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Seppo

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[54] **FIXING APPARATUS FOR OSTEOSYNTHESIS OF FRACTURES OF LONG TUBULAR BONES**

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[58] **Field of Search** ..... 128/92 R, 92 B, 92 BC, 92 D, 128/92 G, 92 E

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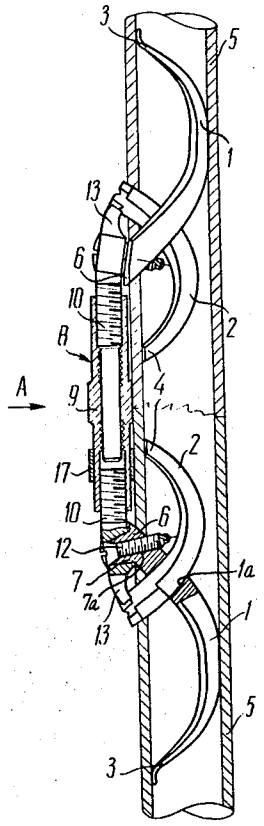
[57] **ABSTRACT**

A fixing apparatus for the osteosynthesis of fractures of long tubular bones in which two pairs of interconnected curved rods have the free ends of each pair being directed to the opposite sides.

Each pair of the rods is intended for introduction into one of the bone fragments so that the free ends of the rods and the middle portion of one of the rods must rest on the compact layer within the wall of the bone tube at the opposite sides.

The pairs of the rods are interconnected through a coupling allowing the distance between the pairs of the rods and their position to be forcibly changed and fixed.

5 Claims, 3 Drawing Figures



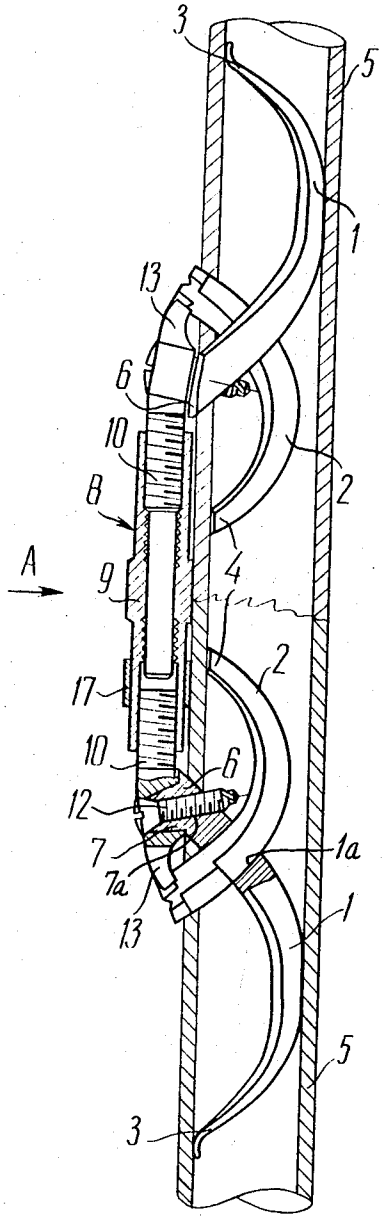


FIG. 1

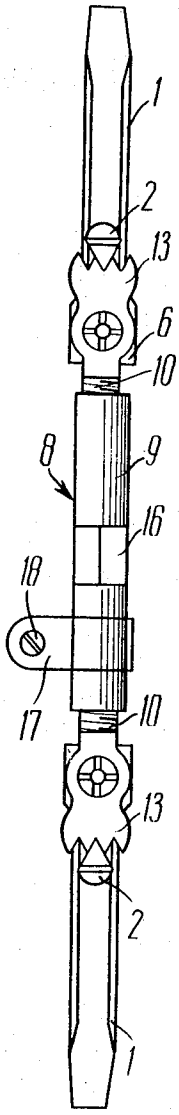


FIG. 3

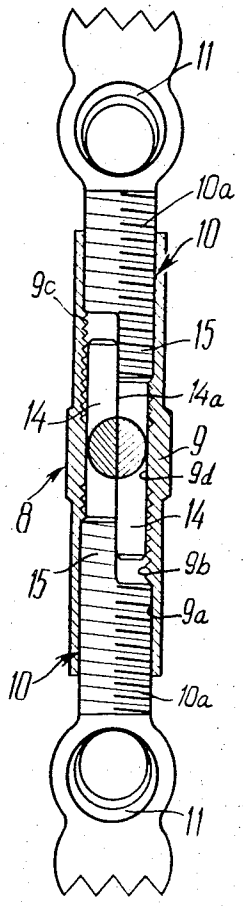


FIG. 2

FIXING APPARATUS FOR OSTEOSYNTHESIS OF FRACTURES OF LONG TUBULAR BONES

BACKGROUND OF THE INVENTION:

The present invention relates to surgeon's instruments and, more particularly, to fixing apparatus for the operative connection and fixation of splintered and non-splintered diaphysary and metaphuso-diaphysory fractures of long tubular bones.

The fixing apparatus used for this purposes at the present time consists of screws, bolts, plates with screws or bolts and various nails: straight, curved and collapsable used for connection of bone fragments. These devices are disadvantageous in that they do not provide for mechanization of the labor-consuming and traumatic process of setting the fragments. Furthermore, such devices introduce an additional trauma into the zone of regeneration due to the fact that the metal is in contact with the ends of the fragments, thus destroying the blood and nervous systems of the ends of the fragments or of the whole bone. This is very dangerous when curing serious fractures caused by heavy blows, in which case the grophic and vital areas of the bone are severely damaged.

During the entire history of the metallic osteosynthesis, various versions of fixation of the fragments were developed empirically, without calculations based on the experimental data of the resistance of the bone offered to crushing and displacement in different layers. Our experiments have shown that in case of all the above-mentioned versions of application of the known fixing apparatus, the stress on the supporting platforms of the contact of the bone with the metal is always higher than the resistance of the bone tissue offered to the crushing action under conditions of a variable load appearing during the operation of lifting and lowering the unloaded limb of the patient, even if the patient is confined to bed. While the resistance of the bone to the crushing action is lower than the appearing stress, the bone tissue is destroyed on the supporting platform of the contact of the bone with the metal. Therefore, it is out of the question to provide for a stable and long-term strong fixation of the bone fragments in the course of curing present day fractures.

Attempts have been made to increase the stability of the fixation by drilling the bone tube on the inside and inserting a thick nail into the thus drilled bore. However the clinical evidence and experiments have demonstrated that this method is associated with a lengthening of the curing period, slowing and retardation of the regeneration and, furthermore, results in heavy complicating sequelae, such as the impossibility of recovering normal structure and strength of the bone or incorrigible necrosis of the bone. In the case of multisplintered diaphysary fractures and metaphysodiaphysary fractures, this method is technically inapplicable due to the fact that the width of the bone-brain cavity of one fragment is two to three times as large as of that of the other. At such a difference in the width of the conical cavities and at the thickness of the walls of the bone within the range of two to seven mm, it is not possible to drill the same into equal-diameter cylinders. An inadequate fixation of the fragments and their tilting on the metal rod create a source of prolonged irritation which can not be cured by additional immobilization of the limb through the use of a gypsum band. The gypsum has a no rigid direct contact with the bone, while the thick layer of the soft tissues between the bone and the gypsum bears the possibility of tilting. It is well known that keeping the limb in gypsum, two weeks and more, leads to an incorrigible disturbance in the mineral exchange in the bone associated with a loss of calcium and phosphorus. Thus, the additional trauma, inadequate fixation of the fragments and long-term gypsum band result in disturbances in circulation, exchange, trophic, regeneration and, particularly, in the function of the muscles and joints. Therefore, the above-mentioned empirical fixing apparatus do not meet the demands of the cure of present day heavy fractures caused by heavy accidental blows.

An object of the present invention is to provide a fixing apparatus for the osteosynthesis of fractures of long tubular bones which, for the purpose of reducing a trauma during the operation of osteosynthesis, makes it possible to mechanize the reposition and exact co-position of the fragments without scalping the same and to protect the surfaces of the fracture and the ends of the fragments from injurious contact with the metal and also to fix the fragment with such a margin of safety as to eliminate a gypsum band and restore the supporting function of the bone and the moving function of the damaged unloaded fragment and of the whole limb immediately after the operation. In this case, the fixation must be efficient for a long time, to allow the contact of the connected fragments with the bone to be released to biologically optimum conditions. Also, the patient should not be confined to bed and allowed to be discharged from the hospital after the healing of the skin wound. The metal portion of the fixing apparatus must not protrude outside through the skin so as to eliminate an introduction of a secondary infection into the bone.

SUMMARY OF THE INVENTION

This object is attained by means of fixing apparatus for osteosynthesis of fractures of long tubular bones which, according to the invention, comprises two pairs of interconnected curved bracing rods whose free ends in each pair are directed to opposite sides and, when each pair of the rods is introduced into one of the bone fragments, used for resting on the compact layer of the wall of the bone tube at one side, while the middle portion of one of the rods is used for resting on the compact layer of the bone tube at the diametrically opposite side, with the pairs of the curved rods being interconnected through a coupling having split hinged joints with the ends of the rods and serving for a forced change and fixation of the distance between the pairs of the rods and of the position thereof, the hinged joint being provided with an adjustable stop to control the angle of rotation.

The coupling is preferably provided with a bushing having oppositely threaded portions at the ends thereof for receiving two stretchers having oppositely threaded portions. The ends of the stretchers located within the bushing are longitudinally cut-off approximately to half of their diameter and engage each other by the cut-off surfaces, with a middle portion of the bore of the bushing being a smooth-wall cylinder, and the inner diameter of the middle portion being selected so as to provide

a pressing of the cut-off ends against each other in a transverse direction normal to the plane of the cuts, thereby allowing sliding of the stretchers in the longitudinal direction without mutual rotation while the fixation of the stretchers in a predetermined position is provided.

The hinged joint of the coupling with the end of the rod includes a projection in the form of a truncated cone at the end of the rod and a complementary conical hole in the coupling braced by a screw.

It is expedient that the end of the screw bracing the hinged joint be in the form of a drill transforming into a tap.

The adjustable stop for controlling the angle of rotation may be a toothed sector at the end of the coupling engaging the end of the rod which does not participate in the hinge-joint connection of the coupling with the rod.

The present fixing apparatus for the osteosynthesis of fractures of long bones, when used as a jack with a multiside control, makes it possible to mechanize the operation of the setting and accurate positioning of the fragments without removing the periosteum and muscles and without breaking the circulation and innervation both outside and inside the bone as well as protecting the ends of the fragments from an additional trauma and contact with the metal. On providing independent and controllable fixation of each fragment separately, present fixing apparatus makes it possible to reduce the contact of the bone fragments with the bone to a biological optimum. By fixing the fragments according to the principle of a prestressed system with a support on a strong compact layer of the bone with an adequate margin of safety for the bone and the metal, it is possible to ensure a lasting and reliable fixation and eliminate a gypsum band, while providing supporting and moving functions for the operated segment of the limb immediately after the operation. The metal portions of the fixing apparatus do not protrude outside through the skin and thus eliminate the possibility of the penetration of a secondary infection.

The invention will be further described by way of example with reference to the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a general view partly in section and partly in elevation of the present fixing apparatus with, the apparatus being shown in the position of connection of the fragments of a tubular bone;

FIG. 2 is an enlarged fragmentary view in longitudinal section of the coupling according to the invention, with the view being along arrow A in FIG. 1; and

and FIG. 3 illustrates in plan the fixing apparatus according to the invention, a view along arrow A.

DETAILED DESCRIPTION OF THE INVENTION

The fixing apparatus for osteosynthesis of long tubular bones comprises two pairs of curved rods **1** and **2** (FIG. 1). Each pair of the rods **1** and **2** has ends **3**, **4** directed to opposite sides and used for resting on a compact layer of the wall of a bone tube **5** on the inside. The middle portions of the rods **1** rest on the opposite inside wall of the bone tube **5**. Provided in the rod **1** is a through slot **1a**, through which passes the rod **2** so that the rods **1** and **2** of each pair are interconnected. The rod **1** has a supporting platform or base **6** for resting on the outside wall of the bone tube **5**.

The end of the rod **1** located above the platform **6** consists of a projection **7** in the form of a truncated cone provided with an inner threaded hole **7*a***. A coupling **8** is placed on the projections **7** of the rods **1**. The coupling **8** includes a bushing **9** and two stretchers **10**. Provided at the ends of the stretchers **10** are conical holes **11** (FIG. **2**) for receiving the conical projections **7** (FIG. **1**) of the rods **1** and defining therewith a hinged joint braced by a screw **12**. The working end of the screw **12** is in the form of a drill transforming into a tap whereby it is possible to drill the edge of the bone hole by the screw **12** when the screw is drawn up.

The stretchers **10** terminate in toothed sectors **13** (FIG. **3**) for engaging the ends of the rods **2** protruding from the bone and providing an adjustable stop of rotation of the hinged joint.

The bushing **9** has a bore **9*a*** provided with oppositely threaded portions **9*b*** and **9*c*** for coacting with threaded portions **10*a*** of stretchers **10**. Ends (FIG. **2**) of the stretchers **10** are coupled with each other and to effect such end, the ends are cut-off approximately to half of their diameter and engage each other by dimetral flat surfaces **14*a***. A middle portion **9*d*** of the bushing bore **9*a*** represents a smooth-wall cylinder, the diameter of which is selected so as to provide a pressing of the surfaces **17*a*** against each other in a transverse direction perpendicular to the plane of the surfaces **14*a*** thereby allowing sliding of the ends **14** of the stretchers **10** in a longitudinal direction without any play in the transverse direction during the rotation of the bushing **9**.

The length of the cuts at the ends of the stretchers exceeds the length of the smooth portions of the ends **14** so that portion **15** of the thread is wedged on the stretchers **10** in the radial direction, and this eliminates a play in the threaded joint. In this case, the tensile, compressive, and torsional strength of the coupling of the stretchers **10** through the bushing **9** is equal to that of a round integral rod of the same diameter and of the same material.

To provide for convenient rotation, the bushing **9** has outer faces **16** (FIG. **3**) for receiving a spanner. The rotation of the bushing **9** makes it possible to change the distance between the stretchers and hence, the distance between the pairs of the rods **1** and **2** holding the bone fragments. If necessary, the fixing apparatus may be provided with one or more splinter holders **17**. The splinter holder **17** is in the form of a collar placed on the bushing **9** and braced by means of a screw in this case which in this case is threaded into the splinter being fixed.

The fixing apparatus for osteosynthesis of long tubular bones operates as follows:

The bone fragments are not scalped but solely freed from the periosteum and muscles within ⅓ to ¼ of a circle along the distance of three to five cm. By rotating the peripheral fragment about the axis, the dislocation ad periferiam is eliminated, and this operation is not associated with any difficulties. Then, in each fragment is drilled a hole approximately at an angle of 45° to the longitudinal axis of the bone with an inclination from the plane of the fracture. From the edge of this hole, a slot is sawed by a cutter for passing therethrough the

rod 2. The holes are made at a distance of two to four cm from the plane of the fracture. Thereafter, the surgeon introduces the rods 1 (FIG. 1) into the bone-brain cavity through the round inclined hole in each fragment. The rods 1 are introduced up to the rest of their ends 3 and the middle portions on the opposite walls of the bone tube 5. Then, the rods 1 are hammered to the rest of the platform 6 on the outer wall of the bone tube 5. If the length of the rods 1 was correctly selected by the roentgenogram, the rods 1 are matched after effecting the above operations. The coupling 8 is placed on the conical portions 7 of the rods 1 protruding from the bone. The hinged joints between the ends of stretchers 10 and the projection 7 are movably secured through the screws 12. By rotating the bushing 9, the fragments are displaced from each other up to the disappearance of the contact therebetween. Now, the fragments can easily be turned to the condition of accurate positioning. In this position of the fragments, the rods 2 are introduced through the slots in the rods 1 into the bone-brain cavity up to the rest of their free ends 4 on the compact layer of the wall of the bone tube 5 on the inside, and the hinged joint is tightened by the screw 12 up to the rest. In this case, both rods 1 and 2 are in the bone-brain cavity in a prestressed state, thus forming an elastic damping system of connection of each segment to the coupling 8 independently on the other.

By rotating the bushing 9 in the opposite direction, the fragments are moved towards each other through their fracture planes. The construction of the fixing apparatus is such that first there are closed the edges of the fragments more remote from the coupling 8 and the last to be closed are the edges under the coupling 8. The contact between the fragments is brought to a biological optimum and compression is not required. Then, the fracture is covered by the previously partially scalped muscle-periosteal shred. The metal portions of the fixing apparatus are disposed beyond the place of fracture and do not contact it so there is not disturbance in the circulation and innervation in the bone, both on the outside and the inside. The wound is stitched layer-by-layer and a sterile dressing is applied. The supporting and moving functions of the operated segment are recovered immediately after the operation.

The use of the present fixing apparatus for the first time in the history the development of metal ostesynthesis makes it possible to fix fragments of a broken tubular bone with a three to nine-fold margin of safety for the bone against crushing under conditions of a variable load. This allows the fractured bone to assume a supporting function immediately after the operation.

The streamlined shape and small diamensions of that portion of the fixing apparatus, which is beyond the bone, do not interfere with the mobility of the muscles and joints. The metal portions of the fixing apparatus do not protrude through the skin and this eliminates the possibility of the penetration of a secondary infection.

Earlier recovery of the supporting and moving functions of the operated limb and liberation of the patient from the bed care assist in the normalization of the circulation and substance exchange which finally accelerate the regeneration.

Scar contractures and development of hardly movable portions of the joints are eliminated.

The present invention will allow the bone recovery operative surgery to be transferred from the level of clinical empiricism to the level of precise clinical and technical sciences. The adoption of the invention into the clinical practice will reduce the period of hospital care of the patients by a factor of two to three and will make it possible to cure those patients which are still considered incurable and make them able-bodied. The invention will considerably reduce the cases of disablement as well as the expenses for curing patients with fractures of tubular bones.

I Claim:

1. A fixing apparatus for osteosynthesis of fractures of long tubular bones comprising in combination: two pairs of interconnected bracing curved rods, the free ends in each pair being directed in opposite directions for introduction of each said pair of rods into one of the bone tube fragments for resting on the inner compact layer of the bone tube at one side with the middle portion of one of said rods for resting on the compact layer of the wall of the bone tube at the opposite side, a coupling connecting both said pairs of the rods and adapted for a forced change and fixation of the distance between said pairs of the rods and their position, hinged joints connecting said coupling with said rods, and adjustable stops controlling the angle of rotation of said hinged joints.

2. The fixing apparatus as claimed in claim 1, in which the coupling comprises a bushing having oppositely threaded portions at the ends thereof in its bore two stretchers threaded into the oppositely threaded portions of said bushing, the ends of said stretchers disposed within said bushing being shaped to provide semi-cylindrical portions, with the diametral surfaces of the semi-cylindrical portions engaging each other, the middle portion of the bushing having a smooth wall cylindrical surface which coacts with said semi-cylindrical portions, the diameter of said cylindrical surface being selected so as to press the diametral surfaces against each other in a transverse direction normal to the plane of the diametral surfaces so that upon rotation of the bushing, there is insured a longitudinal displacement of said stretchers without any play relative to each other and also provide for rigid fixation of said stretchers in a predetermined position.

3. The fixing apparatus as claimed in claim 1, in which said hinged joints are defined by a projection in the form of a truncated cone at the end of said rods and by a complementary conical hole in said coupling, and being braced by a screw.

4. The fixing apparatus as claimed in claim 3, in which the end of said screw is in the form of a drill transforming into a tap.

5. The fixing apparatus as claimed in claim 1, characterized in that said adjustable stops for controlling the angle of rotation comprises a toothed sector at the end of said coupling engaging the end of one of said rods of a respective pair of curved rods.

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