United States Patent

Harris

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[54] ORTHOPEDIC TRACTION APPARATUS

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[52] **U.S. Cl.** ..... **128/84 R**

[51] **Int. Cl.** **A61f 5/04**

[58] **Field of Search** 128/84, 87, 89, 303, 75, 76

[56] **References Cited**

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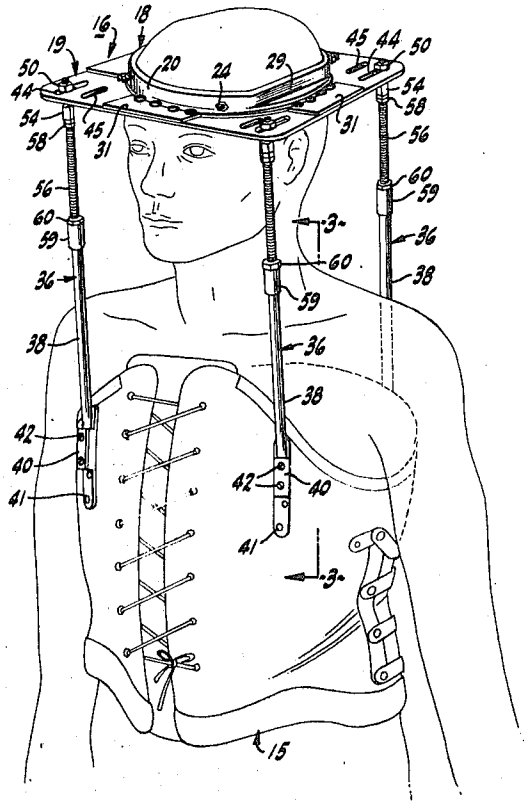
[57] **ABSTRACT**

Traction apparatus for externally splinting the cervical spine to effect fixation thereof. The apparatus is characterized by providing adjustment of the height, tilt, rotation and anterior and posterior position of the patient's head while affording no or only minor inconvenience during anterior or posterior surgical procedures while the traction apparatus is in position on a patient. The traction apparatus includes a skull-gripping mechanism adapted to grip a patient's skull and thereby be fixedly related thereto, a platform or device supporting the skull-gripping mechanism and being inter-connected therewith so as to positively locate one with respect to the other and prevent relative translational and rotational displacements thereof, a plurality of struts interconnecting the platform and a body jacket positioned about a patient, and means for adjusting the lengths of the struts so as to select the magnitude of the tensile stress imparted through the platform and skull-gripping mechanism to the cervical spine of a patient equipped with such body jacket and having such mechanism secured to his skull.

5 Claims, 11 Drawing Figures



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SHEET 1 OF 3

Fig. 1

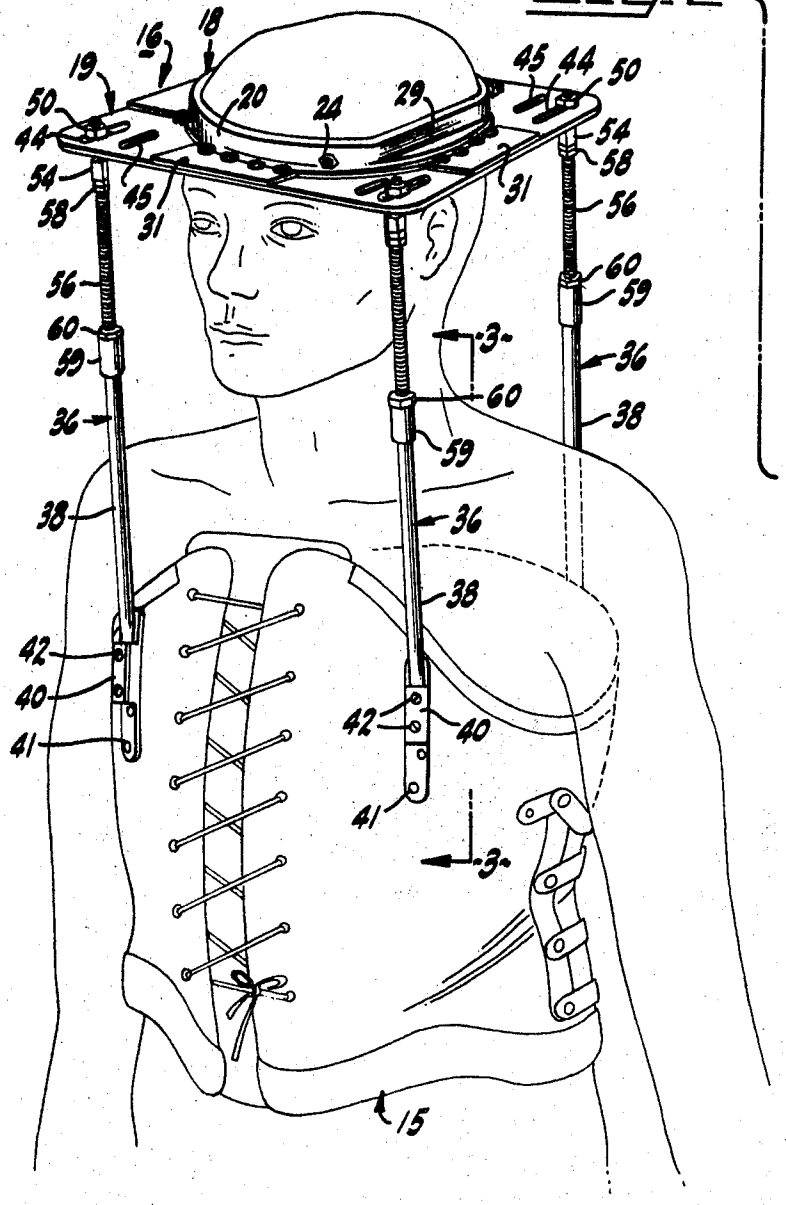
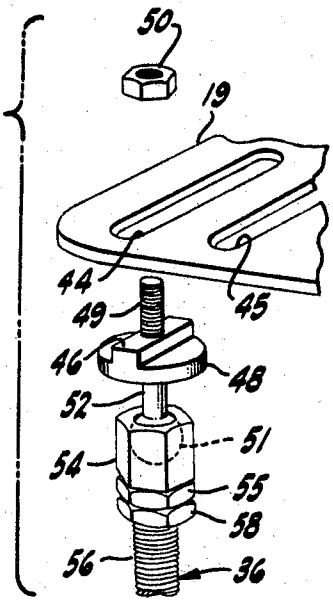


Fig. 2



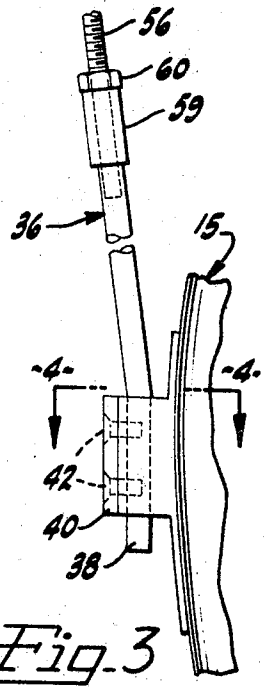


Fig. 3

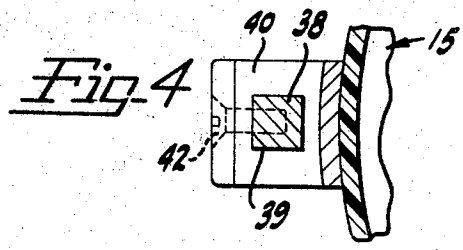


Fig. 4

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Fig. 5

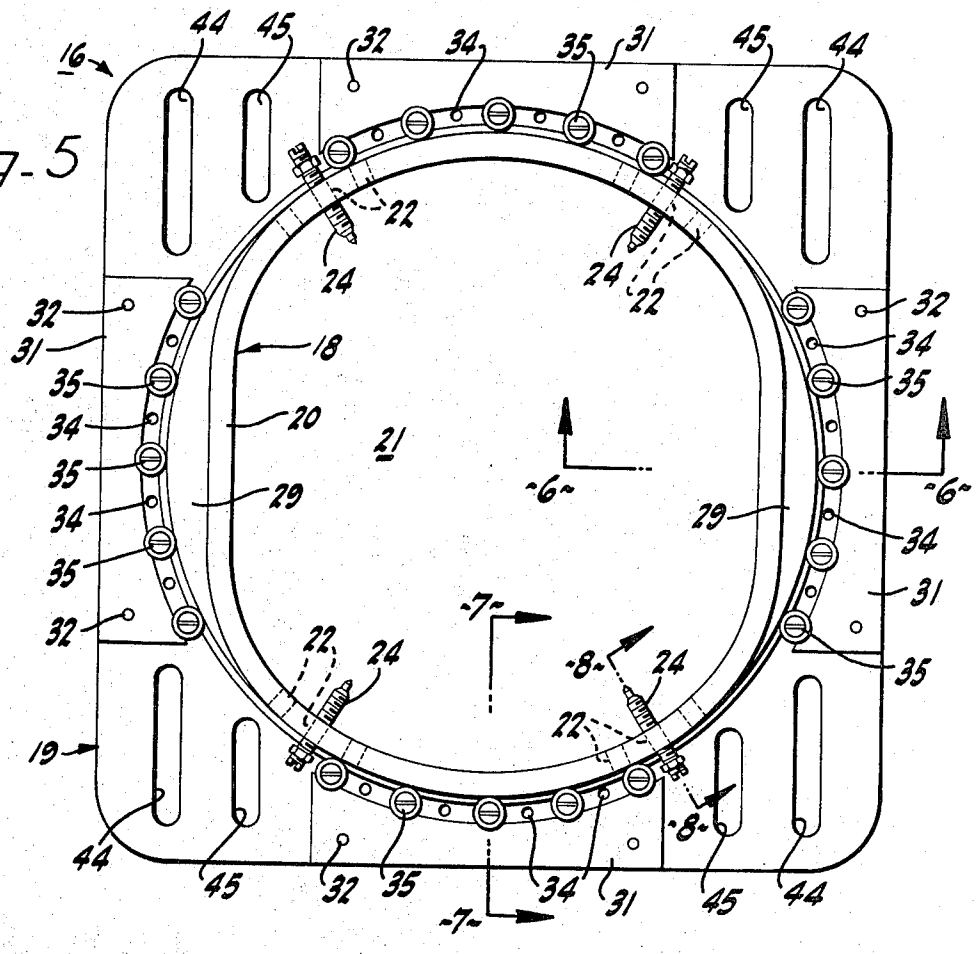

Fig. 6

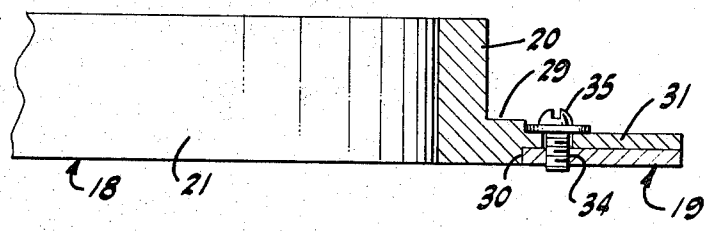

Fig. 7

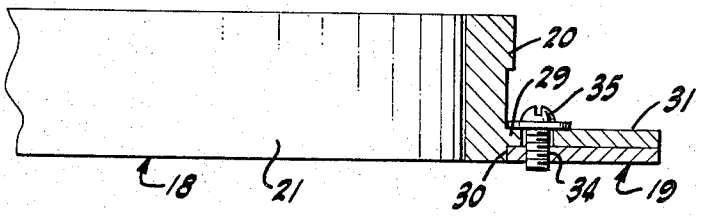

Fig. 8

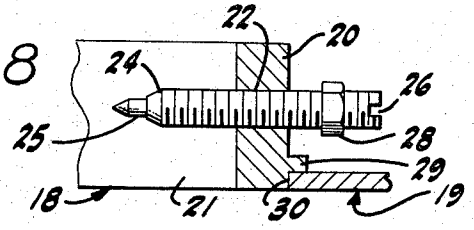

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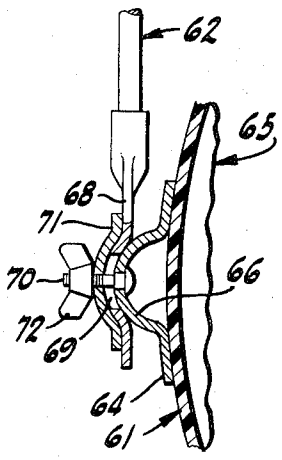
Fig. 9



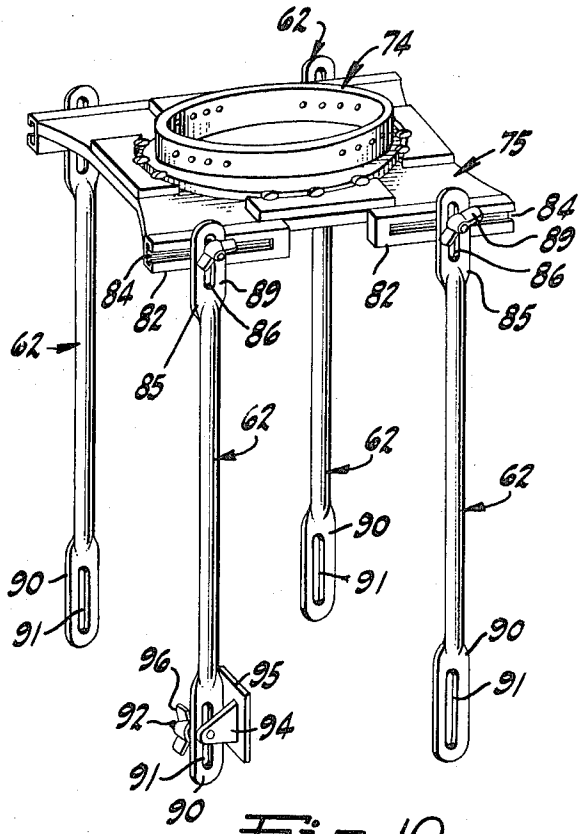


Fig. 10

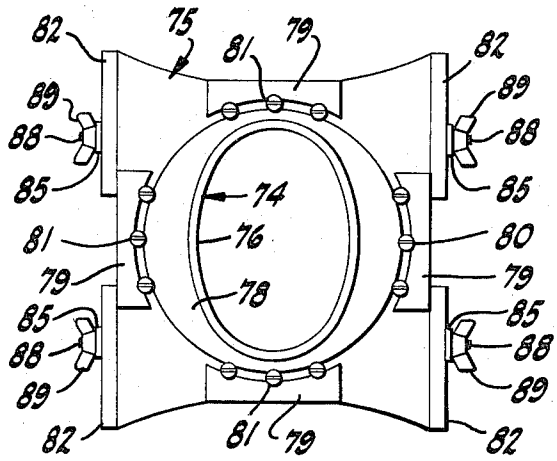


Fig. 11

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ORTHOPEDIC TRACTION APPARATUS

This invention relates to orthopedic traction apparatus and, more particularly, to orthopedic traction apparatus for externally splinting the cervical spine to immobilize or effect fixation thereof.

Until the advent of the "halo" traction apparatus, external fixation of the cervical spine was usually obtained by means of a plaster-of-Paris jacket which the patient usually found to be heavy and frequently hot and uncomfortable. Moreover, even the best fitting plaster jackets often allow more cervical movement than the surgeon may desire, and adjustment of the position of the patient's head or neck is essentially impossible once the plaster jacket has hardened. Additionally, radiographic examination of the spine through a plaster jacket is difficult; and if an unstable spine is to be exposed for operation, the window or opening necessarily cut in the plaster jacket at best gives very little room in which the surgeon can work.

The halo traction apparatus obviates some of the disadvantages characteristic of plaster jackets because it is somewhat more comfortable for the patient to wear; lends itself to visual, physical and radiographic examination of the patient; and allows some adjustment long after the apparatus has been positioned upon the patient. Such traction apparatus includes a band or halo adapted to be placed about the skull of a patient and fixed thereto by a plurality of skull screws that extend through threaded apertures provided therefor in the band and can be forced into the outer table of the patient's skull. Arms connected with the band and extending upwardly therefrom are secured to superstructure located in part above the patient's head and extending downwardly along the back thereof to arcuate brackets that are adapted to be bent in conformity with and secured to the shoulder padding of a plaster body jacket positioned about the upper trunk of the patient.

An object, among others, of the present invention is to provide improved orthopedic traction apparatus generally of the halo type. Another object is that of providing an improved traction device of the character described which is easy for the surgeon to use, is quite versatile in that it readily accommodates patients of different size and body characteristics, and has various features of adjustability enabling the surgeon to obtain the desired degree of traction or tensile stress along a patient's cervical spine and at the most advantageous orientation relative thereto.

Still another object is in the provision of an improved traction apparatus, as stated, which has various degrees of translational and rotational freedom concerning its adjustability so that the surgeon can readily obtain the necessary rotation, tilt, translation (especially anterior and posterior) and vertical adjustments to best accommodate the particular requirements of any patient. Additional objects and advantages of the invention, especially as concerns particular features and details thereof, will become apparent as the specification develops.

In general terms, the traction device includes a skull-gripping mechanism having a large skull-receiving opening adapted to receive the skull of a patient therein. Such mechanism is provided with attachment structure including a plurality of angularly spaced skull screws adapted to project into the patient's skull and grip the same and thereby fixedly relate the mechanism thereto. A generally planar platform or device provides a support for the skull-gripping mechanisms and is attached thereto by means permitting angular adjustments of the skull-gripping mechanism relative to the platform. A plurality of elongated struts are connected to the platform at corner portions thereof and extend downwardly therefrom so as to be affixed at their lower ends to connectors provided therefor along a relatively stiff plaster or molded plastic body jacket secured about the upper trunk or chest of a patient. The struts are individually adjustable in length and thereby enable a tensile stress of appropriate force and orientation to be developed between the body jacket and platform for transmission through the skull-gripping mechanism to the cervical spine of a patient.

Embodiments of the invention are illustrated in the accompanying drawings, in which:

FIG. 1 is a perspective view illustrating an embodiment of the traction apparatus in position on a patient;

FIG. 2 is an enlarged, fragmentary exploded perspective view illustrating the components defining a corner portion of the apparatus in spaced apart relation;

FIG. 3 is an enlarged, side view in elevation showing the connection of one of the struts of the apparatus with a body jacket;

FIG. 4 is a further enlarged, transverse sectional view taken along the line 4—4 of FIG. 3;

FIG. 5 is a top plan view of the skull-gripping mechanism and platform support therefor, each of which comprises a portion of the apparatus;

FIG. 6 is a transverse sectional view taken along the line 6—6 of FIG. 5;

FIG. 7 is a longitudinal sectional view taken along the line 7—7 of FIG. 5;

FIG. 8 is a sectional view along one of the skull screws of the apparatus, the section being taken along the line 8—8 of FIG. 5;

FIG. 9 is a sectional view of a modified connector for affixing a vertical strut to the body jacket of a patient;

FIG. 10 is a perspective view of a modified traction apparatus; and

FIG. 11 is a top plan view of the modified apparatus shown in FIG. 10.

Traction apparatus embodying the invention is adapted for use with a body jacket which, as respects the present invention, may be essentially conventional and may comprise a molded body jacket or plaster body cast, each of which is well known in the art. In FIG. 1 a molded body jacket 15 is shown in position about the upper torso of a patient. Since such body jackets are well known, no particular details concerning the same need be explained other than to say that the jacket is quite rigid and therefore provides a satisfactory perches for the traction apparatus 16. As respects its rigidity, the particular jacket 15 shown is formed of a stiff, hard plastic material as indicated in FIG. 4.

The traction apparatus 16 includes a skull-gripping mechanism 18 and a platform or device 19 supporting the same. The skull-gripping mechanism 18 is adapted to grip the skull of a patient, therefore providing means through which a tensile force can be developed between the body jacket 15 and head of a patient so as to impart a tensile stress to the cervical spine of the patient to effect fixation thereof. Referring to FIGS. 5 through 8 in particular, it will be observed that the skull-gripping mechanism 18 includes attachment structure in the form of an upstanding band or ring 20 that is substantially continuous and defines a large skull-receiving opening 21 therewithin adapted to receive the skull of a patient, as shown in FIG. 1. As is most evident in FIG. 5, the opening 21 is non-circular and, in a more particular reference, is somewhat oblong or ovate so as to conform more accurately in a geometric sense to the usual skull configuration.

The attachment structure further includes a plurality of threaded apertures 22 at angularly spaced locations about the opening 21. Usually several apertures 22 will be provided at each angularly spaced location, and in the apparatus 16 (as shown in FIG. 5) three such apertures are grouped or clustered at each angularly spaced location. At least certain of the apertures 22 are equipped with skull screws 24 adapted to be tightened into respectively adjacent areas of a patient's skull located within the large opening 21 so as to grip the skull and thereby fixedly relate the skull-gripping apparatus 18 thereto. In FIG. 5 four such screws 24 are shown in respective association with one of the apertures 22 in each of the four angularly spaced clusters thereof. Skull screws are generally old in the art and, as is well known, they have rather sharp pointed ends 25 adapted to perforate the skin without incision thereof having first been made and of sufficient length to penetrate only the outer table of the skull. Each screw 24 may be slotted (as shown at 26) to receive the end of a screwdriver and may be equipped with a locking nut 28.

The attachment structure further includes an outwardly extending flange or lip **29** about the upstanding band **20**, and it defines the circumference of a circle about its outer peripheral edge. Accordingly, and because the band **20** is non-circular, the flange **29** is relatively narrow at the anterior and posterior end portions of the generally ovate opening **21** (FIGS. **5** and **7**) and is relatively wide along the sides thereof (FIGS. **5** and **6**). The mechanism **18**, and particularly the flange **29** thereof, is supported by the platform **19** for angular displacement relative thereto about an axis extending through the opening **21** generally along the cervical spine of a patient having his skull positioned within the opening as depicted in FIG. **1**. For this purpose, the platform **19** has a large open center portion **30**, as is most evident in FIGS. **6** through **8**, so as to accommodate the mechanism **18** and permit angular displacement thereof. The lip or flange **29**, it will be observed, overlies the platform **19** about the opening **30** thereof and is supported thereon.

Structure is provided for interconnecting the mechanism **18** and platform **19** so as to prevent relative translational displacements therebetween in axial or vertical directions (i.e., along the cervical spine of a patient equipped with the traction device), and also in both longitudinal and transverse directions referenced to such axis. The structure further constrains the skull-gripping mechanism **18** against angular displacements thereof relative to the platform **19** after the desired angular disposition of the mechanism **18** with respect to the platform **19** has been obtained. As shown in FIGS. **5**, **6** and **7**, such interconnecting structure includes a plurality of guide plates **31** secured to the platform **19** in overlying relation therewith at spaced apart locations therealong. In the particular traction apparatus being considered, there are four such guides **31** spaced about the circumference of the flange **29** at 90° intervals center-to-center and riveted to the platform **19**, as indicated at **32**.

The inner edges of the guides **31** are arcuate and together define the circumference of a circle having a diameter somewhat larger than that of the flange **29** so as to define a space between the flange and each guide within which are provided a plurality of threaded openings or apertures **34** adapted to receive washer-equipped threaded fasteners or cap screws **35**, as shown in FIGS. **5** through **7**. The fasteners **35** when tightened bring the washers thereof into overlying frictional engagement with the facing edges of the flange **29** and associated guide **31** so as to clamp the flange to each guide **31** and platform **19** and thereby constrain the flange and skull-gripping mechanism **18** against rotational and translational displacements with respect to the platform. In the traction apparatus **16** shown, nine such threaded openings **34** are provided in association with each guide **31**, and alternate openings are equipped with fasteners **35** so that five such fasteners are used with each guide.

A plurality of struts **36** are used to interconnect the platform **19** with the body jacket **15**, and means are provided for adjusting the lengths of the struts so that the tensile stress imparted thereby between the body jacket and platform can be selectively varied. The apparatus **16** includes four struts **36** that are respectively disposed adjacent the corner portions of the platform **19** which has a generally square-shaped configuration. Each strut **36** is an elongated bar or rod that is substantially square-shaped at its lower end **38** (as shown best in FIG. **4**) so as to pass through a square-shaped opening **39** provided in a mounting bracket **40** that is secured to the body jacket **15** by any suitable means such as rivets **41** or equivalent fasteners, as shown in FIG. **1**. The mating polygonal configurations of the strut end portion **38** and opening **39** prevent relative rotation therebetween, and the vertical disposition of the rod with respect to the bracket **40** is fixedly determined by a plurality of set screws that extend through the face of the bracket **40** and project into threaded openings provided therefor in the end portion **38** of the strut **36**. Accordingly, the location of each strut **36** relative to the body jacket **15** is positively determined.

At their upper ends each strut **36** is adjustably connected to the platform **19**; and in the embodiment illustrated in FIGS. **1** through **4**, the adjustment accommodates selective longitudinal positioning of each strut continuously along the platform **19** within certain dimensional limits, and also permits limited step-wise adjustment of each strut relative to the platform **19** in a transverse sense. In more particular terms, the platform **19** at each of the four corner locations thereof is provided with a pair of transversely spaced, longitudinally extending slots **44** and **45** selectively adapted to receive therein the tongue **46** of a connector **48** having a threaded shank **49** extending upwardly from the tongue **46** and adapted to receive a nut **50** which is used to fixedly locate the connector **48** along the particular slot **44** or **45** with which it is associated. Accordingly, each strut **36** can be adjusted in a transverse direction relative to the platform **19** by determining the particular slot **44** or **45** with which the connector **48** is to be associated, and it is also adjustable in the longitudinal sense within the dimensional limits of each slot by determining the position of the connector along the slot and then fixing the connector at such position by tightening the nut **50** downwardly and into frictional engagement with the upper surface of the platform **19**. Evidently, the tongue **46** is dimensioned so as to be displaceable longitudinally along each slot **44** and **45** but constrains the connector **48** against rotation relative to the platform.

A universal joint is provided along each strut **36** so as to facilitate accommodation of the traction apparatus **16** to the differing dimensional requirements of various patients, and the universal joint in the apparatus **16** is provided by a ball and socket assembly comprising a ball **51** provided at the end of a downwardly extending pin **52** with which the connector **48** is equipped and a socket provided within a coupling **54** having a nut **55** at its lower end that cooperates with the upper end of threaded extension **56** of the strut **36** andis fastened in position thereon by a lock nut **58**. At its lower end, the extension **56** is threadedly received within an opening provided therefor in a coupling **59** with which the upper end of the strut portion **38** is equipped, and which portion thereof is hollow at least throughout its upper end so as to enable the extension **56** to project thereinto. A lock nut **60** may be tightened to positively maintain the extension **56** in any position of adjustment thereof relative to the coupling **59**.

Accordingly, each strut **36** is adjustable vertically, translationally and longitudinally independently of the others so as to best accommodate the physical characteristics of a particular patient and to impart the desired degree of tensile stress to the cervical spine thereof and at any particular orientation. That is to say, if in stressing the spine best results would be expected if the head were tilted slightly in any one direction, then any one or more of the struts **36** could be elongated relative to the others so as to provide such tilt. By the same token, tilt can be avoided by individually adjusting the struts **36** until the desired orientation of the head is attained, and then the stress imparted to the spine can be selectively established and changed as necessary by varying the elongation of each of the struts.

Essentially, **6** degrees of translational freedom are provided by the apparatus since each strut **36** can be adjusted in opposite directions transversely, longitudinally and vertically; and rotational freedom is also provided generally about the axis of the cervical spine since the skull-gripping mechanism **18** is angularly adjustable relative to the platform **19**. Further, because the length of each strut **36** is adjustable independently of the others, an additional angular freedom is afforded in that the tilt or angular disposition of the platform **19** relative to the halo is also adjustable. All such adjustments of the platform **19** and mechanism **18** are imparted directly to the skull and head of a patient using the apparatus since it is fixedly attached thereto via the screws **24**.

A modified mounting bracket useful in substitution for the previously described bracket **40** is illustrated in FIG. **9** and is denoted in general with the numeral **61**. The bracket **61** in association with the modified strut **62** defines a universal joint generally of a ball and socket type configuration. The bracket

includes a plate **64** riveted or otherwise attached to the body jacket **65**, and the plate is deformed centrally so as to define a ball **66**. The strut **62** at its lower end (generally denoted **68**) is provided with a socket therealong adapted to seat the ball **66** therein and providing a relatively large opening **69** through which a bolt **70** passes. A cup-shaped washer **71** overlies the socket-equipped end **68** of the strut **62** and is tightened thereagainst by a wing nut **72** threadedly received on the bolt **70**.

The head of the bolt **70** bears against the underside of the ball **66** through which the bolt extends, and it will be apparent that the strut **62** is frictionally constrained between the ball **66** and washer **71** by tightening the nut **72**. Whenever the nut is loosened, the strut **72** is universally adjustable in an angular sense relative to the ball **66** within the dimensional limits defined by the opening **69**. Thus, by use of the modified mounting bracket **61**, additional adjustability is afforded for the traction apparatus since each of the struts is then pivotally adjustable relative to the body jacket. As respects the traction apparatus with which the modified strut **62** and modified mounting bracket **61** are used, it may be the same as the apparatus **16** heretofore described in detail.

A more generally modified traction apparatus is illustrated in FIGS. **10** and **11**, and as respects such modification it largely pertains to the struts and manner in which they are connected to the support platform of the apparatus and connected to a body jacket. Generally, then, the modified traction apparatus is essentially the same as the apparatus heretofore described, and it includes a skull-gripping mechanism **74** supported by a platform **75** for adjustable angular displacements relative thereto, as in the manner heretofore described. Thus, the skull-gripping mechanism **76** has an upstanding band or ring **76** of generally ovate configuration equipped with a lip or flange **78** defining a circular configuration along the periphery thereof. The flange **76** seats upon the upper surface of the platform **75** and is confined for angular displacement relative thereto by a plurality of guide plates **79**, each of which is secured to the platform **75** as heretofore explained and which in conjunction with a plurality of fasteners **80** constrains the mechanism **74** in any angular position relative to the support plate **75**, all as heretofore explained.

The platform **75** is equipped along the longitudinal edges thereof with a plurality of longitudinally extending tracks **82** each of which is welded or otherwise rigidly secured to the platform and is provided with an elongated slot **84** closed at its inner end. Each longitudinal edge of the platform **75** is provided with two tracks **82** respectively disposed along the anterior and posterior ends thereof, but it is evident that one continuous track could be provided in apparatus in which it might be found advantageous. The struts **62** are respectively associated with the rails **82**, and each strut at its upper end has a flattened connector having an elongated slot **86** extending therealong. A bolt **88** having its head located within the slot **84** extends outwardly therefrom and passes through the slot **86** in the connector **85**. A wing nut **89** cooperates with the bolt **88** and may be tightened thereonto so as to frictionally lock the connector **85** and therefore the strut **62** in any position of adjustment relative to the track **82**.

It will be apparent that the strut **62** may be slidably displaced along the track **82** to any suitable position of adjustment within the limits of the slot **84**; the strut may also be pivotally adjusted about the axis of the bolt **88**; and it further may be adjusted in a vertical sense within the limits of the slot **86**. As respects vertical adjustment, the lower end of each strut **62** is equipped with a flattened connector **90** having an elongated slot **91** therealong passing therethrough the threaded shank of a bolt **92** that projects between the bifurcated end or spaced ears **94** of a bracket **95** adapted to be secured by rivets or otherwise to a body jacket, as heretofore described with reference to the brackets **40** and **61**. A wing nut **96** cooperates with the bolt **92** so as to constrain the strut **62** in any position of adjustment relative to the bracket **95**.

As concerns adjustment the strut **62** is pivotal relative to the bracket **95** about the axis of the bolt **92**, and the strut is vertically adjustable within the limits defined by the slot **91** thereof. It will be appreciated that the vertical spacing between the platform **75** and bracket **95** (and therefore any body jacket to which the bracket is affixed) can be adjustably increased and decreased to alter the tensile stress applied to the cervical spine of a patient equipped with the modified traction apparatus shown in FIGS. **10** and **11**. However, the "turn-buckle" type adjustment of the strut length shown in FIGS. **1** through **3** and heretofore described can be provided along the strut **62** should this be desired.

Thus, in all forms of the traction apparatus, the cervical spine of a patient is readily fixed or immobilized by external splinting irrespective of the physical differences among patients and irrespective of the magnitude and orientation of the stress that the doctor desires to apply to the spine because of the adjustability and various degrees of freedom described hereinbefore. Therefore, the apparatus permits adjustment of rotation, height, tilt, and interior or exterior positioning of the patient's head and will permit rotation of the head while wearing the apparatus (adjustable rotation if the fasteners **35** or **81** are tightened and relatively free rotation if they are all loosened). Further, anterior or posterior surgical procedures may be performed with the struts **36** or **62** constituting only a minor inconvenience, and if advantageous one or two of the struts may be removed completely to make the surgeon's approach unhampered.

While in the foregoing specification embodiments of the invention have been set forth in considerable detail for purposes of making a complete disclosure thereof, it will be apparent to those skilled in the art that numerous changes may be made in such details without departing from the spirit and principles of the invention.

What is claimed is:

1. In traction apparatus for externally splinting the cervical spine to effect fixation thereof, skull-gripping mechanism having a large skull-receiving opening and being equipped at a plurality of angularly spaced locations with adjustable skull engaging members adapted to be moved into and held in respectively adjacent areas of a skull positioned within said opening to grip such skull and thereby fixedly relate the same to said mechanism, a device supporting said mechanism for angular displacement relative thereto about an axis extending through said opening generally along the cervical spine of a patient having his skull therewithin, structure interlocking said mechanism and device so as to prevent relative translational displacements therebetween along such axis, a foundation member adapted to be supported by the patient's torso, a plurality of struts each adapted to be supported at one end portion thereof on said foundation member and at its other end portion being adapted to be connected to said device, certain of said struts being located for disposition on the front side of the patient's torso and certain other of said struts being located for disposition on the rear side thereof, means for adjusting the length of at least certain of said struts so as to select the tensile stress imparted thereby through said device, mechanism and skull engaging members to the cervical spine of a patient equipped with such foundation member and having the skull attached to said mechanism by means of said skull engaging members, said mechanism being supported by said device for angular adjustments along the arc of a circle generally circujacent said skull-receiving opening, and means for locking said mechanism to said device when in adjusted position.

2. The traction apparatus of claim **1** in which each of said struts is equipped with means including a universal joint enabling the struts to be angularly adjusted relative to said device.

3. The traction apparatus of claim **1** in which the device and mechanism are in substantially the same plane oriented at right angles to the axis of the skull receiving opening.

4. The traction apparatus of claim 1 in which the skull gripping mechanism is mounted on the upper side of said device.

5. In traction apparatus for externally splinting the cervical spine to effect fixation thereof, skull-gripping mechanism having a large skull-receiving opening and including attachment structure providing a plurality of apertures at angularly spaced locations about said opening, at least certain of said apertures being equipped with adjustable skull engaging members adapted to be moved into and held in respectively adjacent areas of a skull positioned within said opening to grip such skull and thereby fixedly relate the same to said mechanism, a device supporting said mechanism for angular displacement relative thereto about an axis extending through said opening generally along the cervical spine of a patient having his skull therewithin, structure interlocking said mechanism and device so as to prevent relative translational displacements therebetween along such axis, a foundation member adapted to be supported by the patient's torso, a plurality of struts adapted to be supported at one end portion thereof on said foundation member and at their other end portion connected to said device, means for adjusting the length of at least certain of said struts so as to select the tensile stress imparted thereby through said device, mechanism and skull engaging members to the cervical spine of a patient equipped with such foundation member and having the skull attached to said mechanism by means of said skull engaging members, said skull-receiving opening being supported by said device for angular adjustment along the arc of a circle generally circumjacent said skull-receiving opening, and means for locking said mechanism to said device when in adjusted position.

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