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GB 754167
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(54) Connector Assemblies

(57) A connector assembly comprises an elongate member (10) and connector (20), the member being a rod (11) with enlarged ball head (12) at one end, and the connector including a body (21) having a stopped bore (22) wholly receiving the head, a relatively transverse through-bore (23) partially intersecting the stopped bore at respective intermediate portions, a keyway (24) in the through bore leading from one end thereof first axially and then circumferentially, a sleeve insert (26) with a key (29) at its outer end engaged in the keyway and its inner end having a part-cylindrical notch (28) and a screw mechanism suitably including a similar sleeve insert (25) in the other end of the through-bore and a bolt (27) inter-connecting the sleeves. The relative locations of the key (29) and the part-cylindrical notch (28) of the first sleeve being in a predetermined relationship with the relative locations of the keyway and stopped bore (22) to mutually close and and open the sleeves when the bolt (27) is actuated. Such an assembly suitably forms part of an orthopaedic fracture fixation apparatus with another elongate member similarly connected in opposition with the connector, and respective sets of bone pin connectors (30) individually rotatably and longitudinally adjustably connected on the members, the last connectors each having clamp mechanisms for their members and pins of similar, but simplified, sleeve/bolt form to those of the first connector.

Fig. 2.

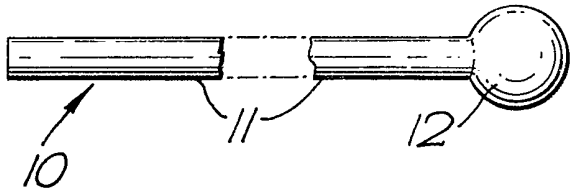

Fig. 4.

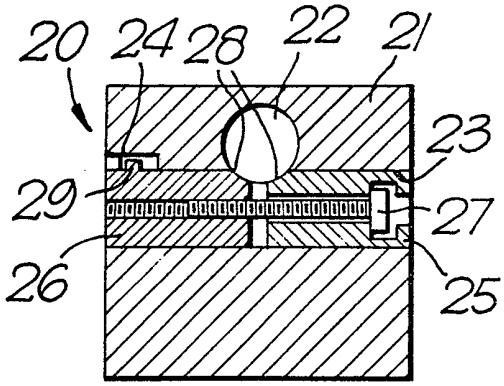

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Fig.1.

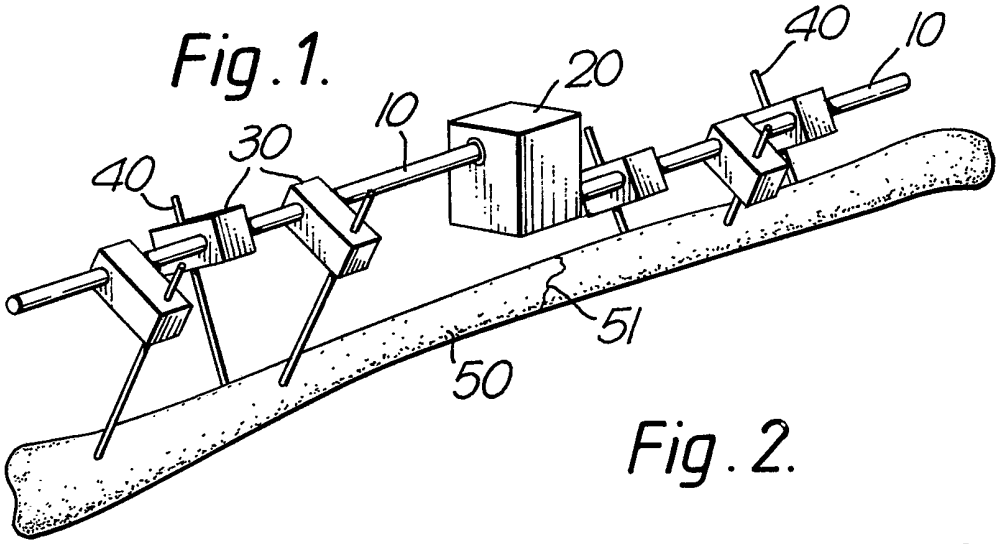


Fig.2.

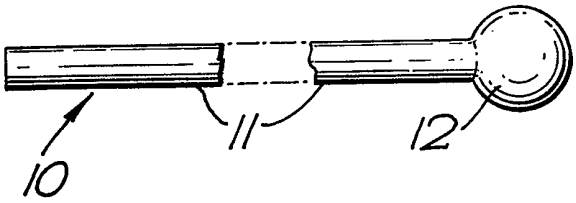


Fig.3.

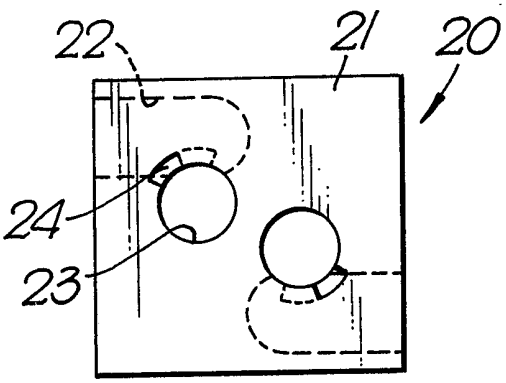


Fig.4.

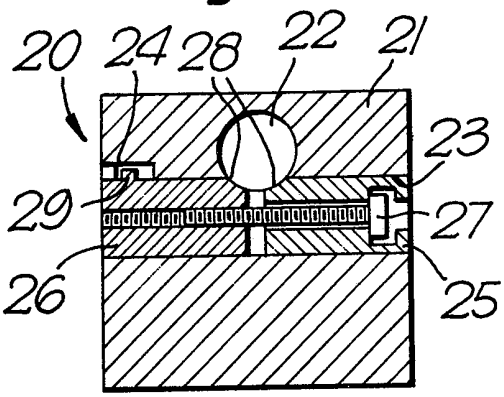
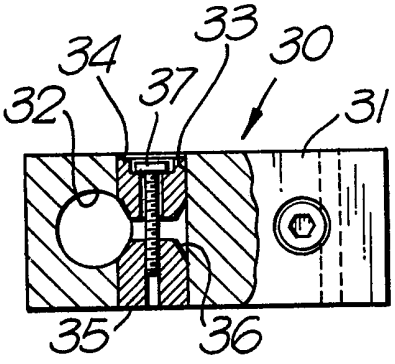


Fig.5.



SPECIFICATION

Connector Assemblies

This invention concerns connector assemblies and more particularly such assemblies which are adjustable in the manner of a ball-and-socket joint.

The invention has in fact been developed primarily for use in orthopaedic fracture fixation apparatus and, while it will be appreciated that other practical applications are possible, it is convenient to describe the invention in its development context.

Orthopaedic fracture fixation apparatus of the kind in question comprises elongate members which are located externally of the patient and are adjustably connected with bone pins secured in the different fragments of a fractured bone, the members and pins forming a rigid framework holding the fragments in a desired manner for union. Apparatus of this kind has recently become the subject of increasing interest and a number of different forms of the apparatus have been proposed and entered routine clinical usage in the last few years.

Earlier ones of these forms are relatively complex and involve a plurality of elongate members, universal and other couplings to allow, when assembled, multi-dimensional adjustment between the members and between the members and pins, and can involve screw mechanisms to allow application of tractive or distractive force across a fracture. Clearly these complex forms of apparatus are suited to use in a considerable variety of fracture situations, but they are correspondingly complicated in usage and, of course, expensive.

More recent forms of the kinds of apparatus in question seek to avoid the difficulties associated with the complex forms and take account of the fact that the more commonly occurring fracture situations involve the long bones of the limbs and can be treated with simpler apparatus. These simpler forms of apparatus generally involve one elongate member for location alongside the limb with pins projecting from the member into the bone, or two such members located along opposite sides of the limb with pins extending between the members by way of the bone. The scope for adjustment is limited and there is a consequent need for accurate positioning of the pins when securing the same in the bone, the pins typically requiring location in a substantially parallel array.

An object of the present invention is to make possible a further form of apparatus of the kind in question which form affords improved adjustment capability compared to the simpler forms just mentioned, but without the complexity of the earlier forms mentioned above.

To this end the present invention provides a connector assembly comprising: an elongate member and a connector; said member having an enlarged ball head at one end thereof; and said connector including a body having a stopped first bore dimensioned to receive said head in a relieved disposition therein, a through second bore extending transversely relative to said first bore with said bores in partially intersecting relation at respective intermediate portions therealong, a keyway laterally enlarging said second bore from one end of the latter with said keyway extending first longitudinally and then circumferentially of said second bore, and insert located in said one end portion of said second bore, said insert having an inner end adjacent to said first bore and a taper over part of its periphery at such end, a key projecting laterally outwardly from the other outer end of said insert, said key being dimensioned to pass along said keyway and being longitudinally movably located in the circumferential portion thereof, the relative locations of said taper and key having a predetermined relationship with the relative locations of said first bore and keyway to incline said taper into and parallel said taper with said first bore respectively when said key is located towards the innermost and opposite ends of said keyway circumferential portion, and a screw device extending from the other end of said second bore to engage with said insert and operable to move the latter towards and away from said first groove.

It is convenient, before discussing the benefits of such an assembly, particularly in relation to orthopaedic fracture fixation apparatus, to consider a specific embodiment thereof as illustrated by way of example with reference to the accompanying drawings, in which:—

Figure 1 schematically illustrates an apparatus according to the invention;

Figure 2 illustrates one component of that apparatus in more detail;

Figures 3 and 4 similarly respectively illustrate in different views another component of that apparatus; and

Figure 4 illustrates yet another component of the apparatus in more detail

The apparatus of Figure 1 comprises two elongate members 10 extending in similar longitudinal directions and coupled together by a central connector 20. Each member 10 has two or more pin connectors 30 coupled to it at intervals therealong and projecting transversely therefrom in opposite senses for successive ones of the connectors. Each connector 30 has an individual bone pin 40 passing therethrough and secured in a long bone 50 of a limb, the bone being fractured at 51 and each fragment having a respective member 10 located alongside it in spaced disposition from the relevant limb.

The members 10 are of like form as shown in Figure 2 and comprise a rod 11 of circular cross-sectional shape with a radially enlarged spherical ball head 12 at one end.

The central connector 20 is shown in an end view and sectional view in Figures 3 and 4, respectively. This connector comprises a rectangular block 21 having similar bores 22 formed partially therethrough from respective end

faces of the block. The bores are just a clearance fit for one of the heads 12 of the members 10 and terminate within the block with hemispherical shaping complementary with the heads 12. Also, the bores have parallel axes but are mutually transversely off-set in the block 21.

The block 21 is also formed with two like, parallel bores 23 passing therethrough between its side faces, and each of these bores partially intersects a respective one of the bores 22 adjacent to the inner end of the latter. Each bore 23 is formed at one end thereof with a keyway 24 which enters the block 21 first axially and then extends circumferentially relative to the associated bore.

The bores 23 each receive like clamp mechanisms of which one is shown in Figure 4. Each clamp mechanism comprises two sleeves 25 and 26 slidably receivable in opposite ends of a bore 23. One sleeve 25, captively holds the headed end of a bolt 27 rotatable therein and having its threaded end projecting from the sleeve. The end of the sleeve 25 from which the bolt projects has its outer surface tapered over part of its edge to form a notch 28 of part-cylindrical shape with its axis perpendicular to that of the sleeve and its diameter complementary with the heads 12. The other sleeve, 26, is internally threaded for screw engagement with the bolt. At one end the sleeve 26 has a radially projecting key 29 shaped and dimensioned to slide into the keyway 24, and at its other end the sleeve 26 is tapered to provide a notch 28 like that of sleeve 25. The key and notch of cleeve 26 are located in a predetermined mutual angular relationship circumferentially around the sleeve, this relationship being repeated for the inner end part of the circumferential portion of keyway 24 and the zone of intersection of bore 23 with bore 22.

Coupling of a member 10 with the connector 20 involves location of a sleeve 26 into a bore 23 with the sleeve key 29 engaged in the part of the keyway 24 where the axial and circumferential portions meet. The notch 28 of the sleeve 26 is then partially located in the associated bore 22 with the notch facing in inclined manner towards the mouth of the bore 22. Entry of the head 12 of the member 10 into the bore 22 causes the head to strike the notch 28 and rotate the same into alignment with the bore 22, and at the same time to rotate the sleeve key 29 into the circumferential portion of the keyway. This action renders the sleeve 26 captive in the block 21. The sleeve 25 is then put in the other end of the bore 23, rotated to locate its notch 28 in alignment with the bore 22 when it abuts the head 12 therein, and the bolt 27 is threadably engaged with the sleeve 26. Screwing of the bolt 27 into the sleeve 26 draws the two sleeves together and wedges their notches 28 against the head 12 to clamp the head between the sleeves and the adjacent end of the bore 22. It will be evident that this coupling requires appropriate dimensioning, proportioning and positioning in respect of the sleeve lengths, bore 22 length and intersection between bores 22 and 23, and also appropriate freedom for axial movement of the key in the keyway when clamping.

The remaining component illustrated in more detail is a pin connector 30. This connector comprises a rectangular block 31 having a bore 32 passing through one opposed pair of side faces to receive the rod 11 of a member 10, and a bore 33 passing through the other side faces and in partial intersecting relationship with the bore 32. The bore 32 receives a clamp mechanism generally similar to, but simpler than that of the central connector. This simplified mechanism comprises two sleeves 34 and 35, each with a chamfer 36 around one end, one of the sleeves, 34, being a clearance fit for the shaft of a headed bolt 37, and the other sleeve, 35, being internally threaded for screw engagement with the bolt. Location of the mechanism is shown in Figure 5 and screwing the bolt will clamp a rod 11.

The connector also has a bore 38 to receive the trailing end of a bone pin, and an associated bore 39 to receive a clamp mechanism of a same form as that just described. These bores 38 and 39 are respectively perpendicular to the bores 32 and 33.

The use of the complete apparatus is largely self-evident from Figure 1 and the above description. However some benefits merit specific comment.

One such benefit is that the central connector 20 can be deployed after assembly of the pins 40, pin connectors 30 and members 10, provided only that the members are within a given range of relative dispositions. This range depends upon the diameter of the rod 11 compared to the diameter and depth of the central connector bore 22, and the separation of the two connector bores 22. Thus the bore 22 receives the ball 12, the rod 11 is narrower than the ball, and so the member and connector are coupled in a ball-andsocket manner giving a conical range of movement limited by abutment of the rod on the mouth of the connector bore. Also, the rods 11 are axially adjustable within the pin connectors once the latter are located by securement of the pins. Accordingly, the members can be axially adjusted, within limits, to narrow or extend the spacing between the heads 12 to match that between the central connector bores 22, and the central connector can be angularly orientated, within limits, to match its bores 22 with the members 10 and to receive the heads for clamping.

Given that the central connector can be located and secured last among the components, it is a simple matter to apply tractive or distractive force at this stage by a screw mechanism (not shown) acting between forked members located to seat over the elongate members 10 and to engage against appropriate ones of the pin connector blocks. The screw mechanism can be removed after securement of the central connector.

A further benefit is that the pin connectors 30 project successively from opposite sides of a

member 10 and it will be seen that, in consquence, successive pins are mutually angled and provide a more rigid framework structure. The connectors 30 are, of course, angularly adjustable around the member before clamping to allow for this and in one embodiment as illustrated allow mutual angling by up to 60° between successive pins.

While the present invention has been described so far with particular reference to the illustrated embodiment, it will be appreciated that it can be varied in detail. For example, in a more complex apparatus the pin connectors can have clamp arrangements similar to those of the central connector. In a simplified apparatus the central connector may be permanently connected with one elongate member. In other simplifications the sleeve 28 of the central connector can be wholly tapered around its inner end and directly screw connected with the associated sleeve 26, and the sleeves of the pin connectors may be similarly directly connected.

Another variation can involve the use of a pin connector which projects from opposite sides of an elongate member, with the opposed end portions having clamps for respective, mutually inclined pins. This last variation is beneficial in relation to fractures towards the ends of long bones when the relatively short fragment can be difficult to secure.

Claims

1. A connector assembly comprising: an elongate member and a connector; said member having an enlarged ball head at one end thereof; and said connector including a body having a stopped first bore dimensioned to receive said head in a relieved disposition therein, a through second bore extending transversely relative to said first bore with said bores in partially intersecting relation at respective intermediate portions therealong, a keyway laterally enlarging said second bore from one end of the latter with said keyway extending first longitudinally and then circumferentially of said second bore, an insert located in said one end portion of said second bore, said insert having an inner end adjacent to said first bore and a taper over part of its periphery at such end, a key projecting laterally outwardly from the other outer end of said insert, said key being dimensioned to pass along said keyway and being longitudinally movably located in the circumferential portion thereof, the relative locations of said taper and key having a predetermined relationship with the relative locations of said first bore and keyway to incline said taper into and parallel said taper with said first bore respectively when said key is located towards innermost and opposite ends of said keyway circumferential portion, and a screw device extending from the other end of said second bore to engage with said insert and operable to move the latter towards and away from said first groove.

2. An assembly according the claim 1 wherein said insert comprises a first sleeve, and said screw device includes a second sleeve similar to said first sleeve, and a bolt passing through said second sleeve into threaded engagement with said first sleeve.

3. An assembly according to claim 1 or 2 comprising a further elongate member interconnected by said connector in generally end-to-end relation with the first-mentioned elongate member.

4. An assembly according to claim 3 wherein said further elongate member is connected with said connector in the same manner as said first elongate member.

5. An assembly according to claim 3 or 4 for orthopaedic fracture fixation, comprising two sets of further connectors respectively connected with said elongate members in individually longitudinally adjustable successions therealong, each said further connector forming a clamp to secure an individual bone pin extending transversely relative to the respective one of said elongate members.

6. An assembly according to claim 5 wherein each said further connector is individually rotatably adjustable around the longitudinal axis of said respective elongate members.

7. An assembly according to claim 6 wherein each said further connector is of elongated form, is connected at one end portion thereof with said respective elongate member to project radially therefrom, and clamps adjacent the other end portion thereof one end portion of a bone pin projecting perpendicularly therethrough, said member, further connector and pin forming an orthogonal array.

8. An assembly according to claim 5, 6 or 7 wherein at least one of said further connectors projects in generally opposed manner from said respective elongate member and forms clamps in its opposed portions for respective ones of two bone pins.

9. An assembly according to any one of claims 5 to 8 wherein each said further connector includes a body having two mutually perpendicular, transversely spaced third bores therethrough and respectively engaged around said respective elongate member and bone pin, two fourth bores therethrough respectively perpendicular and partial intersection with said third bores, each said fourth bore having a pair of inserts respectively in opposite end portions thereof, the mutually adjacent inner ends of each said pair of inserts being tapered, and each said pair of inserts being interconnected by a respective screw mechanism operable to close and open the former mutually towards and away from said respective third bore.

10. An assembly according to claim 9 wherein said pair of inserts are each in the form of sleeves interconnected by a bolt as said screw

mechanism and being tapered wholly around their inner ends.

11. A set of parts adapted for connection into an assembly according to any preceding claim.

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