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(54) APPARATUS FOR KNEE SURGERY AND METHOD OF USE

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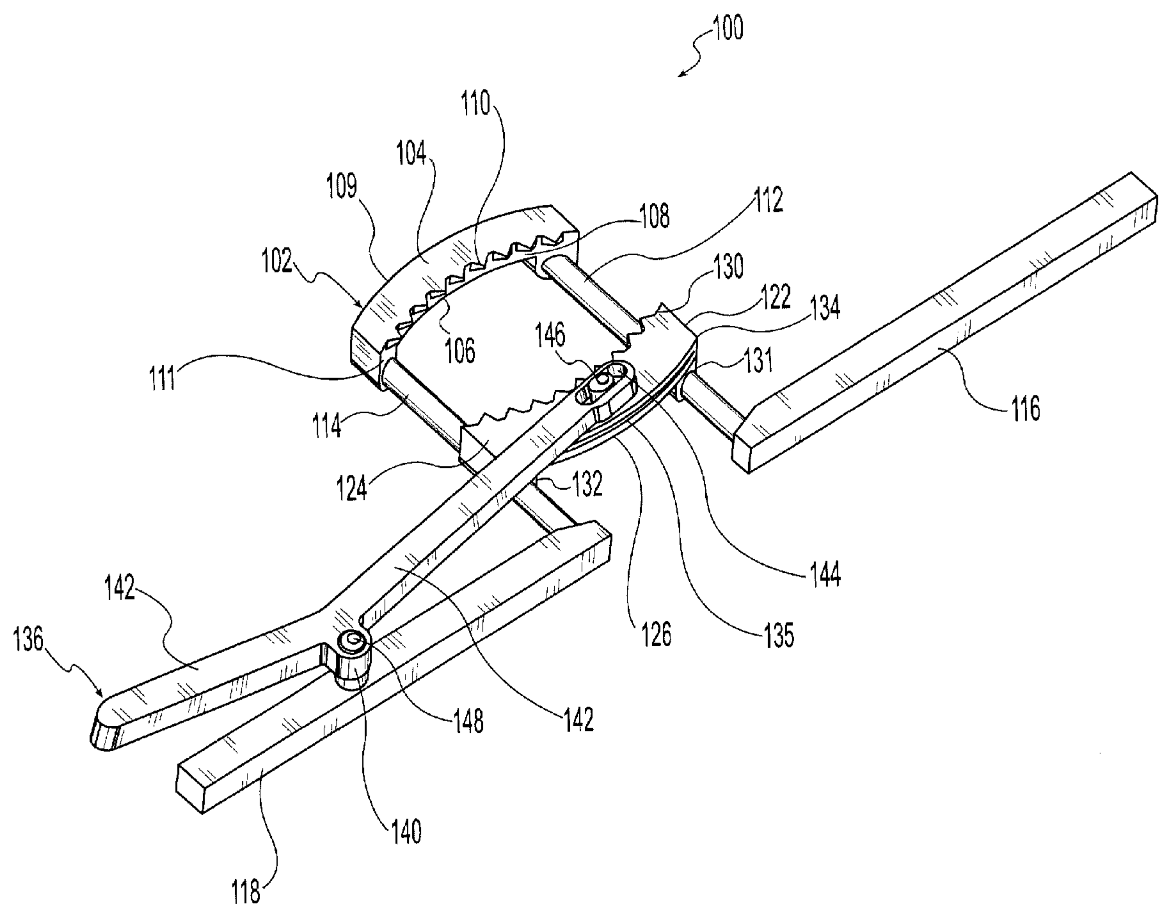
(57) **ABSTRACT**

The present invention comprises a set of instruments and a method for their use in preparing a knee joint to receive knee implants. The inventive instruments and method are generally suitable for knee joint surgery. Furthermore, they include features that make them suitable for performing a minimally invasive knee surgery in which a smaller than normal incision is made and oriented to preserve the quadriceps mechanism and protect the suprapatellar pouch. The instruments permit switching from a minimally invasive technique to a standard open technique at any point in the procedure. An illustrative set of instruments for total knee arthroplasty and an associated minimally invasive technique are described.



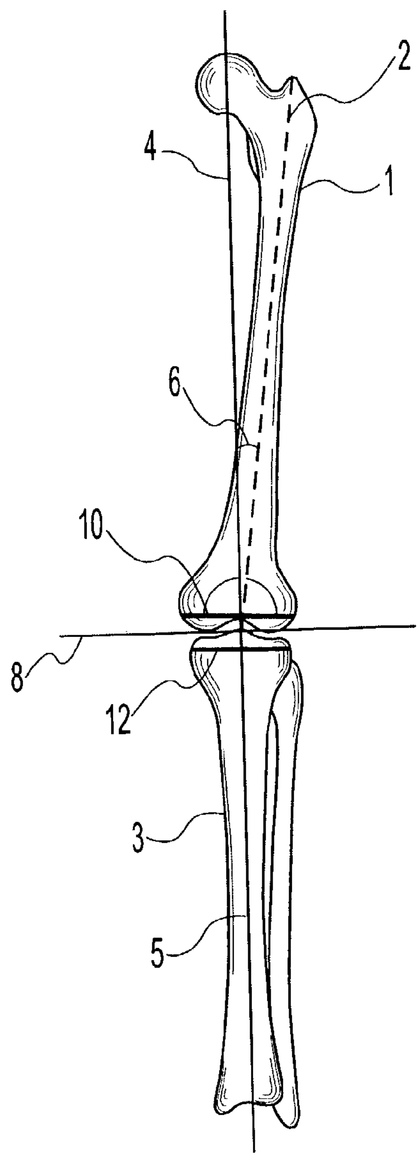
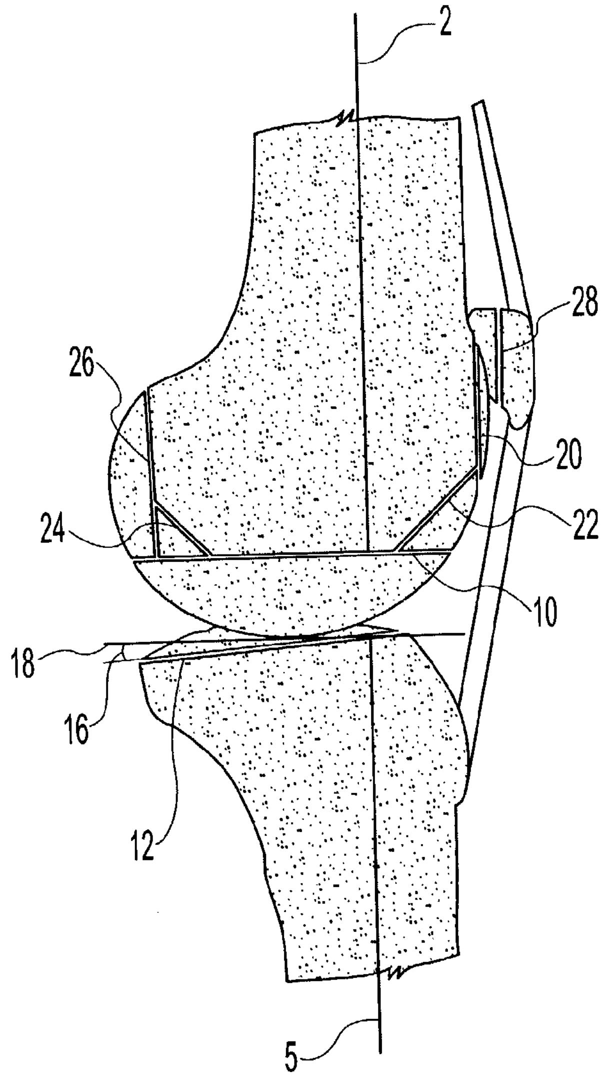


Fig. 1



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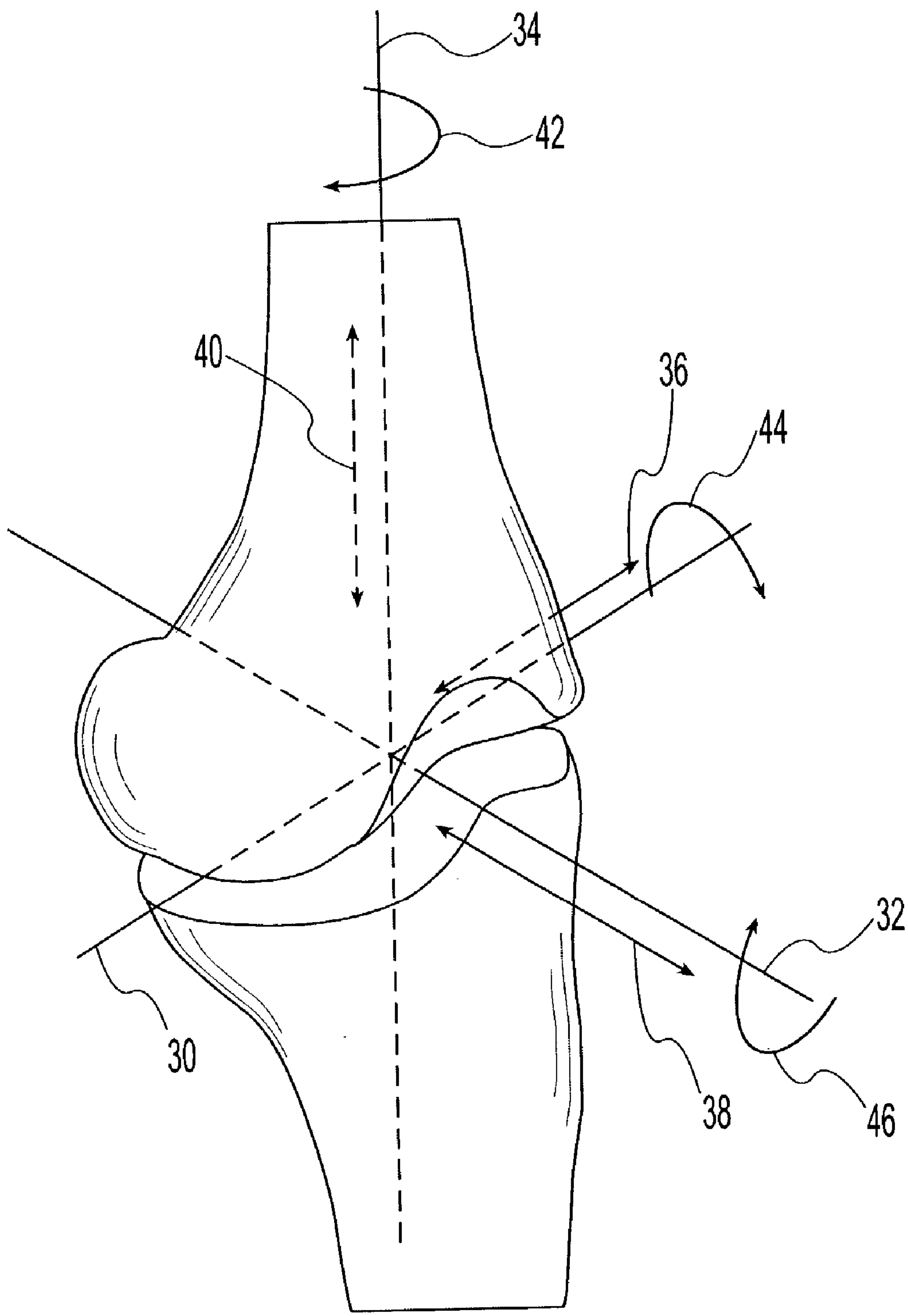
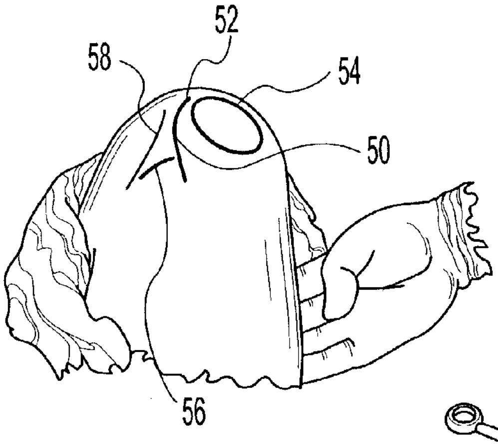


Fig. 3



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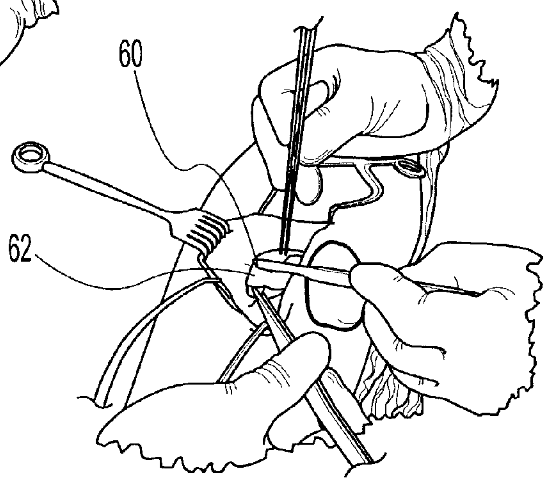

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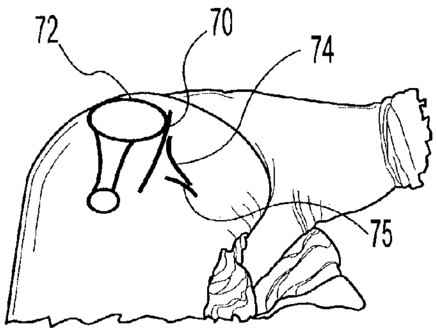

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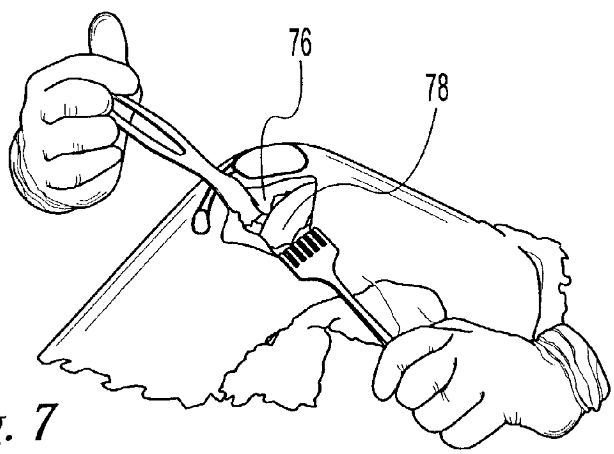

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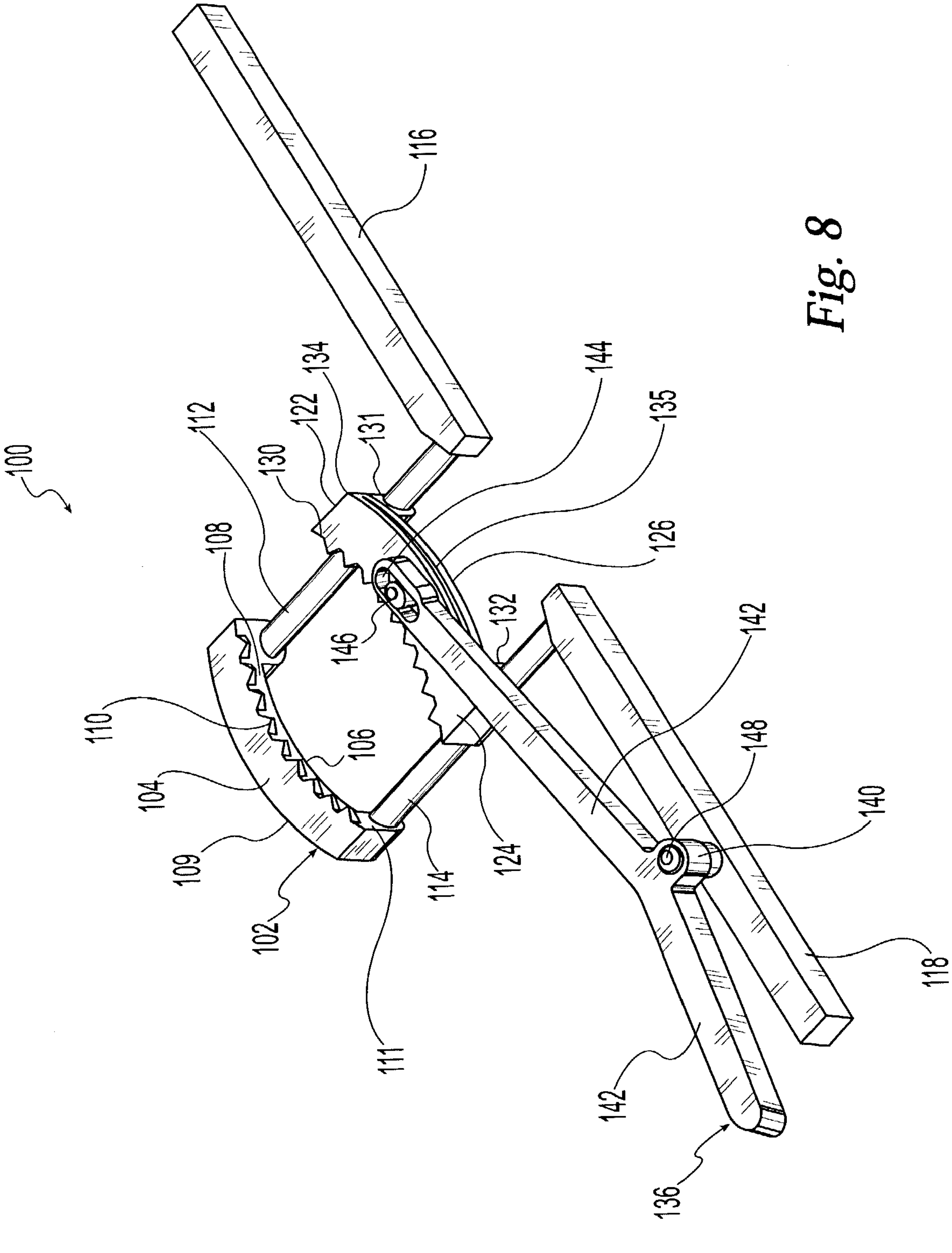

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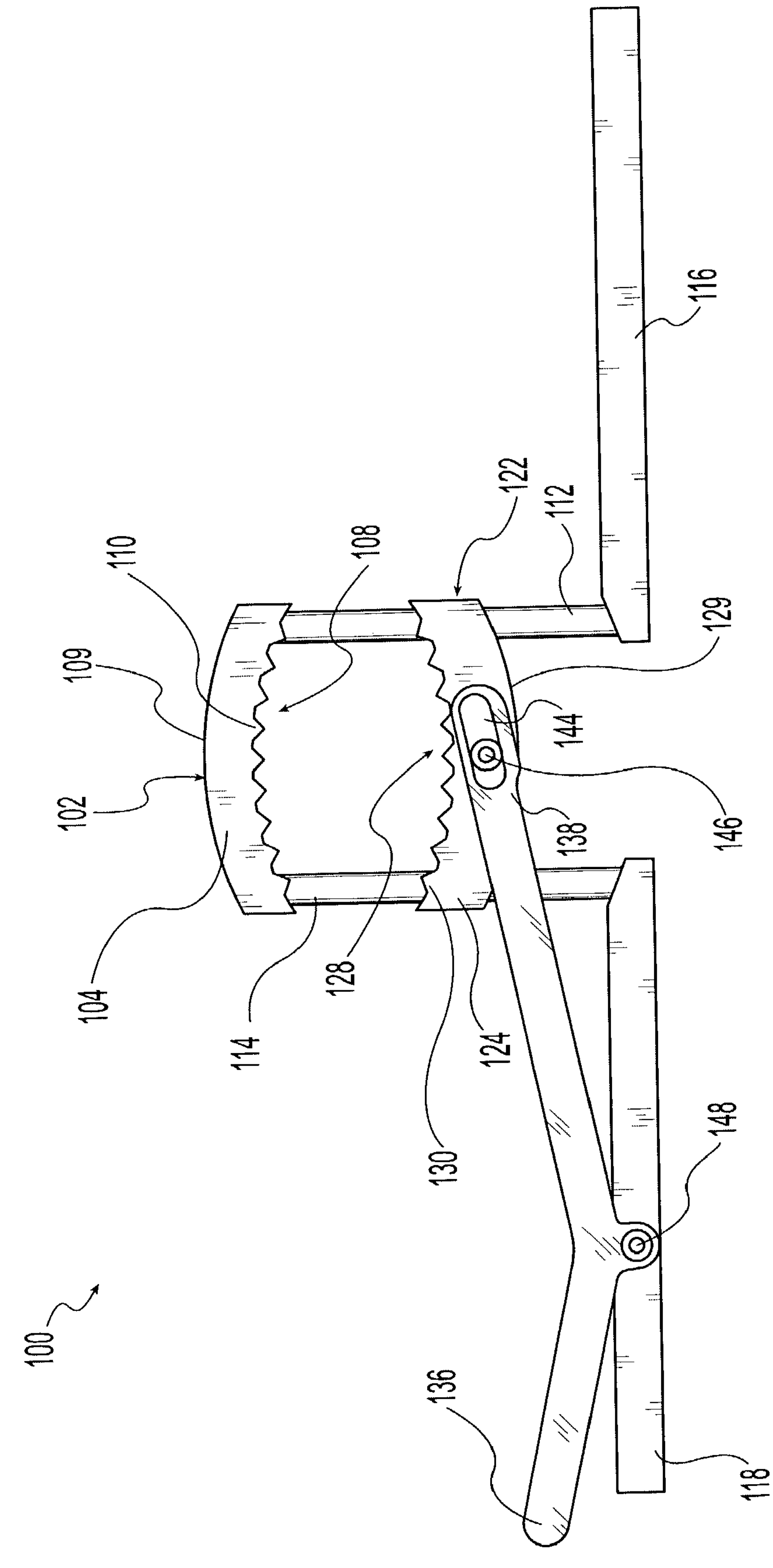
Fig. 8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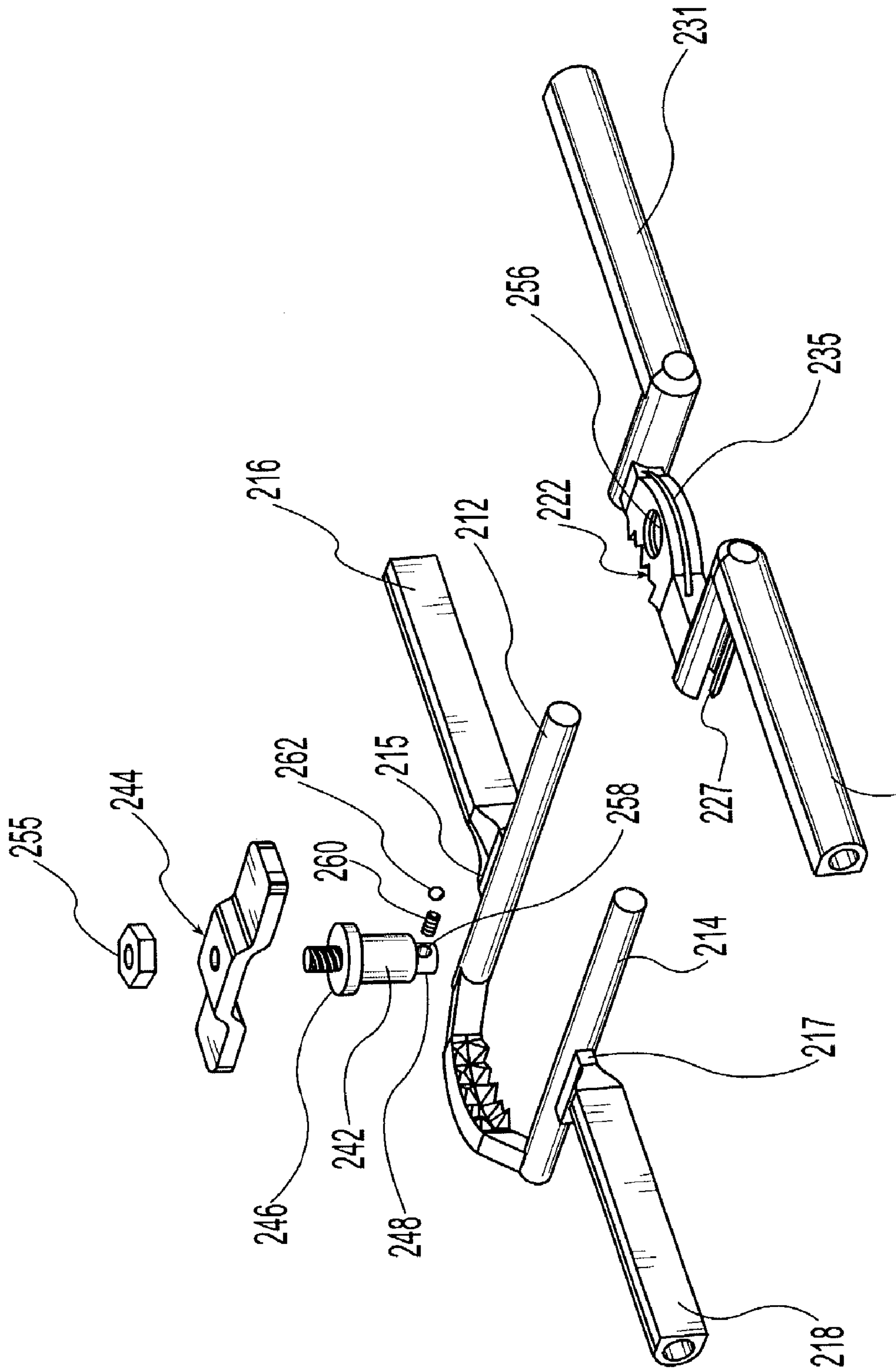
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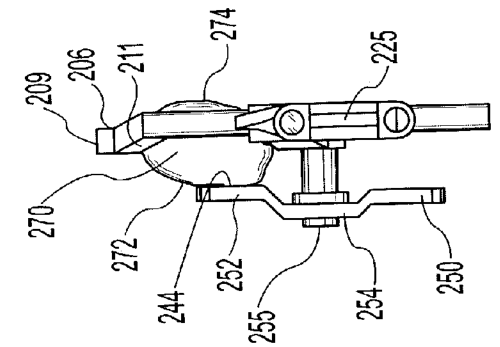
Fig. 10



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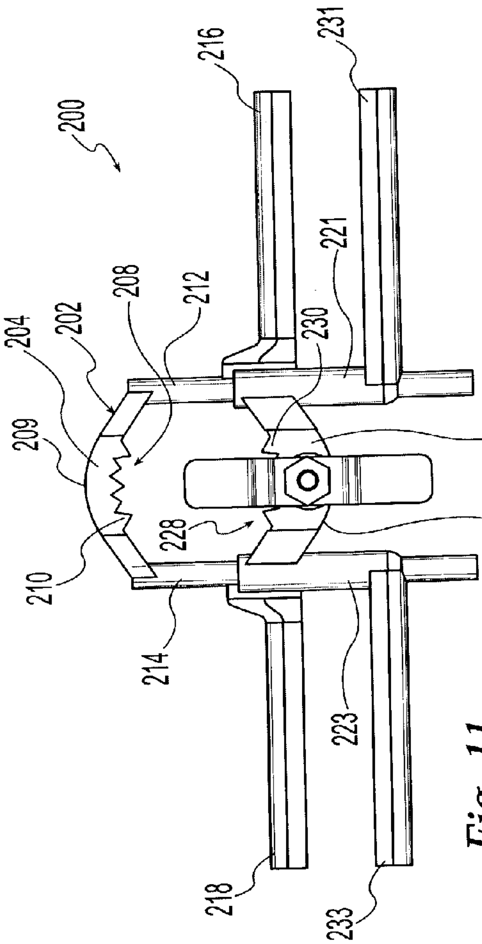

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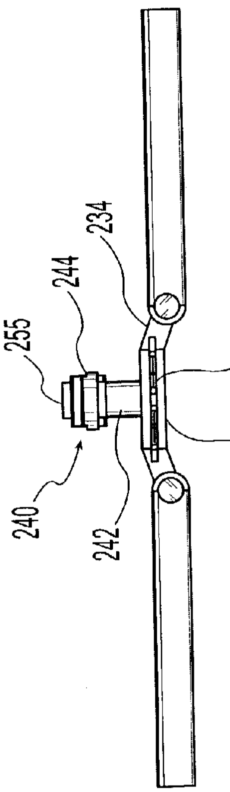

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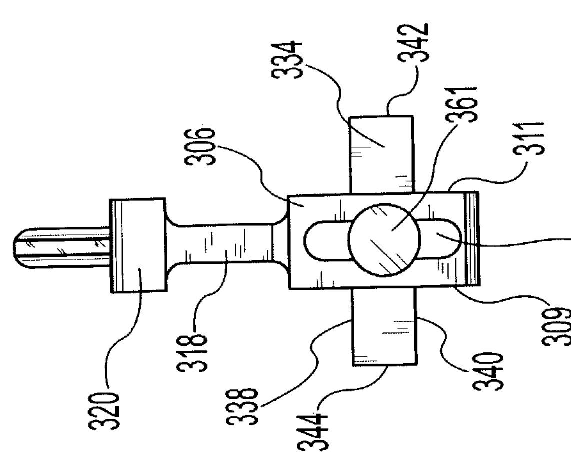

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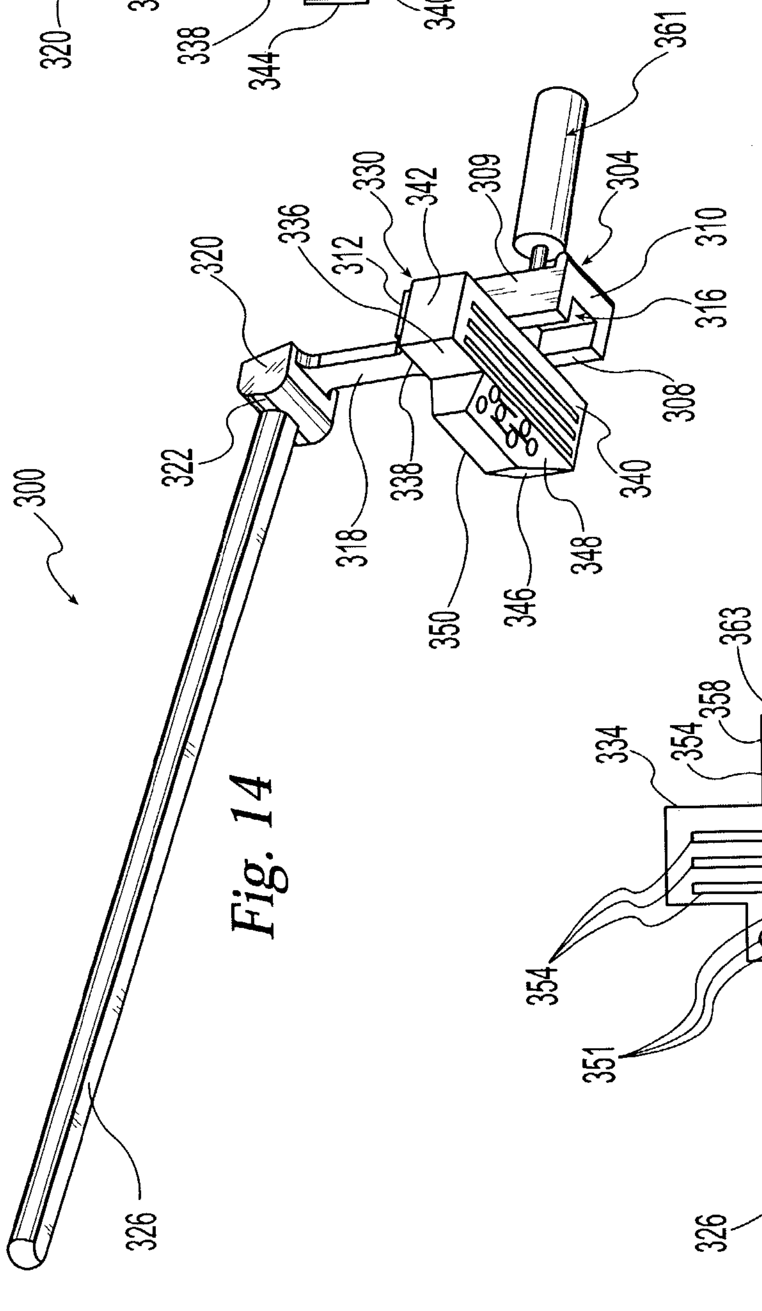

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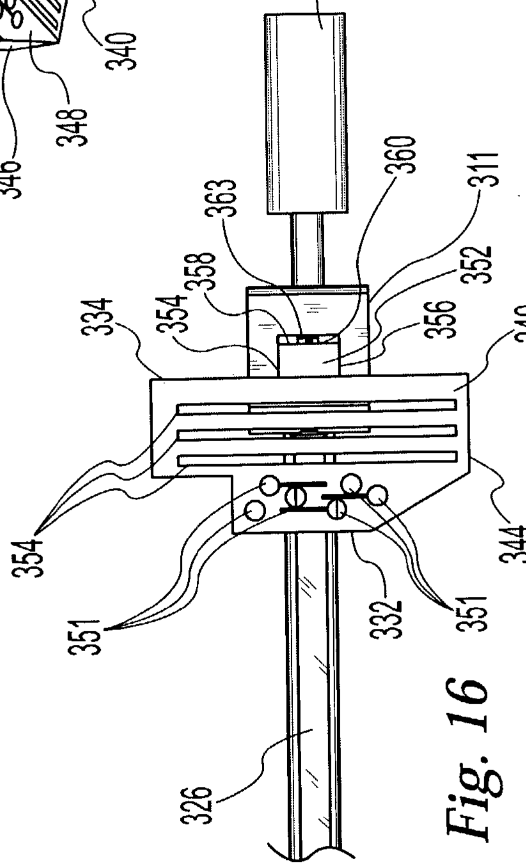

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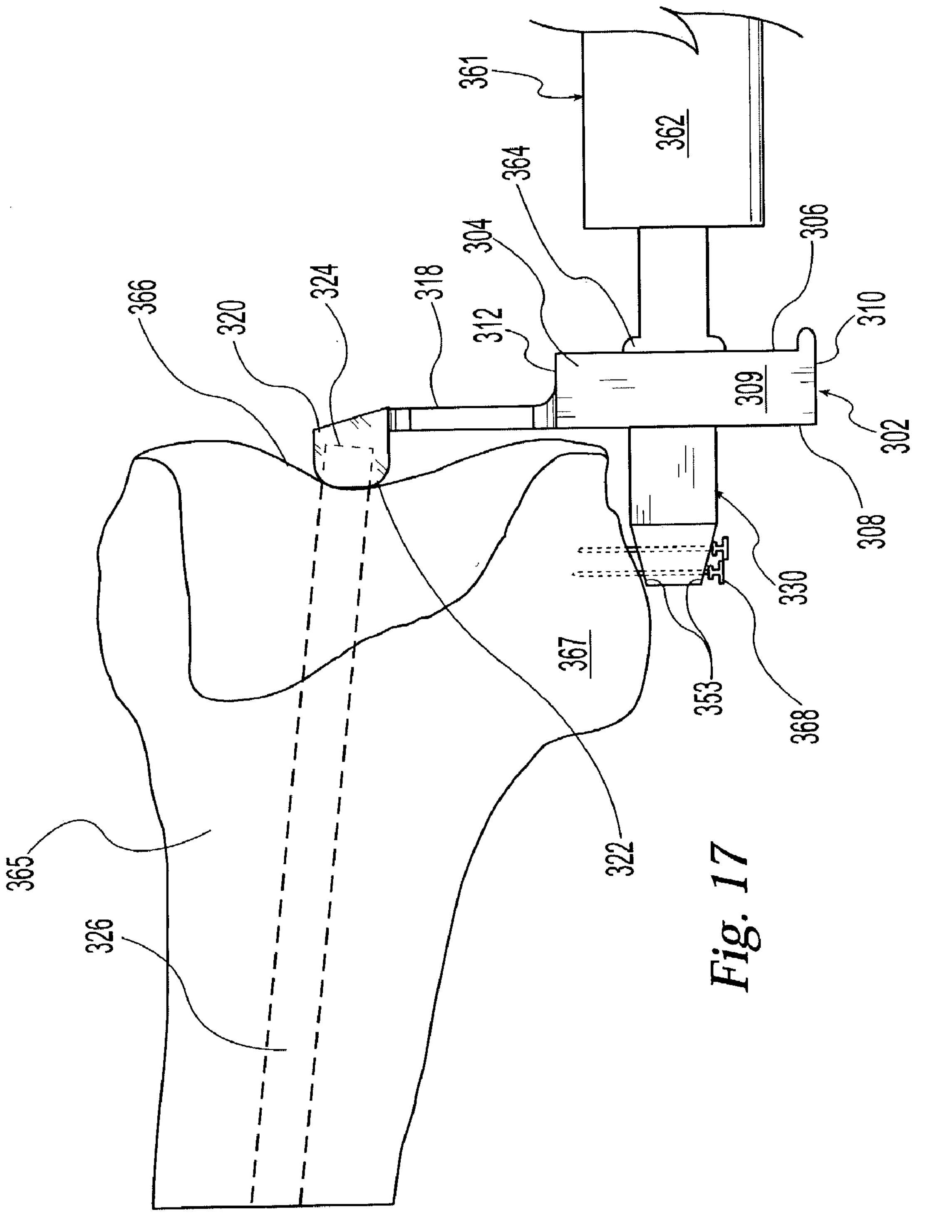
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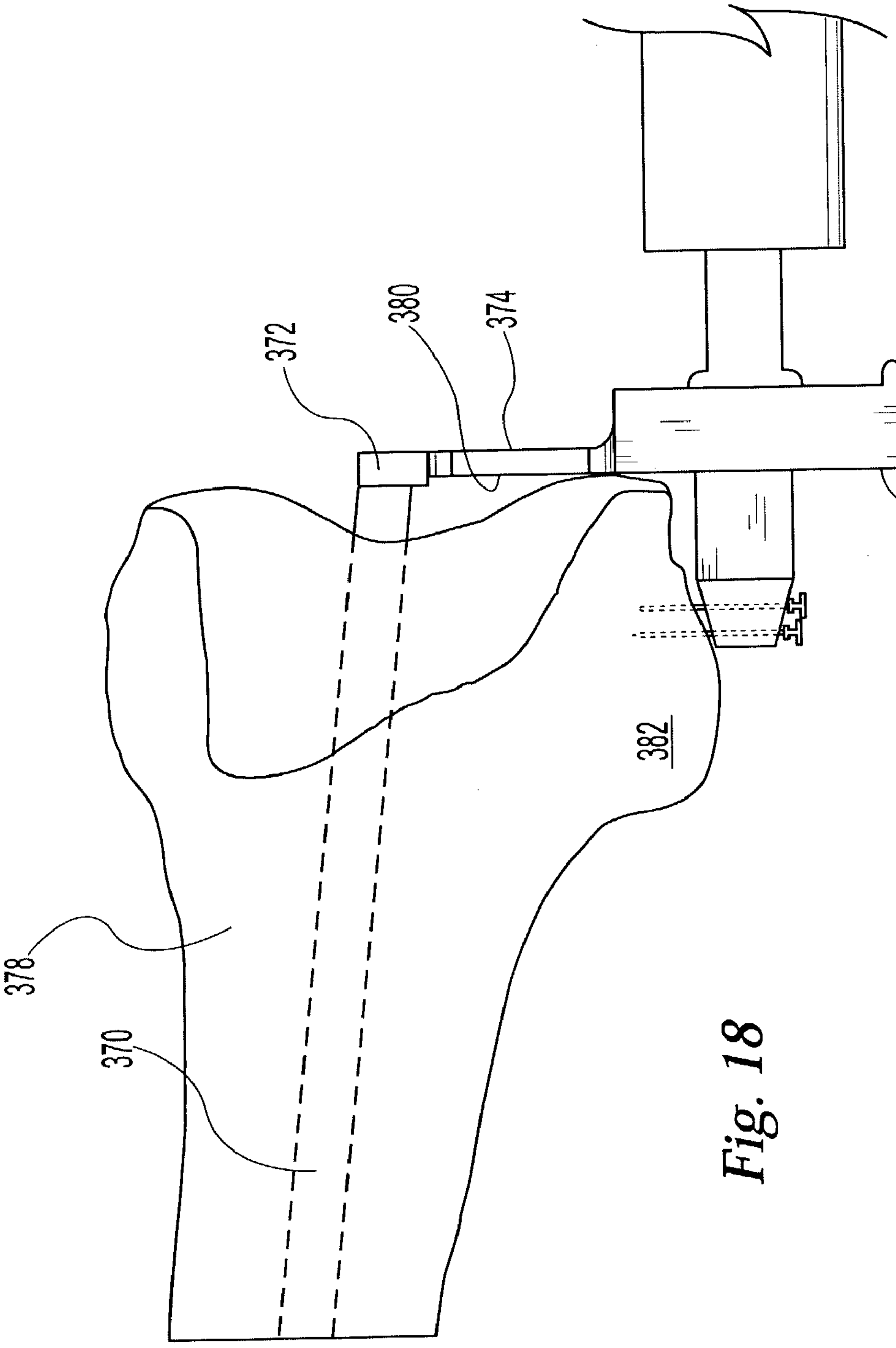
Fig. 17



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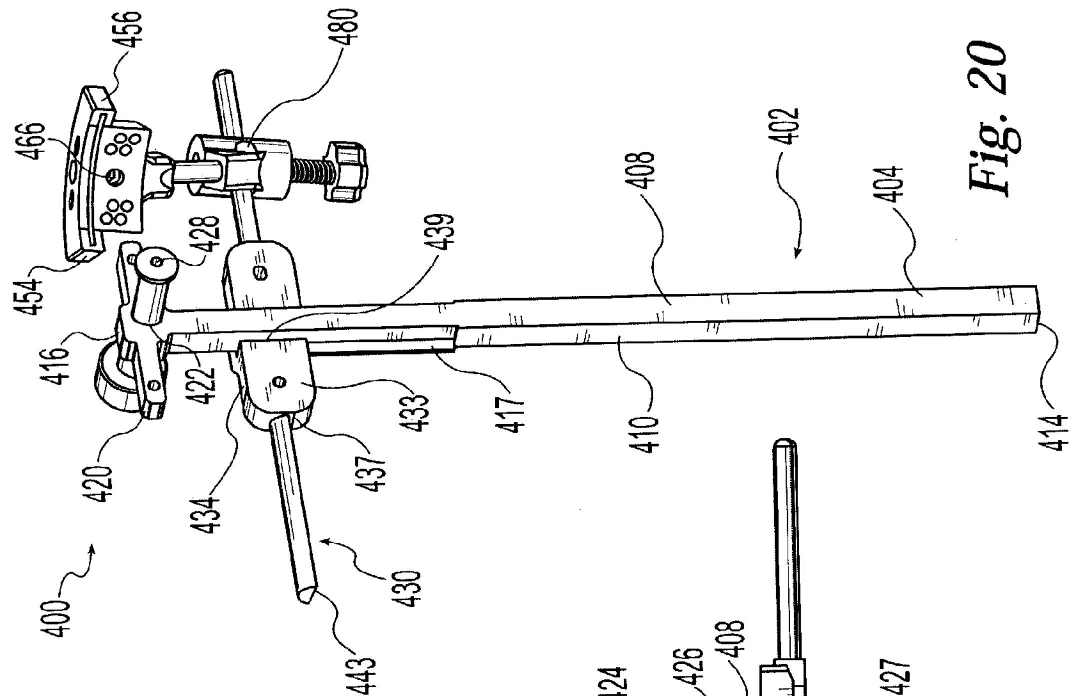

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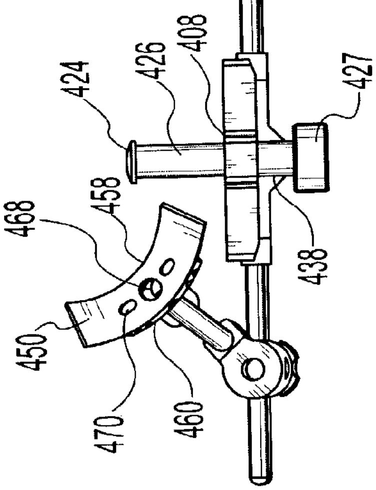

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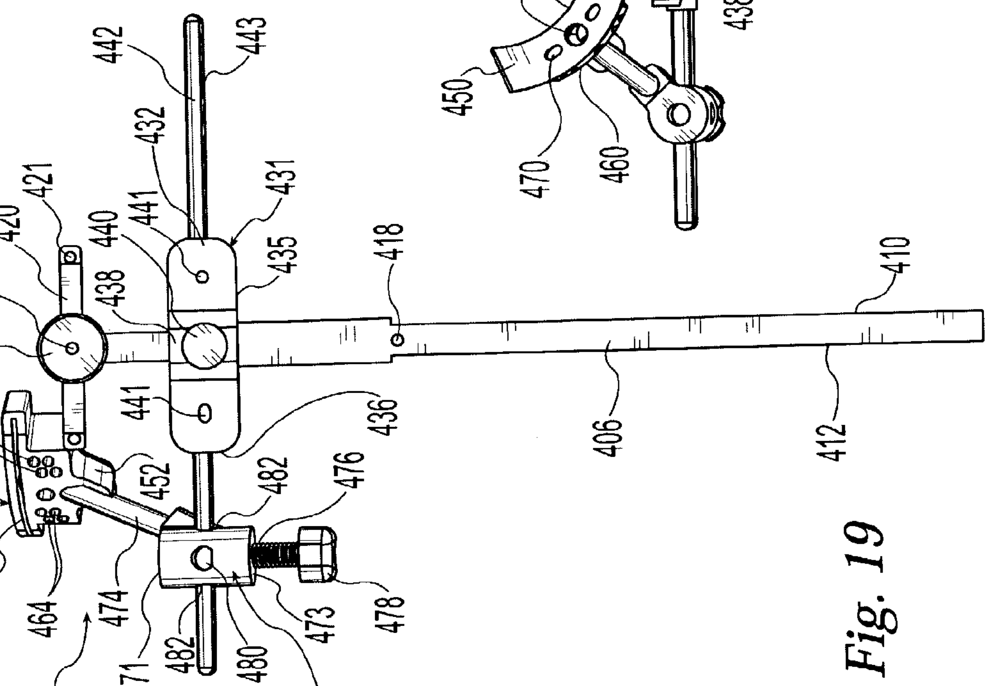

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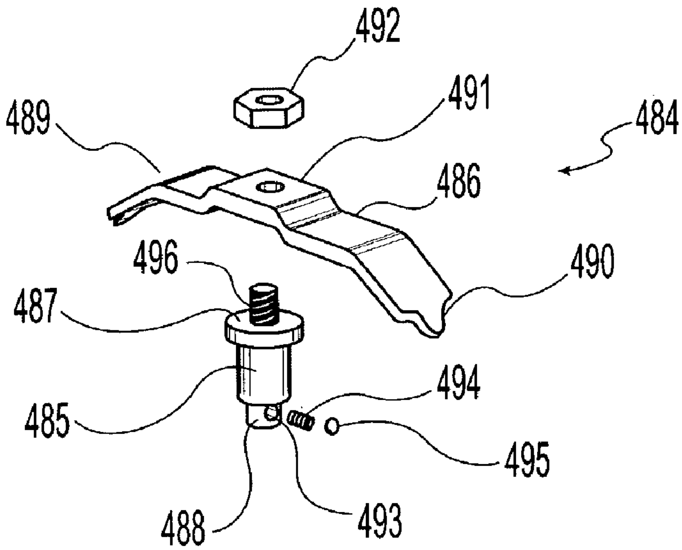
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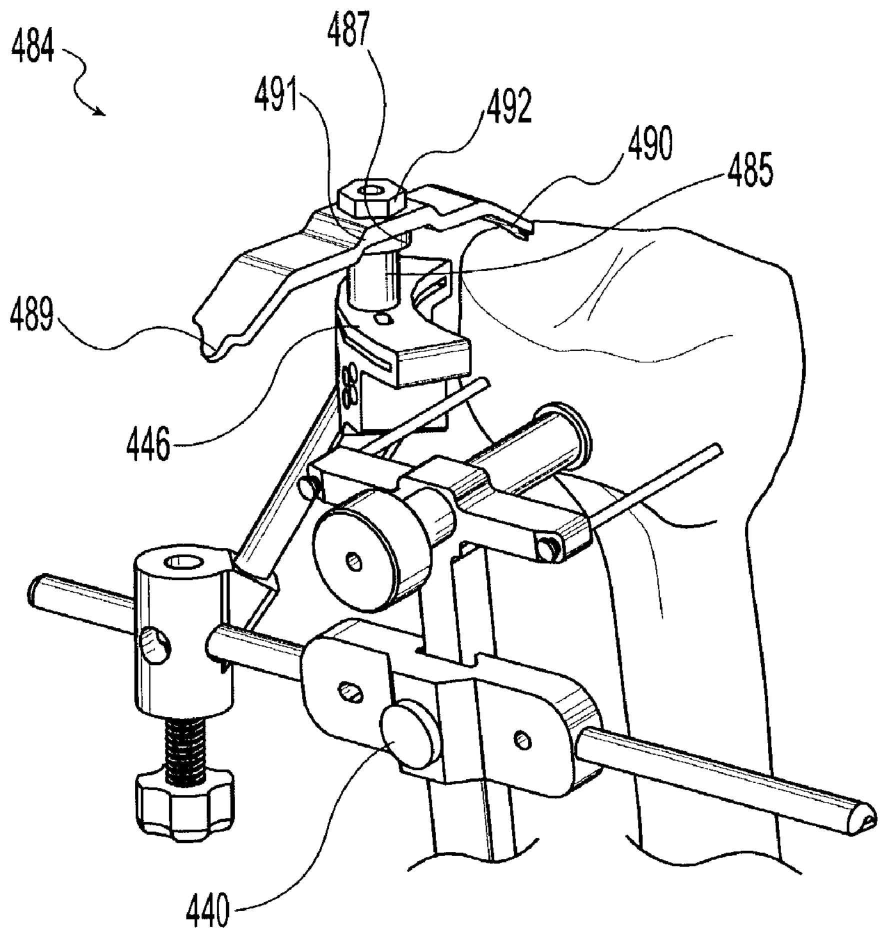
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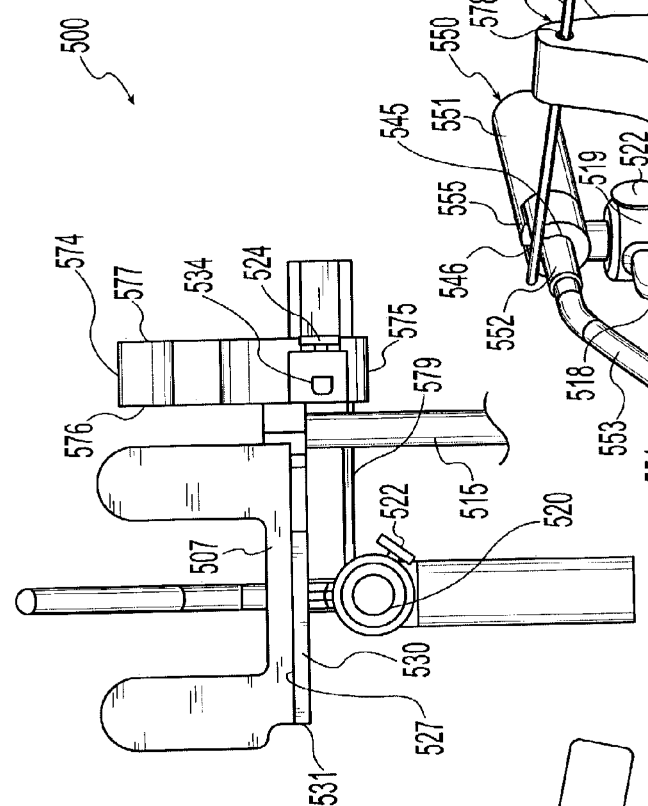

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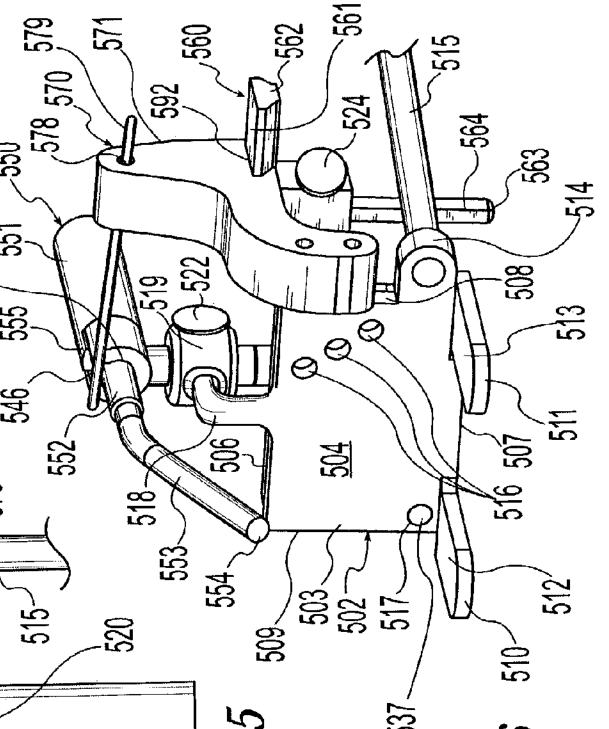

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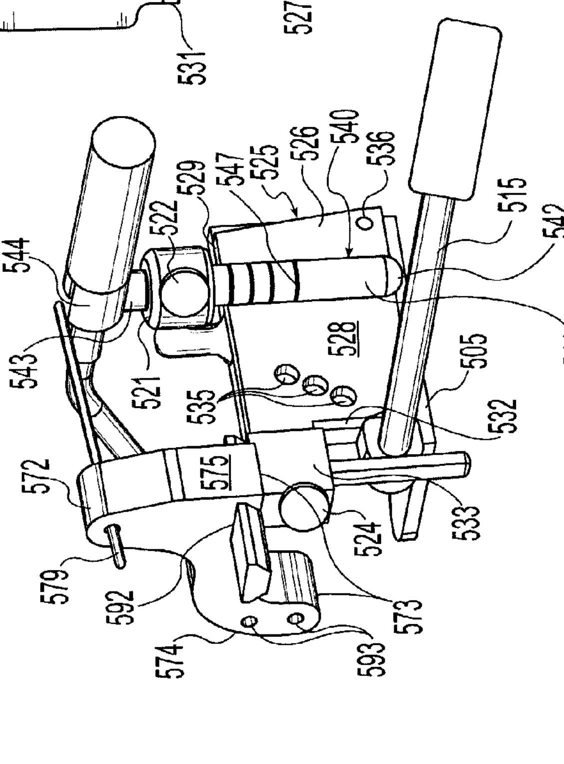

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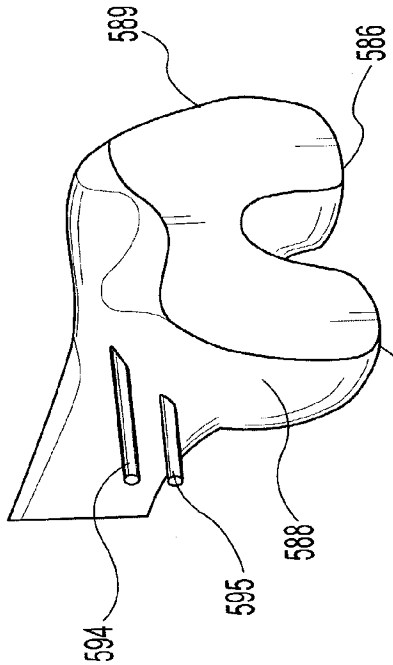

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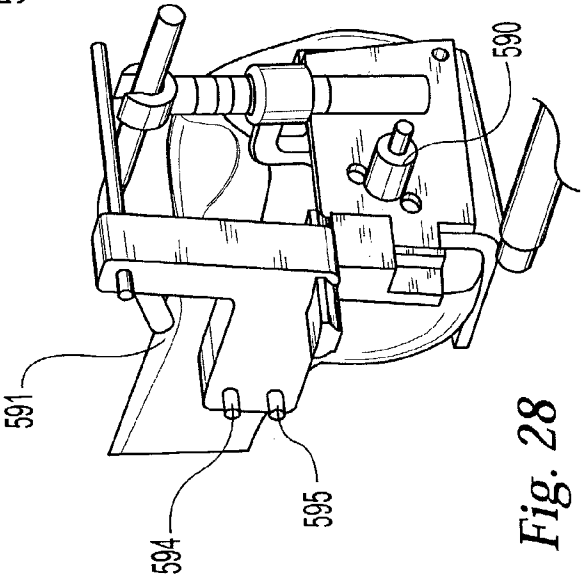

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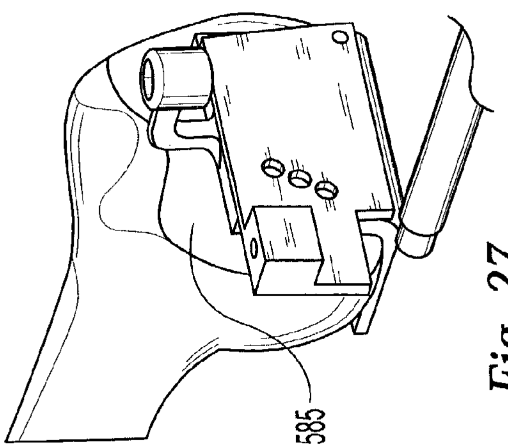

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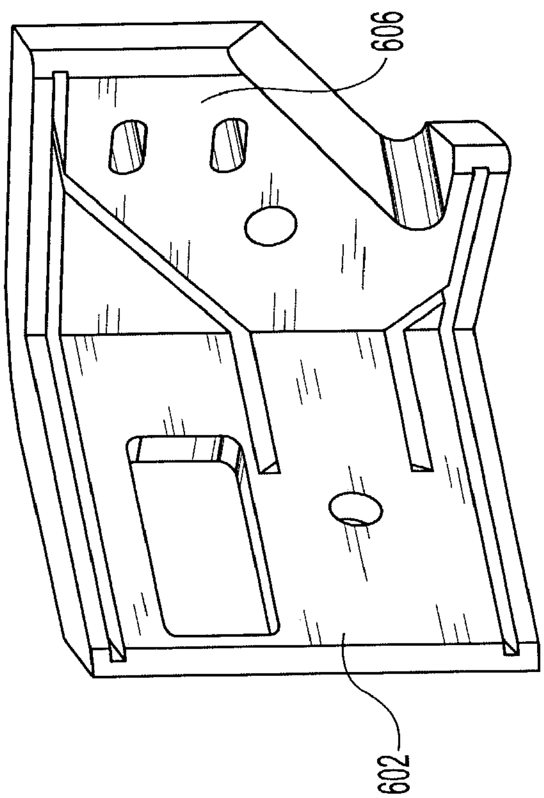

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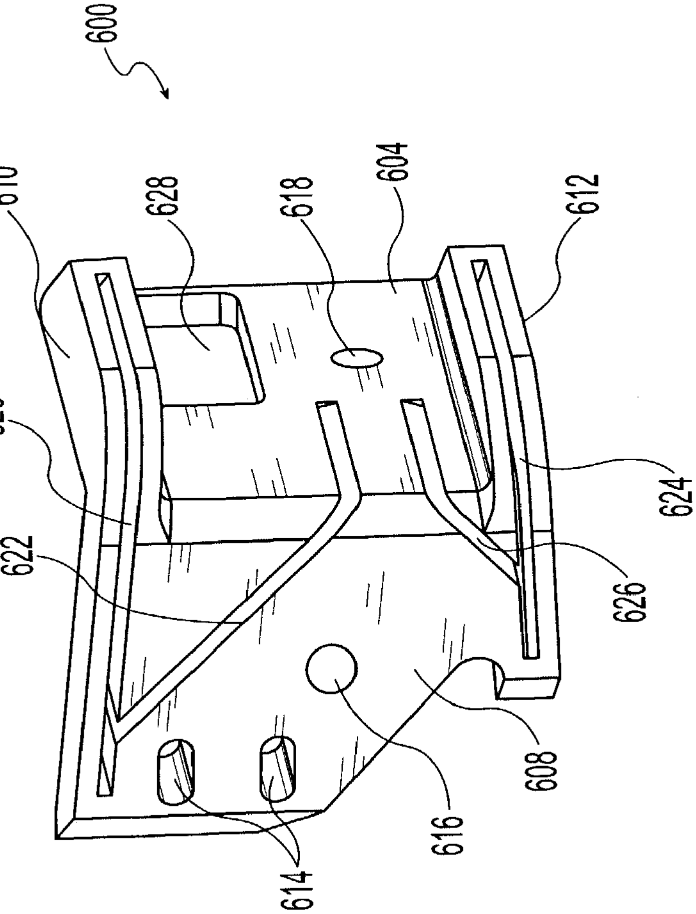

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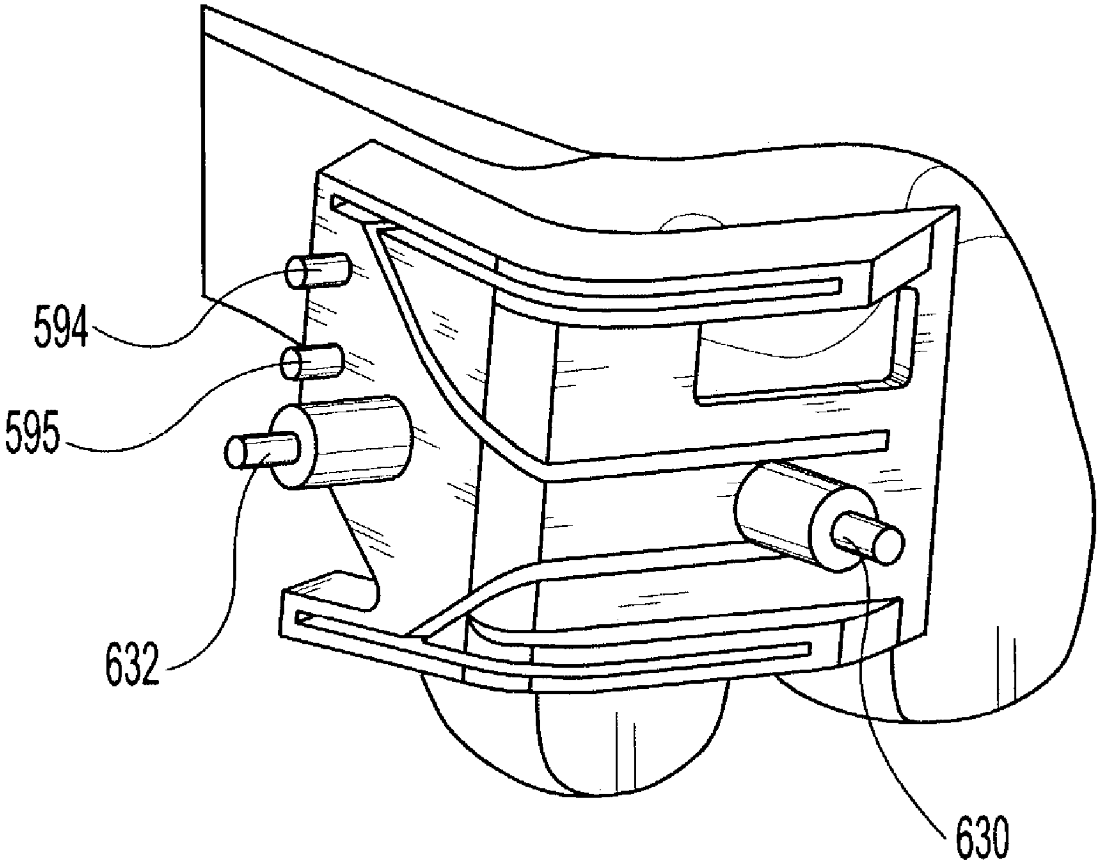

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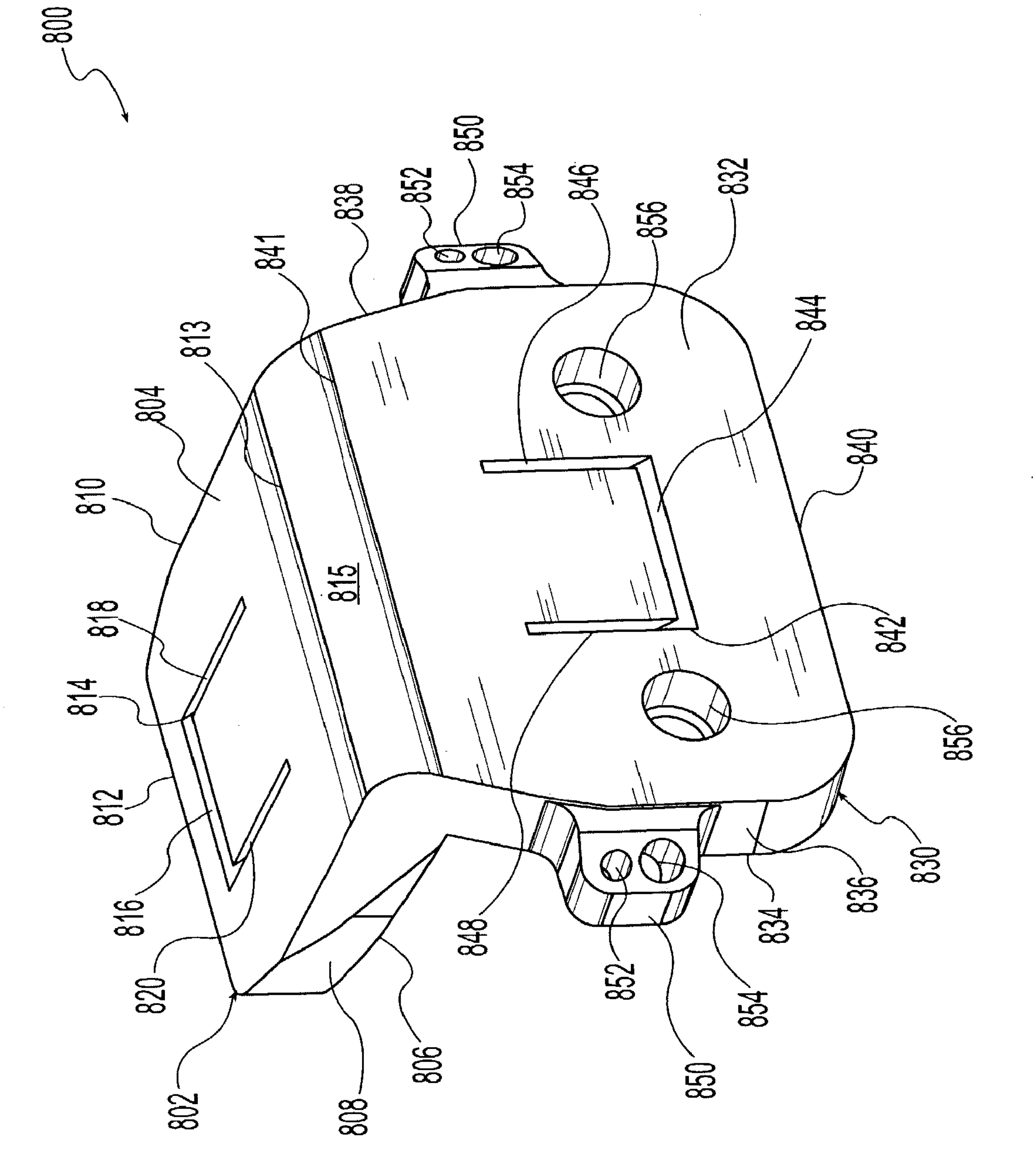
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Fig. 33

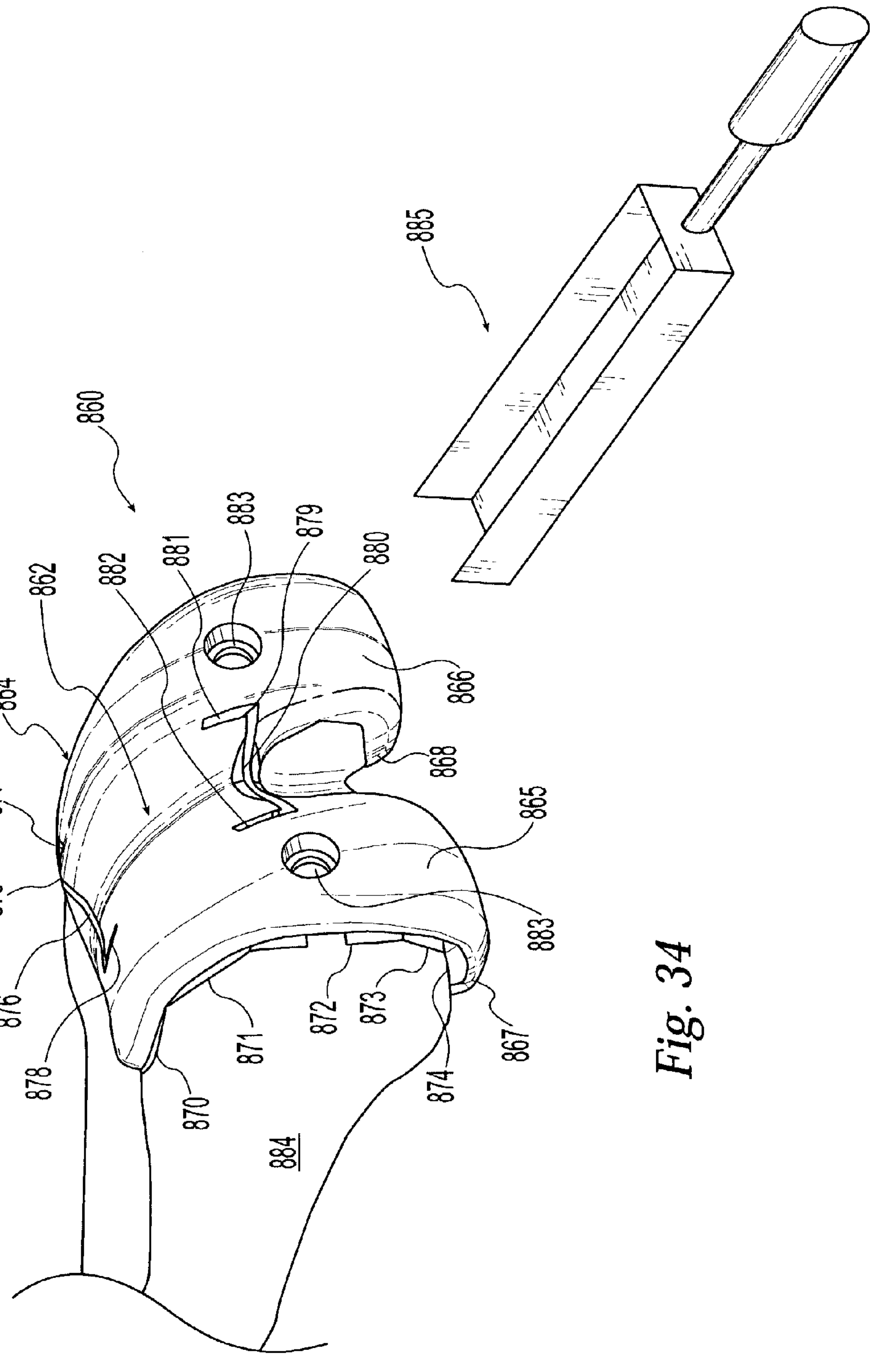
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Fig. 34

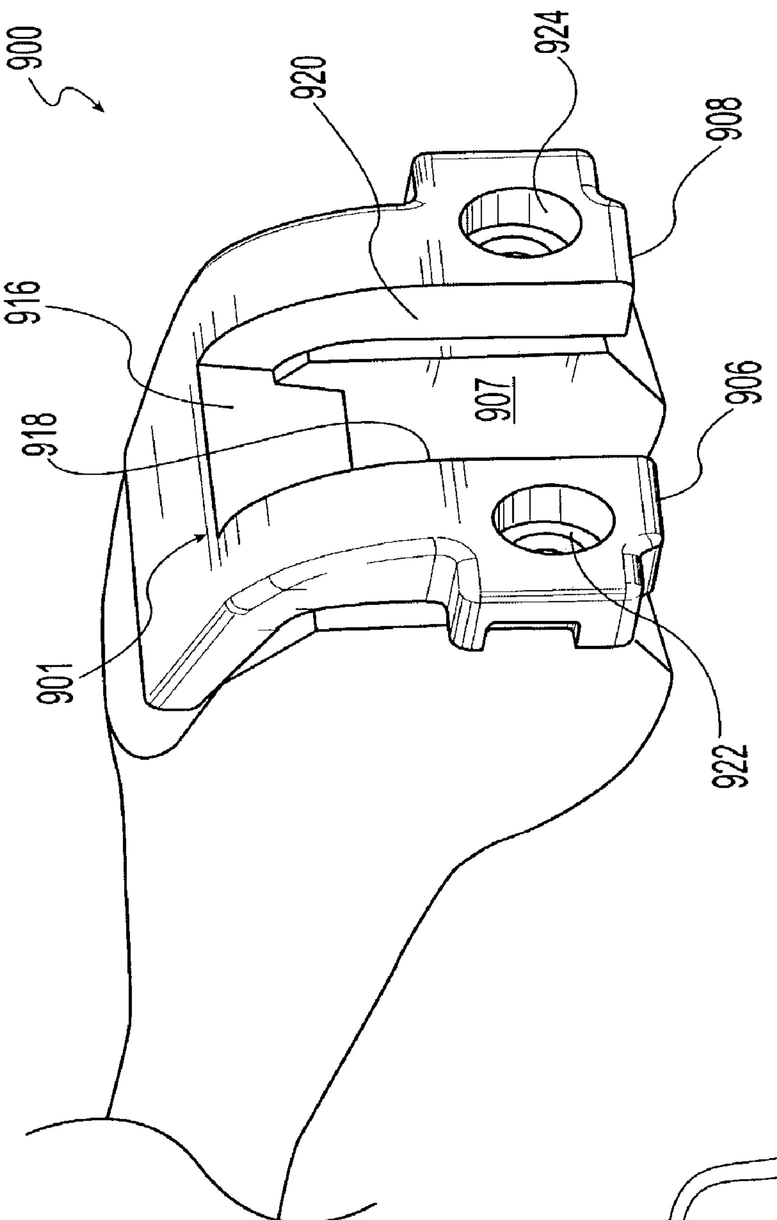

Fig. 36

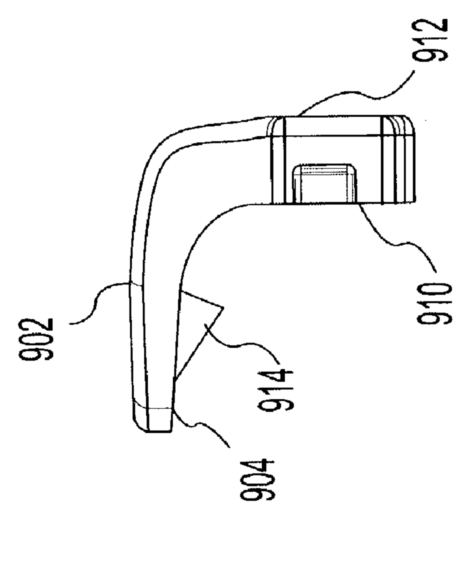

Fig. 35

APPARATUS FOR KNEE SURGERY AND METHOD OF USE

BRIEF DESCRIPTION OF THE DRAWINGS

[0001] Various embodiments of the present invention will be discussed with reference to the appended drawings. These drawings depict only illustrative embodiments of the invention and are not to be considered limiting of its scope.

[0002] **FIG. 1** is a front elevation view of a tibia and a femur showing axes of the knee joint.

[0003] **FIG. 2** is a side section view of a knee joint showing typical bone cuts used in replacing the joint surfaces.

[0004] **FIG. 3** is a perspective view of knee joint showing aspects of component positioning.

[0005] **FIG. 4** is a perspective view of the knee joint showing the incision planning for a medial surgical approach according to the present invention.

[0006] **FIG. 5** is a perspective view of the knee joint showing the medial incision according to the present invention.

[0007] **FIG. 6** is a perspective view of the knee joint showing the incision planning for a lateral surgical approach according to the present invention.

[0008] **FIG. 7** is a perspective view of the knee joint showing the lateral incision according to the present invention.

[0009] **FIG. 8** is a perspective view of an illustrative embodiment of a patella resection guide according to the present invention.

[0010] **FIG. 9** is a top plan view of the patella resection guide of **FIG. 8**.

[0011] **FIG. 10** is an exploded perspective view of another illustrative embodiment of a patella resection guide according to the present invention.

[0012] **FIG. 11** is a top plan view of the patella resection guide of **FIG. 10**.

[0013] **FIG. 12** is a side elevation view of the patella resection guide of **FIG. 10** shown gripping a patella.

[0014] **FIG. 13** is a front elevation view of the patella resection guide of **FIG. 10**.

[0015] **FIG. 14** is a perspective view of an illustrative embodiment of an intramedullary distal femoral cutting instrument according to the present invention.

[0016] **FIG. 15** is a side elevation view of the intramedullary distal femoral cutting instrument of **FIG. 14**.

[0017] **FIG. 16** is a front elevation view of the intramedullary distal femoral cutting instrument of **FIG. 14**.

[0018] **FIG. 17** is a side elevation view of the intramedullary distal femoral cutting instrument of **FIG. 14** mounted on a femur.

[0019] **FIG. 18** is a side elevation view of another illustrative intramedullary distal femoral cutting instrument according to the present invention mounted on a femur.

[0020] **FIG. 19** is a front elevation view of an illustrative embodiment of a tibial cut guide assembly according to the present invention.

[0021] **FIG. 20** is a perspective view of the tibial cut guide assembly of **FIG. 19**.

[0022] **FIG. 21** is a top plan view of the tibial cut guide assembly of **FIG. 19**.

[0023] **FIG. 22** is an exploded perspective view of an illustrative embodiment of a depth gauge for use with the tibial cut guide of **FIG. 19** according to the present invention.

[0024] **FIG. 23** is a perspective view of the tibial cut guide assembly of **FIG. 19** and the depth gauge of **FIG. 22** mounted on a tibia.

[0025] **FIG. 24** is a perspective view of an illustrative embodiment of a femoral A/P sizer and pin guide assembly according to the present invention.

[0026] **FIG. 25** is a bottom plan view of the femoral A/P sizer and pin guide assembly of **FIG. 24**.

[0027] **FIG. 26** is a perspective view, from a different viewing angle, of the femoral A/P sizer and pin guide assembly of **FIG. 24**.

[0028] **FIG. 27** is a perspective view showing the femoral A/P sizer and pin guide assembly of **FIG. 24** being assembled on a distal femur.

[0029] **FIG. 28** is a perspective view showing the femoral A/P sizer and pin guide assembly of **FIG. 24** fully assembled on a distal femur.

[0030] **FIG. 29** is a perspective view showing two reference pins inserted in the distal femur using the femoral A/P sizer and pin guide assembly of **FIG. 24**.

[0031] **FIG. 30** is a perspective view of an illustrative embodiment of a femoral profile cut block according to the present invention.

[0032] **FIG. 31** is a perspective view, from a different viewing angle, of the femoral profile cut block of **FIG. 30**.

[0033] **FIG. 32** is a perspective view of the femoral profile cut block of **FIG. 30** mounted on a femur.

[0034] **FIG. 33** is a perspective view of an illustrative embodiment of a trochlear cut guide according to the present invention.

[0035] **FIG. 34** is a perspective view of another illustrative embodiment of a femoral provisional trochlear cut guide according to the present invention mounted on a femur and further showing an illustrative embodiment of a chisel for use with the cut guide.

[0036] **FIG. 35** is a side elevation view of the intercondylar notch guide of **FIG. 39**.

[0037] **FIG. 36** is a perspective view of an illustrative embodiment of an intercondylar notch guide mounted on a femur according to the present invention.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

[0038] The present invention relates to methods and instruments for performing total knee arthroplasty. An incision is made into the knee joint to expose the bones comprising the joint. Cutting guides are then used to guide the removal of the articular surfaces that are to be replaced. Artificial joint components are then positioned to replace the resected bone ends in order to establish the desired alignment and mechanics of the joint. Each aspect of the surgery affects the ultimate outcome of the procedure. The incision location and size determines the extent to which the bones can be exposed for facilitating the bone cutting steps. The incision also affects the amount of trauma to the soft tissues surrounding the joint and therefore the pain, time for recovery, and stability of the joint postoperatively. The design of the cutting guides affects how much exposure is required to place and orient the guides relative to the bones. The precision of the cuts produced by the guides affects the stability and longevity of the joint replacement. Finally, the manner in which the joint components attach to one another and to the bone affects the amount of exposure required and the stability and longevity of the joint replacement. The inventive instruments and method are generally suitable for knee joint surgery. Furthermore, they include features that make them suitable for performing a minimally invasive knee surgery in which a smaller than normal incision is made and oriented to preserve the quadriceps mechanism and protect the suprapatellar pouch. The instruments permit switching from a minimally invasive technique to a standard open technique at any point in the procedure.

[**0039**] In order to better understand the total knee arthroplasty procedure, it is helpful to understand the relationship of the bones and the cuts made to orient the implant components. FIGS. **1-3** illustrate several aspects of implant orientation. **FIG. 1** illustrates various axes of the lower limb in the frontal plane. Axes can be defined for each segment of the lower limb. For example, the femur **1** has an anatomic axis **2** coinciding generally with its intramedullary canal. It also has a mechanical axis **4**, or load axis, running from the center of the femoral head to the center of the knee. The angle **6** between these two axes varies within the patient population but is on the order of 6°. Likewise, the tibia **3** has an anatomic axis coinciding generally with its intramedullary canal. The mechanical axis **5** of the tibia runs from the center of the knee to the center of the ankle and is generally collinear with the anatomic axis. The transverse axis, or joint line **8**, about which the knee flexes, is parallel to a line through the medial and lateral femoral condyles and parallel to the tibial plateau. This line subtends a slight valgus angle of approximately 87° with the mechanical axis of the femur and a slight varus angle of approximately 87° with the mechanical axis of the tibia. Thus, the distal femur is in slight valgus and the proximal tibia is in slight varus. Normally, the distal femur and proximal tibia are resected to be parallel to the joint line **8**, and thus perpendicular to the mechanical axis **4**, as indicated at **10** and **12**. The intersection of the femoral and tibial mechanical axes, **4** and **5**, may subtend a small angle relative to one another. However, the angle is small and the mechanical axis of the femur has an approximately normal alignment with the proximal tibia if the knee is uninjured. Therefore the tibial mechanical axis may be extrapolated to the distal femur to define the femoral mechanical axis in the distal femur when there is a femoral deformity. Similarly, if there is a deformity in the tibia, the mechanical axis of the proximal tibia may be defined by extrapolating the femoral mechanical axis. The illustrative procedure described herein restores the center of the femoral bead, the knee, and the ankle to a lie on a straight line to establish a neutral mechanical axis. The femoral and tibial components are oriented perpendicular to this axis in the frontal plane.

[**0040**] **FIG. 2** illustrates the knee joint from the side or sagittal view and various bone cuts that may be made to align implant components. The distal femur is typically cut **10** perpendicular, in the anterior-to-posterior direction, to the anatomic axis **2** of the femur. The proximal tibial resection **12** is normally cut to match the natural posterior slope of the proximal tibia relative to the tibial mechanical axis **5**. The amount of posterior slope **16** relative to a reference line **18** perpendicular to the tibial mechanical axis **5** varies in the patient population but is on the order of 7°. The distance between the distal femoral **10** and proximal tibial **12** cuts along the mechanical axes **4** and **5** is the extension gap. Other cuts may be made depending on the components that are to be implanted. These include an anterior femoral cut **20**, anterior femoral chamfer cut **22**, posterior femoral chamfer cut **24**, and posterior femoral cut **26**. The patella **7** may also be cut **28** to allow for replacement of the patellar articular surface. Additional preparation of the bone may include drilling or notching the bones to receive pegs, stems, and other extensions from the components (not shown).

[**0041**] **FIG. 3** depicts six aspects of component positioning relative to a coordinate system in which the x-axis **30** corresponds approximately to the joint line **8**, the z-axis **34** corresponds approximately to the mechanical axes **4** and **5**, and the y-axis **32** is normal to the other two. Position along each of these axes is depicted by arrows. Position along the x, y, and z axes determines the medial/lateral (dx) **36**, anterior/posterior (dy) **38**, and proximal/distal (dz) **40** positioning of components respectively. Rotation about each of these axes is also depicted by arrows. Rotation about the z-axis (rz) **42** corresponds anatomically to external rotation of the femoral component, while rotation about the x-axis (rx) **44** and y-axis (ry) **46**, corresponds to extension plane slope and varus/valgus angle respectively. Depending on the order of the cuts, and the way that subsequent instruments reference each cut, the position of the distal femoral cut **10** can affect the location of the joint line (dz), the extension gap, the varus/valgus angle (ry), and the extension plane angle (rx). Likewise, the position of the proximal tibial cut **12** can affect the varus/valgus angle (ry), extension plane (rx), external rotation (rz), and the joint line (dz) or extension gap. The position of the anterior **20**, posterior **26**, and chamfer **22** and **24** femoral cuts affect anterior/posterior size and placement (dy) and external rotation (rz). Finally, the position of peg holes, stem notches, and other similar bone cuts affect medial/lateral (dx) placement of components.

[**0042**] An illustrative set of instruments for total knee arthroplasty and an associated minimally invasive technique will now be described with reference to the drawings. The illustrative technique utilizes a limited exposure approach from the side of the knee as shown in FIGS. **4-7**. This side approach can be at an oblique angle relative to the front of the knee or transversely, more directly from the side. The side approach permits a minimally invasive knee surgery in which a smaller than normal incision is made and orients the incision and subsequent bone cuts to preserve the quadriceps mechanism and protect the suprapatellar pouch. **FIGS. 4 and 5** depict a medial approach and **FIGS. 6 and 7** depict a lateral approach. Reference lines are made on the knee prior to making the incision. For the medial approach, a curvilinear medial incision **50** is made from the superior pole **52** of the patella **54** to the tibial joint line **56**. The outline of the medial femoral condyle **58** is also marked. The arthrotomy is in line with the skin incision and includes a transverse incision **60** beneath the vastus medialis to increase the exposure of the medial femoral condyle **62**. Alternatively, a lateral approach may be used. For the lateral approach, the incision **70** is made on the lateral side of the patella **72** to the tibial joint line **74** and is almost vertical along the side of the patella. The outline of the lateral femoral condyle **75** is also marked. The arthrotomy is performed in a vertical fashion and the iliotibial band **76** is peeled from the tibial plateau joint line from anterior to posterior to expose the lateral femoral condyle **78**. No transverse capsular incision is used for the lateral approach.

[**0043**] Throughout the description of the illustrative technique and instruments, reference will be made to cutting bone. There are many cutters for surgically cutting bone including: oscillating saws, reciprocating saws, gigli saws, end cutting reamers, side cutting reamers, streams of particles, energy beams, and others known in the art. While the illustrative embodiments depict and describe saw blade guides for guiding a saw blade to cut bone, any means for cutting bone is contemplated. The slots can be replaced with surfaces, jigs, clamps, and other types of fixtures as appropriate to guide the type of cutter being used.

[**0044**] The preparation of the patella is described first. However, the patella can be prepared later if desired. Preparing it first results in more space anteriorly when preparing the distal femur. The illustrative instruments allow preparation of the patella without everting it to avoid damage to the patellar mechanism. Alternatively, waiting until after the distal femur and/or proximal tibia are prepared allows the joint to be collapsed to reduce tension in the patellar tendon and ligament and improve access to prepare the patella.

[**0045**] The patella is prepared using a patella resection guide. **FIGS. 8 and 9** illustrate one embodiment of a patella resection guide **100**. Stationary jaw member **102** includes a top surface **104**, a bottom surface **106**, an inner concave surface **108**, an opposite outer surface **109**, and teeth **110** projecting inwardly from the concave surface **108**, adjacent the top surface **104**. Guide arms **112**, **114** project from the concave surface **108** and connect the concave surface to a pair of handles **116**, **118**. The guide arms **112**, **114** are generally perpendicular to the jaw member **102** and parallel to one another. The pair of handles **116**, **118** are coplanar and are attached generally perpendicularly to the guide arms **112**, **114** and extend in opposite directions from one another. A top portion **111** of the stationary jaw **102**, including the teeth **110** and top surface **104**, projects above the guide arms **112**, **114**. Translating jaw member **122** includes a top surface **124**, a bottom surface **126**, an inner concave surface **128**, an opposite outer surface **129**, and teeth **130** projecting inwardly from the concave surface **128**, adjacent the top surface **124**. Bores **131**, **132** through the translating jaw member **122** provide bearing surfaces in engagement with guide arms **112**, **114** such that the translating jaw member **122** may be moved along the guide arms **112**, **114** in a motion plane from a first position in which the two jaw members **102**, **122** are spaced from one another and the translating jaw **122** is nearer the handles **116**, **118** and a second position in which the two jaw members **102**, **122** are closer to one another and the translating jaw **122** is farther from the handles **116**, **118**. This arrangement constrains the jaws to remain parallel to one another as they move relative to one another. A top portion **134**, including the teeth **130** and top surface **124**, of the translating jaw **122** projects above the guide arms **112**, **114** such that the tops **104**, **124** of the jaws **102**, **122** are coplanar. The translating jaw **122** further includes a saw guide slot **135** extending through the top portion **134** from the outer surface **129** to the inner concave surface **128** parallel to the top surface **124** and extending beyond the attachment point of the guide arms to the handles on either side. The slot **135** is positioned so that it is above the level of the handles **116**, **118** to permit easy access for the insertion of a saw blade anywhere across the entire width of the slot **135**. The slot **135** defines a cutting plane parallel to the motion plane of the translating jaw **122**. Actuator **136** comprises an elongate lever having a jaw engaging end **138**, a pivot portion **140**, and an input end **142**. The jaw engaging end **138** further includes a slot **144** through which a pin **146** connects the jaw engaging end **138** to the translating jaw **122**. The jaw engaging end **138** can pivot and translate via the slot **144** relative to the pin **146** which is fixed to the translating jaw **122**. The actuator **136** is pivotally constrained by a pin **148** extending through the pivot portion **140** and being fixed to the handle **118**. Input end **142** extends at an angle to the handle **118** when the jaws **102**, **122** are in a first position in which they are spaced from one another. In use, a user grips the handles **116**, **118** and squeezes the input end **142** of the actuator **136** to reduce the angle between the input end **142** and the handle **118**. As the actuator pivot portion **140** rotates about its pin **148**, the jaw engaging end **138** presses against its pin **146** and moves the translating jaw **122** toward the stationary jaw **102**.

[**0046**] FIGS. **10-13** illustrate another embodiment of a patella resection guide **200**. Stationary jaw member **202** includes a top surface **204**, a bottom surface **206**, a concave inner surface **208**, an opposite convex outer surface **209**, and teeth **210** projecting inwardly from the concave surface **208**, adjacent the top surface **204**. Guide arms **212**, **214** project from the concave surface **208** and connect the concave surface to a pair of handles **216**, **218** via rectangular bosses **215**, **217**. The guide arms **212**, **214** are generally perpendicular to the jaw member **202** and parallel to one another. The handles **216**, **218** are coplanar and are attached generally perpendicularly to the guide arms **212**, **214** and extend in opposite directions from one another. In this embodiment, the guide arms **212**, **214** extend past their connections **215**, **217** to the handles **216**, **218**. A top portion **211**, including the teeth **210** and top surface **204**, of the stationary jaw **202** projects above the guide arms **212**, **214**. A translating jaw member **222** includes a top surface **224**, a bottom surface **226**, an inner concave surface **228**, an opposite convex outer surface **229**, and teeth **230** projecting inwardly from the concave surface **228**, adjacent the top surface **224**. Cannulated guide sleeves **221**, **223** connect to opposite sides of the translating jaw **222** and connect the concave surface **228** to a pair of handles **231**, **233**. The guide sleeves **221**, **223** are coplanar and are generally perpendicular to the translating jaw **222** and parallel to one another. The pair of handles **231**, **233** are attached generally perpendicularly to the guide sleeves **221**, **223** and extend oppositely and outwardly from the translating jaw **222**. The guide sleeves **221**, **223** have outwardly facing slots **225**, **227** in their outer wall communicating with their inner cannulae. The guide sleeves **221**, **223** receive guide arms **212**, **214** such that the translating jaw member **222** may be moved along the guide arms **212**, **214** from a first position in which the two jaw members **202**, **222** are spaced from one another and the translating handles **231**, **233** are spaced from the stationary handles **216**, **218** and a second position in which the jaw members and handles are closer to one another. This arrangement constrains the jaw members to remain parallel and facing one another while they move relative to one another. A top portion **234**, including the teeth **230** and top surface **224**, of the translating jaw **222** projects above the guide sleeves **221**, **223** such that the tops **204**, **224** of the jaws **202**, **222** are coplanar. The translating jaw **222** further includes a saw guide slot **235** extending through the top portion **234** from the outer surface **229** to the inner surface **228** parallel to the top surface **224**.

[**0047**] This embodiment further includes a depth gauge **240** having a support **242** and blade **244**. The support **242** includes a blade engaging end **246**, a resection guide engaging end **248**, and a longitudinal axis from one end to the other. The blade includes first **250** and second **252** ends and center attachment portion **254**. The center attachment portion **254** is attached to the blade engaging end **246** of the support **242** with a threaded post extending from the support **242** through the attachment portion **254** and secured with a nut **255**. The first **250** and second **252** blade ends are each offset a different distance from the center attachment portion **254** measured along the support **242** axis. The resection guide engaging end **248** and the resection guide **200** include an engagement mechanism for selectively attaching the depth gauge **240** to the resection guide **200**. Translating jaw **222** includes a through bore **256** extending from the top surface **224** to the bottom surface **226** in communication with the guide slot **235**. Depth gauge support **242** includes a hole **258** retaining a spring **260** and ball **262** plunger in the resection guide engaging end **248**. The ball **262** is biased into engagement with the guide slot **235** when the resection guide engaging end **248** is inserted into through bore **256**. The depth gauge can engage the through bore **256** and be supported on either the top surface **224** or bottom surface **226**. When it is thus supported, the blade ends **250**, **252** can be selectively placed to project over the jaws **202**, **222**. Each blade end projects to define a plane a different predetermined axial distance from the guide slot **235**.

[**0048**] Both illustrative embodiments are relatively compact to permit the stationary jaw to be wedged across the joint between the femur and patella. Both also facilitate approaching the patella from the lateral or medial side and gripping it on its sides while presenting an unobstructed side-facing saw guide slot. The use of the instrument will be described relative to the embodiment of FIGS. **10**-**13**. The surgeon first determines whether it is desirable to remove a prescribed amount of patellar bone or to leave a prescribed amount and how much in either case. To remove a prescribed amount of bone, the depth gauge **240** is attached to the top surface **224** of the translating jaw **222** so that the blade **244** references the posterior side **272** of the patella **270** as shown in **FIG. 12**. To leave a prescribed amount of bone, the depth gauge **240** is attached to the bottom surface **226** of the translating jaw **222** so that the blade **244** references the anterior side **274** of the patella **270**. The amount is established by positioning the blade end **250** or **252** having the corresponding amount of offset in contact with the patella. The stationaryjaw **202** is wedged across the joint between the femur and patella with the top surface **204** facing toward the posterior side **272** of the patella **270** and the bottom surface **206** facing toward the femur. The patella **270** is placed between the jaws with the depth gauge blade in contact with the appropriate patellar surface and the handles **218**, **233** and **216**, **231** are gripped and squeezed toward one another to bring the jaws **202**,**222** together to grip the patella **270** medially and laterally. A saw blade is activated through the saw guide slot **235** to resect the patella. A locking mechanism can be provided to selectively prevent the jaws from moving away from one another. For example, the guide arms **212**, **214** can be threaded and provided with nuts at their free ends. After the translating jaw is moved toward the stationary jaw, the nuts would be advanced to prevent the translating jaw from moving backward. Likewise, the guide arms **212**, **214** can be grooved and the guide sleeves **221**, **223** provided with ratcheting palls biased into engagement with the grooves such that the palls ride freely over the grooves as the jaws are moved toward one another but the palls engage the grooves and resist motion of the jaws away from one another.

[**0049**] The distal femur is prepared using a distal femoral cut guide. FIGS. **14**-**17** show an illustrative embodiment of an intramedullary (IM) distal femoral cutting instrument **300** for guiding the distal femoral cut. An IM alignment guide **302** includes a body **304** having front **306** and back **308** surfaces, lateral **310** and medial **312** ends, and first **309** and second **311** side surfaces. A through slot **314** communicates from the front surface **306** to the back surface **308**. A cut guide engaging slot **316** extends part way from the back surface **308** toward the front surface **306**. The cut guide engaging slot **316** is generally aligned with the through slot **314** and is wider than the slot **314** side-to-side. The cut guide engaging slot **316** extends laterally to open at the lateral end **310**. A neck **318** projects from the medial end **312** and extends the back surface **308** medially. A lug **320** is connected to the end of the neck **318** opposite the body **304**. The lug includes a rounded reference surface **322** that projects beyond the back surface **308**. A socket **324**, having a longitudinal axis, is formed in the reference surface **322**. The axis of the socket **324** forms a predetermined angle relative to the back surface **308**. For a medial approach to the knee, the angle will be obtuse and for a lateral approach it will be acute. An intramedullary rod **326** having a longitudinal axis fits into the socket **324** so that the rod **326** axis is coaxial with the socket axis and extends from the IM alignment guide at the predetermined angle. The rod **326** is welded in place.

[**0050**] An IM distal cut guide **330** includes a body **332** with front **334** and back **336** surfaces, medial **338** and lateral **340** surfaces, and first **342** and second **344** sides. Three saw blade slots **345** extend through the cut guide **330** from the medial **338** to the lateral **340** surface. The slots **345** lie in planes parallel to the front surface **334**. A pin tab **346** extends from the back surface **346** and has lateral **348** and medial surfaces **350** that taper **353** inwardly from the medial **338** and lateral **340** surfaces of the body. Fixation holes **351** extend through the pin tab from the lateral surface **348** to the medial surface **350**. An engagement tab **352** extends from the front surface **334** and has sides **354** and **356** and front surface **358**. A threaded hole **360** extends from the front surface **358** toward the body **332**. The engagement tab **352** engages the cut guide engaging slot **316** with the front surface **334** of the distal cut guide resting against the back surface **308** of the IM alignment guide such that the saw blade slots **345** are parallel to the back surface **308** and thus are at the predetermined angle relative to the IM rod **326**. The plane of the middle saw blade slot intersects the extreme end of the reference surface **322**. It is desirable to resect the distal femur perpendicular to the mechanical axis of the femur. Therefore, the distal cut guide is aligned such that a line perpendicular to the saw blade slots **345** is aligned with the mechanical axis. This is accomplished by providing a plurality of IM alignment guides having the angle of the IM rod **326**, relative to the plane of the saw blade slots **345**, equal to the difference between the anatomic and mechanical axes of the femur. Because of variation in the patient population, IM alignment guides having different rod **326** angles are provided. For example, angles of 4°, 6°, and 8° have been found to be suitable to accommodate most patients. The engagement of the tab **352** and slot **316** allows the distal cut guide **330** to slide relative to the IM alignment guide **302** from a first position in which the distal cut guide **330** is farther from the IM rod **326** and a second position in which the distal cut guide **330** is nearer to the IM rod **326**. A handle **361** includes a grip portion **362**, a threaded stud **363** opposite the grip portion **362**, and a shoulder **364** intermediate the grip portion **362** and the threaded stud **363**. The threaded stud **363** extends through the slot **314** in the IM alignment guide **302** to threadingly engage the threaded hole **360** in the engagement tab **352** of the distal cut guide **330**. As the handle **361** is rotated to further engage the threaded hole **360**, the shoulder **364** bears against front surface **306** of the IM alignment guide **302** and the front surface **334** of the distal cut guide **330** is drawn into tight locking engagement with the back surface **308** of the IM alignment guide **302**. By means of the handle **361**, the distal cut guide **330** can be slid and locked at any position of its travel along the IM alignment guide.

[0051] In use, a hole is drilled in the center of the patellar sulcus **366** of the distal femur, making sure that the hole is parallel to the shaft of the femur **365** in both the frontal and sagittal planes. The hole provides access to the IM canal of the femur **365**. An IM alignment guide **302** is selected as appropriate for a medial or lateral approach and having a rod **326** angle that accounts for the difference between the anatomic and mechanical axes of the femur as determined by preoperative templating. The IM distal cut guide **330** is attached to the alignment guide **302** using the handle **361**. Using the handle, IM rod **326** is inserted into the IM canal of the femur **365**. The assembly is inserted until the reference surface **322** contacts the intercondylar sulcus **366** with the IM alignment guide **302** projecting toward the exposed side of the knee. The distal cut guide **330** is slid in slot **316** until the medial surface **338** is adjacent the bone. In **FIG. 17**, the distal cut guide **330** is shown adjacent the medial condyle **367**. The handle **360** is rotated to lock the distal cut guide **330** relative to the IM alignment guide **302**. Pins **368** are then inserted through the holes **351** in the pin tab **346** and into the bone to hold the distal cut guide **330** in place. The taper **353** of the medial side **350** of the pin tab **346** causes it to fit the condylar bone more closely and therefore more stably. Once the pins are placed, the handle **361** is unthreaded from the distal cut guide **330** and the IM alignment guide **302** and IM rod **326** are removed from the bone leaving the distal cut guide **330** pinned to the bone. A saw blade is then directed through one of the slots **345** to resect the distal femur. If the reference surface **322** was fully seated in the intercondylar sulcus **366**, the middle saw guide slot will resect the distal femur to the depth of the sulcus. The other slots provide more or less resection.

[0052] **FIG. 18** shows an alternative embodiment of distal femoral cut guide **300** in which the lug **320** and rounded reference surface **322** have been omitted. Instead, an IM rod **370** is connected directly to the end **372** of the neck **374** of the IM alignment guide. In this embodiment, the IM rod **370** is inserted into the IM canal of the femur **378** until the back surface **380** contacts the near distal femoral condyle. In this case the back surface **380** contacts the distal medial condyle **382**. The plane of the middle saw blade slot is offset 10 mm from the back surface **380**. The other slots are offset 6 mm and 14 mm respectively. Thus, the appropriate slot is chosen based on how much bone is to be resected from the distal femur relative to the near condyle. Typically, the middle or 10 mm slot would be used with a medial approach and less would be used with a lateral approach.

[0053] The proximal tibia is prepared using a tibial cut guide. FIGS. **19-23** show an illustrative embodiment of a tibial cut guide assembly **400** for guiding the proximal tibial cut. The assembly includes a tibial tubercle alignment bar **402**, a tibial boom **430**, a tibial cut guide **446**, and a tibial depth gauge **484** (FIGS. **22-23**). The tibial tubercle alignment bar **402** includes an elongate body **404** having an anterior face **406**, a posterior face **408**, first and second side walls **410**, **412**, a distal end **414**, a proximal end **416**, and a longitudinal axis running from the distal end to the proximal end. A dovetail **417** is formed on a portion of the alignment bar **402** adjacent the anterior face **406**. A stop **418** projects from the anterior face **406** near one end of the dovetail **417** toward the distal end **414** of the alignment bar **402**. Extensions **420** project perpendicularly from either side **410**, **412** of the body **404** near the proximal end **416**. Fixation holes **421** are formed through the extensions **420** from anterior to posterior for receiving fixation pins. A threaded bore **422** extends through the alignment bar **402** from the anterior face **406** to the posterior face **408** near the proximal end **416**. A plunger **424** having a threaded shaft **426** and an adjustment knob **427** is received in the threaded bore **422** such that rotating the adjustment knob **427** moves the plunger **424** anteriorly and posteriorly to change the spacing from the end of the plunger **424** to the posterior face **408**. A cannula **428** extends through the plunger **424**, shaft **426**, and knob **427** to allow a pin to pass.

[0054] A tibial boom **430** includes a body **431** having an anterior face **432**, a posterior face **433**, a proximal end **434**, a distal end **435**, and first and second sides **436**, **437**. A boss **438** projects from the anterior face and a dovetail groove **439** is formed into the posterior face. A threaded bore is formed through the boss **438** from the anterior face **432** to the dovetail groove **439**. A set screw **440** is received in the threaded bore such that rotating the set screw **440** moves it into and out of the dovetail groove **439**. Extension bars **442** extend from the first and second sides **436**, **437**. The extension bars **442** are "D"-shaped in that they are generally cylindrical with a flat **443** along one side. The extension bars **442** define a longitudinal axis along their length that is perpendicular to the dovetail groove **439**. The tibial boom **430** is mounted on the alignment bar **402** with the dovetail groove **439** engaging the alignment bar dovetail **417** such that the boom **430** can translate along the longitudinal axis of the alignment bar between a first position nearer the proximal end **416** of the alignment bar **402** and a second position further from the proximal end **416** of the alignment bar **402**. The set screw **440** is operable to lock the tibial boom **430** in place by turning the set screw **440** so that it moves into the dovetail groove **439** to engage the dovetail **417**. When the tibial boom is unlocked, it can slide freely distally until it abuts the stop **418** which prevents it from sliding further distally. In this way, the tibial boom **430** can be left unlocked and resting against the stop **418** ready to be moved into position. The longitudinal axis of the tibial tubercle alignment bar **402** and the longitudinal axis of the extension bars **442** together define a guide plane.

[**0055**] A tibial cut guide **446** includes a cutting head **448** having a proximal face **450**, a distal face **452**, opposite side faces **454**, **456**, a concave posterior face **458**, and a convex anterior face **460**. A saw guide slot **462** extends through the cutting head **448** from the anterior face **460** to the posterior face **458** generally parallel to the proximal face **450**. Fixation holes **464**, **466** also extend through the cutting head **448** from anterior to posterior. The smaller holes **464** are sized to receive conventional fixation pins, while the larger hole **466** is sized to receive a spring pin. Proximal face **450** includes a through bore **468** extending from the proximal face **450** to at least the saw guide slot **462** for receiving a depth gauge. In the illustrative embodiment, the bore **468** extends all the way through the cutting head **448** to ease assembly and cleaning. The cutting head **448** is supported on a base **472** by a leg **474**. The base **472** is a cylinder having a longitudinal axis and proximal **471** and distal **473** faces. Two pairs of "D"-shaped transverse bores **480**,**482** extend through the base **472** perpendicular to its longitudinal axis, the flat portion of the "D"-shaped holes also being perpendicular to the base axis. A threaded axial bore **476** in the distal face **473** communicates with the path of the "D"-shaped holes **480**, **482** and receives a set screw **478**. The leg **474** attaches to the base **472** adjacent the proximal face **471** and angles away from the base **472** to support the cutting head **448** in a position offset from the base **472** axis with the saw guide slot **462** defining a cutting plane perpendicular to the longitudinal axis of the base **472**.

[**0056**] The tibial cut guide **400** is provided with a depth gauge **484** having a support **485** and a blade **486**. The support **485** includes a blade engaging end **487**, a resection guide engaging end **488**, and a longitudinal axis from one end to the other. The blade **486** includes first **489** and second **490** ends and a center attachment portion **491**. The center attachment portion **491** is attached to the blade engaging end **487** with a threaded post **496** extending from the support **485** through the attachment portion **491** and secured with a nut **492**. The first **489** and second **490** blade ends are each offset a different distance from the center attachment portion **491** measured along the support **485** axis. The depth gauge support **485** includes a hole **493** retaining a spring **494** and ball plunger **495**. The ball **495** is biased into engagement with the guide slot **462** when the resection guide engaging end **488** is inserted into the through bore **468**. When it is thus supported, the blade ends **489**, **490**, can be selectively positioned to project posteriorly over a tibial bone. Each blade end projects to define a point a different predetermined axial distance above the saw guide slot **462**.

[**0057**] The tibial cut guide **446** is assembled to the tibial boom **430** by sliding one of the "D"-shaped extension bars **442** through one pair **482** of the "D"-shaped holes **480**,**482**. One pair of holes **482** provides for a left knee medial/right knee lateral orientation while the other **480** provides for a left knee lateral/right knee medial orientation. Thus assembled, the cutting head **448** is supported in a position proximal and posterior to the base **472**. The set screw **478** can be tightened until it engages the flat **443** of the extension bar **442** to lock the cut guide **446** in position on the extension bar **442**. Thus locked, the longitudinal axis of the base **472** is perpendicular to the flat **443** of the extension bar **442** resulting in the saw guide slot **462** being parallel to the flat **443**. The angle of the flat **443**, and thus the saw guide slot, relative to the guide plane defined by the alignment bar **402** and extension bar **442** axes is the posterior slope angle of the tibial cut guide assembly **400**. Tibial booms **430** providing varying degrees of posterior slope may be provided. For example, having two booms **430**, one with the flat **443** rotated 3° and the other with the flat rotated 7° would allow the surgeon to choose to cut the tibia with 3° or 7° of posterior slope.

[**0058**] In use, a tibial boom **430** is selected having the desired posterior slope angle. The tibial boom is assembled to the alignment bar **402** and allowed to slide all the way down to rest on the stop **418**. The plunger **424** is positioned proximal of the tibial tubercle and centered mediolaterally with the medial third of the tibial tubercle. A pin is inserted through the cannula **428** of the plunger **424** to stabilize the alignment guide. Alternatively, a pin can be placed proximal of the tibial tubercle and centered mediolaterally with the medial third of the tibial tubercle and the cannula **428** then slipped over the pin until the plunger **424** contacts the patient. The distal end **414** of the alignment bar **402** is adjusted mediolaterally so that the guide is aligned with the mechanical axis of the tibia. In the sagittal plane, the alignment bar **402** is adjusted so that it is parallel to the anterior tibial shaft. Proximally, this adjustment is made by turning the knob **427** to move the plunger **424** anterioposteriorly. Additional pins are placed through fixation holes **421** to further secure the alignment bar **402**. This establishes the position of the guide plane relative to the tibia. Now, as the tibial cut guide **446** is positioned along the boom **430** and the boom is adjusted up and down, the saw guide slot **462** will be constrained to parallel planes of posterior slope having the same angular relation to the guide plane. Thus, the tibial cut guide **446** can now be adjusted medial-laterally and proximal-distally without changing the varus-valgus orientation or the posterior slope of the resection plane.

[**0059**] The tibial cut guide **446** is assembled to the tibial boom using the appropriate pair of holes **480**, **482** for medial/lateral orientation of the cut guide **446**. The tibial depth gauge **484** is inserted into the top of the tibial cut guide **446** with the blade end **489**, **490** corresponding to the desired resection level oriented over the tibia. The tibial cut guide **446** is positioned by moving the tibial boom **430** vertically until the depth gauge **484** references the desired spot on the tibial surface and sliding the cut guide medial-laterally on the extension bar **442** so that it is adjacent the tibia. This position is maintained by tightening the boom set screw **440** and the cut guide set screw **478**. Pins and/or screws can then be placed in fixation holes **464**, **466** to stabilize the tibial cut guide. The depth gauge is removed and a saw blade is inserted through the saw guide slot **462** to cut the proximal surface of the tibia.

[0060] FIGS. **24-29** show an illustrative embodiment of a femoral A/P sizer assembly **500** for determining femoral anterior/posterior (A/P) size and placing reference datums for guiding the femoral box cuts. The assembly includes an A/P sizer base **502**, an external rotation plate **525**, an A/P sizing tower **540**, an anterior boom **550**, a drill guide slide **560**, a parallel pin drill guide **570**, and an alignment pin **579**. The A/P sizer base **502** includes a plate-like body **503** having a front surface **504**, a back surface **505**, an anterior edge **506**, a posterior edge **507**, and side surfaces **508,509**. Posterior condyle referencing feet **510, 511** extend perpendicularly from the front surface **504** and define a posterior reference plane with their top surfaces **512** and **513**. Internally threaded boss **514** projects from one side **508** of the sizer base **502** to threadably receive a handle **515**. Three alignment holes **516** extend through the sizer base **502** from the front surface **504** to the back surface **505**. A countersunk pivot pin hole **517** extends through the sizer base **502** from the front surface **504** to the back surface **505**. An anterior extension **518** projects from the anterior edge **506** to support a hollow, cylindrical tower bushing **519** having a top surface **521** and a bore **520** with a longitudinal axis parallel to the front and back surfaces **504, 505** and perpendicular to the posterior condyle referencing feet **510, 511**. A through hole in the side of the tower bushing **519** receives a set screw **522** in communication with the bore **520**.

[0061] An external rotation plate **525** includes a plate-like body **526** having a front surface **527** a back surface **528**, an anterior edge **529**, a posterior edge **530**, and side surfaces **531, 532**. A drill slide bushing **533** is connected to, and projects from, one side **532** of the external rotation plate **525**. The drill slide bushing **533** includes a "D"-shaped bore **534** having a longitudinal axis parallel to the front surface **527**. A through hole in the side of the drill slide bushing **533** threadably receives a set screw **524** in communication with the flat side of the "D"-shaped bore. Three, alignment holes **535** extend through the external rotation plate **525** from the front surface **527** to the back surface **528**. A pivot pin hole **536** extends through the external rotation plate **525** from the front surface **527** to the back surface **528**.

[0062] The external rotation plate **525** is mounted on the A/P sizer base **502** with the external rotation plate front surface **527** flat against the sizer base back surface **505**. A pin **537** secured in the pivot pin holes **517, 536** holds the assembly together and permits planar rotation of the external rotation plate **525** relative to the sizer base **502**. The alignment holes **516, 535** are positioned so that a pair of holes aligns when the external rotation plate **525** is rotated relative to the sizer base **502** at each of 3°, 5°, and 7° as measured between a line perpendicular to the top surfaces **512, 513** of the posterior condyle referencing feet **510, 511** and the drill slide bushing **533** axis.

[0063] A femoral A/P sizing tower **540** includes a shaft **541** having a first end **542**, a second end **543**, and a longitudinal axis extending from the first end to the second end. A collar **544**, connected to the second end **543** of the sizing tower **540**, includes a through hole **545** having an axis perpendicular to the longitudinal axis of the shaft **541**. A keyway **546** is cut in the side of the collar **544** opposite the shaft **541**. Femoral A/P size indicia **547** are inscribed on the shaft **541**. The sizing tower **540** is mounted on the A/P sizer base **502** with its shaft **541** slidably received within the tower bushing **519** in coaxial relation such that the sizing tower **540** is free to slide up and down, and rotate about, their coincident axes. An anterior boom **550** includes a handle **551** and a shaft **552** having a common longitudinal axis. A probe **553** extends beyond the shaft **552** and bends away from the shaft axis to a probe tip **554** that is offset a predetermined distance from the shaft **552** axis. A key **555** extends longitudinally from the handle **551** and overlies a portion of the shaft **552**. The anterior boom **550** is mounted in the collar **544** of the sizing tower **540**. The diameter of the probe **553** is smaller than the keyway **546** and the diameter of the shaft **552** fits closely with the through hole **545**. Thus, the anterior boom **550** can be mounted by moving the probe **554** down through the keyway **546** and then sliding the shaft **552** into of the through hole **545**. As the shaft **552** is slid into place, the key **555** engages the keyway **546** to prevent the anterior boom **550** from rotating about its shaft **552** axis. The handle **551** abuts the collar **544** to prevent the anterior boom **550** from further translating along its shaft axis. Thus mounted, the probe tip **554** is in a predetermined position relative to the indicia **547** of the sizing tower **540**. As the sizing tower **540** is moved up and down in the tower bushing **519**, the probe tip **554** moves up and down in known relation to the top surfaces **512, 513** of the posterior condyle referencing feet **510, 511**. This relationship is indicated by the position of the indicia **547** adjacent the top surface **521** of the tower bushing **519**. The sizing tower **540** can be locked in position within the tower bushing bore **520** by tightening the set screw **522**.

[0064] A drill guide slide **560** includes a base **561** having a dovetail profile **562** defining a longitudinal dovetail axis. A support arm **563** extends from the base **561** perpendicular to the dovetail and the dovetail axis. The support arm **563** is "D"-shaped, being generally cylindrical with one side milled flat **564**. The support arm **563** is received in the bore **534** of the drill slide bushing **533** for sliding movement along the bore axis. The "D"-shape of the arm **563** and bore **534** prevents the arm from rotating. The support arm **563** can be locked axially within the bore **534** by tightening the set screw **524** so that it bears against the flat **564**.

[0065] A parallel pin drill guide **570** includes a body **571** having top **572**, bottom **573**, front **574**, back **575**, and side **576, 577** surfaces. A dovetail groove **592**, having a longitudinal dovetail groove axis, is formed from side-to-side in the bottom surface **573**. Drill guide holes **593** extend through the body **571** from side-to-side. The guide holes **593** each have a longitudinal axis that is parallel to the other and parallel to the longitudinal axis of the dovetail groove **592**. An anterior alignment hole **578** extends through the body **571** from side-to-side to receive an alignment pin **579**. The parallel pin drill guide **570** is mounted on the drill guide slide **560** with the base dovetail **562** engaging, and coaxially aligned with, the dovetail groove **592** so that the parallel pin drill guide **570** can slide along the coincident axes. Thus assembled, the guide hole **593** axes are parallel to the front surface **504** of the A/P sizer base and they are at an angle relative to the top surfaces **512, 513** of the posterior condyle referencing feet **510, 511** as determined by the rotated position of the external rotation plate **525**. The alignment pin **579** can be extended over the shaft **552** of the anterior boom **550** to act as a feeler gauge to reference the vertical position of the drill guide **570** to the vertical position of the probe tip **554**. By adjusting the parallel pin drill guide up and down until the alignment pin **579** rests on the shaft **552**, the guide holes **593** can be positioned at a predetermined position relative to the probe tip **554**. In this illustrative embodiment, the A/P sizer base **502** and the external rotation plate **525** are hinged on the lateral side in order to adjust external rotation. Also in this illustrative embodiment, only one drill slide bushing **533** (medial or lateral) is provided on each external rotation plate **525**. Because of this design, four A/P sizer base **502** and external rotation plate **525** combinations would be provided to allow for medial and lateral approaches to both a left and a right knee.

[0066] In use, the handle **515** is assembled to the appropriate A/P sizer **500** depending on whether the operative knee is left or right and whether the approach is medial or lateral. In the illustrative embodiment, the A/P sizer **500** is placed so that the front surface **504** of the A/P sizer base is flat against the resected distal femur **585** and the top surfaces **512, 513** of the feet **510, 511** are flush against the posterior condyles **586, 587**. Alternatively, the A/P sizer could be placed on an unresected femur and the distal femoral cut made later. In such a case, the distal cut depth could also be set with the A/P sizer. The A/P sizer **500** offers three methods for setting external rotation: the epicondylar axis, the A/P axis, or the posterocondylar axis. To use the epicondylar axis, a line is drawn between the medial and lateral epicondyles **588, 589**. The feet **510,511** are placed against the posterior condyles **586, 587** and the anterior edge **529** of the external rotation plate **525** is then set parallel to the line drawn between the epicondyles **588, 589**. The pair of alignment holes **516, 535** that most nearly align are then aligned and the sizer **500** is secured by inserting a spring pin **590** through the aligned holes **516, 535**. Likewise, to use the A/P axis, Whiteside's line is drawn along the A/P axis. The feet **510,511** are placed against the posterior condyles **586, 587** and the anterior edge **529** of the external rotation plate **525** is then set perpendicular to the line drawn along the A/P axis. The pair of alignment holes **516, 535** that most nearly align are then aligned and the sizer **500** is secured by inserting a spring pin **590** through the aligned holes **516, 535**. To use the posterior condylar axis, the appropriate set of alignment holes **516, 535** are aligned to correspond to 3°, 5°, or 7° of external rotation while the feet **510, 511** are kept against the posterior condyles **586, 587** and a spring pin **590** is inserted through the aligned holes.

[0067] Once rotation is established, the A/P sizing tower **540** is inserted into the tower bushing **519**. The anterior boom **550** is inserted into the collar **544** with the key **555** engaging the keyway **546**. The probe tip **554** is positioned on the anterior cortex **591** of the femur. The position of the probe tip **554** will determine the exit point of the anterior bone cut and the ultimate position of the femoral joint component. The vertical position of the A/P sizing tower **540** is locked by tightening the set screw **522**. The femoral size is indicated by the indicia **547** appearing above the top surface **521** of the tower bushing **519**. The drill guide slide **560** is mounted in the drill slide bushing **533** and the parallel pin drill guide **570** is mounted on the drill guide slide **560**. The alignment pin **579** is inserted through the anterior alignment hole **578**. The drill guide **570** and drill guide slide **560** are raised until the alignment pin **579** rests on top of the shaft **552** to set the A/P position of the femoral component. The vertical position of the drill guide slide **560** is locked by tightening the set screw **524**. The drill guide **570** is slid along the drill guide slide **560** until it is adjacent the femur. A hole is drilled into the femur through one of the guide holes **593** and a headless pin **594** is placed in the drilled hole to establish a datum that records the rotation angle and A/P position in such a way that the datum can be subsequently referenced by bone cutting guides to produce bone cuts relative to the rotation and position information. The illustrative embodiment describes using pins set in the femur as datums. Other datums that can record the information are contemplated and include by way of example: one or more holes, screws, notches, and grooves. A single pin can record the external rotation and A/P position. However, rotation about the pin axis is not constrained by a single pin without some other reference such as the distal femur. If desired, a second hole can be drilled into the femur through the other guide hole **593** and a second headless pin **595** placed to constrain rotation about the pin axes and also to provide a more stable datum. All components of the A/P sizer assembly **500** are now removed leaving the headless pins **594, 595** in place to locate the femoral profile cut.

[0068] The femoral box cuts, or profile, are cut using a femoral profile cut block. FIGS. **30-32** show an illustrative femoral profile cut block **600** for guiding the anterior, posterior and chamfer cuts on the distal femur. The cut block **600** is generally an "L"-shaped body having inner **602** and outer **604** distal surfaces, inner **606** and outer **608** side surfaces, an anterior surface **610**, and a posterior surface **612**. A pair of pin reference holes **614** extends through the side of the cut block **600** from the outer side surface **608** to the inner side surface **606** for receiving the headless femoral reference pins **594, 595**. The reference holes **614** are elongated proximal-to-distal to allow proximal-to-distal motion relative to a reference pin while still constraining the A/P position and external rotation relative to the pin. This arrangement allows the proximal-to-distal position of the block **600** to be referenced from the distal surface **602** rather than the holes **614**. A side fixation hole **616** extends through the side of the cut block **600** from the outer side surface **608** to the inner side surface **606** for receiving a fixation pin. A distal fixation hole **618** extends through the distal side of the cut block **600** front the outer distal surface **604** to the inner distal surface **602** for receiving a fixation pin. Anterior **620**, anterior chamfer **622**, posterior **624**, and posterior chamfer **626** saw guide slots corresponding to the anterior, posterior, and chamfer surfaces of a femoral implant box are positioned in fixed predetermined relationship to the pin reference holes **614**. The slots sweep around the cut block **600** from the side surfaces to the distal surfaces to permit a saw blade to be directed medial-laterally and proximal-distally to make a complete cut across the femur through each slot. A visualization window **628** extends from the outer distal surface **604** to the inner distal surface **602** to allow direct visualization of the distal femur during positioning of the cut block **600** and cutting of the distal femur. When surgery is performed through a small surgical incision, this window **628** permits the surgeon to observe the saw blade in action. The medial side of the instrument is contoured to match the incision by providing a notch **629** to provide soft tissue clearance for the illustrative minimally invasive surgical procedure. For a lateral approach, a cut block is provided with the lateral side contoured to match the incision.

[0069] In use, the appropriate size femoral profile cut block **600** is positioned over the headless pins **594, 595** with the pins engaging pin reference holes **614** which sets the A/P position and external rotation of the cut block **600**. The cut block **600** is secured to the femur with a spring pin **630** through the distal fixation hole **618**. As the pin **630** is tightened, the cut block **600** can move proximally due to the elongated holes **614** until the inner distal surface **602** is stably seated on the distal femur. An additional spring pin **632** can be inserted from the side through the side fixation hole **616** to further stabilize the cut block **600**. A saw blade can now be used to cut the femoral profile by directing it through the posterior **624**, posterior chamfer **626**, anterior **620**, and anterior chamfer **622** saw guide slots. The cuts can be made in any order; however, by making them in this order optimal stability of the cut guide can be maintained. After the cuts are made, the cut block and headless pins are removed.

[0070] Where required, a trochlear recess or notch is cut using a trochlear notch guide. This would be required when a femoral implant has a trochlear recess or notch that extends into the anterodistal portion of the femoral box profile. For example, in an implant where a deeper patellar groove is incorporated, extra material may be added to the inside of the implant to accommodate the deeper groove. Consequently, a cutout must be formed on the bone to receive this extra material for a conforming fit between the implant and bone. **FIG. 33** shows an illustrative embodiment of a trochlear cut guide **800**. The trochlear cut guide **800** comprises a generally "L"-shaped body including an anterior portion **802** having an external anterior surface **804**, an internal anterior surface **806**, opposing sides **808, 810**, a proximal side **812**, and a distal side **813**. An anterior chisel guide slot **814** extends through the anterior portion **802** from the external anterior surface **804** to the internal anterior surface **806**. The chisel guide slot **814** comprises a proximal slot opening **816** and two side slot openings **818, 820**. A distal guide portion **830** extends at an angle from the distal side **813** of the anterior portion **802**. The distal portion **830** includes an external distal surface **832**, an internal distal surface **834**, opposing sides **836, 838**, a posterior side **840**, and an anterior side **841**. The anterior side **841** of the distal portion **830** and the distal side **813** of the anterior portion **802** blend at a radius **815** to form the connection between these two portions. A distal chisel guide slot **842** extends through the distal portion **830** from the external distal surface **832** to the internal distal surface **834**. The chisel guide slot **842** comprises a posterior slot opening **844** and two side slot openings **846, 848**. Ears **850** extend from each side **836, 838** of the distal portion **830**. The ears **850** include fixation holes **852** and **854**. Distal drill guide holes **856** guide a drill for making peg receiving holes in the distal femur. The chisel guide slots **814, 842** are aligned with the proximal slot opening **816** being coplanar with the posterior slot opening **844** and the anterior portion side slot openings **818, 820** being coplanar with the distal portion side slot openings **846, 848**. A cutting instrument inserted into distal chisel guide slot **842** will exit anterior chisel guide slot **814** and cut a notch across the anterodistal aspect of the femur.

[0071] **FIG. 34** shows an alternative embodiment of a trochlear cut guide comprising a slotted femoral provisional **860**. This trochlear cut guide facilitates making the trochlear notch cut and drilling the distal peg holes in similar fashion as trochlear cut guide **800**. However, the slotted provisional **860** includes an external articulating surface that matches the external articulating surface of a corresponding femoral implant. This pennits the option of finishing the tibial and patellar cuts and conducting a trial reduction in which provisional implants of all of the knee components are inserted and flexed through their range of motion to check implant sizing and function. The mediolateral position of the slotted femoral provisional **860** can be adjusted and retested before making the trochlear notch cut and drilling the distal peg holes which set the mediolateral position. The slotted provisional **860** articular surfaces include an anterior patellar flange **864** connecting arcuate, spaced apart distal **865, 866** and posterior **867, 868** condyles. Opposite the articulating surfaces are the internal box surfaces including anterior **870**, anterior chamfer **871**, distal **872**, posterior chamfer **873**, and posterior **874** box surfaces. An anterior chisel guide slot **875** extends through the anterior flange **864** from the external anterior surface to the internal anterior box surface **870**. The chisel guide slot **875** comprises a proximal slot opening **876** and two side slot openings **877, 878**. A distal chisel guide slot **879** extends through the distal condyles **865, 866** from the external distal surface to the internal distal box surface **872**. The distal chisel guide slot **879** comprises a posterior slot opening **880** and two side slot openings **881, 882**. Distal drill guide holes **883** guide a drill for making peg receiving holes in the distal femur. Anterior chisel guide slot **875**, distal chisel guide slot **879**, and drill guide holes **883** are configured and function like those of the trochlear cut guide **800** of **FIG. 33**.

[0072] The use of the trochlear notch cutting guide will be described with reference to the slotted provisional embodiment **860** of **FIG. 34**. The appropriate size femoral provisional is placed on the end of the femur **884**. The appropriate mediolateral position can be established visually or, in the case of the slotted provisional **860**, by trial reduction. A hole is drilled into the distal femur through one of the drill guide holes **883** and a holding peg (not shown) is inserted. A hole is drilled into the femur through the other one of the drill guide holes **883** and another holding peg is inserted. A chisel **885** having a three sided blade configured to engage the chisel guide slots **875, 879** is inserted into the distal chisel guide slot **879**. The chisel **885** is driven across the distal femur to engage the anterior chisel guide slot **875** and cut the trochlear notch.

[0073] Posterior stabilized femoral components have a protruding cam box. A piece of bone is cut from the intercondylar region of the distal femur using an intercondylar notch guide to accommodate this cam box. FIGS. **35-36** show an illustrative embodiment of an intercondylar notch guide **900**. The notch guide **900** comprises a generally "L"-shaped body including an anterior portion **901** having an anterior outer surface **902** and an anterior inner surface **904**. Spaced apart condylar portions **906, 908** depend at an angle from the anterior portion **901** to define a "U"-shaped opening **907** between them. The condylar portions have distal inner **910** and outer **912** surfaces. A trochlear ramp **914** projects from the anterior inner surface **904**. The ramp **914** has a planar, distal saw guide surface **916** that intersects the anterior outer surface **902** and defines the closed end of the "U"-shaped opening **907**. The condylar portions **906, 908** have parallel, spaced apart, inner side walls **918, 920**. The side walls **918, 920** define medial and lateral saw guide surfaces perpendicular to distal saw guide surface **916**. Each of the condylar portions **906, 908** includes a threaded peg hole **922, 924**. Pegs can optionally be threaded into the holes to extend from the distal inner surface **910**. In use, the appropriate size intercondylar notch guide **900** is chosen and placed on the distal femur. The trochlear ramp **914** fits within the trochlear notch cut in the prior step to position the notch guide mediolaterally. Additionally, pegs can be threaded into peg holes **922**, **924** to align mediolaterally with the femoral peg holes drilled in the prior step. A saw blade is then guided along the distal **916** and side **918**, **920** saw guiding surfaces to cut the base and sides of the intercondylar notch. The cut bone and intercondylar notch guide are then removed.

[**0074**] It will be understood by those skilled in the art that the foregoing has described illustrative embodiments of the present invention and that variations may be made to these embodiments without departing from the spirit and scope of the invention defined by the appended claims. For example the illustrative embodiments depict using saw guides and blades to make the bone cuts. However, the claimed methods and alignment guides could also be used with other bone removal systems to set their reference bases to achieve the desired position and rotation of prepared bone surfaces.

What is claimed is:

1. A patella resection guide for guiding a cutter to cut a patella having an anterior side, an opposite posterior side, a medial side and a lateral side, the patella resection guide comprising:

a first jaw for engaging said medial side of said patella;

a second jaw for engaging said lateral side of said patella;

means for moving the first jaw relative to the second jaw from a first position in which the jaws are disengaged from said medial and lateral sides of said patella to a second position in which the jaws are engaged with said medial and lateral sides of said patella, the means being actuable from a location that is medial or lateral of said patella; and

means for guiding a cutter to cut said patella.

2. The patella resection guide of claim 1 further comprising means for gauging the amount of bone to be resected.

3. The patella resection guide of claim 1 further comprising means for gauging the amount of bone that will remain after the patella is cut.

4. A patella resection guide for guiding a cutter to cut a patella having an anterior side, an opposite posterior side, a medial side and a lateral side, the patella resection guide comprising:

a first jaw shaped to engage said medial side of said patella;

a second jaw shaped to engage said lateral side of said patella;

a handle connecting the first and second jaws in translating relationship, the handle being actuable to move the jaws from a first position in which the jaws are disengaged from said medial and lateral sides of said patella to a second position in which the jaws are engaged with said medial and lateral sides of said patella, the handle being actuable from a location that is medial or lateral of said patella.

5. The patella resection guide of claim 4 wherein the jaws are have curved faces for engaging curved sides of said patella.

6. The patella resection guide of claim 4 wherein the handle comprises a guide arm connecting the first and second jaws, at least one of the first and second jaws mounted for translation along the guide arm to move from the first position to the second position.

7. The patella resection guide of claim 6 wherein the jaws remain parallel as they are moved from the first to second positions.

8. The patella resection guide of claim 7 wherein the handle comprises an actuator pivotably mounted on the handle at a first end and connected to one of said first and second jaws at a second end such that pivoting the actuator moves the jaws between the first and second positions.

9. The patella resection guide of claim 6 wherein the handle further comprises a first grip portion connected to the first jaw and a second grip portion connected to the second jaw, the first and second grip portions being parallel to one another, such that pressing the first and second grip portions together in parallel manner causes at least one of the first and second jaws to translate along the guide arm from the first position to the second position.

10. The patella resection guide of claim 4 further comprising a depth gauge removably mountable on the first side of the resection guide to indicate the amount of bone to be removed from said patella and alternately mountable on the second side of the resection guide to indicate the amount of bone to remain on said patella.

11. The patella resection guide of claim 4 further comprising a cutter guide to guide a cutter.

12. The patella resection guide of claim 11 wherein the cutter is selected from the list consisting of a saw blade, a side cutting reamer, a end cutting reamer, and a water jet cutter.

13. A patella resection guide comprising:

a first side;

a second side; and

a depth gauge removably mountable on the first side of the resection guide to indicate the amount of bone to be removed from said patella and alternately mountable on the second side of the resection guide to indicate the amount of bone to remain on said patella.

14. A patella resection guide for guiding a cutter to cut a patella having an anterior side, an opposite posterior side, and a periphery around the patella, the patella resection guide comprising:

a first jaw member shaped to engage said periphery of said patella;

a second jaw member shaped to engage said periphery of said patella, the second jaw member connected to the first jaw member in translating relation;

a first handle connected to the first jaw member;

a second handle connected to the second jaw member, the second handle being actuable to move the second jaw member in a motion plane toward and away from the first handle; and

a cutter guide adjacent the jaws, the cutter guide able to guide a cutter to cut in a plane parallel to the jaw motion plane.

15. A patella resection guide for guiding a cutter to cut a patella having an anterior side, an opposite posterior side, and a periphery around the patella, the patella resection guide comprising:

a first jaw member shaped to grip said periphery of said patella;

- a second jaw member shaped to grip said periphery of said patella;
- a support member connecting the first jaw member in translating relationship to the second jaw member, the support constraining the jaw members to remain parallel when they move relative to one another;
- a handle actuable to move the first and second jaw members in a motion plane from a first position in which the jaw members are further from one another to a second position in which the jaw members are nearer one another;
- a cutter guide adjacent the jaws, the cutter guide able to guide a cutter to cut in a plane parallel to the jaw motion plane.

16. A method comprising the steps of:

- providing a patella resection guide having patella gripping jaws and a cutter guide;
- making an incision on at least one of the medial and lateral sides of a knee to expose said patella from the side;
- gripping the medial and lateral sides of the patella with the jaws of the patella resection guide while the patella remains in its normal orientation relative to the femur; and
- guiding a cutter with the cutter guide through the incision from the side of the knee to resect the patella.

17. The method of claim 16 further comprising the steps of:

- providing a gauge alternately connectable to a first side of the patella resection guide to indicate the amount of bone to be removed and to a second side of the patella resection guide to indicate the amount of bone to remain;
- determining whether to gauge the amount of bone to remove or the amount of bone to remain;
- attaching the depth gauge to the appropriate side; and
- cutting the bone.

18. A femoral distal cut guide for cutting a femur, the femur having a frontal plane, a sagittal plane, a femoral head adjacent a hip joint, a femoral shaft with an intramedullary canal, a condylar portion adjacent a knee joint having a medial side and a lateral side, an anatomic axis lying along the intramedullary canal, and a mechanical axis lying along a line from the center of the femoral head to the center of the knee joint, the cut guide comprising:

- an intramedullary rod having a longitudinal rod axis; and
- a distal cut guide, the distal cut guide mounted on the intramedullary rod at an angle to the longitudinal rod axis, as measured in the frontal plane, so that aligning the intramedullary rod with the anatomic axis and extending the distal cut guide toward the side of the knee orients the distal cut guide to guide a cutter from the side of the knee to cut the distal femur perpendicular to the mechanical axis.

19. The femoral distal cut guide of claim 18 further comprising an intramedullary alignment guide connected to the intramedullary rod and having a longitudinal guide axis at an angle to the longitudinal rod axis, as measured in the frontal plane, so that when the rod is aligned with the anatomic axis and the longitudinal guide axis is parallel to the frontal plane, the longitudinal guide axis is perpendicular to the femoral mechanical axis and extended toward one of the medial and lateral sides of the knee.

20. The femoral distal cut guide of claim 19 further comprising a distal cut guide mounted for motion parallel to the longitudinal guide axis with the distal cut guide directed toward one of the medial and lateral sides of the knee, the distal cut guide able to be translated along the longitudinal guide axis to a position adjacent one of the medial and lateral sides of the knee.

21. The femoral distal cut guide of claim 20 wherein the intramedullary alignment guide further includes a reference surface for contacting a distal femoral condyle to position the distal cut guide to make a cut at a predetermined distance from the femoral condyle.

22. The femoral distal cut guide of claim 20 wherein the intramedullary alignment guide further includes a reference surface for contacting said intercondylar sulcus to position the distal cut guide to make a cut at a predetermined distance from the intercondylar sulcus.

23. A method of cutting a distal femur comprising the steps of:

- providing a distal cut guide having an intramedullary rod;
- making an incision on at least one of the medial and lateral sides of a knee to expose the distal femur from the side;
- inserting the intramedullary rod into an intramedullary canal of the femur;
- orienting the distal cut guide so that it extends toward one of the medial and lateral sides of the femur; and
- guiding a cutter with the cutter guide to cut the distal femur from the side to form a planar distal surface.

24. The method of claim 23 further comprising the steps of:

- providing an alignment guide extending at an angle to the intramedullary rod;
- providing a distal cut guide having a cutter guide and being mounted for translation along the alignment guide; and
- sliding the distal cut guide along the alignment guide until the distal cut guide is adjacent the side of the femur.

25. The method of claim 24 further comprising the steps of:

- positioning the alignment guide so that a reference surface on the alignment guide contacts a distal femoral condyle; and
- guiding a cutter with the distal cut guide to make a cut at a predetermined distance from the femoral condyle.

26. The method of claim 24 further comprising the steps of:

- positioning the alignment guide so that a reference surface on the alignment guide contacts the intramedullary sulcus; and
- guiding a cutter with the distal cut guide to make a cut at a predetermined distance from the intramedullary sulcus.

27. A tibial cut guide assembly comprising:

a support having a longitudinal support axis;

a cross member mounted on the support, the cross member having a cross member axis perpendicular to the support axis, the cross member axis and support axis defining a guide plane, the cross member having a slope reference oriented at a predetermined slope angle relative to the guide plane;

a cut guide having a cross member engaging end and a cutter guide, the cross member engaging end being mounted on the cross member in engagement with the slope reference, the cutter guide defining a cut plane that is oriented at a predetermined slope angle relative to the guide plane as determined by the slope reference.

28. The tibial cut guide assembly of claim 27 further comprising a plurality of interchangeable cross members, each interchangeable cross member having a slope reference oriented at a different predetermined slope angle relative to the guide plane.

29. The tibial cut guide assembly of claim 27 wherein the cut guide is mounted on an arm projecting upwardly and inwardly from the cross member to position the cutter guide adjacent a tibia to be cut.

30. The tibial cut guide assembly of claim 27 wherein the cut guide is translatable along the cross member from a first position to a second position, the cutter guide defining parallel planes in the first and second position.

31. The tibial cut guide assembly of claim 30 wherein the cross member is translatable up and down along the support axis.

32. The tibial cut guide assembly of claim 27 further comprising a proximal adjustment mechanism actuable to change the spacing of a proximal end of the support and a proximal end of a tibia to change the angle of the support axis relative to a tibial axis.

33. The tibial cut guide assembly of claim 32 wherein the proximal adjustment mechanism comprises a screw threadingly engaging the support and abuttable with a proximal end of a tibia.

34. A tibial cut guide assembly for cutting a proximal end of a tibia having a proximal end, a distal end, a tibial shaft, a tibial axis along the shaft, an anterior side parallel to a frontal plane, a medial side parallel to a sagittal plane, and a lateral side parallel to said sagittal plane, the tibial cut guide assembly comprising:

a support having a support axis, the support being mountable on said tibia with the support axis parallel to said tibial axis;

a cut guide, the cut guide being mounted on the support with the cut guide oriented to guide a cutter obliquely toward said tibia between the anterior side and one of the medial and lateral sides of said tibia to cut the proximal end of said tibia when the support is mounted on said tibia.

35. The tibial cut guide assembly of claim 34 further comprising a cross member mounted on the support connecting the support and cut guide, the cross member having a cross member axis perpendicular to the support axis, the cross member axis and support axis defining a guide plane, the guide plane being positionable parallel to the frontal plane and the tibial axis, the cross member having a slope reference oriented at a predetermined slope angle relative to the guide plane.

36. The tibial cut guide assembly of claim 35 wherein the cut guide has a cross member engaging end and a cutter guide, the cross member engaging end being mounted on the cross member in engagement with the slope reference, the cutter guide defining a cut plane that is oriented at a predetermined slope angle relative to the guide plane as determined by the slope reference, the cutter guide being translatable along the cross member from a first position to a second position, the cutter guide defining parallel planes in the first and second position.

37. A tibial cut guide assembly comprising:

an alignment bar having a longitudinal alignment bar axis;

a boom mounted on the alignment bar, the boom having a boom axis perpendicular to the alignment bar axis, the boom axis and alignment bar axis defining a guide plane, the boom having a slope reference oriented at a predetermined slope angle relative to the guide plane;

a cut guide having a boom engaging end and a cutter guide, the boom engaging end being mounted on the boom in engagement with the boom slope reference, the cutter guide defining a cut plane that is oriented at a predetermined slope angle relative to the guide plane as determined by the boom slope reference.

38. The tibial cut guide assembly of claim 37 wherein the cut guide slidingly engages the boom so that the cut guide can slide along the boom from a first position further from the alignment bar to a second position nearer to the alignment bar while maintaining the cut plane at a constant angle to the guide plane.

39. The tibial cut guide assembly of claim 38 wherein the boom is mounted for translation along the alignment bar axis so that moving the boom along the alignment bar axis changes the level of the cut plane.

40. The tibial cut guide assembly of claim 37 further including a depth gauge, the depth gauge including a blade having a reference end, the depth gauge being mounted on the assembly with the reference end a predetermined fixed distance from the cut plane as measured along the alignment bar axis.

41. The tibial cut guide assembly of claim 37 wherein the cutter guide comprises a saw blade slot defining a plane for a saw blade.

42. A method for cutting a proximal end of a tibia having a proximal end, a distal end, a tibial shaft, a tibial axis along the shaft, an anterior side parallel to a frontal plane, a medial side parallel to a sagittal plane, and a lateral side parallel to said sagittal plane, the method comprising the steps of:

mounting a cut guide on the tibia with the cut guide oriented to guide a cutter obliquely toward the tibia between the anterior side and one of the medial and lateral sides of the tibia; and

guiding a cutter obliquely toward the tibia with the cut guide to cut the proximal end of the tibia.

43. The method of claim 42 further comprising the steps of:

providing a support having a support axis;

mounting the support on said tibia with the support axis parallel to the tibial axis;

mounting the cut guide on the support.

44. The method of claim 43 wherein the step of mounting the support includes mounting the support on the anterior surface of the tibia.

45. The method of claim 44 further comprising the step of adjusting the cut guide mediolaterally while maintaining parallel cut planes.

46. A method for cutting a proximal end of a tibia having a proximal end, a distal end, a tibial shaft, a tibial axis along the shaft, an anterior side parallel to a frontal plane, a medial side parallel to a sagittal plane, and a lateral side parallel to said sagittal plane, the method comprising the steps of:

providing a tibial alignment bar having an alignment bar axis and a tibial boom mounted on the alignment bar for translation along the alignment bar axis, the tibial boom having a boom axis perpendicular to the alignment bar axis, the alignment bar axis and boom axis together defining a guide plane, the boom further including a posterior slope reference defining a predetermined angle relative to the guide plane;

mounting the alignment bar on said tibia with the alignment bar axis parallel to the tibial axis;

providing a cut guide;

mounting the cut guide on the boom for translation along the boom axis and in engagement with the posterior slop reference such that the cut guide is oriented to guide a cutter obliquely toward the tibia between the anterior side and one of the medial and lateral sides of the tibia to cut a planar surface at the predetermined angle relative to the guide plane; and

guiding a cutter obliquely toward the tibia with the cut guide to cut the proximal end of the tibia.

47. The method of claim 46 further including the steps of:

providing a tibial alignment bar with a selection of booms having different posterior slope reference angles;

determining a desired slope;

picking a boom corresponding to the desired slope.

48. The method of claim 46 further comprising the step of making an incision on the at least one of the medial and lateral sides of a knee to expose the proximal tibia from the side.

49. The method of claim 48 further comprising the step of adjusting the cut guide mediolaterally to be adjacent until it is obliquely adjacent the proximal tibia.

50. The method of claim 49 further comprising the step of positioning the tibial boom along the alignment bar axis to set the depth of the tibial cut.

51. The method of claim 46 further comprising the steps of:

setting a proximal end of the tibial alignment bar adjacent the proximal end of the tibia at a desired mediolateral position and the distal end of the alignment bar adjacent the distal end of the tibia at a desired mediolateral position to establish mediolateral vertical reference axis relative to which the cut guide sets the varus-valgus angle;

independently of the mediolateral setting, setting the proximal end of the alignment bar at a desired anteroposterior position relative to the proximal end of the tibia and the distal end of the alignment bar at a desired anteroposterior position relative to the distal end of the tibia to establish an anteriorposterior vertical reference axis relative to which the cut guide sets the posterior slope;

adjusting the cut guide mediolaterally while maintaining parallel cut planes having the same varus-valgus angle and posterior slope;

adjusting the proximal distal position of the cut plane independently of mediolateral position to set the depth of cut; and

guiding a cutter with the cut guide to cut the tibia at the independently established depth, varus-valgus angle, and posterior slope.

52. A guide for establishing a position reference on a distal portion of a femur having a distal end, an anterior surface, a medial side surface, a lateral side surface, posterior condyles, and anatomic landmarks, the guide comprising:

a base having a reference surface for engaging said distal end; and

a pin guide mounted for rotation relative to the base, the pin guide including at least one pin guide hole for guiding a reference pin to engage one of said medial and lateral side surfaces of said distal femur.

53. The guide of claim 52 wherein the pin guide has an alignment portion for aligning with anatomic landmarks on said distal femur.

54. The guide of claim 53 further comprising a foot connected to the base, the foot extending at an angle from the reference surface to engage said posterior condyles to establish a posterior size reference.

55. The guide of claim 54 further comprising a plate, the plate rotationally mounted to the base and the pin guide mounted on the plate so that as the pin guide rotates relative to the base the pin guide also rotates relative to the base.

56. The guide of claim 55 wherein the base includes a plurality of rotational alignment holes and the plate includes a plurality of alignment holes, different pairs of holes aligning at different angles of rotation between the base and plate.

57. The guide of claim 56 wherein the pin guide is mounted for translation relative to the plate so that the plate can be rotated to set the rotation of the pin guide hole relative to the base and the pin guide can be translated relative to the plate to set the spacing of the pin guide hole from the base.

58. The guide of claim 57 further including an anterior probe mounted for translation relative to the plate, the anterior probe having a probe tip for engaging said femoral anterior surface, the probe having size indicia to indicate the distance the probe is translated relative to the plate.

59. The guide of claim 58 further including a feeler gauge that indexes the translation of the pin guide relative to the plate to the translation of the probe relative to the plate so that sizing information determined by the probe is reflected in the position of the pin guide.

60. The guide of claim 59 wherein the pin guide is mounted for mediolateral translation relative to the plate so that it can be moved to a position adjacent the side of the femur.

61. A guide for establishing a position reference on a distal portion of a femur having a distal end, an anterior surface, a posterior surface, a medial side surface, a lateral side surface, posterior condyles, a femoral axis, and anatomic landmarks, the guide comprising:

means for establishing a desired rotation angle relative to said femoral axis; and

means for establishing a desired A/P position between said anterior and posterior surfaces of said femur; and

means for establishing a datum on said distal femur that records the rotation angle and A/P position in such a way that the datum can be subsequently referenced by bone cutting guides to produce bone cuts relative to the rotation and position information.

62. The guide of claim 61 wherein the datum comprises an element selected from the group consisting of a pin, a hole, a slot, and a notch.

63. The guide of claim 61 wherein the datum is able to be referenced by subsequent instruments to establish the varus-valgus angle, external rotation, and anteroposterior position of bone cuts.

64. The guide of claim 61 wherein the means for establishing a desired rotation angle comprises a base having a reference surface for engaging said distal end of said femur and a datum guide mounted for rotation relative to the base, the datum guiding the positioning of a datum on one of said medial and lateral side surfaces of said distal femur.

65. A method for establishing a position reference datum on a distal portion of a femur having an anterior surface, a posterior surface, posterior condyles, a femoral axis, medial and lateral epicondyles, and an A/P axis, the method comprising the steps of:

determining a desired rotation angle relative to the femoral axis;

determining a desired A/P position between the anterior and posterior surfaces of the femur;

creating a datum on the distal femur that records the rotation angle and A/P position in such a way that the datum can be subsequently referenced by bone cutting guides to produce bone cuts relative to the rotation and position information.

66. The method of claim 65 wherein the step of determining a desired rotation angle is accomplished by aligning a datum guide relative to an anatomic reference selected from the group consisting of the femoral posterior condyles, a line drawn between the medial and lateral femoral epicondyles, and a line drawn along the distal femoral A/P axis.

67. The method of claim 65 wherein the step of determining a desired A/P position comprises contacting the anterior femoral surface with a probe.

68. The method of claim 65 wherein the step of creating a datum comprises a step selected from the group consisting of drilling at least one hole, cutting at least one slot, and setting at least one pin in the femur.

69. The method of claim 65 further comprising the steps of:

providing a pin guide;

establishing the rotation by aligning the pin guide with one of the femoral posterior condyles, a line drawn between medial and lateral epicondyles, and a line drawn along the A/P axis;

establishing the A/P position by offsetting the pin guide from a probe in contact with the anterior surface; and

establishing the datum by guiding at least one pin through the pin guide and into the femur.

70. The method of claim 69 wherein the step of establishing the datum comprises guiding at least two pins through the pin guide and into the femur.

71. The method of claim 65 further comprising the steps of:

referencing the datum with a cut guide to orient the cut guide relative to the rotation angle and A/P position; and

guiding a cutter with the cut guide to cut the femur.

72. The method of claim 71 further comprising the step of making an incision on the at least one of the medial and lateral sides of a knee to expose the femur from the side and performing the other steps through the incision from the side of the knee.

73. A method for establishing a position reference datum on a distal portion of a femur having a distal end, an anterior surface, a posterior surface, a medial side surface, a lateral side surface, posterior condyles, a femoral axis, and anatomic landmarks, the method comprising the steps of:

providing a guide having a base and a pin guide mounted for rotation and translation relative to the base;

placing the base against the distal end of said femur;

rotating the pin guide relative to the base to a desired rotation angle;

translating the pin guide relative to the base to a desired A/P position; and

inserting at least one pin into said femur with the pin guide, the at least on pin fixing the rotation angle and A/P position for future reference.

74. The method of claim 73 wherein the step of inserting at least one pin comprises inserting at least two pins.

75. The method of claim 73 further comprising the steps of:

mounting a cut guide on the pin to orient the cut guide at the desired rotation angle and A/P position; and

guiding a cutter with the cut guide to make anterior, posterior and chamfer cuts on the distal femur.

76. The method of claim 75 further comprising the steps of:

making an incision on one of the medial and lateral sides of the knee to expose the femur from the side; and

performing the other steps through the incision from the side of the knee.

77. An apparatus for guiding a cutter to cut a femur having a datum established on it, the datum fixing a desired external rotation and A/P position, the apparatus comprising:

a cut guide for guiding a cutter to cut said femur; and

means for engaging said datum to orient the cut guide to guide a cutter to cut said femur at said desired external rotation and A/P position.

78. The apparatus of claim 77 wherein the cut guide comprises a saw blade guide.

79. The apparatus of claim 78 wherein the saw blade guide includes slots for guiding a saw blade to form anterior, posterior, and chamfer cuts on said femur.

80. The apparatus of claim 79 wherein the guide includes a side portion and a distal portion, the slots sweeping from the side portion to the distal portion to allow cutting from the side and distally.

81. The apparatus of claim 77 wherein the means for engaging said datum comprises a hole formed in the cut guide.

82. A guide for guiding a cutter to cut a profile on a distal femur, the femur having at least one pin inserted into the side of the femur fixing a desired external rotation and A/P position, the guide comprising:

a distal portion having inner and outer distal surfaces;

a side portion having inner and outer side surfaces with at least one hole extending through the side from the inner to the outer side surface for receiving said at least one pin to set the guide at said desired external rotation and A/P position; and

a cut guide for guiding a cutter to cut said femur at said desired external rotation and A/P position.

83. The guide of claim 82 wherein the cut guide comprises a saw guide slot.

84. The guide of claim 83 wherein the saw guide slot sweeps from the side portion to the distal portion.

85. The guide of claim 82 wherein the distal portion further comprising an opening for visualizing the distal end of the femur.

86. The guide of claim 82 wherein the at least one hole is slotted so that the guide can slide between a proximal position and a distal position on the pin to permit the inner, distal guide surface to be positioned in contact with said distal femur.

87. The guide of claim 86 further comprising a distal fixation hole to receive a fastener to fix the guide in a position with the inner, distal guide surface in contact with said distal femur.

88. A method for cutting a distal portion of a femur having an anterior surface, a posterior surface, and a femoral axis, the method comprising the steps of:

determining a desired rotation angle relative to the femoral axis;

determining a desired A/P position between the anterior and posterior surfaces of the femur;

creating a datum on the distal femur that records the rotation angle and A/P position;

referencing the datum with a cut guide to orient the cut guide relative to the rotation angle and A/P position; and

guiding a cutter with the cut guide to cut the femur.

89. The method of claim 88 wherein the cut guide comprises a saw guide slot and the step of guiding a cutter comprises guiding a saw blade.

90. The method of claim 89 wherein the saw guide slot sweeps from a side portion to distal portion and further comprising the step of guiding a saw blade through the slot from the side and moving the saw blade through the swept slot to guide the saw blade through the slot distally.

91. The method of claim 88 wherein the cut guide further includes window for viewing the distal end of the femur and further comprising the step of viewing the cutting of the distal end of the femur through the window.

92. The method of claim 88 wherein the datum is a pin and the cut guide has a hole for receiving the pin, the method further comprising the step of engaging the pin with the hole to position the cut guide.

93. The method of claim 92 wherein the hole comprises an elongated slot to permit the cut guide to slide proximally and distally on the pin, the method further comprising sliding the cut guide proximally on the pin until it abuts the distal femur.

94. The method of claim 93 wherein the cut guide further comprises a distal fixation hole, the method further comprising the step of inserting a fastener through the fixation hole to hold the cut guide against the distal femur.

95. The method of claim 88 further comprising the steps of:

making an incision on at least one of the medial and lateral sides of a knee to expose the femur from the side; and

performing the other steps through the incision from the side of the knee.

96. A cut guide for a femur having an anterior side, a posterior side, a proximal end, and a distal end, the cut guide comprising:

an anterior body portion having an outer anterior surface, an inner anterior surface, and an anterior cut guide surface;

a distal body portion having an outer distal surface, an inner distal surface, and a distal cut guide surface, the distal body portion extending from the anterior body portion at an angle, the distal cut guide surface being aligned with the anterior cut guide surface; and

a cutter guidable from the distal cut guide surface to the anterior cut guide surface to cut the anterodistal aspect of said femur along an angle from posterior and distal to anterior and proximal.

97. The cut guide of claim 96 wherein the anterior cut guide surface comprises an anterior chisel guide and the posterior cut guide surface comprises a posterior chisel guide and the cutter comprises a chisel.

98. The cut guide of claim 97 wherein the anterior chisel guide comprises a slot extending from the outer anterior surface to the inner anterior surface, the distal chisel guide comprises a slot extending from the outer distal surface to the inner distal surface and the chisel comprises a cross sectional shape matching the anterior and distal chisel slots so that the chisel is insertable through the chisel slots from the distal chisel slot to the anterior chisel slot.

99. The cut guide of claim 98 wherein the slots are three sided and the chisel comprises a corresponding three sided shape.

100. The cut guide of claim 99 further comprising at least one distal drill guide hole formed through the distal body portion from the outer distal surface to the inner distal surface to guide a drill to form at least one hole in the distal end of the femur at a predetermined location relative to the slots.

101. The cut guide of claim 97 further comprising medial and lateral articular condyles having articulating surfaces formed thereon permitting trial fitting of the cut guide to simulate the fit of a corresponding femoral implant relative to the tibia.

102. The cut guide of claim 101 further comprising a patellar articular surface formed thereon permitting trial fitting of the cut guide to simulate the fit of a corresponding femoral implant relative to the patella.

103. The cut guide of claim 97 further comprising an inner box profile corresponding to the inner box profile of a femoral implant.

104. A method for cutting the anterodistal aspect of a femur having an anterior side, a posterior side, a proximal end, and a distal end, the method comprising the steps of:

mounting a cut guide on the femur, the cut guide having a chisel guide; and

guiding a chisel with the chisel guide to cut the anterodistal aspect of the femur along an angle from posterior and distal to anterior and proximal.

105. The method of claim 104 wherein the chisel guide comprises an anterior chisel slot and a distal chisel slot and the chisel comprises a cross sectional shape matching the anterior and distal chisel slots, the method further comprising the step of inserting the chisel through the slots from the distal chisel slot to the anterior chisel slot.

106. The method of claim 105 wherein the cut guide further comprises at least one drill guide hole, the method further comprising the step of guiding a drill with the at least one drill guide hole to drill a hole in the distal end of the femur at a predetermined location relative to the slots.

107. The method of claim 104 wherein the cut guide further comprises medial and lateral articular condyles having articulating surfaces formed thereon, the method further comprising the step of performing a trial fitting of the cut guide on the femur and articulating it relative to the tibia to simulate the fit of a corresponding femoral implant relative to the tibia, before the step of guiding a chisel to cut the femur.

108. The method of claim 104 wherein the cut guide further comprises a patellar articular surface formed thereon, the method further comprising the step of performing a trial fitting of the cut guide on the femur and articulating it relative to the patella to simulate the fit of a corresponding femoral implant relative to the patella, before the step of guiding a chisel to cut the femur.

109. The method of claim 104 further comprising the steps of first making an incision on one of the medial and lateral sides of the knee joint to expose the femur from the side and performing the other steps through the incision from the side of the knee.

110. The method of claim 104 further comprising the steps of providing a femoral notch guide comprising a notch cut guide and a protrusion for engaging the cut in the anterodistal aspect of the femur, engaging the protrusion with the cut in the anterodistal aspect of the femur to align the femoral notch cut guide, and guiding a cutter with the notch cut guide to cut a notch in the femur.

111. The method of claim 106 further comprising the steps of providing a femoral notch guide comprising a notch cut guide and at least one protrusion for engaging the at least one hole drilled in the distal end of the femur, engaging the protrusion with the hole in the distal end of the femur to align the femoral notch cut guide, and guiding a cutter with the notch cut guide to cut a notch in the femur.

112. A method of total knee arthroplasty comprising the steps of:

making an incision on at least one of the medial and lateral sides of a knee to expose the knee joint from the side;

placing a patella cut guide adjacent the patella;

guiding a cutter with the patella cut guide through the incision to cut the patella from the side of the knee;

placing a femoral cut guide adjacent the femur;

guiding a cutter with the femoral cut guide through the incision to cut the femur from the side of the knee;

placing a tibial cut guide adjacent the tibia; and

guiding a cutter with the tibial cut guide through the incision to cut the tibia from the side of the knee.

113. The method of claim 112 wherein the step of cutting the femur comprises cutting the distal end of the femur and wherein the method further comprises the steps of:

establishing a datum on the femur engageable from the side of the knee to fix the desired external rotation and anteroposterior position of subsequent bone cuts;

engaging the datum with a cut guide to orient the cut guide in the desired external rotation and anteroposterior position; and

cutting the distal femur profile from the side of the knee.

114. The method of claim 112 wherein the step of cutting the patella further comprises cutting the patella while maintaining the patella in its normal anteroposterior orientation relative to the femur.

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