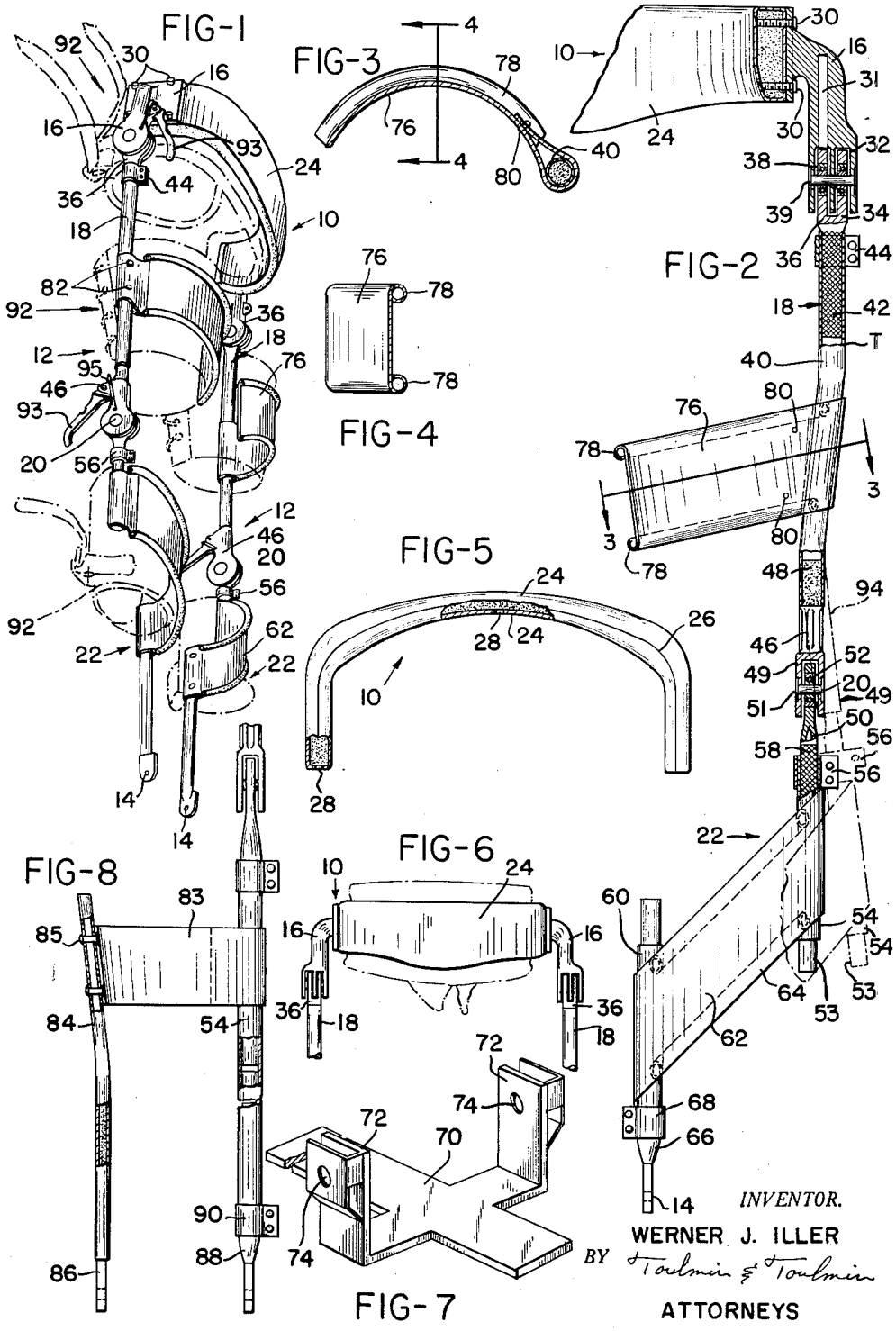
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ORTHOPEDIC BRACE

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ORTHOPEDIC BRACE

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This invention relates to orthopedic braces and particularly to orthopedic braces useful in connection with patients who have become afflicted with cerebral palsy and poliomyelitis.

Cerebral palsy patients particularly in the most serious aspect of the affliction, tend to retain their capacity for control in the muscles and tendons on the inner side of the legs below the crotch, but very generally lose control of the muscles on the adjacent outer sides and accordingly there is a very great tendency for the knees to come together in a strong scissors action of the legs. Further the affliction may last for many years, from infancy to the adult stage, and early training is necessary to enable the afflicted person to attain control of the muscles and to learn to walk. Also adequate orthopedic support may be required in the adult years of the trained patient.

A primary object of this invention is to provide an orthopedic brace which will position the legs and feet of patients properly during the growing and training period.

A particular object of the invention is to provide an orthopedic device, individual parts of which may be replaced as the patient matures and, which device has parts which are readily subject to being mass produced.

An important object of the present invention is the provision of an orthopedic device which provides a minimum of encumbrance to a patient wearing the same while providing a maximum of controlled support.

Another object of the invention is to provide a strong, light weight brace which is substantially free from mechanical failure.

A specific object of the invention is to provide an orthopedic brace which in the condition of use by a patient is effective to provide a biasing action to the legs to tend to cause the knees of the user to move apart laterally; this permits spreading of the feet in a natural manner, assisting training of the patient and encouraging use of muscles and tendons which would not otherwise be employed. Further the spreading of the feet gives greater support to the patient and aids in attaining balance.

Yet another object of the invention is to provide an orthopedic brace which requires only a minimum of components and also does not require cross supports between the leg members for completely adequate support of a user of the brace.

The invention will be more fully understood by reference to the following detailed description and accompanying drawings wherein:

FIGURE 1 is a perspective view of an assembled brace constructed according to my invention;

FIGURE 2 is a frontal vertical sectional view taken along the left leg member of the brace of FIGURE 1;

FIGURE 3 is a sectional view taken on line 3—3 of FIGURE 2 showing a thigh-engaging portion of the brace and which engages the back of the leg above the knee;

FIGURE 4 is a sectional view taken on line 4—4 of FIGURE 3 showing the manner in which the thigh-engaging portion is provided with rolled edges to add strength thereto;

FIGURE 5 is a plan view partly broken away showing the construction of the waistband of the brace from which the leg members are suspended;

FIGURE 6 is a rear elevational view of the upper portion of the brace showing the configuration of the waistband assembly;

FIGURE 7 is a perspective view showing a typical device adapted for mounting in the patient's shoe and for connection with the lower ends of the leg members of the brace; and

FIGURE 8 is a fragmentary view showing a modified construction of a portion of a brace in accordance with my invention.

Referring to the drawings somewhat more in detail, the orthopedic brace according to the present invention comprises a waistband assembly generally indicated at 10 which comprises a back section and forwardly extending side sections, and leg members generally indicated at 12, which leg members have means at their lower ends 14 for connection with a rigid element to be associated with the patient's shoes as referred to hereinafter.

The waistband 10 is provided at its opposite sides with brackets 16 from which are pivotally suspended the upper leg parts 18; at their lower ends the leg parts 18 include pivot means 20 to which are attached the lower leg parts generally indicated at 22 (FIGURE 2).

According to the present invention, the weight of the brace is minimized, and its efficiency is greatly increased by so forming the parts of the brace that they will be as light as possible while providing a high degree of rigidity in those portions that are subjected to the greatest loading. Further, the brace is adjustable so that the points thereof at which pivots occur can be moved to bring the pivots into close alignment with the corresponding body joints.

The lightness of the brace is achieved by constructing the metallic parts thereof so that the metal is presented in the most advantageous manner to sustain the loads imposed thereon. The leg members accordingly, are made tubular, thereby presenting the greatest resistance to bending with the least weight.

Similarly, the waistband is made tubular to provide the greatest strength and the lightest weight, and both the waistband and portions of the tubular legs are preferably filled with a light plastic material such as isocyanate foam; alternatively, a similarly rigid-like member can be obtained by forming the waistband from an expanded light metal such as a heat-treated aluminum or magnesium honey-comb. Such metals which are heat-treated after forming to the desired shape are commercially available.

In a further embodiment the waistband may be formed by casting the isocyanate foam or a similar plastic foam to the proper rigid shape and then wrapping the waistband with a resin-impregnated woven fiber glass wrapping which is preferably then plastic coated to provide for a smooth surface.

The preferred manner of forming the waistband is illustrated in FIGURE 5 wherein it will be seen that the waistband comprises two formed thin metal sheets 24 welded together as at 26; these sheets are very thin—.051" aluminum having been found to be very satisfactory. The sheets define an interior spacing and the assembly body is provided with means for introducing the filler material such as the apertures 28. The function of the filler is to maintain the thin skins of metal separated and to insure of rigidity in the waistband. As will be seen in FIGURE 5, the waistband is thickest adjacent the corners thereof which will be subjected to bending stresses so that no greater weight is built into the waistband than is necessary for the loads applied. The applied load when the structure is in use passes from one leg part to the other through the waistband, and accordingly rigidity of the waistband is most important.

As will be seen in FIGURE 6, the waistband is deepest from top to bottom at about the center of the back section since this portion thereof is subjected to the greatest bending moments in a vertical plane.

The brackets **16**, previously referred to, are securely fixed to the side sections of the waistband as by screws or bolts **30** and at their lower ends the brackets are provided with a re-entrant portion defining (FIGURE 2) slot means **32** to receive the bifurcated upper end **34** of a vertically extending member **36** forming the upper end of the upper leg part **18**. The arrangement is best seen in FIGURE 2 and provides means to receive two sealed anti-friction vertically rotatable bearings **38** between bracket **16** and member **36**.

A hardened pin **39** receives the bearings of each leg member and is supported by bracket **16**. The outer bearing races are suitably secured to the bracket **16** with metal adhesive and therefore the bearings need not be staked.

By spacing the bearings as shown at the hip joint they are ideally situated to resist lateral loads imposed on the leg parts of the brace. This greatly increases the resistance of the brace against yielding and reduces the bearing loads such that free motion of the leg members is had in front and back directions but substantially no side yielding thereof occurs.

This particular point of orthopedic braces according to the prior art was quite defective and it was not uncommon for braces to yield at this point, for the bearings to wear out and become loose, and for the brace to bend, permitting a scissors action of the legs of the user so that one would catch to the other, thus inhibiting free leg movement and also preventing adequate balance training because of the narrowed support area of the feet which is thus occasioned.

According to the construction of the brace of the present invention, wherein side loading is resisted by a vertical couple acting through the bearings, thus permitting use of the full bearing capacity, the bearings have long-life, the leg portions move freely, and the strong rigid brackets **16** and their rigid connection with the extremely strong waistband eliminates all of the weaknesses referred to above.

The brackets are suitably slotted at **31** to receive a conventional locking means (not shown) in the form of a spring biased plunger which cooperates with a slot in the bearing race to effect locking between the bracket **16** and part **18** through the agency of a handle referred to hereinafter.

The lower end of the member **36** extends into the upper end of the tubular portion **40** of the upper leg part **18**. Member **36** is preferably finely knurled as at **42** to inhibit movement thereof and in addition a clamping collar **44** provides means for fixing tubular portion **40** thereto in any desired position of adjustment. That part of tubular portion **40** which is not occupied by the lower end of member **36** may advantageously be filled with a light rigid foam such as isocyanate foam which will substantially prevent the wall of the leg member from collapsing even though overloaded to the point of yielding.

At its lower end, leg part **18** comprises a bifurcated member **46** the upper end of which is advantageously riveted or more preferably cemented into the lower end of the leg part **18** as by the metal adhesive indicated at **48**. Member **46** has a bifurcated lower end **49** and receives the upper end of tubular member **50** which is a portion of the lower leg part **22**. An anti-friction bearing **52** carried by member **50** and supported on pin **51** provides a free moving, but extremely strong pivotal connection between members **46** and **50**.

In the construction illustrated in FIGURES 1 and 2, member **50** is received in a relatively short tubular element **54** and is clamped therein by clamp collar **56** and, as in connection with member **36**, member **50** comprises

knurling **58** to make its connection with tubular element **54** more positive. The numeral **53** indicates a tubular member pinned or otherwise secured in member **54** and which may be extended or trimmed as desired to provide the length suitable for a given application.

Spaced laterally from tubular element **54** is a tubular element **60**, so located as to be immediately inside the patient's leg above the ankle. Tubular elements **54** and **60** are connected by an arcuate calf-engaging metallic strip **62** which is fixed to the tubular elements in any suitable manner, preferably by a metal adhesive or a combination of metal adhesive and rivets, although welding or any other suitable connecting means may be employed. This metallic strip preferably has the top and bottom edges thereon rolled as at **64** to eliminate sharp edges and also to provide for stiffening of the strip so that relatively thin metal can be employed in its construction.

Tubular element **60** receives a member **66** which is clamped therein by clamp collar **68** which, at its lower end comprises the previously referred to means **14** for pivotal connection with a rigid member in the patient's shoe.

The member to be incorporated in the patient's shoe is illustrated at **70** in FIGURE 7 and comprises a metallic plate adapted for fitting beneath or within the sole portion of the patient's shoe and having laterally spaced upstanding ears **72** which are bifuracted to receive the extreme lower ends of members **66** and which are apertured at **74** to receive pivot pins. The brace arrangement of FIGURES 1 and 2 requires only one of the upstanding ears **72** and the other thereof may be eliminated when this brace is used. The modification of FIGURE 8, however, engages both of the ears **72** when the brace is applied.

Returning to the upper leg part **18**, between top and bottom thereof there is mounted a thigh-engaging arcuate strap **76** adapted for engaging the back of the leg between the knee and the hip. Strap **76** likewise has its edges rolled as at **78** to eliminate sharp edges and to provide greater strength even though the strap is made of relatively thin metal.

As will be seen in FIGURE 3, a preferred way of mounting strap **76** to the upper leg portion is to wrap it therearound and use the rivet means **80** to connect the wrapped around end to the strap. There is suitably a metal adhesive, such as the Epon resins utilized for joining metail air-craft parts, between the strap and the upper leg part to hold it fixedly in place thereon. Alternatively, rivets can be employed as indicated at **82** in FIGURE 1, it being understood that such rivets would be located as near to the neutral axis of the upper leg part **18** as possible in order not materially to reduce the strength thereof.

In the modification of FIGURE 8, substantially an identical brace is illustrated except that instead of the strap portion **62** being inclined downwardly toward the inside of the patient's leg, as it is illustrated in FIGURES 1 and 2, the corresponding strap portion **83** extends straight across and is connected by rivets **85** for example (or by spot welding or metal adhesive) with a tubular member **84** extending downwardly toward the inside of the ankle of the patient and having mounted on the lower end thereof member **86** which will engage the inside one of the ears **72** of the member **70** in the patient's shoe.

Also in FIGURE 8 the outer tubular element **54** is extended downwardly and has fixed in its lower end member **88** adjustably clamped therein by clamp **90** for engagement with one of the ears **72** of the member **70**.

In utilizing the brace according to this invention, substantially conventional leather cuffs and the like are employed about the waist and in connection with the straps passing about the legs. These leather cuffs, buckles, straps and laces are generally indicated at **92** in FIGURE

1. These are of a conventional material and form no integral part of the present invention.

Similarly, substantially conventional locking handle means **93** provided for the upper leg parts are pivoted to the brackets **16**; similar means are provided where the upper and lower leg parts are pivoted together so that the leg parts can be made rigid with the waistband when it is desirable to permit the patient to stand.

As shown in FIGURE 1, the legs are in locked position; wire member **95** secured to leg portion **18** and engaging the handle **93** of the locking means may be drawn downwardly to engage in a groove or slot of the handle to provide for retaining the handle in unlocked condition when such is desired.

According to this invention the upper leg part **18**, when unloaded, flexes somewhat to the outside and which flexure is indicated to an exaggerated degree by the dot-dash outline at **94** in FIGURE 2. Thus the load is cantilevered from the outside and this feature is very important because there is provided a predetermined degree of bias on the legs of the brace when the brace is applied to a patient and this provides a restoring force which tends to draw the legs of the patient apart.

The entire brace structure according to the present invention is light and strong, is readily producible by mass production methods, and can be quite closely fitted to the patient; the brace is readily adjustable within predetermined limits thus permitting the brace to be worn for quite a length of time, eliminating the necessity of the patient having to be fitted frequently with new braces, which involves added expense and inconvenience. Further, as the patient grows, new replacement parts may be secured as required and the necessity for purchasing a complete new brace with each change in condition of the patient is eliminated. Moreover, the patient is not required to become accustomed to completely different braces each time a new condition of growth and training occurs. The brace parts are suitably interchangeable regardless of the age and condition of the patient.

It is to be particularly noted that the structure of the invention is so designed that the weight of the structure may be at a minimum for the size or weight of the user. This stems not only from the selection of tubular strength members but from the fact that in use the leg parts will be substantially vertical and the bearings will be free to permit movement in the desired forward and reverse direction while inhibiting lateral movement.

Somewhat more specifically, the brace as described may be sized to the patient—I have found that braces currently in use weigh 8 to 12 pounds for a child of about 35 pounds. With the construction of my invention which attains the same or improved results the brace weight for a child of 35 pounds weight is reduced to 2 pounds 3 ounces. In general a weight reduction of at least 65% is attained over commercial braces when my structure is employed.

The improved results particularly relate to the ease of training the patient to walk. The bias on the patient's legs adequately provides against contact between leg members when the patient moves. This also permits the patient to "toe out" in a normal manner and allows for the employment of muscles and tendons which with the usual commercial braces are quite out of use; thus the brace will aid recovery of the patient.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions and accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

I claim:

1. In an orthopedic brace, a waistband, a bracket secured to the waistband and having a depending trifurcated portion, a leg member having an upper bifurcated portion interleaved with the furcations of said bracket, a pair of roller bearings mounted one within each of the furcations of said leg member, the furcations of said bracket and leg member being pinned together through said bearings to provide an articulated joint, whereby upon the application of transverse loading of the leg member a vertical couple is caused to act through the bearings to counteract the transverse loading and permit fore and aft movement of the leg member.

2. In an orthopedic brace, a pair of leg members adapted to extend substantially vertically under loading, a waistband assembly bridging the leg members and jointed thereto at the upper ends thereof and adapted to transmit the loading from one leg member to the other in the utilization of the brace, each said leg member comprising tubular circular cross-section elements, said leg members each comprising upper parts adapted to pass along the thigh of a wearer and lower parts adapted to pass along the calf of a wearer, said upper and lower parts being pivotally connected together, said leg members in the unloaded condition being biased outwardly of a vertical position from its jointed connection with the waistband, said lower parts each having means for securing the brace to a calf of the wearer to draw the leg members towards the vertical.

3. An orthopedic brace comprising a waistband, an outer leg member pivotally jointed thereto, said outer leg member having a knee joint and terminating slightly therebelow, an inner leg member joined to the lower extremity of the outer leg member by a calf-receiving means, said inner leg member terminating in a portion adapted to be connected in an ankle joint, whereby the vertical loading due to the weight of the wearer is reacted upwardly through the inner leg member, is transferred to the outer leg member through the calf-receiving means and thence through the outer leg member to the waistband so that outward rolling force is applied to the ankle of the wearer.

4. An orthopedic brace comprising a waistband, a pair of outer leg members bridged at the top by said waistband and pivotally joined thereto, said outer leg members having knee joints and terminating slightly therebelow, a pair of inner leg members associated one with each of said outer leg members and joined to the lower extremities thereof by a calf-receiving means, said inner members terminating in portions adapted to be connected in an ankle joint, whereby the vertical loading due to the weight of the wearer is reacted upwardly through the inner leg members, is transferred to the outer leg members through the calf-receiving means and thence through the outer leg members to the waistband so that outward rolling force is applied to each ankle of the wearer.

5. An orthopedic brace having a waistband assembly with a portion thereof extending downwardly therefrom, a leg member, bearing means arranged within said downwardly extending portion and pivotally interconnecting the leg member to the waistband assembly, said bearing means comprising two discrete horizontally spaced apart bearings within said downwardly extending portion so arranged that upon the application of transverse loading of the leg member a vertical couple is caused to act through the bearing means to counteract transverse loading and permit freedom of fore and aft movement of the leg member.

6. In an orthopedic brace, a waistband, a bracket secured to the waistband and having a portion thereof depending below the waistband and provided with reentrant portions, a leg member, and a pair of bearing means arranged in said reentrant portions of the bracket and rotatable in a substantially vertical plane pivotally connecting the leg member and said depending portion of said bracket, said bearing means being restrained against lateral movement by said bracket and horizontally spaced apart so that upon the application of transverse loading of the leg member a vertical couple is caused to act through the bearing means to counteract the transverse loading and

permit freedom of fore and aft movement of the leg member.

7. An orthopedic brace comprising opposed leg members, a waistband comprising a back portion and side portions extending forwardly therefrom, said waistband being pivotally secured to the upper ends of the leg members, the waistband being further of greatest cross-section at the joinder of the back and side sections, the leg members each having means for securing the brace to the thighs and calves of a patient, each leg member in the unloaded condition being cantilevered outwardly below the pivoted joint with the waistband to provide a predetermined degree of bias tending to draw the legs of the wearer apart and adapted to be drawn inwardly to a substantially vertical position when the calf-securing means are engaged about a patient.

8. In an orthopedic brace, a waistband comprising an integral hollowed load-carrying member adapted to extend from hip to hip of the wearer and including a back section and side sections extending forwardly therefrom and so shaped as to engage the waist of the wearer thereof, and a cellular elastomeric filler material substantially completely filling the hollowed portion of the member and reinforcing the load-carrying member and adapted to maintain the spacing between the walls of the load-carrying member.

9. In an orthopedic brace, a waistband comprising an integral hollowed load-carrying member adapted to extend from hip to hip of the wearer and including a back section and side sections extending forwardly therefrom and so shaped as to engage the waist of the wearer thereof, and formed of opposed metal sections defining an interior chamber spacing, and a rigid light weight organic foam filler material filling the spacing between the walls of the load-carrying member.

10. In an orthopedic brace, a waistband comprising an integral hollowed load-carrying member adapted to extend from hip to hip of the wearer and including a back section and side sections extending forwardly therefrom and so shaped as to engage the waist of the wearer thereof, and a rigid light weight filler material reinforcing the load-carrying member against collapse, the waistband being of greatest cross-section at the joinder of the back and side sections.

11. In an orthopedic brace, a waistband comprising an integral hollowed load-carrying member formed of heat treated light metal and adapted to extend from hip to hip of the wearer and including a back section and side sections extending forwardly therefrom, and a rigid light weight filler material within said hollowed member, said waistband being of greatest cross-section at the joinder of the back and side sections, and being vertically widest centrally thereof.

12. In an orthopedic brace, a waistband comprising interconnected back and side sections, with said side sections extending forwardly from the back section, and so shaped as to engage the waist of a wearer thereof, said waistband being formed of a core of cast isocyanate foam, a resin impregnated fiber wrapping about said core and an outer coating of plastic therearound.

13. The orthopedic brace of claim 12 wherein said waistband is of greatest cross-section at the joinder of the back and side sections.

14. An orthopedic brace for permitting to and fro movement of the limbs of the wearer comprising a waistband assembly, a leg member depending from the waistband assembly, said leg member comprising upper and lower parts, the upper part including strap means adapted to engage the thigh and the lower part including strap means for engaging the calf, an articulatable knee joint interconnecting the upper and lower parts, the upper part of said leg member including adjustable telescoping elements detachable each from the other, whereby the joint may be aligned by vertical adjustment of the telescoping members to be juxtaposed to the knee joint of the wearer, and means provided by said leg member for distributing forces urging the legs apart over an extended area of the upper and lower parts of the leg of the wearer.

15. An orthopedic brace of light weight but rigid construction comprising a waistband of hollowed structural cross-section, a leg member depending therefrom, the leg member having bearing means connecting the member with the waistband and forming a hip joint, said leg member also having bearing means providing a knee joint, the leg member between the knee and hip joint comprising telescoping members at least one of which is tubular, and having clamping means associated therewith at the jointure with the waistband, said knee joint being thus adapted to be aligned to be juxtaposed to the knee joint of the wearer by vertical adjustment of the length of telescoping members, means for affixing said leg member to the leg of the wearer, and means provided by said leg member for distributing forces urging the legs apart over an extended area of the leg of the wearer, the hollowed portion of said waistband and tubular leg member containing a lightweight reinforcing material.

16. The orthopedic brace of claim 14 wherein the means for distributing forces urging the legs apart comprises the leg member in the unloaded condition being cantilevered outwardly below the waistband assembly and above the articulatable knee joint to provide a predetermined degree of bias tending to draw the legs of the wearer apart, thereby distributing the forces over an extended area.

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