

[54] **FRACTURE REDUCTION SYSTEM**

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[22] Filed: **Mar. 30, 1973**

[21] Appl. No.: **346,462**

[52] U.S. Cl. **128/84 C, 128/77**

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

[58] Field of Search 128/84 R, 84 B, 84 C, 75,
128/87, 77; 250/475

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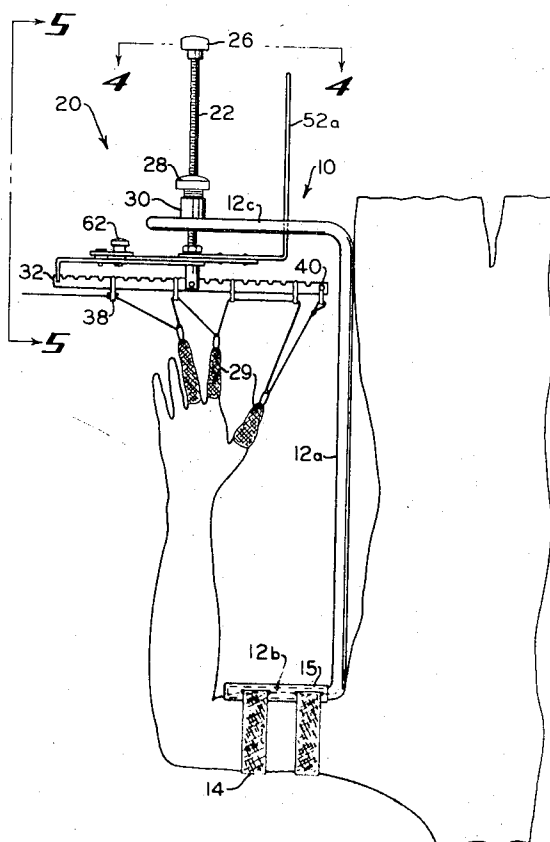
Attorney, Agent, or Firm—Oldham & Oldham Co.

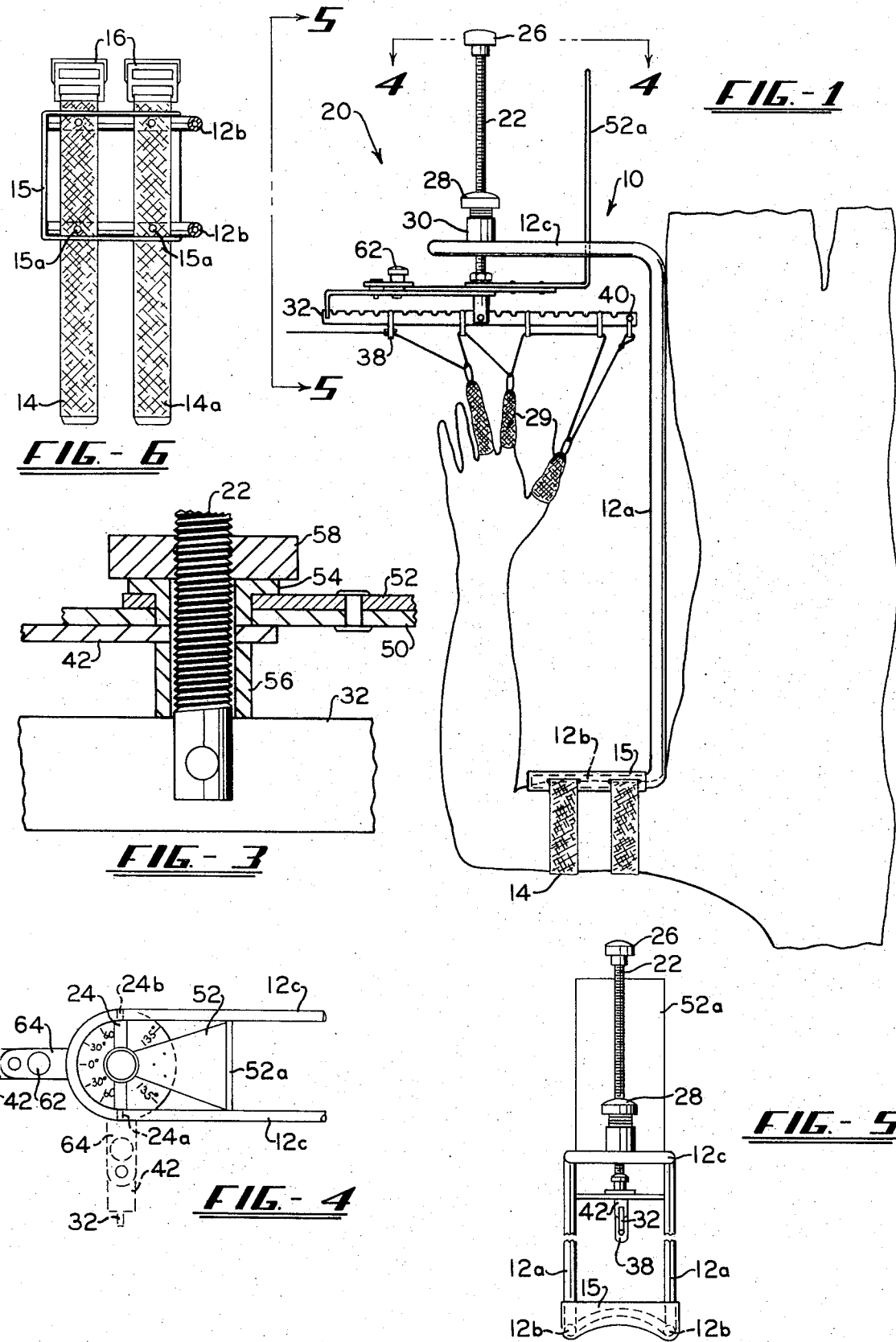
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ABSTRACT

The invention relates to a portable mechanical system for reducing lower limb fractures by the concurrent application of relative linear and rotational displacement of the fractured limb segments. The reduction device is externally reactive on the digital end of the lower limb and on an axially distributed region of the upper limb, the lower and upper limbs being in static equilibrium with respect to all forces and moments exerted on the digital end of the lower limb by the device. Means are provided to indicate the amount of force being applied to the fractured limb when it is under tension. Means are further provided for selectively mounting X-ray cassettes to the device in at least two orthogonal planes for taking X-rays of the limb when it is in the device under load. Means are provided to adapt the device to fractures of the forearm or the lower leg. The mechanism is self-aligning with respect to the limb being reduced, and by being self-reactive with respect to the associated upper limb of the patient allows a qualified person to reduce a fracture quickly and effectively despite movement of the patient, and without the need for a qualified assistant. The device consists essentially of a U-shaped tubular frame from which a self-aligning, rotative, screw adjustable assembly is mounted to achieve the tensional and torsional forces necessary to effect the proper fracture reduction.

19 Claims, 13 Drawing Figures





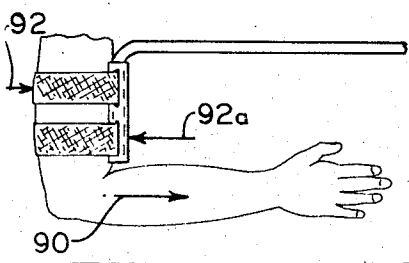


FIG. 12

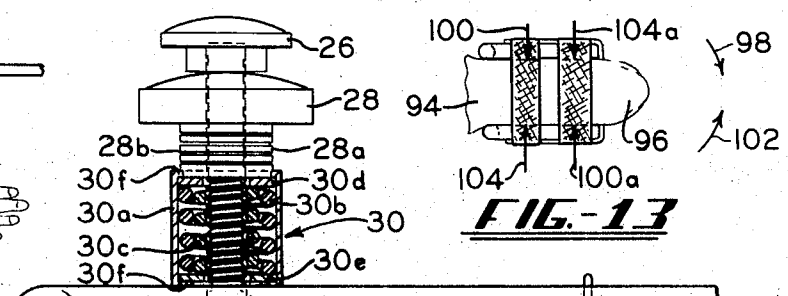


FIG. 13

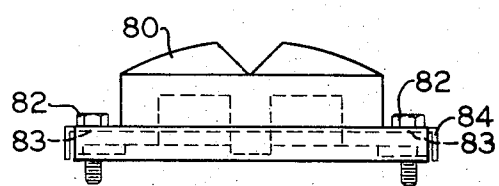


FIG. 11

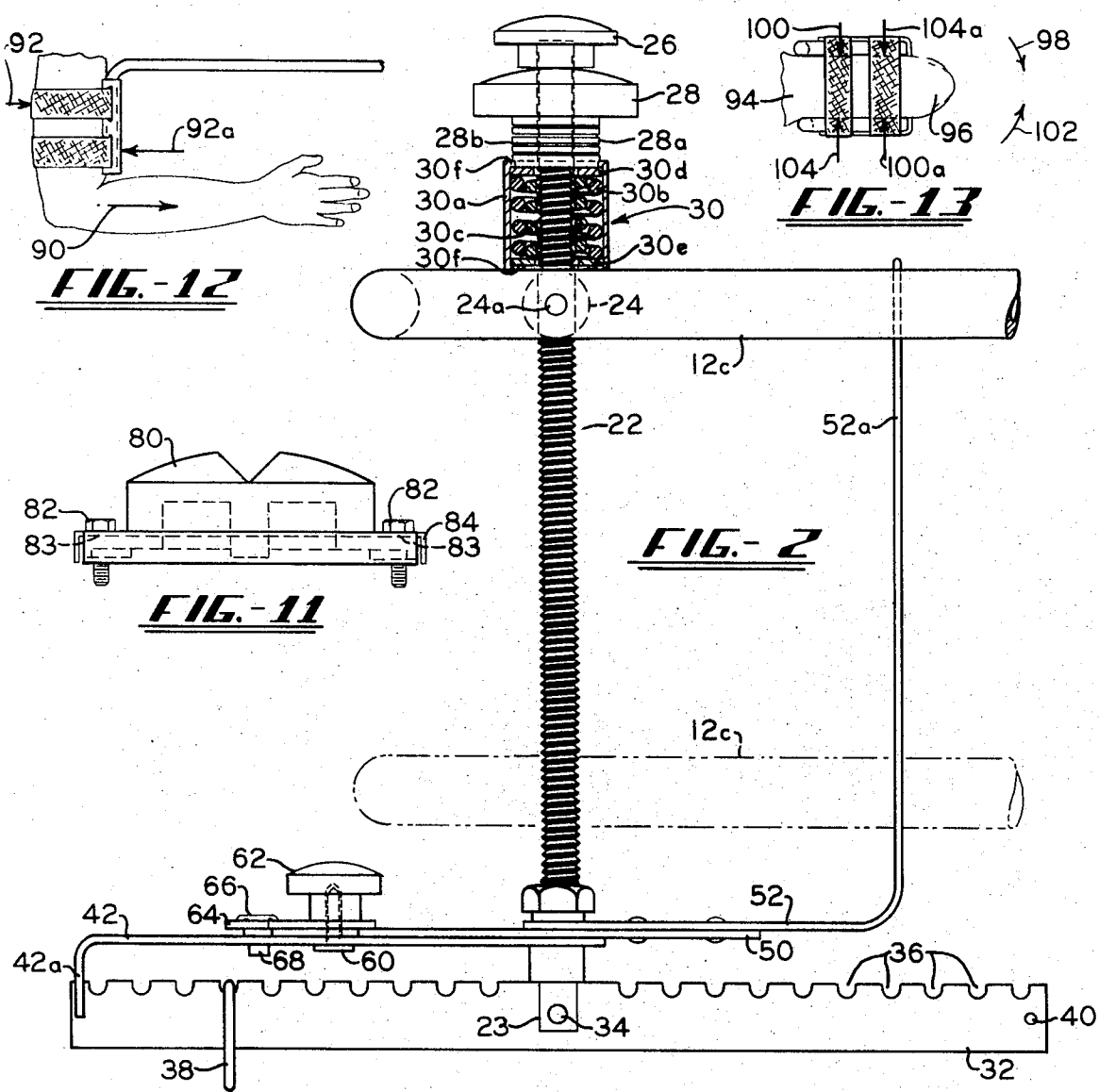


FIG. 2

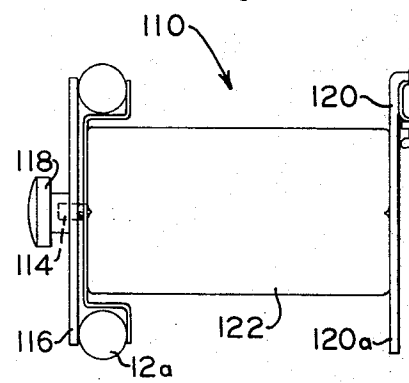


FIG. 7

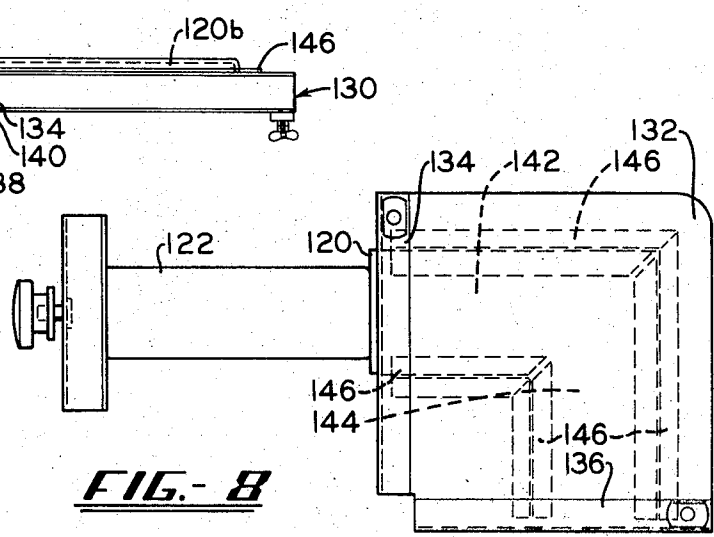


FIG. 8

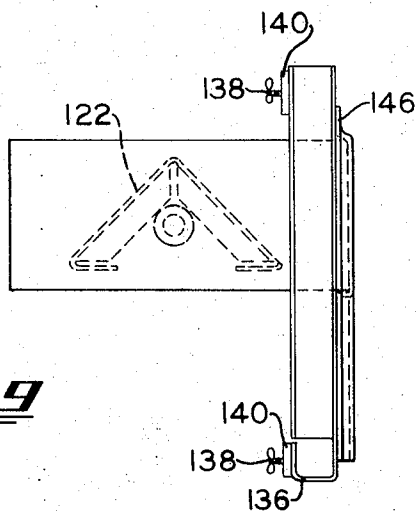


FIG. 9

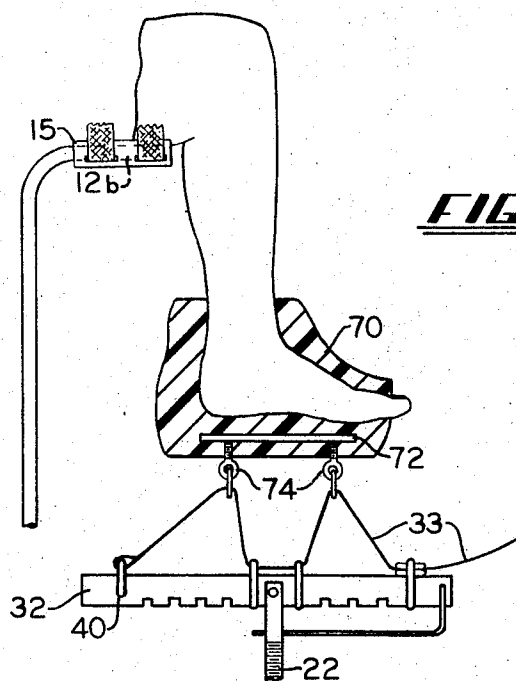


FIG. 10

FRACTURE REDUCTION SYSTEM

PRIOR ART

One of the basic teachings in the prior art is shown in U.S. Pat. No. 2,783,758 which is a portable fracture reducing device adapted only for the arm for reducing the so called Colles fracture by the principle of straight traction and counter traction. The unit is not self-reactive and does not apply torsional forces.

A further typical prior art teaching is in what is called a surgical table orthopedic implementing device, and typical of these is U.S. Pat. No. 2,691,979 which is adaptable to reduce many different types of fractures and hence utilizes many different adjustable techniques, all of which are taught in the patent. However, none of these is adaptable to a simple portable device with tensional and torsional capabilities.

Other prior art which we have reviewed includes U.S. Pat. Nos. 2,606,550; 2,584,203; 2,243,294; 2,091,643; 2,035,952; 2,014,111; 1,697,121; 1,663,921; 1,662,464; and 1,268,932. However, none of these patents teaches the simplistic combination of externally applied tensional and torsional loading capability with complete self-reactive restraints to offset such tensional and torsional forces, all combined with a tensional indicator, a torsional indicator, the ability to incorporate X-ray cassettes with the apparatus in operative position, and with selective locking features to hold the device in self-reactive position with the fracture properly reduced. Some of the above-cited prior art Pats. such as No. 2,014,111 teach pin techniques which physicians prefer to avoid because of the possible detrimental side effects of the pins piercing the body. In fact, as is well known today it is highly desirable to avoid open surgery or breaking of the skin in any way possible as infections and other secondary problems can and many times do develop.

OBJECTS OF THE INVENTION

Therefore, it is the general object of the invention to avoid and overcome the foregoing and other difficulties of and objections to prior art practices by the provision of an accurately controllable device which simultaneously places the limb, either a forearm or lower leg, in tension and provides for pronation or supination (rotation) of the hand or foot preparatory to cast construction. The pronation or supination is necessary so that proper alignment can be achieved to allow the patient to obtain full mobility after knitting of the fractured bone.

The present practice for fracture reduction by most orthopedic surgeons is to place "chinese fingers" on two or three fingers of the hand (typically thumb, index finger, middle finger). The hand is then hung through the "chinese fingers" from a fixed support and weight is added to the upper arm (typically 10 to 30 pounds) to provide forearm traction. Pronation or supination is determined visually and held by hand by a nurse while the cast is constructed. This technique is used in the structure shown in U.S. Pat. No. 2,783,758 referred to above.

A further object of the invention is to provide a portable device for the reduction of lower limb fractures which device is externally reactive on the digital end of the lower limb and on an axially distributed region of the associated upper limb.

A further object of the invention is to provide a portable device for the reduction of lower limb fractures which device contains means for the concurrent application of relative linear and rotational displacement of the fractured lower limb segments.

A further object of the invention is to provide a portable device for the reduction of lower limb fractures where the lower limb and the upper limb are in static equilibrium with respect to all forces and moments exerted on the digital end of the lower limb by the device, this accomplished by an upper limb reaction means comprising axially distributed restraint generally normal to the upper limb surface in at least two orthogonal planes.

A further object of the invention is to provide a portable device for the reduction of lower limb fractures which includes means for the measurement of the force attendant to the relative linear displacement of the fractured lower limb segments, as well as the angle of supination or pronation.

A further object of the invention is to provide a portable device for the reduction of lower limb fractures which when adapted to a lower leg includes an insert for inclusion in the digital end of a cast applied to the foot, said insert containing means for threadable engagement with a connection to the fracture reduction device in at least two spaced locations. This object of the invention further includes a walking heel adapted for attachment by threadable engagement with the insert after reduction and full casting have been accomplished.

In some cases an unstable fracture such as the so called Piedmont fracture may require open reduction in order to provide internal fixation, typically by means of a plate fixed to the bone at the fracture site. Such an open procedure is substantially simplified and may be performed through a smaller incision if the fracture is externally held in reduced position while internal fixation is applied. For this purpose as well as for x-ray examination and application of a cast it is important to provide complete access to the fractured limb while it is held in reduced position.

A further object of the invention is to provide a portable device for the reduction of lower limb fractures where complete access to the lower limb is maintained while the fracture is held in reduced position.

A further object of the invention is to provide a portable device for the reduction of lower limb fractures which includes means for mounting x-ray cassettes in at least two orthogonal planes, with such means being selectively engageable and disengageable while the device is in reductive position with respect to the fracture. This last means also is capable of mounting various sizes of x-ray cassettes.

The aforesaid objects of the invention and other objects which will become apparent as the description proceeds are achieved by providing a portable system for the reduction of lower limb fractures including apparatus which comprises a frame adapted to impose forces on the exterior of the digital end of the lower limb while concurrently imposing reactive forces on an axially distributed region of the exterior of the upper limb, and means associated with the frame to provide concurrent relative linear and rotational displacement of the fractured segments of the lower limb.

For a better understanding of the invention reference should be made to the accompanying drawings wherein:

FIG. 1 is a plan view of the apparatus in position with a patient showing its relationship to the body and the forearm while being capable of applying concurrent tensional and torsional displacements to the forearm;

FIG. 2 is an enlarged side elevation of the traction head of the apparatus illustrating certain features of the invention in greater detail;

FIG. 3 is an enlarged cross sectional view of the traction mounting head taken on line 3—3 of FIG. 2;

FIG. 4 is an end elevation of the traction head illustrating the angular indication of the head;

FIG. 5 is a side elevation of the device of the invention;

FIG. 6 is a plan view of the reactive loading end of the device particularly illustrating the axially spaced straps to attach the device to the upper limb in reactive loaded position;

FIG. 7 is a top view of the x-ray cassette fastener which may be removably mounted to the device;

FIG. 8 is a side elevation of the x-ray cassette fastener of FIG. 7;

FIG. 9 is an end elevation of the x-ray cassette fastener of FIGS. 7 and 8;

FIG. 10 is a schematic cross sectional diagram showing the special plate for a foot cast to adapt the device of the invention to reducing a fracture of the lower leg;

FIG. 11 is a side elevation of a walking heel that can be attached to the foot cast of FIG. 10 after reduction has been accomplished;

FIG. 12 is a schematic illustration of the self-reacting aspects of the invention to the tensional loading of the limb; and

FIG. 13 is a schematic illustration of the self-reacting aspects of the invention to the torsional loading of the limb.

PREFERRED EMBODIMENT OF INVENTION

Now with reference to the preferred embodiment of the invention illustrated in FIG. 1 of the drawings, the numeral 10 illustrates the device in general as positioned in operative relationship to reduce a break or fracture in the forearm of a patient. In essence, the device 10 comprises a frame 12, normally made from tubular stainless steel formed in a configuration of parallel relationship having U-shaped ends, as is most clearly seen in FIGS. 4 and 5. The entire frame 12 is actually made up of a central section 12a generally parallel to but substantially displaced from the lower limb receiving region, an upper limb reacting section 12b and a lower limb reacting section 12c generally normal to section 12a. The upper limb reacting section is designed to engage the major portion of the length of the upper arm, and is normally held in position by straps 14 and 14a or the like, to be more fully defined hereinafter. Conventional Chinese fingers 29 are used to attach the digital end of the limb to a load distribution bar 32 through a cord 33. Tension and rotation are applied by a unit indicated generally by numeral 20.

The tensional and torsional force applying unit or head 20 of the invention associated with the lower limb reacting section 12c is most clearly shown in FIG. 2 of the drawings. This head basically comprises a threaded shaft 22 received through the center of a mounting bar

24, which mounting bar has pins 24a and 24b on each end thereof received in mating holes in pivotal relationship on the opposite parallel sides of the frame section 12c, as best seen in FIG. 4. It should be understood that the rod 22 is slidably received through the bar 24, as there is no threaded connection therebetween.

The rod 22 includes a fixed knob 26 mounted to the top end thereof for allowing one to grasp this knob and by holding onto the upper frame section 12c to quickly move the rod for initial set up purposes. The rod 22 is actually maintained in a determined relationship with the bar 24 by means of an adjustable threaded knob 28 acting in conjunction with a load cell indicated generally by numeral 30. The exact operational relationship between the adjustable knob 28 and load cell 30 will be defined in more detail hereinafter.

On its lower end rod 22 has a bifurcated end 23 into which a load distribution bar 32 is received and mounted by pin 34 into fixed relationship with rod 22, all as best seen in FIG. 2. The bar 32 is preferably of equal length on each side of the bifurcated end 23 of rod 22, although it need not be, and includes a plurality of U-shaped notches 36 uniformly positioned across the top edge thereof. The notches 36 are adapted to receive in selectively engageable relationship one or more obround links with only one link 38 indicated in FIG. 2. Normally, the invention contemplates that three to four links will be slidably received over each end of the bar 32 to be selectively positioned by manual insertion into an appropriate notch 36, all as is well understood by one skilled in the art. In order to retain the links, an appropriate roll pin 40 might be provided at one end of the bar 32 after the links are assembled while at the other end, the links are retained by a locking arm 42 associated with the protractor rotating mechanism to be described in more detail below.

It should be understood, however, that the bar 32 can rotate with rod 22 which is slidably received through mounting bar 24. It is this rotational capability which achieves the torsional loading characteristics desired, as more fully explained hereinafter.

In order to selectively achieve a rotational characteristic in a controlled and measurable manner for bar 32, the invention incorporates a circular protractor plate 50 which is pinned to an L-shaped holding arm 52, both of which are slidably and rotatably received over the rod 22. The arm 52 includes an upper section 52a extending parallel to rod 22 positioned between the parallel sections of frame 12c so as to effectively always hold the protractor plate 50 in a predetermined oriented relationship with respect to the frame 12c whenever the rod 22 may actually rotate with respect thereto.

In order to maintain a rotatable relationship of protractor 50 and arm 52 with respect to rod 22, a sleeve arrangement, as best seen in FIG. 3 is utilized. The sleeve, indicated by numeral 54, has sufficient axial spacing with respect to rod 22 so that the protractor plate 50 and arm 52 are both in a free rotational relationship with respect thereto, as shown in the enlarged view of FIG. 3. The sleeve 54, however, is not threadably received onto rod 22. The sleeve 54 at its lower end abuts with the arm 42 mentioned above which arm 42 also slips over the rod 22, as indicated. A spacer sleeve 56 then extends from the bottom side of arm 42 and abuts against the top surface of bar 32, again all as very clearly seen in FIG. 3. The spacer sleeve 56, arm 42 and sleeve 54 then are locked into position with re-

spect to bar 32 by means of an appropriate nut 58 threadably received on rod 22 and very tightly secured down into position so as to form a rigid interconnecting arrangement. As noted previously, however, the length and spacing relationships are as shown in FIG. 3 so that the interlocked protractor plate and its arm 52 are free to allow the rod 22 in its associated relationship with bar 32 to rotate without having the protractor 50 or arm 52 move at all.

In order then to effectively lock the rotatable rod 22 and bar 32 with respect to the protractor plate 50 and arm 52, the invention incorporates a screw 60 welded to arm 42 and extending vertically upwardly therefrom to receive a threaded knob 62 thereonto. A clamp plate 64 is slidably received over the upwardly extending portion of screw 60. The clamp plate 64 further includes a rivet 66 having a downwardly extending portion 68 which is adapted to be inserted through a receiving hole in arm 42. Hence, with clamp plate 64 having sufficient length to engage the outer peripheral edge of protractor plate 50, it can be readily seen that whenever knob 62 is screwed tightly down into position, it locks arm 42 with respect to protractor plate 50. The end of arm 42 at 42a is bifurcated and extends slidably down over the end of bar 32, all as clearly shown in FIG. 2 so that in effect whenever the clamp plate 64 is tightly secured into position, it effectively locks the bar 32 from any rotation with respect to frame 12c.

Another thing to be observed in FIG. 2 is the fact that the solid line drawing of frame 12c would be in what might be called the initial application or initial installed position of the apparatus, while the broken line showing of frame 12c would indicate the position of the frame when the knob 28 would have been screwed well down into position so as to provide a tensional loading such as shown in FIG. 1.

FIG. 4 illustrates the degree indication on protractor plate 50, and how the bar 32 in the solid line position is at a zero degree relationship, while in the dotted line position is in a 90° relationship. The bar 32 is actually limited to about 135° rotation from the zero point in either direction by clamp plate 64 contacting the lower end of arm 52 at the rearward positions. The bar 32 is normally manually rotated to the desired angle of supination or pronation by the physician reducing the fracture, and then locked at this position for x-ray examination, completion of reduction and forming of the cast.

LOAD CELL ARRANGEMENT

Referring particularly again to FIG. 2, the load cell 30 effectively comprises a circular housing 30a which receives two nested springs 30b and 30c helically coiled of opposite hand. Movable annular washers 30d and 30e hold the springs in the housing 30a while allowing passage of the rod 22 through their respective apertures. The washers 30d and 30e are held in place by overturned lips on the ends of housing 30a, these being indicated by 30f. The knob 28 then includes a lower portion 28a of appropriate reduced diameter to clear the upper lip 30f of housing 30a but to abut against the washer or plate 30d. The portion 28a contains a plurality of concentric equally spaced grooves 28b, which when calibrated with respect to the particular springs 30b and 30c indicate the actual force on rod 22, depending upon how far the springs 30b and 30c are compressed. It is contemplated that the grooves 28b will be

arranged appropriately so as to give indicated incremental loading between grooves of 5 kilograms. The actual instructions with respect to reading the load cell 30 will be contained on the face of the extension arm 52a, as will be other data for operation of the device.

REACTIVE LOADING CUFF

With respect to FIG. 6, the reactive loading cuff 15 is illustrated in more detail as effectively having a considerable width, this being typically for example between 4 and 8 inches. Upper limb containment is completed by spaced straps 14 and 14a to allow wrapping fully around an upper arm or leg, said straps adapted for adjustable engagement with buckles 16 and 16a to complete firm closure about the upper limb, and having sufficient length so as to be adaptable for large and small upper arms and large and small thighs, as different patients have such physical differences. Normally, a fiberglass or other appropriate strong polymer material is used for the cuff 15 which will be appropriately attached by rivets 15a so as to allow the full wrapping and thus firm holding of the upper limb with respect to the frame 12b along the major axial extent of the upper limb to provide the means to balance applied force couples and give a truly reactive loading against the patient without causing discomfort or any undue sources of strain when the device is used for reducing fractures. The cuff 15 is positioned within the frame 12b so that the upper limb may be nestled between and hence located for load transfer with respect to the parallel sides of the frame 12b.

A very important feature of the invention is to eliminate couples resulting from out-of-line forces. This is accomplished by the long length of section 12b of the frame so as to provide bearing over the major surface of the upper limb. With respect to FIG. 12, it is then seen how a tension indicated by arrow 90 is appropriately balanced with respect to both force and moment by spaced reactive forces indicated by arrow 92a on the upper side of the upper limb most closely adjacent the elbow and arrow 92 on the underside of the upper limb most closely adjacent to the shoulder of the individual.

Similarly, with respect to torsional loading, the arm is indicated in FIG. 13 by numeral 94 with the forearm extending into the page from the right side so that the elbow is at 96. In this instance, a clockwise torque indicated by arrow 98 is counteracted by equal opposed forces on the top side of the arm most closely adjacent to the shoulder as indicated by arrow 100 and on the bottom side of the arm most closely adjacent to the elbow as indicated by arrow 100a. On the other hand, a counter clockwise torque on the forearm indicated by arrow 102 is counteracted on the upper arm by the corresponding equal opposed forces indicated by arrows 104 and 104a. Effectively then, the long cuff arrangement associated with the upper limb creates an axially distributed reaction region of the upper limb when the device is externally reactive on the digital end of the lower limb. The arrangement effectively places the lower and upper limbs in static equilibrium with respect to all forces and moments exerted on the digital end of the lower limb when the rod 22 is tightened with bar 32 appropriately engaged to the digital end of the lower limb.

ADAPTION TO LOWER LEG

The adaption of the device to the lower leg is illustrated in FIG. 10. Here the end 12b of the frame fits under the lower portion of the upper thigh, and extends down to allow bar 32 to take the position with respect to the lower limb indicated. It is interesting that the same size device can be adapted for the lower limb of the leg, but such is the case in view of anatomical facts well known by any physician, and as reported by Henry Dreyfus in his book "Measure of Man" which shows that the length of the forearm from the elbow to the end of the fingers is typically close to the length of the lower leg from the knee to the bottom of the foot.

The application to the foot is achieved by utilizing a conventional plaster foot cast, indicated by numeral 70, which incorporates an embedded substantially flat metal plate 72 which threadably receives eye bolts 74, with bolts 74 in effect achieving the same result as the chinese fingers 29 shown in FIG. 1. The eye bolts 74 cooperate with the cord 33 which is in turn laced through the appropriately positioned links so as to maintain a properly distributed and directed tension when the rod 22 is drawn up to effect the tension on the broken limb.

This application is entirely feasible, as the physician normally constructs a leg cast in sections. In fact, the casting process is simplified sufficiently so that an assistant is not required, since the fractured lower leg is held in reduced position without interfering with access for application of the cast.

In order to utilize this particular type of foot cast and embedded plate for a walking cast, an appropriate rubber walking heel 80 is illustrated in FIG. 11. The walking heel 80 is held in place by bolts 82 which are inserted through holes 83 in the baseplate 84 exactly aligned with the holes in plate 72 when the eye bolts 74 have been removed. This also provides an easier way for replacing a rubber walking heel than is possible with the present techniques where the heel is actually embedded into the plaster, and replacement thereof normally comprises a breaking down and rebuilding of the cast itself.

X-RAY CASSETTE ATTACHMENT

In a device of the type described above, it is extremely desirable to be able to not only apply a cast or apply internal fixation in an open reduction with the limb properly reduced and held in position by the apparatus, both of which are quite clearly possible because of the large space between the lower limb and the frame 12a, but it is also desirable to be able to take x-rays of the limb to be sure the reduction is properly accomplished. To enable this capability, the invention contemplates a separate attached x-ray cassette holding frame, which is shown in FIGS. 7 through 9. The cassette holding frame indicated generally by numeral 110 in FIG. 7 is adapted to be positioned appropriately along the elongated main frame portion 12a by a clamping plate 112 which carries a screw 114 that passes through a flat bar 116, and which then is engaged by a threaded knob 118 to effectively clamp bar 116 with respect to plate 112 and thereby hold a fixed relationship to frame 12a. Naturally, the longitudinal adjustment with respect to frame 12a in this arrangement can be slidably achieved to the proper location desired.

The plate 112 is then connected to a frame holder 120 by a somewhat triangularly shaped frame member 122. The member 122 is preferably formed from a thin gauge metal to the shape configuration illustrated in FIGS. 7 through 9 so as to give a light weight yet firm and rigid connection between plate 112 and angle 120. The attachment of frame member 122 to plate 112 and angle 120 can be by riveting, spot welding, or the like.

The angle 120 has legs 120a and 120b of the same length from the 90° angle. It should be noted, however, that the frame member 122 is attached on the central back portion of leg 120a of angle 120 so as to leave the lateral edges of the leg 120a free and unencumbered. This is important with respect to slidably receiving the x-ray cassette mounting frame thereon, as will be defined hereinbelow.

It should be further noted that frame 110 may be positioned on frame 12a in an orientation inverted to that shown in FIG. 7 resulting in a location of leg 120b parallel but opposite with respect to the plane of symmetry of frame 12a to that shown in FIG. 7. It is seen that three alternate planes are thereby provided by legs 120a and 120b to locate the x-ray cassette mounting frame for lateral and anterior-posterior x-rays of a left or right lower limb.

The x-ray cassette mounting frame indicated generally by numeral 130 comprises a flat sheet 132 with U-shaped channels formed thereon on two sides at 134 and 136. The U-shaped channels are of an inside width substantially equal to the standard thickness of a conventional x-ray cassette so that a cassette of any size may be inserted into the corner created by the channels, and then locked into position by thumb screws 138 received through threaded mounting plates 140, respectively.

Now, to allow the frame 130 to be mounted in two orthogonal planes, as well as at 90° angles in the same plane, a pair of right angled dovetail openings are provided, as best seen in FIG. 8, indicated by dotted lines 142 and 144 respectively with arm 120b of plate 120 being inserted into opening 142 as indicated. The openings 142 and 144 are formed by offset guide plates 146 which are preferably spot welded to the back side of plate 132 in the relationship best seen in FIG. 8.

Hence, it should be understood that with the clearance on the top and bottom lateral edges of arm 120a with respect to frame member 122, the arm 120a can be inserted into either opening 142 or 144 so as to mount the cassette frame in that plane, orthogonal to that shown in the drawings.

In effect, this then allows lateral and anterior-posterior x-rays of a right or left forearm or lower leg to be taken while the limb is in full operative position with respect to the reduction device of the invention.

Therefore, it should be understood that the objects of the invention have been achieved by providing a portable device for the reduction of lower limb fractures which device is externally reactive on the digital end of the lower limb as well as on an axially distributed region of the upper limb. The device contains means for the concurrent application of relative linear and rotational displacements of the fractured lower limb segments while maintaining the lower limb and the upper limb in static equilibrium with respect to all forces and moments exerted on the digital end of the lower limb

by the device. Because the head 20 can pivot on cross bar 24, the device is self-aligning so that tensional load is applied in the proper direction. The load cell provides means for the measurement of the force attendant to the relative linear displacement of the fractured lower limb segments. To adapt the device for a lower leg, a metallic insert is utilized in the foot cast with the insert containing means for threadable engagement with eye bolts to cooperate with the tension head. An attachment device is provided for mounting x-ray cassettes in at least two orthogonal planes and in at least two relationships in each plane, this means being selectively engageable and disengageable with the device while it is in the reductive position with respect to a fracture.

While in accordance with the Patent Statutes, only the best known embodiment of the invention has been illustrated and described in detail, it is to be particularly understood that the invention is not limited thereto or thereby, but that the inventive scope is defined in the appended claims.

What is claimed is:

1. A portable system for the reduction of lower limb fractures including apparatus which comprises a frame including restraint means adapted to engage only the upper limb and including means adapted to engage the digital end of the lower limb and to impose forces on the exterior of the digital end of the lower limb while concurrently restraining an axially distributed region of the upper limb in rigid attachment to said frame, and first means connected to the frame for providing independent coaxial relative linear and rotational displacement of the fractured segments of the lower limb, said system configured such that, when applied to reduce a lower limb fracture, the apparatus and the lower and upper limbs are in static equilibrium with respect to all reductive forces exerted on the digital end of the lower limb by the apparatus without restraint by other external forces.

2. A system according to claim 1 including means for adjusting and indicating the relative rotation of the lower limb independent of linear displacement thereof.

3. A system according to claim 1 including means for adjusting and indicating the linear force imposed on the lower limb independent of rotational displacement thereof.

4. The system according to claim 1 which further includes means functional in connection with said system to reduce a lower leg fracture comprising an insert for substantially complete inclusion within the structure of a foot cast, said insert containing means engageable with said first means in at least two spaced locations to transmit coaxial linear and rotational displacement for fracture reduction and removable therefrom upon fixation of the fracture.

5. The system as recited in claim 1 which further includes means removably applicable to said system and selectively engageable with the frame while in reductive association with the lower limb to alternately mount x-ray cassettes in at least two orthogonal planes generally parallel to the axis of said limb and selectively at two or more axial positions between the proximal and distal ends of said limb, said means configured to interchangeably retain film cassettes of various dimensions as measured in the plane of the film.

6. A system according to claim 1 where the portion of the frame adapted to react with the exterior of the upper limb comprises means providing axially distributed restraints of the upper limb substantially normal to the limb at least in two orthogonal planes.

7. A system according to claim 1 where the first means is self aligning to the lower limb so that the relative linear and rotational displacements thereof are axially disposed with respect to the limb.

8. A system according to claim 1 including means interchangeably engageable with the first means and adapting the apparatus for the selective reduction of both forearm and lower leg fractures.

9. The system according to claim 4, where said insert is threadably engageable with removable fasteners.

10. A system according to claim 9 which further includes walking heel means adapted for threadable engagement with the cast insert when lower leg fracture reduction and cast application are complete.

11. Apparatus for the reduction of lower limb fractures comprising a frame having an elongated central portion and a portion on each end-substantially normal to said central portion in the same direction, one of the said end portions being of appropriate length and adapted to lie in parallel adjacent relation to the major axial extent of the upper limb when the central portion is generally parallel to but remote from the lower limb, means to attach the one end portion only to the exterior of the upper limb providing axially distributed restraints of the upper limb with respect to said frame substantially normal to the limb in at least two orthogonal planes, and a force transmitting head mounted to the other end portion adapted to grasp the exterior of the digital end of the lower limb and to apply independently adjustable coaxial linear and rotational displacement thereto.

12. Apparatus according to claim 11 where the head comprises an elongated threaded rod slidably engaged and in substantially perpendicular relation with the other end portion of the frame, an elongated load carrying bar mounted in substantially normal relation to the end of the rod in substantially parallel facing relation to the one end portion of the frame, means to attach the exterior of the digital end of the lower limb to selective locations along the length of the bar, nut means threadably received onto the other end of the rod adjustable to control the axial position of the bar relative to the other end portion of the frame, and means to selectively lock the angular position of the bar relative to the frame.

13. Apparatus according to claim 12 where said angular locking means comprises a protractor plate operatively constrained by the frame from rotational displacement about the axis of the rod, a link mounted in fixed relation to the load carrying bar, and means to selectively lock the link to the protractor plate.

14. Apparatus according to claim 12 where a load cell is located between the nut means and the other end portion of the frame.

15. Apparatus according to claim 14 where the load cell comprises at least one elastically yieldable element disposed about the rod and one rigid element spanning the yieldable element and adapted to cooperate with the nut means to indicate deflection of the elastic element as a measure of linear tensional force on the rod.

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16. Apparatus according to claim 11 wherein said one end portion of the frame has a cuff associated therewith adapted to engage the major axial extent of the upper limb and adjustable means associated with the cuff to enclose the circumference of the upper limb at least in two axially spaced locations to firmly bind the upper limb to the cuff.

17. Apparatus according to claim 11 where the head is self aligning by being pivotally mounted to the other end portion of the frame.

18. The system according to claim 17 including means interchangeably engageable with said other end portion of the apparatus adapting the apparatus for the selective reduction of both forearm and lower leg frac-

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tures.

19. The apparatus as recited in claim 17 which further includes means removably applicable to said apparatus and selectively engageable with the central portion of the frame while in reductive association with the lower limb to alternately mount x-ray cassettes in at least two orthogonal planes generally parallel to the axis of said limb and selectively at two or more axial positions between the proximal and distal ends of said limb, said means configured to interchangeably retain film cassettes of various dimensions as measured in the plane of the film.

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