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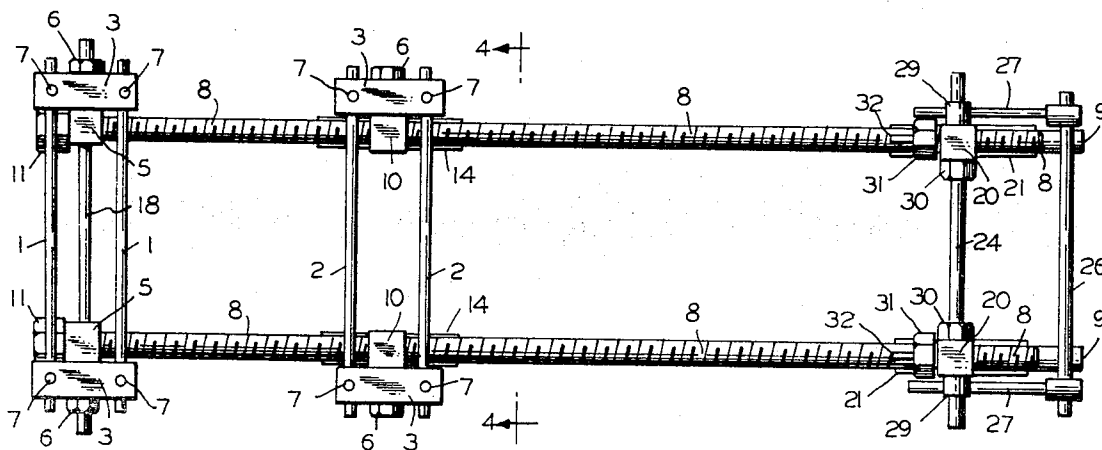
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[54] **ORTHOPEDIC DISTRACTION INSTRUMENT**
4 Claims, 5 Drawing Figs.

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[51] Int. Cl. A61F 5/04
[50] Field of Search 128/85, 84,
84.1, 84.2, 84.4, 86, 87

ABSTRACT: An orthopedic distraction instrument particularly desirable for use in operations for lengthening the tibia, comprising two pairs of bone fixation pins which are mutually parallel and coplanar and are held by supporting members joined by screw thread adjustment means permitting the distance between pairs of pins to be adjusted with precision while maintaining the parallel, coplanar relationship.



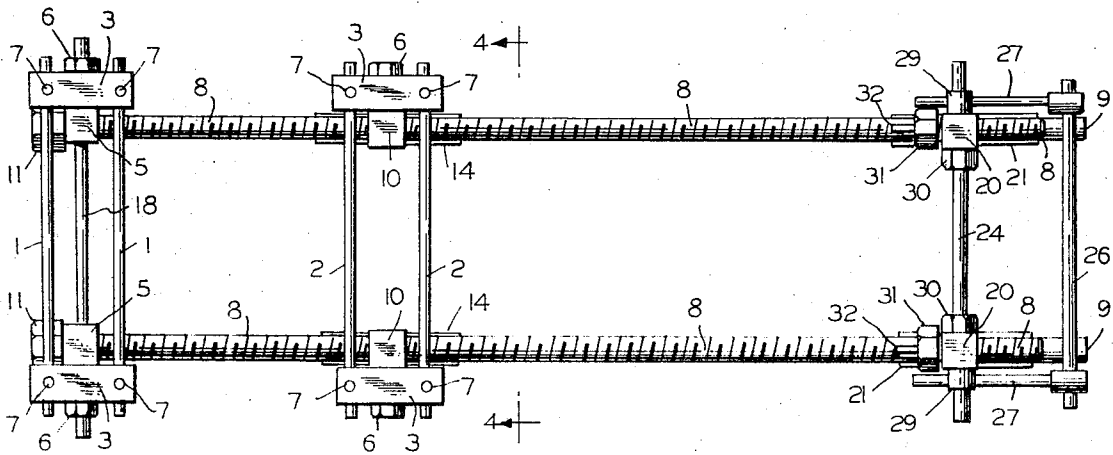


FIG. 2

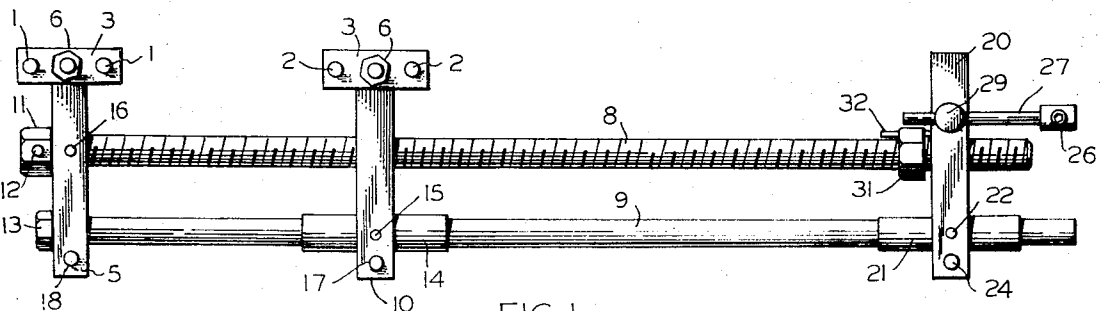


FIG. 1

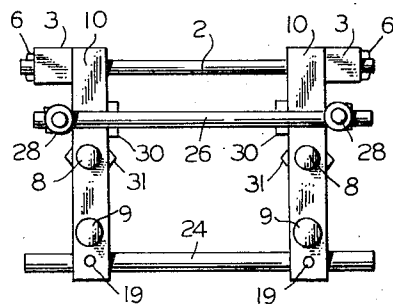


FIG. 3

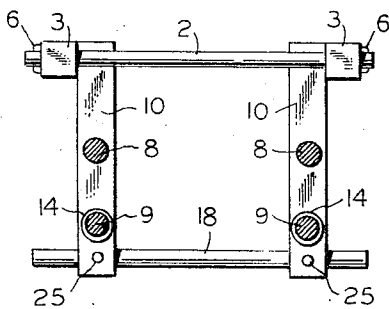


FIG. 4

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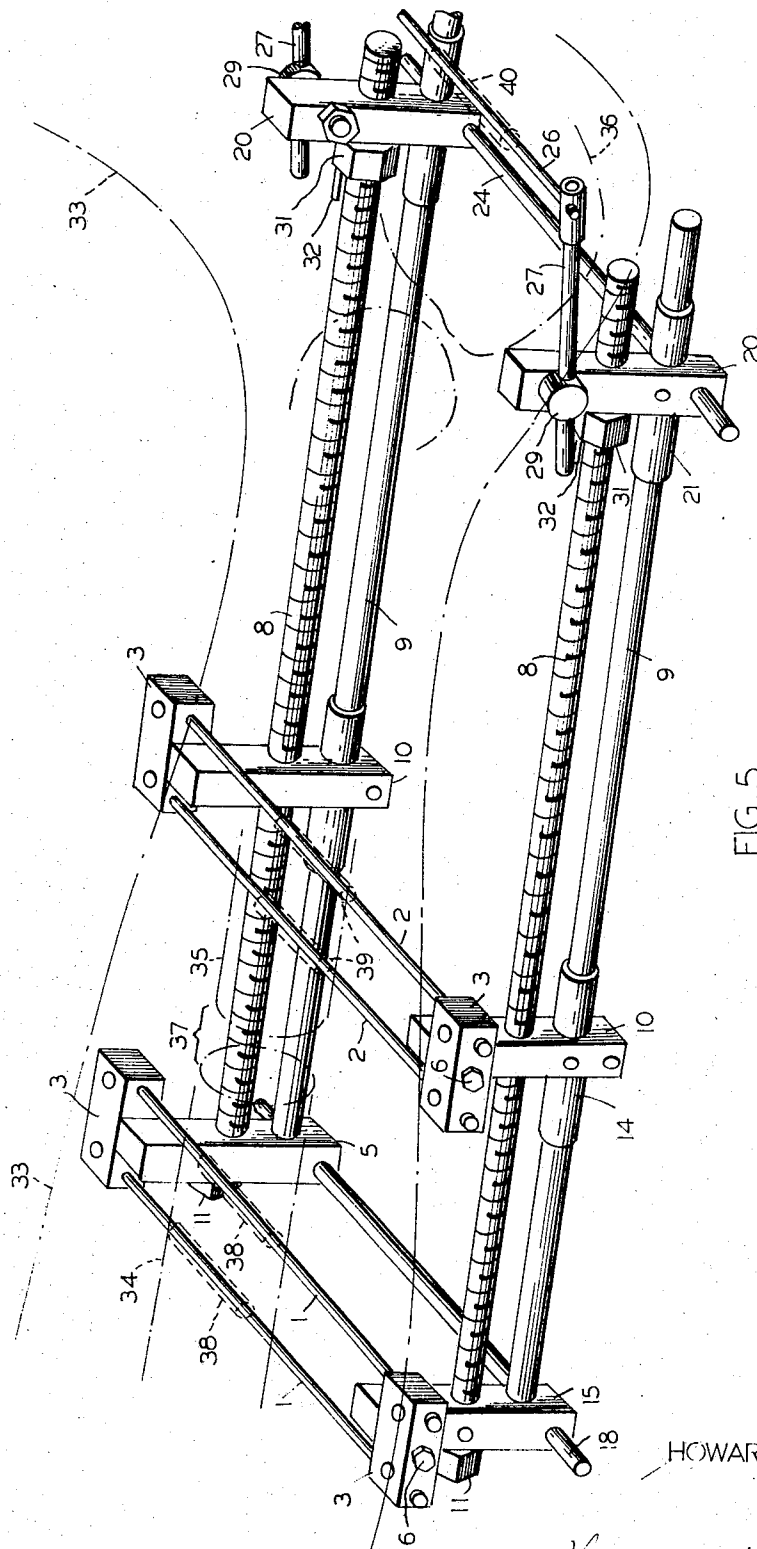


FIG. 5

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ORTHOPEDIC DISTRACTION INSTRUMENT

THE DISCLOSURE

This invention relates to an orthopedic distraction instrument, and more particularly an instrument which may be used for lengthening the human tibia while maintaining the separated portions of the tibia in proper relationship to each other without associated damage to the leg, until the knitting of the bone has been completed.

There are known orthopedic surgical procedures by means of which a bone is held by pins spaced apart from each other, the bone is broken between the pin locations and measures taken to remedy a defect in the bone growth, shape, size, or the like. In such procedure the pins are intended to serve the purpose of maintaining a desired alignment of the bone portions on both sides of the break. One such specialized procedure is described by Coleman and Noonan in "Anderson's Method of Tibial-Lengthening by Percutaneous Osteotomy and Gradual Distraction," Jour. Bone and Joint Surgery, Vol. 49—A, No. 2, 263—279 (March 1967). This article describes a surgical procedure wherein two pairs of bone fixation pins (Steinmann Pins) are placed through the tibia, which is then broken at a point between the two pairs of pins. The pins are then attached to the distraction apparatus of the prior art which comprises two threaded rods to which are attached two pairs of supports, the upper extremities of which hold the ends of the bone fixation pins. The supports can then be moved and adjusted by means of the threaded connecting rod pulling the two pairs of pins and the portions of the tibia affixed thereto apart a fixed amount on a periodic basis. In this fashion the two portions of tibia are pulled apart over several days, up to a maximum of about two inches and maintained in that condition until the void is filled in by new bone growth, thus lengthening the tibia by that amount.

The prior art devices have suffered from many difficulties which have either been eliminated or substantially mitigated by the device of the present invention. Among the problems which such an operation presents are those of maintaining the bone portions in the proper relationship to each other so as to control angulation and rotation, to prevent anterior bow and valgus, and to prevent pressure necrosis of overlying skin. The devices of the prior art have not been designed properly from a structural point of view to provide the rigidity and inflexibility necessary to maintain the proximal and distal portions of the bone in proper relationship to each other while pulling those portions apart against the substantial forces provided by the muscles in resisting that action. Furthermore, the prior art devices have not been properly designed to provide facility in adjustment and in clamping the moving parts in a fixed immobile relationship.

It is an object of this invention to provide an improved orthopedic distraction instrument.

It is another object of this invention to provide an orthopedic distraction instrument which provides proper control over angulation and rotation.

It is still another object of this invention to provide an orthopedic distraction instrument which is sufficiently rigid, inflexible and yet adjustable to prevent anterior bow and valgus.

It is still another object of this invention to provide an orthopedic distraction instrument which can be used without any development of pressure necrosis of overlying skin.

Still other objects will be apparent to those skilled in the field of orthopedic surgery upon reading and understanding the further detailed description of this invention.

The orthopedic distraction instrument of this invention comprises two pairs of horizontally disposed, coplanar, mutually parallel bone fixation pins, each pair of pins supported by a pair of upright parallel rigid supports, a third pair of upright parallel rigid supports spaced apart from, in alignment with and similarly positioned to the other pairs of upright parallel rigid supports so as to result in two parallel rows of three upright supports, each of said two rows having a

threaded rod located in close proximity to said pins and operatively connected to said uprights, and a nonthreaded rod slideably connected to said uprights at the ends distant from said pins, a pair of arms adjustably connected to said third pair of supports holding the ends of a single bone fixation pin in a generally parallel relationship to said two pairs of pins, adjustable means for holding said two rows of supports in a fixed spaced relationship with each other, means for rotating said threaded rods to adjust the distance between supports in either of said rows, and means for clamping said threaded rod to prevent rotation.

In a preferred embodiment of this invention, the inflexible threaded rods which provide the adjustment means are mated with female threaded portions in the centrally located pair of supporting members, but with nonthreaded portions in the pair of supporting members adjacent the proximal bone fixation pins; and clamping devices, such as set screws, are incorporated at the nonthreaded location so as to provide means for clamping or unclamping the threaded rod respectively in an immobile or operative condition.

A more complete understanding of this invention may be had by reference to the attached drawings wherein FIG. 1 is an elevational view of the instrument of this invention. FIG. 2 is a plan view of the instrument of this invention. FIG. 3 is an end view of the instrument of this invention. FIG. 4 is a cross-sectional view taken along line 4—4 of FIG. 2. FIG. 5 is an isometric view of the instrument of this invention as employed in a tibial-lengthening procedure.

By specific reference to FIGS. 1—4, the features of the instrument of this invention may be understood. Two pairs of bone fixation pins (preferably Steinmann Pins) perform the actual holding of the bone portions in fixed relationship to each other. The first pair of pins 1 are attached to the proximal bone portion and the second pair of pins 2 are attached to the distal bone portion. These two pairs of pins must be maintained parallel to each other and lie in the same plane so as to pull the two bone portions apart along a predetermined path. Although several sizes of such pins are available, the typical diameter might be five thirty-second inches. Each of the pairs of pins 1 and 2 are held by substantially identical pairs of upright supporting members. Each of these supporting members comprises a crossbar 3 affixed at right angles to the upper end of uprights 5 or 10 and held in that position by suitable joining means such as screw 6 to produce the general shape of a T. Suitable set screws 7 or other clamping means are provided to hold fixation pins 1 and 2 in an immobile relationship with respect to crossbars 3.

From the foregoing description, it may be seen that the combination of bone fixation pins and upright supporting members provides two substantially identical subassemblies to which portions of the same bone may be attached. These two subassemblies are joined to each other in an adjustable relationship by means of threaded rods 8 and smooth rods 9 so as to produce a rigid, inflexible structure which will permit adjustment whereby bone fixation pins 2 may be moved closer to or farther away from bone fixation pins 1 without disturbing the parallel, coplanar relationship between pins 1 and 2. Each of threaded rods 8 is terminated with head 11, which in this instance is a hexagon shape, but which may be square or any other configuration suitable for the application of a tool for turning the threaded rods 8. The bore through uprights 5 for accommodation of threaded rod 8 is a smooth, unthreaded bore and threaded rod 8 is likewise smooth and unthreaded so as to mate properly with that bore. A convenient procedure for producing the parts which fit together at the junction of threaded rods 8 with uprights 5 and with heads 11, is to machine the threaded rod to a smooth, smaller diameter to mate with a hole drilled through upright 5, and similarly to attach head 11 having a smooth internal bore to a smooth end portion of rod 8 by means of appropriate set screws 12 so as to prevent head 11 from turning relative to rod 8. Uprights 10 are fashioned with threaded holes to accommodate threaded rod 8 so that any turning movement applied through head 11

causes upright 10 to move relative to upright 5. Smooth rods 9 provide additional support to cause the entire instrument to be rigid and also function as guides to maintain uprights 5 and 10 in a parallel relationship to each other. Smooth rods 9 are fixed to uprights 5 by any suitable assembly means, such as screw 13 and pass in sliding relationship through upright 10. For ease of operation, it is a preferred embodiment to employ sleeve 14 which fits into a female bore in upright 10 and through which smooth rod 9 passes in a sliding relationship. Set screw 15 may be tightened against sleeve 14 and effectively clamp upright 10 in place. This arrangement permits the outer surface of sleeve 14 to become marred by the repeated applications of set screw 15 without affecting the smooth, sliding relationship between the inside of sleeve 14 and smooth rod 9. It may be seen therefore that when set screw 15 is loosened, the device may be adjusted by simply turning heads 11 until the proper location for uprights 10 and pins 2 is reached, and thereafter set screw 15 may be tightened to prevent movement of uprights 10, and in addition, if it is desired, set screw 16 may be tightened to prevent any turning of rods 8. The clamping action of set screws 15 and 16 is effective in preventing any longitudinal movement between pins 1 and pins 2 without causing any damage to the threads of rods 8, as might be the case if set screws were applied directly to the threaded portions of rods 8.

At the lower extremities of uprights 5 and 10, holes 17 are positioned generally parallel to pins 1 and 2. Through these holes, if it is desired for purposes of assisting in the rigidity of the structure, a spacer rod 18 may be placed and held in position by set screws 19. In these drawings such a spacer rod 18 is shown joining the lower portions of uprights 5, while such a spacer rod is omitted between uprights 10. While it is frequently advisable to employ such spacer rods, it is not a necessary part of this invention and should therefore be considered a preferred embodiment.

When the instrument of this invention is employed in a tibial-lengthening procedure, another subassembly is desirable in order to provide a further improvement. This subassembly is employed to hold the heel and the foot of the patient in the proper relationship to the remainder of the leg, while the bone is knitting in its new lengthened condition. Prior to this invention, the heel and foot were encased in a cast which was heavy, uncomfortable, and medically undesirable. This subassembly comprises two uprights 20 similar in many regards to uprights 5 and 10, fitted with holes to accommodate threaded rod 8 and smooth rod 9 and sleeve 21. In this instance, however, the mating hole in uprights 29 through which threaded rod 8 passes is not threaded, but is smooth and slightly larger than the outside diameter of threaded rod 8, permitting a sliding relationship therebetween. The relationship between uprights 20, sleeve 21, and smooth rod 9 is substantially the same as that found between upright 10, sleeve 14, and rod 9. Set screws 22 may be tightened on sleeve 21 which in turn tightens against rod 9, preventing further sliding movement of upright 29. Holes 23 are placed in the lower extremities of upright 20 so as to receive spacer rod 24 which serves the same purpose as spacer rod 18, described above. The position of spacer rod 24 is maintained by set screws 25 when this embodiment of the invention is employed.

Heel fixation pin 26 which is identical in structure to fixation pins 1 and 2 is held at the end of two pin arms 27 in a fixed position by set screws 28. Pin arms 27 fit into holes in studs 29 which are held in place by nuts 30. The relationship between stud 29, arm 27, and upright 20 is such that when nut 30 is loosened, arm 27 is capable of sliding in the hole in stud 29 so as to move pin 26 closer to or farther away from upright 20, and at the same time, stud 29 may be rotated within its mating bore in upright 20, permitting a radial adjustment of pin 26. However, in any position, nut 30 may be tightened, preventing any movement of stud 29 and arm 27, thus causing pin 26 to maintain a fixed position.

A desirable feature which is not necessary but which is a valuable assistant in employing this instrument is the use of

nuts 31 in conjunction with locking pins 32. Nuts 31 have internal threads which match the threads of rods 8 and serve, by the action of locking pins 32, to fix uprights 20 to an operative connection with rods 8. After heel fixation pin 26 has been placed in the calcaneus of the patient and appropriate adjustments have been made with arms 27, stud 29, and nuts 30, to place the foot in the proper position nuts 31 may be screwed in closely to uprights 20 and locking pins 32 pushed into place through matching holes in nut 31 and upright 20. From that moment on, the distance between bone fixation pins 2 and heel fixation pin 26 maintains a constant measurement and any adjustment made by rotation of head 11 will move pins 2 and 26 in a fixed relationship with each other, thus assuring proper control of angulation, rotation, anterior bow, and valgus. Furthermore, since there need not be any heavy cast placed around the leg of the patient because all portions are maintained in a rigid, fixed relationship, there is no pressure necrosis of the overlying skin when employing this instrument.

The operation of the instrument may be seen in FIG. 5 wherein the instrument is shown in relationship to the lower limb and bones of a patient to which this instrument is being applied. The leg of the person is shown 33 with the tibia shown in two portions on either side of a break 37, the proximal portion 34 and the distal portion 35, and in the heel of the patient is shown the calcaneus 36. In the setting of bone fixation pins 1, holes 38 are drilled through the tibia and pins 1 are placed through those holes. Similarly, holes 39 are drilled through the tibia at a position sufficiently farther down the leg to leave room for the bone to be broken in between at a desired location. Pins 2 are placed through holes 39 and similarly a hole is drilled through the calcaneus and pin 26 is placed through that hole. The entire instrument is then built around the five bone fixation pins by fixing crossbars 3 to the ends of pins 1 and 2, and attaching arms 27 to the ends of pin 26. Crossbars 3 are attached to uprights 5 and 10 which may already be in position on threaded rods 8 and smooth rods 9. By suitable adjustment, uprights 5 and 10 are placed into position and one or more spacer rods 18 are fixed to produce the rigid relationship desired.

At the heel of the patient portions of the instrument are assembled by placing nuts 31 on rods 8 and sliding uprights 20 over rods 8 and 9 to the proper position so that the ends of arms 27 may be inserted into the appropriate holes in studs 29 which, after proper adjustment to place the heel and the foot of the patient in the desired position, may be fixed by tightening nuts 30. Nuts 31 are then tightened against uprights 20 and pins 32 are inserted through nuts 30 and into uprights 20 to lock the nuts in place. Thereafter, through known surgical procedures, the tibia may be broken and over succeeding days heads 11 may be turned so as to pull the proximal portion 34 away from the distal portion 35 at the desired rate. It may be seen that by the turning of heads 11, the distance between pins 2 and 26 maintains itself as a constant, and as the muscles are lengthened the foot is maintained at proper position and "foot drop," which has occurred frequently when prior art devices have been used, is prevented entirely.

Suitable sizing of the various pieces of the instrument described above and proper locations thereof cause this instrument to be fully rigid and inflexible, and thereby prevent the development of undesirable side effects which frequently occurred in the use of prior art instruments. For use in tibial-lengthening procedures, uprights 5, 10, and 20, as well as crossbars 3, may be made of five-eighths inches square stock. Rods 8 are $\frac{3}{8}$ ×16 threaded rods, and rods 9 are three-eighths inches smooth rods. All materials are preferably made of stainless steel. When these portions are manufactured with suitable close tolerances and assembled, they provide a rigid structure which is easily adjusted and which overcomes any tendency for the orthopedic surgical procedure to produce side effects such as angulation, rotation, anterior bow and valgus. It is highly desirable that the location of threaded rods 8 be close to the upper end of uprights 5 and 10, so that when pressure is applied by turning rods 8 to move the proximal

portion 34 and the distal portion 35 apart, the pressure will be applied as nearly as possible to the plane defined by pins 1 and 2. Furthermore, the presence of smooth rods 9 adds to the rigidity and the inflexibility of the instrument, as well as to assist in maintaining the rectangularity of the apparatus. It is highly desirable from a structural point of view that rods 9 be located at the opposite extremities of uprights 5 and 10 from the location of threaded rods 8. Prior art devices normally contain only a threaded rod such as rods 8 and locate such a rod in the general vicinity of that shown in the instrument of this device for smooth rod 9. As a result, there was a sizable distance between the plane of fixation pins 1 and 2 and the location of the force for pushing uprights 5 away from uprights 10. The resistance force of the stretching muscles was located at a considerable distance from the force applied through the threaded rod to produce the stretching of the muscles and, accordingly, the resulting side effects of anterior bow and valgus were produced. Rotation and angulation are, of course, prevented by the absolute rigidity and inflexibility with which the proximal portion and distal portion of the bone is maintained.

Although the invention has been described in considerable detail with reference to certain preferred embodiment thereof, it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinabove and as defined in the appended claims.

I claim:

1. An orthopedic distraction instrument comprising two pairs of horizontally disposed, coplanar, mutually parallel bone fixation pins, each pair of pins supported by a pair of upright parallel rigid supports; a third single bone fixation pin supported in a third pair of upright parallel rigid supports spaced apart from, in alignment with and similarly positioned to the other pairs of upright parallel rigid supports so as to result in two parallel rows of three upright supports, each of said two rows having a threaded rod located in close proximity to said pins and operatively connected to said uprights and a nonthreaded rod slidably connected to said uprights at the ends distant from said pins; a pair of arms adjustably connected to said third pair of supports holding the ends of said

single bone fixation pin in a generally parallel relationship to said two pairs of pins; adjustable means for holding said two rows of supports in a fixed spaced relationship with each other; means for rotating said threaded rods to adjust the distance between supports in either of said rows; and means for clamping said threaded rod to prevent rotation.

2. An orthopedic tibial-lengthening instrument comprising two pairs of horizontally disposed, coplanar, mutually parallel bone fixation pins, the first pair being adapted to be fixed to the proximal portion of a tibia and the second pair being adapted to be fixed to the distal portion of the tibia, the ends of said first pair of pins being held by a first pair of upright, parallel rigid supporting members and the ends of said second pair of pins being by second pair of upright, parallel, rigid supporting members; a horizontally disposed bone fixation pin adjustable in a generally parallel relationship to said two pairs of pins and adapted to be fixed to the calcaneus, said pin being held by adjustment means attached to a third pair of upright parallel rigid supporting members; two parallel longitudinal, substantially inflexible, threaded rods operatively connected said three pairs of supporting members substantially at right angles to said pins and in close proximity to said pins; two parallel longitudinal, substantially inflexible, unthreaded rods slidably connected to said three pairs of supporting members substantially at right angles to said pins and distant from said pins; means for adjusting the distance between adjacent pairs of supporting members by rotation of said threaded rods; and means for clamping said pairs of supporting members in any given location.

3. The instrument of claim 2 wherein said means for adjusting the distance between adjacent pairs of supporting members includes an unthreaded connection between said threaded rods and said first pair of supporting members and mating threaded connections between said threaded rod and said second and third pairs of supporting members.

4. The instrument of claim 3 wherein said means for clamping includes a set screw in said first pair of supporting members operatively connected to the unthreaded portions of said threaded rods.

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