Dec. 23, 1941. W. M. LIPPINCOTT 2,267,157

FRACTURE NAIL GAUGE AND APPLICATOR

Filed Dec. 29, 1938 2 Sheets-Sheet 1

Fig. 1.

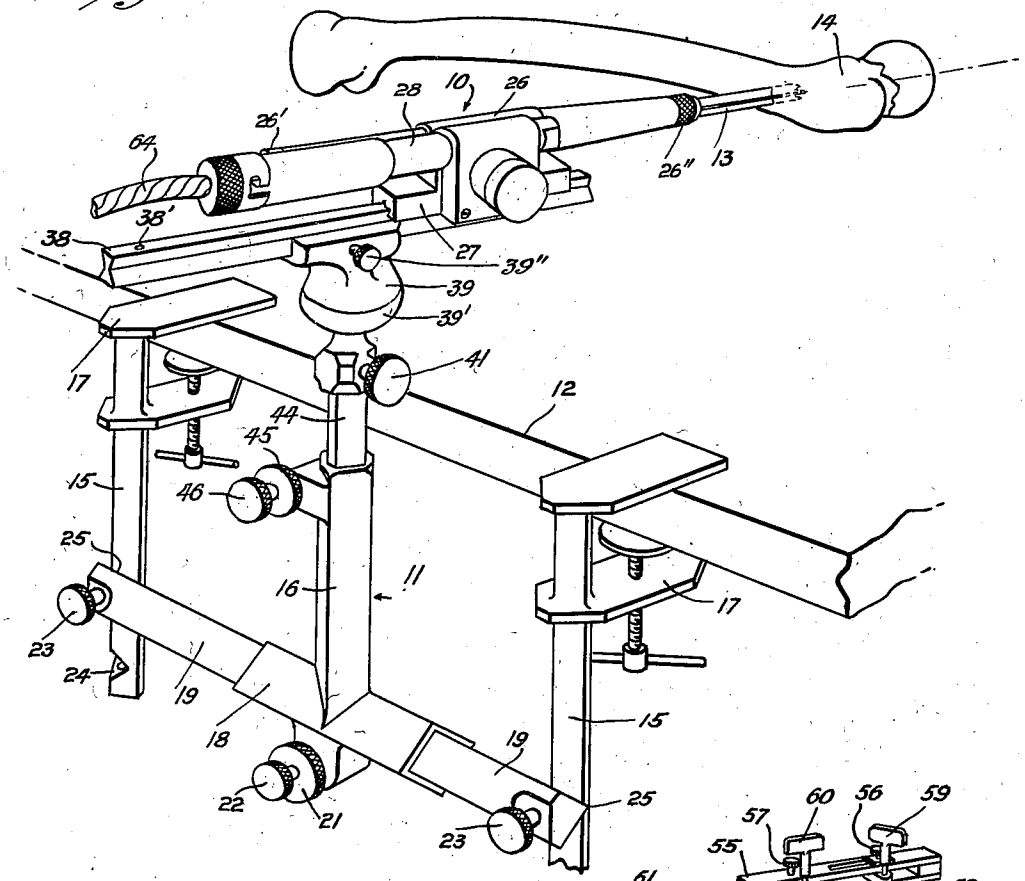


Fig. 2.

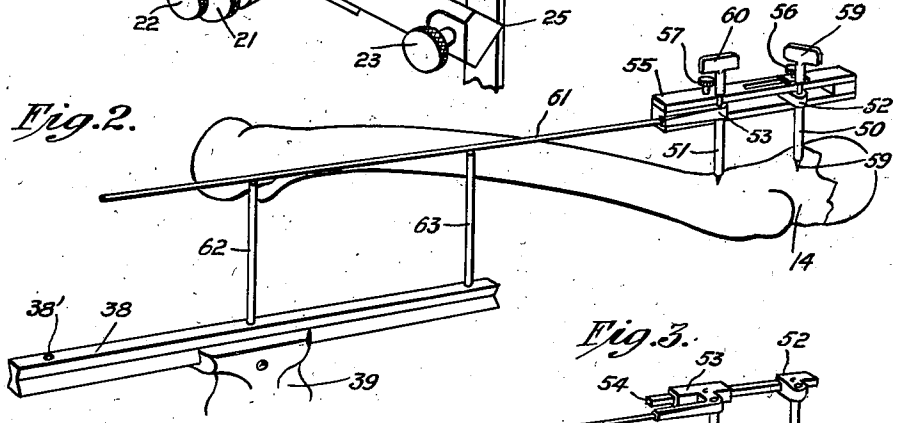
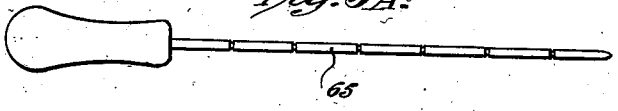


Fig. 3.

Fig. 3A.



INVENTOR
Walter Maynard Lippincott
BY
ATTORNEY

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Fig. 4.

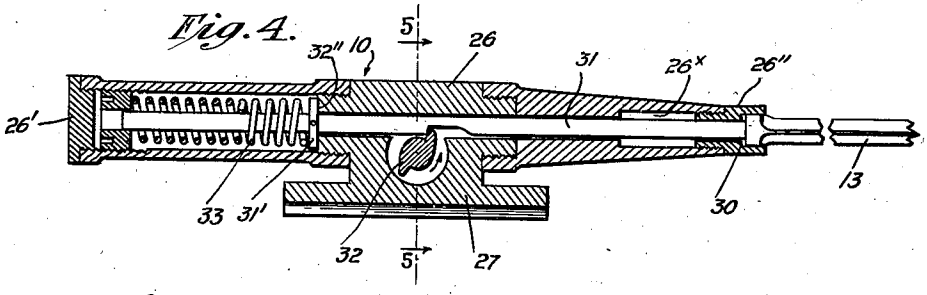

Fig. 5.

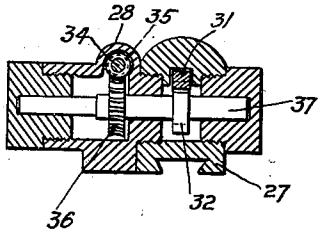

Fig. 6.

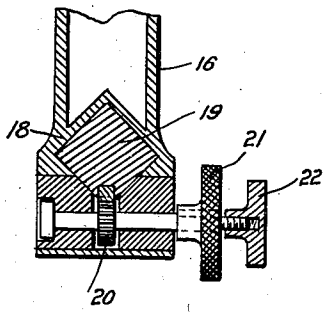

Fig. 7.

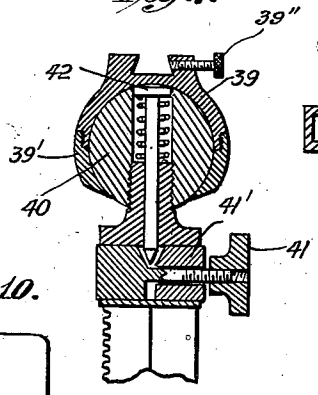

Fig. 8.

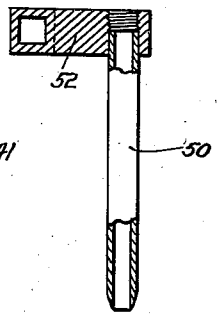

Fig. 9.

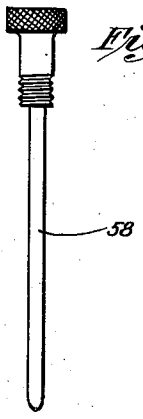

Fig. 10.

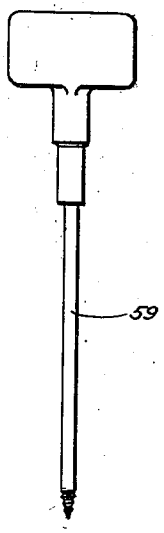

Fig. 11.

INVENTOR

Walter Maynard Lippincott

BY

ATTORNEY

Patented Dec. 23, 1941 2,267,157

UNITED STATES PATENT OFFICE

2,267,157

FRACTURE NAIL GAUGE AND APPLICATOR

Walter Maynard Lippincott, Lynbrook, N. Y.

Application December 29, 1938, Serial No. 248,162

11 Claims. (Cl. 128—83)

The use of the Smith-Petersen and Johansson nails in the repair of cervical fractures of the hip has become accepted practice.

The substantial biological background in the design of the nail accounts for the admirable results in its application. Interest of orthopedic surgeons throughout the world is manifested by the many articles appearing in journals. The majority of these deal with special techniques designed primarily for the accurate placing of the nail in the axial line of the femoral neck.

In fractures of the femoral neck, the splinting of the fragments, by the Smith-Petersen nail, has been found to be a distinct advance in treatment. The nail is designed to accomplish its purpose. Its keen cutting end insures its introduction with a minimum disturbance of the tissues along its path. Its wide thin radiating flanges secure a firm grip of the tissues, thus preventing rotative or shearing displacement of the fragments. Owing to its design, the nail occupies very little space, hence compression of tissues between it and the cortical wall is negligible. To obtain a good result it is necessary that the nail advance unswervingly directly through the center of the neck, and into the central part of the head of the bone, with the least possible trauma.

The surgical procedures for the introduction of the nail are the open and closed operations. In the open operation the head and neck of the femur are exposed through a suitable incision. When the fragments are in normal apposition the soft tissues are sufficiently retracted to expose the lateral aspect of the great trochanter and a portion of the upper lateral part of the shaft. The cutting end of the nail is now placed on this surface at a point ¾ to 1 inch below a prominent ridge at the lower part of the great trochanter. The nail is now driven in by an ordinary bone mallet, sighting it as it progresses and judging by the eye as to its central position and the distance between the anterior and posterior surfaces of the neck. This is a difficult procedure and subject to errors in judgment of direction with consequent malposition of the nail.

In the closed operation the femoral neck and head are not exposed. Only the site of entrance of the nail on the lateral surface of the femur is exposed by an incision over the lateral aspect of the great trochanter. The neck, head and anterior surface of the great trochanter are out of sight and it is difficult to drive a flanged nail through its central axis unerringly.

Many devices and methods have been used in an effort to place the nail accurately but these have not proven entirely satisfactory. Many of them depend upon a guide wire or pin first placed in the line of axis of the femoral neck and a canalated flanged nail threaded over this guide wire. The nail is then hammered in with an ordinary bone mallet, the guide wire directing its course.

In all of these methods with which applicant is aware, the nail is guided only by hand through an applicator or not at all. This refers to control of introduction and not to the guide wire in the bone. The only driving force has been the bone mallet, with its uncertain and varying angle of impact. Because of these shortcomings and the varying personal element in the operator, the nail is not always under complete control, and at times may veer off from its intended path, necessitating its withdrawal and reinsertion. This churns up the tissues, makes a very unstable nail bed, interferes with circulation, causes a liquifaction around the nail with the possibility of its dropping out and consequent non-union. In other words, the introduction of the nail by inadequate mechanical means to control its advance and direction is apt to create a biological setting not conducive to repair and not commensurate with the design of the nail. The present improvements overcome the uncertainty in the manual introduction of the nail and insure its introduction with mechanical precision.

The tools herein described were designed to avoid the necessity of the guide wire and to attack the problem from a different angle. The cooperation of the X-ray department at the operating table is also essential.

My improvements involve the use of three principal units. First, a nail driver or hammer provided with a mechanically actuated plunger. Second, a support for the hammer including an adjustable guide rail mounted on an adjustable stand which is clamped or otherwise fastened to the operating table. Third, a finder or gauge including posts to be applied to the femoral neck for accurately localizing the axis of the femoral neck and by means of which the guide rail can be adjusted to bring the hammer into proper alignment coinciding with the axis of the femoral neck.

The hammer is fashioned so as to slide along the guide rail, the line of force always being parallel to the guide rail at a given distance above it. This distance is so proportioned to the length of the depth posts of the gauge that when the hammer is placed on the guide rail, which has been adjusted to operative position, the line of

force, through the hammer, coincides with an extension of the axial line of the femoral neck.

I have also improved the nail itself as will hereinafter appear in order that it may more readily and accurately be inserted.

Fig. 1 is a perspective view of the apparatus for driving the nail into the femur.

Fig. 2 is a perspective view of the localizing gauge in place.

Fig. 3 is a perspective view of a part of the gauge without the holder.

Fig. 3A is a side view of the finding and measuring rod.

Fig. 4 is a longitudinal sectional view of the hammer device.

Fig. 5 is a transverse sectional view of the hammer on the general plane of the line 5—5 of Fig. 4.

Fig. 6 is a sectional view showing one of the horizontal adjusting devices.

Fig. 7 is a sectional view of the tilting adjustment.

Fig. 8 is a detail section of the gauge device.

Fig. 9 is a side view of the starting pin.

Fig. 10 is a side view of the screw pointed pin.

Fig. 11 is a side view of the tip portion of the improved nail.

In the form shown, the hammer 10 is carried by a frame 11 adapted to be secured to the operating table 12 in such a manner as to be universally adjustable so as to insert the nail 13 into the femoral neck 14 at exactly the right point and angle.

The frame has a number of vertical rods 15, 16, 15, one or more of which may have a clamp 17 for securing it to the edge of the operating table. The center rod 16 is carried by a sleeve 18 which is horizontally adjustable on the cross bar 19 by means of a gear 20 and thumb piece 21 and may be clamped by a set nut 22. The cross bar 19 is secured to the uprights 15, 15 by clamp screws 23 and may be set at different heights, for instance, in notches 24 or 25.

The hammer housing 26 has a removable butt 26', a removable tip 26'' and a base 27, and has a recess 30 to receive the head of the nail 13. The plunger 31 is guided to be reciprocated in the housing by the cam 32 and spring 33. The cam is rotated by the shaft 34 in the tubular housing 26. The shaft is suitably connected to a source of electric current, such as the house current, preferably by a flexible connection 64 and has a worm gear 35 meshing with the gear 36 on the cam shaft 37.

The hammer housing base 27 slides on the guideway or rail 38 which in turn is removably supported by the split socket 39 on the ball 40. The rail may be clamped to the socket 39 by a clamp screw 39''. The socket and guide-way are thus supported so that they may be tilted at any angle and clamped by the screw 41 which operates a slide 41' coacting with the spring pressed plunger 42 which in turn presses against the inside of the upper part of the socket 39. The lower part 39' of the socket is removable.

The ball support is mounted on a rod 44 which slides vertically in the hollow rod 16 and which may be adjusted up and down by thumb piece 45 and clamped by nut 46.

The localizing gauge has two tubes or depth posts 50, 51 carried by blocks 52, 53, one of which blocks, for instance 53, is slidable on a rod 54. These blocks may be adjusted longitudinally in the holder 55 and clamped by screws 56 and 57. Round ended pins 58 are insertable into the tubes 50 and 51 so as to provide rounded ends for insertion into the tissues above the bone until they touch the bone. Pointed screw tipped members 59 and 60 then replace the pins 58 and are screwed into the bone in the proper places to hold the blocks securely in position. Block 53 carries a stiff straight wire 61 which extends parallel with the axis of the femoral neck.

When the gauge has been properly located two pins 62 and 63 are inserted into openings 38' in the guide rail 38 (the hammer being removed). The guide-rail is then adjusted so that the wire 61 will just touch the tips of the pins 62 and 63. The adjustments are then all tightened and the gauge and pins removed and the hammer 10 set up on the guide rail 38. The parts are so proportioned and designed that the axis of the hammer will thus be in exact alignment and will coincide with the axis of the femoral neck.

After the shaft 34 has been connected to the source of electric current by means of the flexible shaft 64, the cam 32 is rotated thus reciprocating the plunger 31 against the action of spring 33. The plunger in its outward movement travels an appreciable extent before striking the head of nail 13 to drive said nail forward into the bone. Subsequent to striking the nail 13, the plunger in its travel carries its collar 31' into contact with the shoulder 32'' of the housing 26 thus driving the housing forward. The reciprocation of the plunger is so rapid that the forward movements of the nail and housing are practically continuous.

A septic trap 26x may be provided in the hammer casing and a similar trap in the drive shaft housing 28 if desired.

Nail 13 comprises a shank portion having three radially spaced webs or flanges 13', each web ending in its outer end in a cutting edge having oppositely slanting sides 13x. A pin point or pilot point 13'' is formed axially of the nail and projects beyond the radial cutting edges. The formation of the cutting edges is such that a combined drawing and chiselling cutting action results. Such a cutting action results in a clean and sharp cut through the bone tissues and prevents splintering. At the same time, it affords a secure hold at its outer cutting end. The flanges in the cutting edge of the nail render it free from chattering when starting in its introduction into the cortex of the bone.

The technique for using the apparatus follows. The patient is placed on the operating table. The guide rail frame is clamped by clamps 17 to the operating table on the side of the fractured hip, the clamp 17 nearest the head of the table being opposite the great trochanter of the injured leg. After the fracture is reduced the legs are secured in abduction, slight inward rotation, and extension. The exterior skin of the leg above the fracture is now suitably marked. This is preferably done by a thin wire or it may be marked by drawing a line by means of a pencil or the like. The thin wire when used is laid on the skin and is fastened thereto by means of adhesive plaster or the like to prevent its movement out of line. This wire or line extends from a point on the lateral surface of the thigh just over the point on the lateral surface of the femur one inch below the ridge at the lower part of the great trochanter, to a point on the skin one-half inch below the center of a line extending from the anterior superior spine of the ilium to the spine of the os pubis. This wire or line approximately represents the angle of the neck of the femur. An incision is now made through

the skin and subcutaneous tissues only. This incision begins about one inch lateral to the inner end of the above mentioned wire or line and parallels it to the lateral surface of the great trochanter, and from this point it is continued at an angle downward along the lateral surface of the thigh over the great trochanter for about three inches.

A notched or scored finding and measuring needle-like rod, such as **65**, is now forced into the soft tissues, starting one inch below the ridge on the lower part of the great trochanter, keeping the point of the rod in contact with the bone, passing over the anterior surface of the great trochanter and neck and following the direction of the thin wire marker or line on the skin to the acetabulum. An X-ray or fluoroscopic examination is now made to ascertain if the measuring rod is properly positioned on the neck of the bone, that is, if it is truly in alignment with the long axis of the neck of the femur, and if the end of the rod is at the junction of the neck with the head. From this X-ray the distance between the lateral surface of the shaft of the bone and the junction of the neck with the head can be ascertained. The length of the head or the distance from said junction to the innermost surface of the head can be estimated, and by adding these two distances, the length of the nail necessary can be readily obtained. Of course, the X-ray will also disclose whether in the antero-posterior view the fragments of the bone are still properly reduced.

If it is found that the measuring rod is not in proper position, it can be adjusted.

The blocks **52** and **53** of the gauge with the starting pins **58** in the depth posts **50** and **51** are now adjusted so that the depth posts are the proper distance apart in relation to the distance from the fracture line to the lateral surface of the great trochanter. The depth posts with the pins **58** are now forced through the intervening soft tissues, until the lower ends of the depth posts contact the bone and notched finding rod. The points of contact should now be on the imaginary line bisecting the femoral neck in its long axis, and these points should be confined to the distal fragment. The starting pins **58** are now removed from the depth posts and the screw pointed pins **59** and **60** are introduced and screwed into the bone. A fluoroscope or X-ray check-up as to proper position of the gauge is now made. Having obtained the correct position for the gauge, the straight stiff aligning rod **61** is inserted by one end into the block **53** of the gauge. This rod will now be parallel to the femoral axis and its extension in both vertical and horizontal planes, at a given distance above it. The two angle and depth localizing posts **62** and **63** are now inserted by their lower end into the holes **38'** on the upper surface of the guide rail **38**. The guide rail by means of the horizontal and vertical adjustments of its stand, and its ball and socket angular adjustment is now adjusted into position so that the upper ends of the two localizing angle and depth posts **62** and **63** just touch the straight stiff aligning rod **61**. All adjustments are then locked. The complete localizing gauge including tubes **50** and **51** is now removed from the bone and the localizing angle and depth posts **62** and **63** are removed from the guide rail. The recessed base **27** of the hammer **10** is now slid over the outer end of the guide rail **38**, and the head of a Smith-Petersen nail **13** placed in the recess **30** in the removable tip **26''** at the inner end of the hammer, the size of the nail having first been determined by the measuring rod which was removed with the localizing gauge. The hammer is now slid along the guide rail until the cutting end of the nail contacts the lateral surface of the bone which has just been bared subperiosteally. The motor is started and the rapid impacts of the plunger drive the nail firmly and accurately concentric to the line of the axis of the femoral neck, with the least possible traumatism to the bony structures. The surgeon may hold the hammer to manually control its movement if desired.

I claim:

1. A fracture-nail hammer having a housing with a nail-receiving chamber in one end, a plunger in alinement with said chamber, a spring pressing the plunger toward said chamber, retracting means for the plunger and stops for the plunger and nail, the stops being so related to the stroke of the plunger that the nail is moved away from its stop before the plunger reaches its stop.

2. A fracture-nail gauge comprising a frame member, a pair of aligned tubular members depending from said frame member, means for supporting one of said members in adjustably parallel relation to the other, said adjustable member carrying a gauge wire extending in a direction parallel with the plane containing said tubular members and forming an extension of the frame member.

3. A fracture-nail gauge comprising a pair of aligned tubular members, means for supporting one of said members in adjustably parallel relation to each other, said adjustable member carrying a gauge wire extending in a direction parallel with the plane containing said tubular members and blunt filler rods adapted to be removably secured in said tubular members, with their ends protruding.

4. A fracture-nail gauge comprising a pair of aligned tubular members, means for supporting one of said members in adjustably parallel relation to the other, said adjustable member carrying a gauge wire extending in a direction parallel with the plane containing said tubular members and auger-tipped rods insertable in said tubular members and adapted to be set into the femur.

5. In a device for applying a fracture nail to the neck of a femur, a frame member for movably supporting a vibrating hammer having a recess for receiving a fracture nail, removable guide nails vertically disposed on the frame member, a guide wire member, means for removably mounting the wire on the femur in alinement with the axis of the neck thereof, and means for moving the frame member with the hammer and fracture nail into position so that the tops of the removable nails are adapted to engage the guide wire to position the fracture nail to coincide with the axis of the neck of the femur.

6. A device for gauging the axis of the neck of a femur including a frame, a tubular member adjustable on said frame, a removable nail extending through said tubular member for fastening the tubular member to the femur and an elongated wire carried by said tubular member and forming an extension of the frame.

7. A device for gauging the axis of the neck of a femur including a bar, a block fixed to said bar, a tubular member depending from said block, a second block slidable on said bar, a tubular member depending from said slidable block,

means for locking the slidable block on the bar, a removable nail in each of said tubular members and an elongated wire carried by the slidable block and forming an extension of the bar.

8. In a device of the kind described, a hammer for driving a nail of the Smith-Petersen type comprising a housing, a plunger reciprocatingly mounted in said housing, a cam for moving said plunger in one direction, a spring for moving the plunger in the opposite direction, and a removable socket member on the outer end of the housing for holding a nail in extended position, said plunger being adapted to strike said nail to drive same forward and subsequently to strike said housing to drive the latter forward.

9. A fracture-nail applying device comprising, in combination, a frame, a slidable rail swivelly mounted on the frame and adjustable up and down thereon for slidably supporting a vibrating hammer with a fracture nail on the outer end thereof, means for vibrating said hammer, and means for gauging the position of said hammer so that the fracture-nail will coincide with the axis of the neck of a femur, said means comprising removable guide nails vertically disposed on the rail, a tubular member adapted to be removably mounted on the neck of the femur and an elongated wire carried by the tubular member and adapted to coact with the tops of the vertical nails for positioning the hammer and fracture nail.

10. In a device for applying a nail to the neck of a femur, the combination with a gauge device having spaced pins adapted to be fastened to the neck of the femur in alignment with the axis thereof and a wire carried by one of said pins in alignment with the said axis; of a frame having a rail adjustable thereon in a plurality of directions for supporting a vibrating hammer with a fracture nail thereon and for supporting removable pins adapted to cooperate with said wire for guiding the adjustment of the rail so that the hammer will be in position to drive the nail through the axis of the neck of the femur.

11. In a device for driving a fracture nail through the neck of a femur, the combination with a device for gauging the axis of the neck of the femur, of a frame, spaced clamping means for adjustably fastening the frame to a support, a vertically adjustable post on the frame between said clamps, a rail mounted for universal movement on the post, a vibrating hammer slidably mounted on said rail and having a recess for supporting a fracture nail, and means carried by the rail and adapted to coact with said gauging device for positioning the hammer to drive the nail through the axis of the neck of the femur.

WALTER MAYNARD LIPPINCOTT.