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None

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A5R
Selected US specifications from IPC sub-class A61F

(54) **Orthopedic splint for external axial fixation**

(57) An orthopedic splint having a wide range of available length adjustability comprises a central body (10) with at least three mutually displaceable telescoping parts (12, 13, 14), not rotatable one with respect to the other, with separate clamps (30, 32, 34, 36) selectively driven in each possible couple between the parts and by means of a jack mechanism (11) with at least three mutually threaded members (40, 45, 50) displaceable along a common axis by rotation of one of them, wherein the members at the ends of the jack are provided with pins which are movable nestable in the hollows of the clamping cams (21, 21') of the ball-joints (16, 18) which anchor two pin-mounts (15, 17) at the ends of the central body.

FIG. 1.

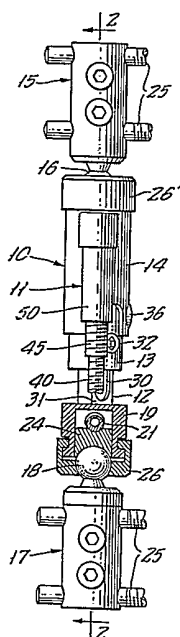


FIG. 2.

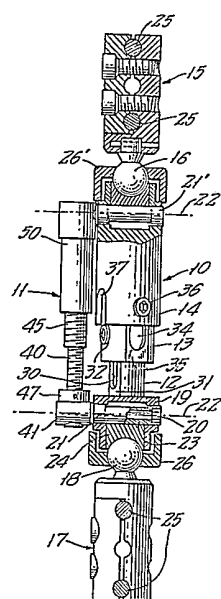


FIG. 1.

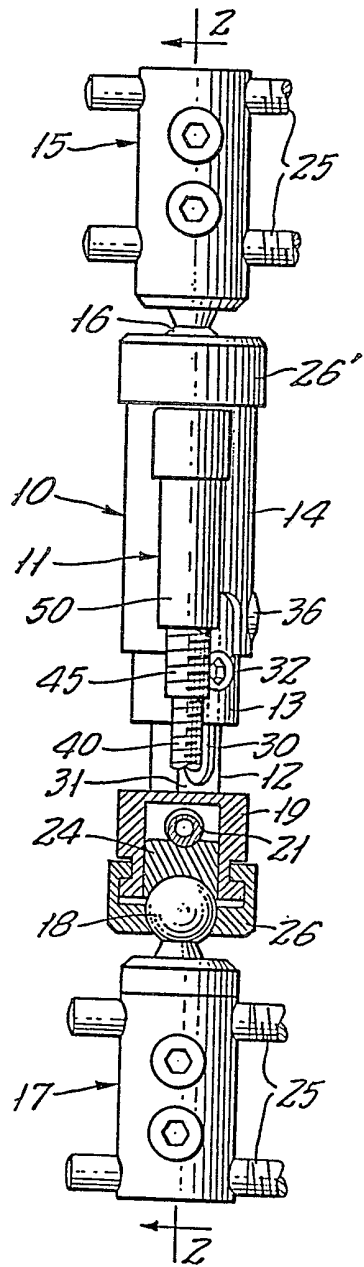


FIG. 2.

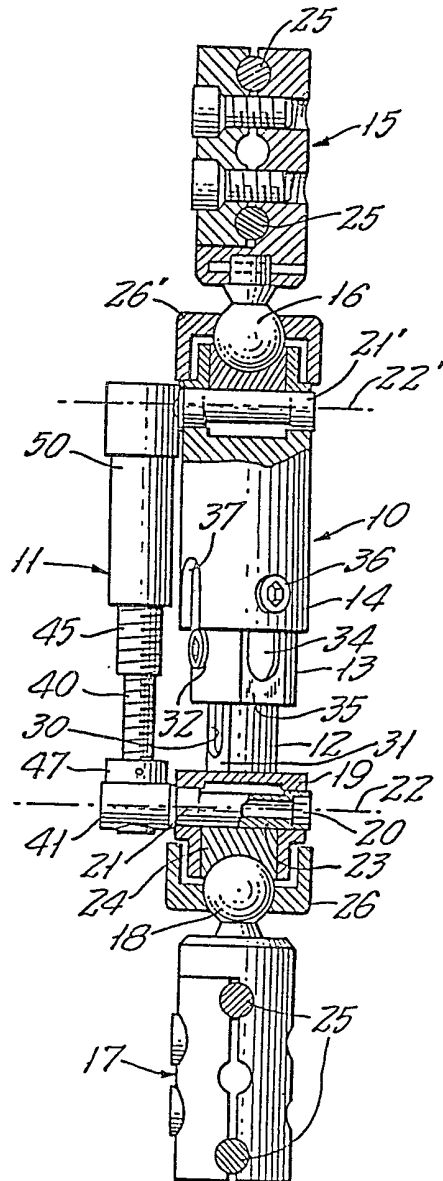


FIG. 3.

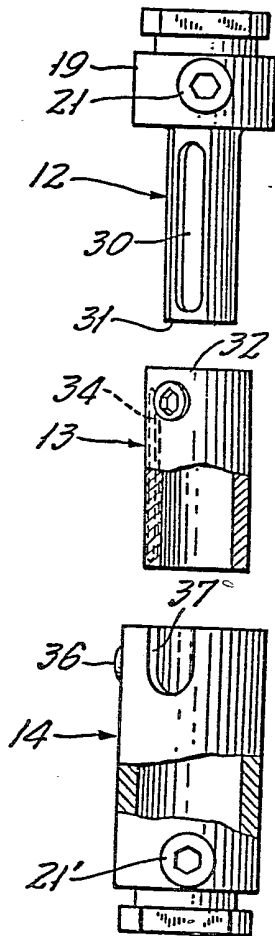


FIG. 3A.

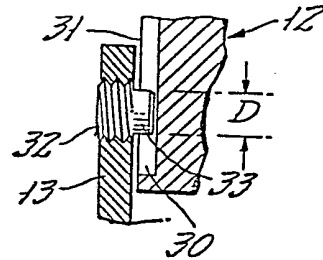


FIG. 4.

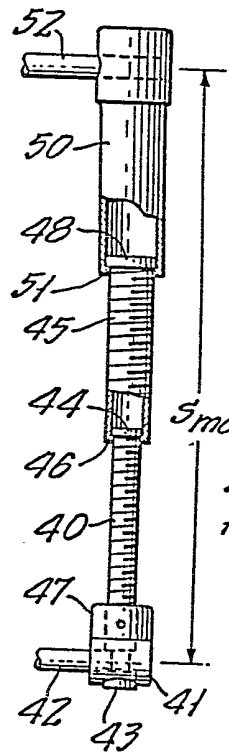
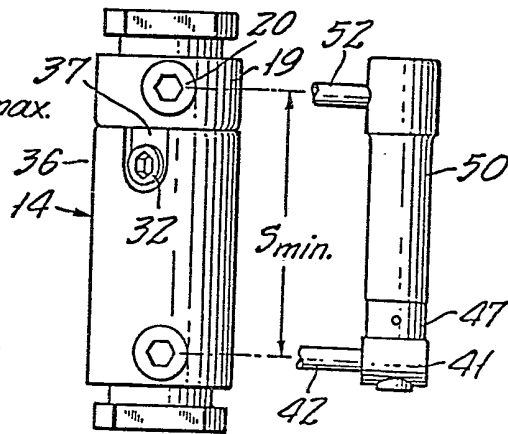


FIG. 5. FIG. 6.



SPECIFICATION

Orthopedic apparatus with a wide range of adaptability for external axial fixation

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The invention relates to an orthopedic device of the sort of that described in the U.S patent No. 4,312,336 as for external axial fixation of bones or bone-fragments. The device referring to the above mentioned patent is provided with a central body made of two mutually telescoping (displaceable in telescoping relation) members, not rotatable one with respect to the other, at the ends of which pin-mounts are linked by means of ball-joints. In such a device provision is also made for clamping selectively the two members of the central body according to a desired length of the same. Still further such a device is provided with jack-mechanism in order to extend or retract the central body length. Said device is apt to be used to solve problems affecting the larger bones, such as tibias and femurs, particularly when the surgeon keeps an inventory of devices with different minimal body length, so that he might choose the more suitable device in a given situation. Nevertheless for smaller bones such as radius or ulna and the like, wherein less bulk is desirable and wherein it is also desirable to achieve a greater ratio of length adjustment of the central body with a single device, the patented device is not apt to the aim.

Thus the main object of the invention is an orthopedic device which can also provide with a wide range of available length adjustability of the central body with a minimum bulk of the central body and in which bulk and adjustability go far beyond the capabilities of prior known devices. The technical problem connected with such object has been solved as said in claim 1.

The device object of the invention gives the advantage of being apt to the solution of many orthopedic problems which the surgeon had once to solve choosing for each of them a device with a central body of suitable length and extensibility.

Another peculiar advantage is the fact that the device permits an adjustability of maximal body length more than twice with respect to the minimal, such thing being completely impossible with previous devices. Other advantages will appear in the following detailed description of the invention, which has to be considered in connection with the accompanying drawings, where, as a non-limitative example, a preferred form of embodiment is shown, and precisely:

Fig. 1 is a view in longitudinal elevation of an axial fixation device of the invention, partly broken away and in section to reveal internal details;

Fig. 2 is a view similar to Fig. 1, but taken at 90 degrees from aspect of Fig. 1, with parts shown in section for the plane 2-2 of Fig. 1;

Fig. 3 is an exploded view of parts of the body of the device of Figs. 1 and 2;

Fig 3a is an enlarged fragmentary detail, in longitudinal section, to show a set-screw for clamping two mutually telescoping parts of the device of Figs. 1 and 2;

Fig. 4 is a view in longitudinal elevation of a

jack-mechanism, used with the device of Figs. 1 and 2 and shown in fully extended relation;

Fig. 5 is a view of the body of Fig. 3 in fully compressed assembly; and

Fig. 6 is a view similar to Fig. 5 of the jack-mechanism in fully contracted condition.

In Figs. 1 and 2 the device is shown in an intermediate-length adjustment, wherein all three of the telescoping parts of the central body 10 and all three parts of jack-mechanism 11 are partially exposed to view. The three telescoping body parts are an inner cylindrical member 12, an intermediate cylindrical member 13, or sleeve, and an outer member 14, having a cylindrical bore which is capable of fully receiving the telescoped insertion of members 12 and 13. Two pin-mounts 17, 15 are connected with ball-joints 18, 16 which are selectively lockable at the two ends of body 10.

Quick releasable setting of a clamp for ball-joint 18 relies on an inner hexagonal head 20 of a tubular pin with an inner cylindrical bore. Said pin extends normal to the longitudinal axis of body 10 on a pin axis 22 and is journaled for rotation in the headed end 19 of inner body member 12. Between its spaced locations of journal support, pin 21 has an eccentric cylindrical formation 23 by which an engaged ball-joint seat member 24 may be jammed against the involved ball of the joint. The releasable clamp for the other ball-joint connection 16 is of similar construction, involving a tubular pin 21' rotatable about the axis 22', located in the closed upper end of outer body member 14.

Each of the pin mounts 15-17 is shown with two surgical pins 25, and when the eccentric lock of a pin 21 (21') is actuated to release its clamp, the involved pin-mount has universal freedom for orientation by rotation about the ball center which is on the longitudinal body axis or the involved pin-mount may be disengaged from body 10, by partial rotation of a ball-joint retaining ring 26 (26') having bayonet engagement to the involved end of body 10.

Further details of surgical pins, pin-mounts, and clamp/release mechanism are contained in said patent No. 4,312,336.

The pin axes 22-22' are retained in parallel relation by reason of the keyed anti-rotation engagement between the three body members 12, 13, 14, as it will become clearer upon reference to Fig. 3.

In the case of inner body member 12, a relatively wide but shallow elongate flat bottomed groove 30 is formed in a chordal flat 31 of the outer cylindrical surface. Said groove extends near but short of the full axial extent of the cylindrical surface.

In the case of sleeve 13, a set screw 32 radially located near the end of the member 12 close to head 19, has an inner cylindrical end 33 of diameter D to pilot along the elongate lateral walls of groove 30 to secure a clamped condition of sleeve 13 along inner member 12. Upon releasing set-screw 32, the cylindrical end 33 remains as a guide key thereby enabling adjustment of the telescoping action within end limits of freedom for set-screw end (33) accommodation in groove 30.

Sleeve 13 has also a groove 34 with the same width and depth dimensions as groove 30, see Fig. 2, which

is formed on chordal flat 35 extending the full length of sleeve 13.

The open cylindrical telescoping end of outer body member 14 mounts a set-screw 36, which may be a duplicate of set screw 32, for radial coaction with groove 34. Thus as long as the cylindrical inner end of set screw 36 remains within groove 34, an antirotation keyed relation is maintained between members 13 and 14, and telescoping action is retained between longitudinal limits of set-screw engagement with groove 34. At one end of member 14 of central body an opening 37 is provided which enables wrenching access to the head of set-screw 32, even when the body members are in their fully telescoped relation (Fig.5).

The parts of body 10, and associated ball-joints and pin-mounts, are retainable in unit handling relation to facilitate involved length and angle relationship and it is thus clear that once any of these relationships is decided upon, it may be secured by use of a single tool (for example an Allen wrench), both to screw completely set-screw 32,36 and to clamp the ball-joints with pins 21,21'.

For precision jacking, i.e. longitudinal expansion or reduction in the length of body 10, it is preferred that jack-mechanism 11 be removably applicable to body members 12 and 14. As with body 10, jack-mechanism 11 comprises essentially three mutually telescoping parts along a common axis, as shown in Figs. 1,2,3 and 6. As best seen in Fig. 4 an inner member 40 is externally threaded for most of its longitudinal length; at one end it is formed for axially retained rotational freedom with respect to a boss 41 which mounts a radial pin 42; the end 43 of inner member 40 will be understood to be exposed beneath boss 41 and to be internally hexagon-formed so as to receive an Allen wrench, preferably the same single wrench as used for screws 32 and 36. At its other end member 40 is formed with a short radially outward circular flange 44, which pilots on the cylindrical bore of an intermediate sleeve member 45. The lower end of member 45 is characterised by a short radially inward flange 46, having threaded engagement to member 40; the expanded limit of this engagement occurs when flange 44 becomes point of abutment to flange 46, while the contracted limit of this engagement occurs when collar 47, near boss 41, becomes point of abutment to flange 46.

Sleeve 45 is externally threaded, except that it is characterized by a short radially outward circular flange 48 which pilots on the cylindrical bore of an outer member 50. The lower end of member 50 is characterized by a short radially inward flange 51 having threaded engagement to member 45; the expanded limit of this engagement occurs when flange 48 becomes point of abutment to flange 51, while the contracted limit occurs when the closed end of member 50, lightly beneath pin 52, becomes point of abutment to flange 48.

Operation of jack-mechanism 11 is via simple rotation of member 40 by means of an Allen wrench inserted in the inner hexagon of end 43. Both thread engagements, namely at 40-46 and at 45-51 are preferably to the same pitch.

If one commences with the fully collapsed condi-

tions of Fig. 6, the engagement 45-51 may be the first to advance, and this advance may proceed to the point of flange-to-flange abutment at 48-51 before further wrench torque is operative to advance the engagement 46-40; at full advance, both flange abutments (48-51 and 44-46) will have occurred accounting for a maximum span "S max" as indicated in Fig. 4, between the axes of pins 42-52. In collapsing the jack-mechanism from its extreme expansion condition to that of extreme contraction, as indicated in Fig. 6 with "S min", a simple rotation of member 40 in the opposite direction to that which has been used to reach the extreme expansion will be sufficient.

Obviously pins 42,52 have such dimensions so that they may be selectively inserted in the bores of pins 21,21'.

It will be noted that in the described example, the extreme expansion length is more than twice compared with that of the extreme contraction but it is evident that such a relationship may be increased by realising the central body and the jack, each one with four or more parts.

From what has been said it is clear that the described orthopedic device, thanks to its particular structure, is suitable for application to solve an extended range of operational situations which only partially might be solved by using devices according to U.S. patent No. 4,312,336, which mutually differ in their central body dimensions.

Still further the greatly expanded range of available precision-length adjustment, according to the present invention, doesn't require any change of given pin-mounts orientations and no interference to accessibility to set-screws 32,36 is possible, considering their locations which are angularly offset from the plane of axes 22-22' of the eccentric pins.

The device according to the present invention permits also possible variations of the pin-mounts orientations by maintaining the selected central body length unchanged.

It is furthermore evident that, in a practical actuation, modifications may be made in the object of the invention, without departing from the scope of said invention as defined by the following claims.

CLAIMS

1. Orthopedic apparatus for external axial fixation comprising an elongate extendable central body, at the ends of which two pin-mounts are connected by means of ball-joints whose relation central lie on the longitudinal axis of the central body, selectively operable means associated with each ball-joint for locking a given orientation of the involved pin-mounts, and selectively operable jack-mechanism operative near the ends of the central body, characterized by the fact that central body is provided with at least three mutually telescoping parts with anti-rotation axial drive means and clamping means selectively operable between said parts, with two tubular eccentric pins rotatably located in parts which constitute support area for two pins of a jack-mechanism.

2. Apparatus as said in claim 1, characterized by the fact that a member is provided with an intermediate cylindrical sleeve, which is concentric with the longitudinal axis of the body and radially interposed

with telescoping relation with inner and outer members, the latter having an opening.

3. Apparatus according to claim 1, characterized by the fact that the anti-rotation axial drive means and

5 clamping means between the central body members are comprised of two set-screws with an inner cylindrical flat end which may be screwed into the sleeve and in the outer member, and angularly offset both one in relation to the other with respect to the
10 plane containing the axes of the pins and of two grooves, with a flat end and lateral walls in coaction with the ends whose length is less inferior to that of the chordal flats, on which they are formed, and of the inner member and sleeve.

15 4. Apparatus according to claim 3, wherein the head of the set-screws is internally hexagon formed.

5. Apparatus according to claim 1, wherein the tubular pins at one of their ends are internally hexagon formed.

20 6. Apparatus according to claim 1, characterized by the fact that the jack-mechanism comprises at least an outer, an intermediate and an inner cylindrical member which are concentrically related along a displaceable axis, wherein each of intermediate and
25 outer members has an inner cylindrical bore and terminates at one of its ends with a radially inward threaded flange, having external threaded engagement with inner and intermediate members respectively and wherein each of said last mentioned
30 members terminates with a radially outward flange which is contained in the relative cylindrical bore of the two previously mentioned members, and wherein said threads have the same pitch and orientation.

7. Apparatus according to claim 6, wherein in the
35 outer member at the opposite end to flange a radially outward pin is inserted and wherein the inner member at the opposite side to flange is provided with a collar, beneath which, it terminates in an inward hexagon-shaped end, rotatably connected with a boss by
40 means of a pin radially projecting outward the boss.