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E. J. HABOUSH

2,590,532

DEVICE FOR BENDING FRACTURE NAILS AND THE LIKE FOR
IMPACTING FRACTURES AND EXTRACTING SUCH NAILS

Filed Nov. 30, 1949

2 SHEETS—SHEET 1

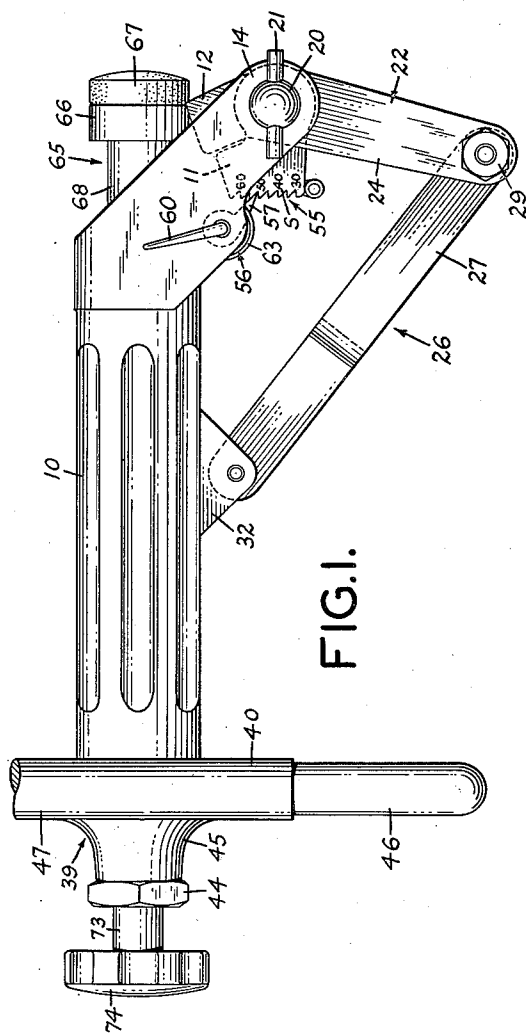


FIG. 1.

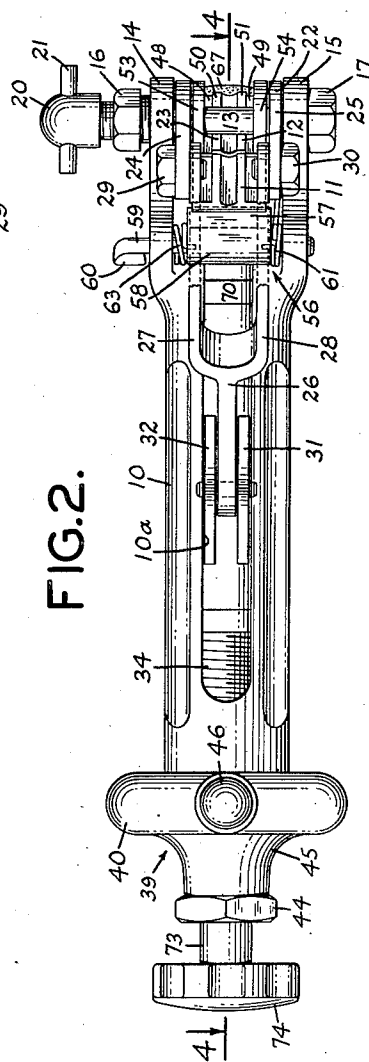


FIG. 2.

INVENTOR.
EDWARD J. HABOUSH
BY
Campbell, Birmingham, Free & Seaver
HIS ATTORNEYS.

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2 SHEETS—SHEET 2

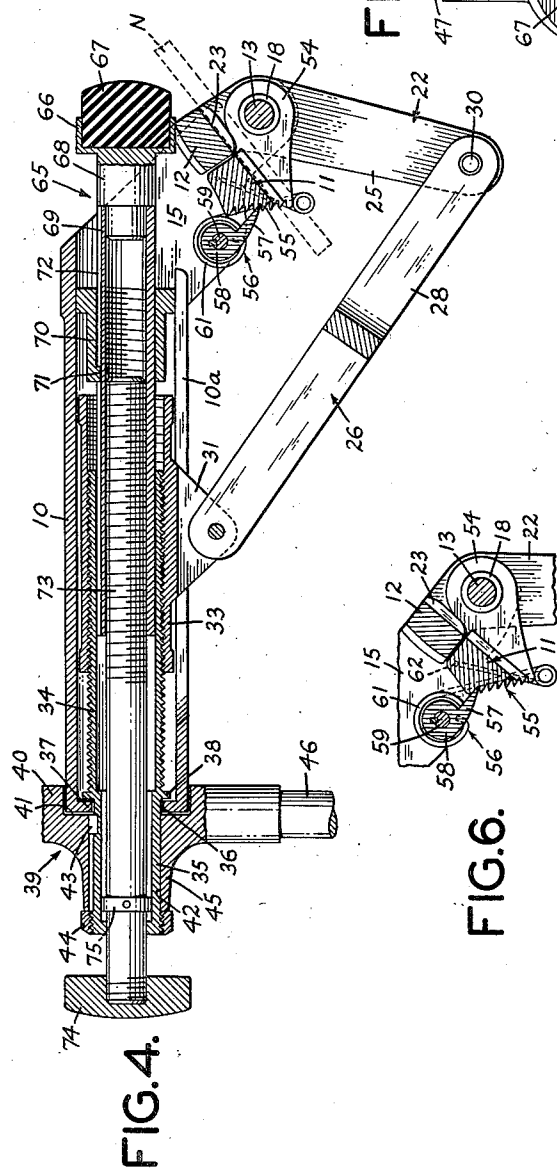


FIG. 3.

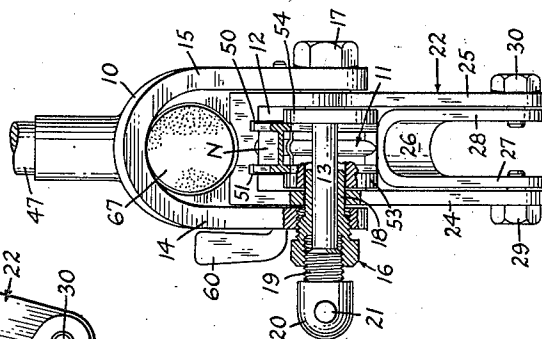
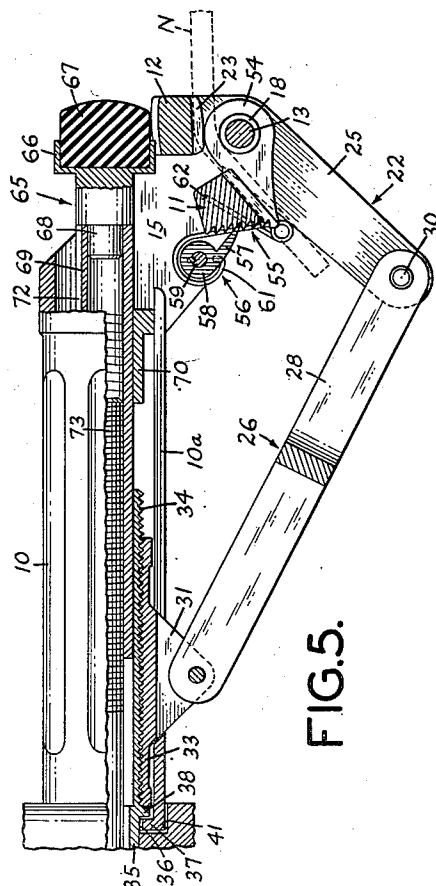
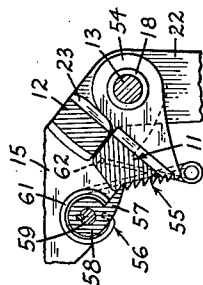


FIG. 6.



INVENTOR.
EDWARD J. HABOUSH
BY

Campbell, Brumbaugh, Freer & Groves

HIS ATTORNEYS.

UNITED STATES PATENT OFFICE

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DEVICE FOR BENDING FRACTURE NAILS
AND THE LIKE FOR IMPACTING FRACTURES
AND EXTRACTING SUCH NAILS

Edward J. Haboush, Brooklyn, N. Y.

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5 Claims. (Cl. 128—303)

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This invention relates to surgical instruments and it relates particularly to instruments for bending, inserting and removing nails and bone plates used for the reduction and fixation of fractures, especially fractures of the hip.

In reduction of fractures of the hip, as well as other fractures, it has become rather common practice to reinforce and fix the fracture by means of bone nails or pins, bone plates or combined nails and plates which are driven into the bone fragments and/or secured to them to span the fracture to fix the fragments relative to each other so that they may knit together. In many cases, the use of these artificial reinforcing elements permits the use of the fractured member while the fracture is knitting or healing.

When combined nails and bone plates are used for the fixation of fractures at the neck of the femur, one end of the nail and bone plate is driven into the fragments so that it spans the fracture with the end of the nail embedded in the ball of the femur. The remainder of the nail and bone plate is bent down and fastened to the shaft of the femur by means of screws to form a strong and rigid connection across the neck of the femur.

One of the difficulties encountered in this type of fracture fixation is the bending of the nail and bone plate to the proper angle so that the projecting portion of the plate lies parallel with the shaft of the femur.

Nail and bone plates must be strong and relatively rigid so that motion between the bone fragments is prevented, even when the patient is permitted use of the fractured member. Because of this rigidity, it is most difficult to bend the plate to the desired angle with the instruments now available. Especially it is not possible to do this when the nail and plate has been driven into the bone and is in the best position to determine the angle to which the protruding portion of the nail and plate must be bent to render it parallel to the bone. Therefore, it is customary to bend the plate or nail prior to driving it into the bone. Such bending produces, at best, only an approximation of the correct angle. Moreover, the bent condition of the nail makes it difficult to drive and guide the nail accurately into the bone.

The present invention provides an instrument which overcomes the disadvantages of prior nail bending devices, and makes possible easy and accurate bending of such bone nails and plates.

A typical embodiment of the invention may include a pair of relatively movable anvil mem-

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bers which support a nail or nail plate in contact with a fulcrum member closely adjacent to the bone. The anvil members are first moved into alignment to engage a straight nail or plate and then are moved relatively to bend the nail around the fulcrum member to a preset angle or to a desired angle by visual inspection. One of the anvils may be preset to a predetermined angle so that when the other anvil is moved to the limit of its angular movement, the nail is bent to the predetermined angle.

The device is provided with power multiplying means so that while it is compact and convenient to manipulate, sufficient power may be developed at the anvils to bend the most rigid types of nails and plates available.

Moreover, the instrument may include an impactor for seating the bone fragments and this impactor may be used in conjunction with the bending elements to drive the nail into the bone and to withdraw the nail from the bone if it is inserted improperly or too deeply.

For a better understanding of the present invention, reference may be had to the accompanying drawings, in which:

Fig. 1 is a view in side elevation of a typical bending and impacting instrument embodying the present invention;

Fig. 2 is a bottom plan view of the instrument shown in Fig. 1;

Fig. 3 is a view in elevation of the head of the instrument which is partly broken away to disclose details thereof;

Fig. 4 is a view in section taken on line 4—4 of Fig. 2;

Fig. 5 is a view partially in side elevation and partially in section and of a part of the instrument broken away showing an adjusted position thereof; and

Fig. 6 is a view in section of a detail of the instrument illustrating a different relation of the parts thereof.

The instrument chosen for purposes of illustration is constructed for use with combined nails, nail plates and nail and bone plates of the type disclosed in my copending application Serial No. 782,503, filed October 28, 1947, and now Patent No. 2,496,126. Nails and nail bone plates of the type disclosed in the application will be referred to hereinafter as nails for brevity. These nails are generally I-shaped in cross-section.

The instrument is designed to accommodate the flanges on the I-shaped section, but it will be understood that the device can be modified

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to receive and bend other types of nails and plates than the nails disclosed in the above-mentioned application.

As best shown in Figs. 1 and 2, the nail bending instrument includes a tubular handle 10 which may be grooved, knurled or serrated to afford a suitable grip so that the handle will not turn readily in the hand. The handle 10 serves as a support for a pair of relatively movable anvil members 11 and 12 and also for a fulcrum pin 13 about which the nail N, shown in dotted lines in Figs. 4 and 5, is bent. The anvil members 11 and 12 are supported between a pair of spaced apart arms 14 and 15 which are connected to the right-hand end of the handle 10, as viewed in Fig. 1 and project outwardly therefrom at an acute angle to the axis of the handle. The fulcrum pin 13 is mounted in the ends of the arms 14 and 15 by means of a pair of externally threaded sleeves 16 and 17 which are screwed into the arms 14 and 15 and have non-threaded end portions 18 which project beyond the inner surfaces of the arms; for example, the arm 14, as shown in Fig. 3, to form a bearing or bearing sleeve for supporting the anvil members 11 and 12, as will be described. Each of the sleeve members 16 and 17 also is internally threaded for a portion of its length to receive the threaded enlargement 19 on the fulcrum pin 13. The inner ends of the sleeves 16 and 17 are smooth and serve as bushings for receiving the reduced portion of the pin 13. The pin 13 may also be provided with an enlarged head 20 and a cross pin 21 to facilitate its rotation to insert it and remove it from the sleeves 16 or 17. The pin 13 can be inserted through either of the sleeves 16 and 17 as may be desired and depending upon the convenience to the operator.

The sleeves 16 and 17 support a U-shaped member 22 which has its base formed by the anvil member 12. The arms 24 and 25 of the U-shaped member 22 on the opposite side of the pivot pin 13 from the anvil 12 are inclined at an obtuse angle to a line extending through the axis of the pivot 13 normal to the adjacent face 23 of the anvil 12. (Figs. 4, 5 and 6.) The arms 24 and 25 of the member 22 form one arm of a toggle system by means of which the anvil member 12 can be rocked around the fulcrum pin 13. The other arm of the toggle consists of a Y-shaped member 26 having spaced apart arms 27 and 28 connected by means of pivot screws 29 and 30 to the ends of the arms 24 and 25, respectively. The opposite end of the Y-shaped link 26 is connected between a pair of lugs 31 and 32 extending from a tubular internally threaded sleeve member 33 which is slidable axially within the handle 10. The lugs 31 and 32 extend through a guide slot 10a extending lengthwise of the handle 10.

Upon sliding movement of the sleeve 33 to the right, as viewed in Figs. 4 and 5, the anvil member 12 is rocked counterclockwise around the pivot and upon sliding movement of the sleeve 33 to the left, the anvil member 12 is rocked clockwise around the pivot. Sliding movement of the sleeve is produced by means of an externally threaded tubular member 34 mounted within the handle 10 and threaded into the sleeve 33.

As best shown in Fig. 4, the tubular member 34 has at its left-hand end a reduced unthreaded tubular portion 35 which is rotatable in the opening 36 in the left-hand end of the handle

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10 formed by the inturned flange 37. The member 34 has an enlarged collar 38 which bears against the flange 37 and limits movement of the member 34 to the left.

Movement of the threaded member 34 to the right is prevented by means of the operating handle 39 including a disc-like portion 40 having an internal circular recess 41 for receiving the left-hand end of the handle 10. The handle 39 has an internal bore 42 receiving the sleeve portion 35 and is secured thereto against relative rotation by means of a suitable key 43 or its equivalent. The handle 39 is retained in position by means of a lock nut 44 threaded on the outer end of the sleeve portion 35 and abutting the tubular extension 45 on the handle 39.

To facilitate rotation of the handle 39, it may be provided with outwardly extending rods 46 and 47 (Figs. 1 and 3) by means of which more power can be applied to the tubular member 34.

Inasmuch as the handle 39 abuts the end of the handle 10, rotation of the handle 39 relative to the handle 10 will cause the sleeve 33 to move lengthwise of the handle 10, thereby rocking the anvil member 12, as described above.

As best shown in Fig. 2, the surface 23 of the anvil member 12 is provided with a pair of spaced apart grooves 48 and 49 defined by spaced apart ribs 50 and 51, substantially fitting the cross-sectional shape of the nail N to hold it against lateral sliding movement.

The anvil 11 is provided with similar aligned grooves and ribs so that it can engage a portion of the nail adjacent to that supported by the anvil 12 when the anvil members 11 and 12 are in alignment, as shown in Figs. 4 and 6.

The anvil member 11 is also supported on the bearing sleeves 18 of the members 16 and 17 for rocking movement relative to the arms 14 and 15. As best shown in Figs. 3 and 6, the anvil member 11 is supported on the sides of a pair of spaced arms 53 and 54 disposed between the arms 24 and 25 of the U-shaped member 22.

Above and behind the grooved surface of the anvil member 11 is an arcuate surface formed with ratchet teeth 55 by means of which the angular position of the anvil member around the fulcrum pin 13 can be controlled. The anvil member 11 is held in adjusted position by means of a pawl member 56 having a pawl tooth 57 and a hollow cylindrical barrel portion 58 fixed to a cross pin 59 which is rotatably mounted in apertures in the arms 14 and 15. The end of the cross pin 59 is bent laterally and is flattened to form an actuating lever 60 by means of which the pawl member 56 can be rocked to disengage the pawl tooth 57 from the ratchet 55. The ratchet 55 and the anvil member 11 are normally urged clockwise as viewed in Figs. 4, 5 and 6, by means of a looped spring 61 having one end 62 bent laterally and engaging in a hole in the side of the anvil member 11. Its opposite end is bent around the barrel 58 of the pawl and engages in an aperture therein to normally urge the pawl toward the ratchet 55. In this way, the pawl and the ratchet are always urged toward each other so as to retain the anvil member 11 against rotation in a clockwise direction unless the pawl is retracted, whereupon the anvil member 11 will swing into engagement with the side of the anvil member 12. If desired, a second spring 63 can be included to hold the pawl more strongly against the ratchet.

The above-described pawl and ratchet mecha-

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nism affords accurate control of the extent of bending of the nail.

The anvil member 12 is limited in its angular displacement by the extent of movement of the sleeve 33 relative to the handle 10 so that the total movement of the anvil member 12 in a typical instrument will be in the neighborhood of 60°. Therefore, if the anvil member 12 is rocked in a counterclockwise direction to its limit of movement and the anvil member 11 is aligned with it so that the nail N is in flat engagement with the surfaces of both of the anvil members, the nail can be bent to a 60° angle by rotating the handle 39 to cause the sleeve 33 to move to its limit of travel, as shown in Fig. 5. Assuming that the pawl 57 engages the uppermost tooth of the ratchet 55 when the anvil 12 is in alignment with the anvil 11, the nail will be bent by movement of the anvil member 12 through an angle of 60°. For lesser angles, the pawl member 56 is released so that the anvil member 11 can swing around in a clockwise direction to permit one of its lower teeth to engage the pawl 56 when the latter is released. By suitably spacing the teeth of the ratchet 55 and providing a scale S (Fig. 1) on the face of the anvil member 11, it is possible to bend the nail N through any of a series of angles of predetermined values.

The anvil member 11 is adjustable to increase the angularity of bending by rotating the handle 39 in such a direction as to bring the anvil 12 up against the anvil 11, as shown in Fig. 4, and continuing the rotation in a direction to further collapse the toggle so that the anvil member 11 is rocked against the action of the spring 61 in a counterclockwise direction to engage the pawl 56 with successively higher teeth on the ratchet, as shown in Fig. 6.

In use, the anvils 11 and 12 may be adjusted to approximately the desired angle to which the nail is to be bent by reference to the scale S. The handle 39 then is turned to grip the nail firmly between the anvil members 11 and 12 and the fulcrum pin 13. With the nail gripped tightly, the instrument can be used to drive the nail into the bone fragments across the fracture to a point where the end of the instrument is substantially in contact with the shaft of the bone to which the protruding end of the nail is to be fixed by means of screws and the like. The handle 39 is then rotated further, bending the nail over the fulcrum 13, as shown in Fig. 5, until the projecting portion of the nail lies parallel with the bone fragment to which it is to be secured.

The handle 39 is then rotated in the opposite direction to relieve the bending pressure on the nail and the fulcrum pin 13 can then be unscrewed and pulled out of the supporting sleeves 16 and 17, thereby leaving the nail in a position spanning the fracture. The nail can then be driven in fully until the downwardly bent portion thereof lies against the fragment of the bone to which it is to be fixed.

The ability of the device to be used in driving the nail and bending the nail after it has been partially driven into position is a great advantage for it makes possible the proper alignment of the relatively bent portions of the nail with the axis of the fractured bone and the outside of one of the bone fragments. The device can, of course, be used for bending nails prior to insertion, and after bending them, it may be used to drive the nail almost completely into the bone to span the fracture.

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The instrument is also provided with means for impacting fractures and for withdrawing nails which are not inserted properly or accurately. The impacting mechanism may consist of a hammer 65 which consists of a cup-like member 66 having a block of rubber 67 or the like mounted therein and projecting beyond the cup and having a shaft portion 68 which is fixed in the end of an internally threaded tube 69. A bearing sleeve 70 is fixed in the right-hand end of the handle 10 to receive the member 69 and guide it for sliding movement axially of the handle 10. The guide sleeve 70 is provided with a spline 71 which engages in a groove 72 in the exterior of the sleeve 69 to prevent rotation of the sleeve.

The sleeve 69 is moved axially by means of a screw threaded shaft 73 having an operating knob 74 threaded on its outer end and a collar 75 pinned to it which has a sliding fit in the sleeve portion 35 on the screw member 34. The collar 75 is spaced from the knob 74 so that the threaded shaft 73 is capable of limited axial movement relative to the handle 10. This limited movement permits the knob 74 to be retracted and then struck to cause the endwise movement of the hammer 65 to permit impacting and proper seating of the bone fragments. Also, rotation of the knob 74 will project the rubber block 67 against the fractured member so that if the nail is gripped between the fulcrum pin 13 and the anvil members 11 and 12, sufficient pressure can be exerted to withdraw the nail partially or completely from the bone fragments.

By rotating the knob 74 in the opposite direction, the hammer block 67 can be completely retracted within the end of the handle 10 and the knob 74 drawn up tightly against the left end of the nut 44 so as to form a fixed abutment which can be struck by the hand or with a mallet to drive the nail into the bone fragment.

It will be understood that the apparatus described above will be formed of materials such as to render the device capable of sterilization without corrosion. Such materials may be stainless steel, "Monel" and other oxidation and acid-resisting materials. It will be understood further that the instrument may be made of a suitable size to accommodate the specific type of nail required for the operation and that other changes may be made in the device, depending upon requirements, without departing from the invention. Accordingly, the form of the invention described herein should be considered as illustrative and not as limiting the scope of the following claims.

I claim:

1. An instrument for bending bone nails and the like comprising a handle member, a pair of spaced apart arms extending obliquely from one end of said handle member, a fulcrum pin detachably mounted in and extending between said arms, a pair of anvil members mounted between said arms for angular movement about the axis of said pin, said anvil members being spaced from said pin, pawl and ratchet elements on said handle member and one of said anvil members to releasably retain said one anvil member against movement in one direction and allow angular adjustment of said one anvil member in either angular direction, a toggle mechanism connected to the other anvil member, and means carried by and rotatable relative to said handle member to collapse and straighten said toggle

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mechanism and move said other anvil member angularly around said fulcrum pin.

2. An instrument for bending bone nails and the like comprising a handle member, a pair of spaced apart arms extending obliquely from one end of said handle member, a fulcrum pin detachably mounted in and extending between said arms, a pair of anvil members mounted between said arms for angular movement about the axis of said pin, said anvil members being spaced from said pin, means to releasably retain one of said anvil members against angular movement in one direction, a toggle mechanism connected to the other anvil member, a member connected to said toggle mechanism and slidable relative to said handle member to collapse and straighten the latter, an actuating member rotatably mounted in said handle member and having a handle thereon for rotating it, and means connecting said actuating member to said slidable member to slide the latter upon rotation of said actuating member.

3. An instrument for bending bone nails and the like comprising a hollow handle member, a pair of spaced apart substantially parallel arms at one end of said handle member and extending obliquely therefrom, a pair of bearing sleeves mounted in said arms and extending inwardly therefrom in axial alignment, a fulcrum pin detachably supported in said sleeves, a pair of anvil members pivotally mounted on said bearing sleeves in spaced relation thereto for relative angular movement into and out of alignment with each other, and means on said handle member for moving said anvil members relatively to bend a nail between them and said fulcrum pin around said fulcrum pin.

4. An instrument for bending bone nails and the like comprising a hollow handle member, a pair of spaced apart substantially parallel arms at one end of said handle member and extending obliquely therefrom, a pair of bearing sleeves mounted in said arms and extending inwardly therefrom in axial alignment, a fulcrum pin detachably supported in said sleeves, a pair of anvil members pivotally mounted on said bearing sleeves in spaced relation thereto for relative angular movement into and out of alignment with each other, means on said handle member for moving said anvil members relatively to bend a nail between them and said fulcrum pin around said fulcrum pin, an elongated threaded member non-rotatably mounted in said handle mem-

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ber and movable axially thereof, an impacting head on one end of said threaded member adjacent to said arms, and another elongated threaded member rotatably and axially movable in said handle member, said threaded members being in threaded engagement and relatively rotatable to project said impacting head beyond said arms and said fulcrum pin and to retract said impacting head into said handle member.

5. An instrument for bending bone nails and the like comprising a hollow handle member, a pair of spaced apart substantially parallel arms at one end of said handle member and extending obliquely therefrom, a fulcrum pin detachably supported in said arms, a pair of anvil members pivotally mounted on said arms in spaced relation to said fulcrum pin for relative angular movement into and out of alignment with each other, means on said handle member for moving said anvil members relatively to bend a nail between them and said fulcrum pin around said fulcrum pin, an elongated threaded member non-rotatably mounted in said handle member and movable axially thereof, an impacting head on one end of said threaded member adjacent to said arms, and another elongated threaded member rotatably and axially movable in said handle member, said threaded members being in threaded engagement and relatively rotatable to project said impacting head beyond said arms and said fulcrum pin and to retract said impacting head into said handle member.

EDWARD J. HABOUSH.

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