and similarly coated face 41 of the link so that the bearing 28 has an action similar to the action of the bearing 26 whereby said link can move relative to the brace portion 20 again in a number of different directions.

The plates 32 and 45 of the bearing 26 are held in face-to-face sliding contact by pivot means generally indicated at 60. As shown best in FIGS. 2, 3, 6 and 9 of the drawings, the means 60 comprises pivot pins 62 and 63 which are suitably secured to the plate 32 to project outwardly from the convex face 37. These pivot pins, which have short shanks and flattened heads, are located on opposite sides of the center of the substantially circular bearing plate 32 as can best be seen in FIG. 3. Bearing plate 45 is provided with arcuate guide slots 64 and 65, see particularly FIG. 2. The shank of the pivot pin 62 projects freely through the slot 64 and the shank of the pivot pin 63 similarly projects through the relatively long guide slot 65 with the enlarged heads of these pins slidably engaging the outer or convex face 47 of the bearing plate 45 to hold these two parts of the bearing 26 against separation.

A similar pivot means 70 is provided to interconnect the plates 33 and 50 of the bearing 28. The means 70 comprises identical pivot pins 72 and 73 which are secured to the plate 33. Arcuate guide slots 74 and 75 are formed in the bearing plate 50, see FIG. 2, and the short shanks of the pins 72 and 73 project freely through these slots with the heads of said pins slidably engaging the convex face 52 of the plate to hold the bearing 28 against separation.

The mechanical joint 24 includes stop means generally indicated at 80 for limiting swinging movement of the lower brace portion beyond the position assumed thereby when the wearer's leg is straightened and the upper and lower brace portions are substantially aligned. Referring now particularly to FIG. 2, the means 80 is shown to comprise opposing stops 82 and 83 which are flattened end edges of the bearing plates 45 and 50 respectively. These stops 82 and 83 come into contact with one another when the leg 11 is straight and the knee 14 is locked. At this time, the shanks of the pivot pins 62 and 63 are in contact with the opposite ends of the guide slots 64 and 65. The pins 72 and 73 are similarly positioned in their slots 74 and 75. The upper and lower portions 15 and 20 are substantially aligned when the leg 11 is straight and it is at this alignment that the stop means 80 comes into play to halt further bending movement of the mechanical joint 24 which might impose a strain on the locked knee 14. In other words, the stops 82 and 83 cooperate with the arrangement of pivot pins and slots to limit swinging movement of the brace portions 15 and 20 beyond their substantially aligned positions.

The present joint 24 also includes locking means generally indicated by the numeral 90 for securing the bearing plates of the dual bearings against relative movement when the upper and lower brace portions are in the substantially aligned position. Referring to FIGS. 2, 7 and 8, the means 90 is shown to comprise a flap 92 which extends across the center of the link 30. A hinge 93 secures one end of the flap 92 to the web 34 of the link. In FIG. 7, a small spring 94 will be seen incorporated into the hinge 93 to bias the flap 92 away from the link, and said flap is fitted with a lug 95 which contacts the web 34 to limit outward swinging movement of the flap. The flap 92 is provided with spaced dowels 96 and 97 which are adapted to enter holes 98 and 99 formed in the link 30 to register with the ends of the slots 65 and 75 when he mechanical joint 24 is in the FIG. 2 position.

Normally, the flap 92 is held in the FIG. 7 position by the action of the spring 94 and lug 95 at which time the dowels 96 and 97 are supported clear of the bearing plates 45 and 50. The joint 24 is then free to operate as required. At some time the wearer of the brace 10 might decide to lock the joint 24 so that his knee could no longer be flexed and, in order to do so, he would first straighten the leg to the limit determined by the stop means 80. This places the holes 98 and 99 in register with the dowels 96 and 97 whereupon the flap 92 can be pressed inwardly to project the dowels through the slots 65 and 75 and into said holes where they are held by friction. The joint 24 is then locked and cannot be released until the flap 92 is moved manually to the FIG. 7 position.

The operation of the mechanical joint 24 is best understood with reference to FIGS. 9 and 10. When the lower leg 16 swings to the rear as the wearer of the brace 10 walks, the joint 24 performs a hinging action which closely simulates the flexing action of the knee 14. The several pivot pins of the bearings 26 and 28 allow the link 30 and brace portion 15 to swing relative to the brace position 20 but, since these pins are free to move as required within their arcuate slots, the effect is to provide the joint with a plurality of transverse axes of pivot. In other words, the mechanical joint can elongate slightly in the same manner as does the knee joint when it is flexed.

Since the several plates of the bearings 26 and 28 are segment of a thin-walled, hollow spheroid, the link 30 and brace portion 15 can also rotate slightly about their longitudinal axes to assume positions substantially as shown in FIG. 10. This allows the wearer to turn his lower leg when the knee 14 is flexed as he may be required to do in order to execute a particular step. The mechanical joint allows the knee joint to function in a

natural manner while being supported to the extent that any undue strain is unlikely to be placed thereon.

Referring to FIGS. **11, 12** and **13**; the numeral **110** indicates generally a modified mechanical joint for a leg brace having portions **112** and **114.** The brace portion **112** has a flat bearing plate **116,** see FIG. **12,** provided with arcuate guide slots **117** and **118.** Brace portion **114** has a similar flattened bearing plate **120** in which arcuate slots **121** and **122** (FIG. **12**) are formed.

A link **124,** which is also flat as shown best in FIG. **13,** has bearing plates **125** and **126** which overlap the plates **116** and **120** of the brace portions. Pivot pins **130, 131, 132** and **133** are carried by the link **124** to slidably project through the slots **117, 118 121** and **122** respectively. A cover **135** of substantially the same shape as the link **124** extends over the bearing plates **116** and **120,** the cover being secured to the link the aforesaid pivot pins which are riveted over as shown in FIG. **11.**

The above described arrangement provides the mechanical joint **110** with dual bearings which are generally indicated at **137** and **138.** Since these dual bearings are formed with flattened bearing plates, they allow the brace portions **112** and **114** to hinge or fold in a substantially common plane but, of course, one position cannot twist with respect to the other portion as is the case when dished or concave-convex bearing plates are used. The pivot pins **130** to **133** are still received in arcuate slots so that the resulting pivot means provides a plurality of transverse axes of rotation for the mechanical joint **110.** Such a joint is particularly intended for use by paraplegics and others who might find it easier to get around provided their legs were reinforced by braces fitted with the modified joint.

The joint **110** has stop means and locking means which are generally indicated by the numerals **140** and **141** respectively. Since these two means are constructed substantially as their counterparts **80** and **90** of the main embodiment of the invention, and operate in almost the same manner, detailed description of the two devices is not considered necessary.

From the foregoing, it will be apparent I have provided a mechanical joint for a leg brace which is simply yet sturdily constructed without being heavy or bulky. The knee joint is not restricted in its movement any more than is necessary to provide the required support and therefore the wearer can walk and run with quite a natural gate assuming the brace he is wearing is equipped with the preferred mechanical joint. Both embodiments of the invention provide a joint which might be described as polyaxial, viz. there is no fixed axis of pivot but rather a multitude of pivotal axes which move about or shift as required to accommodate the natural flexing action of the anatomical knee joint.

I claim:

1. In an orthopedic brace having portions attachable to parts of a wearer's body on opposite sides of a body joint, a mechanical joint comprising a bearing plate on an end of each brace portion near the body joint, a link extending across the body joint and having a bearing plate on each opposite end thereof, said bearing plates of the link overlapping the bearing plates of the brace portions to provide dual bearings, and pivot means interconnecting the bearing plates of each of the dual bearings, said pivot means providing each of the dual bearings with a plurality of transverse axes of pivot which are shiftable to accommodate the natural pivotal movement of the body joint whereby one of said brace portions is movable away from and towards the other of said brace portions as the body joint is flexed and straightened.

2. A joint as claimed in claim **1,** in which said bearing plate of each of the dual bearings have opposing concave-convex faces whereby one of the brace portions is rotatable about the longitudinal axis thereof and with respect to the other brace portion and the link when the body joint is flexed.

3. A joint as claimed in claim **1,** and including stop means for limiting folding movement of the mechanical joint in one direction beyond a position assumed when the body joint substantially is straight.

4. A joint as claimed in claim **3,** and including locking means for securing the mechanical joint against folding movement in the opposite direction.

5. A joint as claimed in claim **1,** in which said bearing plates are flat whereby to move parallel to one another and substantially in the vertical planes of the brace portions.

6. In an orthopedic brace having upper and lower brace portions securable to a leg above and below the knee joint, a mechanical joint comprising a bearing plate on each of the upper and lower brace portions near the point of pivot of the knee joint, a link extending across the knee joint and having a bearing plate overlapping a bearing plate of each upper and lower brace portions to provide dual bearings, said bearing plates having opposing faces, one opposing face of each of the dual bearings being convex and the other opposing face of said bearing being concave, one bearing plate of each of the dual bearings having pivot pins spaced apart thereon and the other bearing plate of said joint having correspondingly spaced arcuate guide slots through which said pivot pins project, said pivot pins and arcuate guide slots providing each of the dual bearings with a plurality of transverse axes of pivot which are shiftable to accommodate the natural pivotal movement of the knee joint and whereby the link and the lower brace portion are rotatably about their longitudinal axes and are movable away from the upper brace member when the knee joint is flexed.

7. A mechanical joint as claimed in claim **6,** and including stop means for limiting swinging movement of the lower brace portion beyond the position assumed thereby when the wearer's leg is straightened and the upper and lower brace portions are substantially aligned.

8. A mechanical joint as claimed in claim **7,** and including locking means for securing the bearing plates of the dual bearings against relative movement when the upper and lower brace portions are in the substantially aligned position.

9. A mechanical joint as claimed in claim **8,** wherein said locking means comprises a hinged flap carried by the link, said bearing plates of the upper and lower brace portions each haaving a hole adapted to register with a guide slot when said portions are substantially aligned, and dowels carried by the hinged flap adapted to project through the registering guide slots to enter the holes.

* * * * *