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(54) Title: BONE CUTTING ASSEMBLY

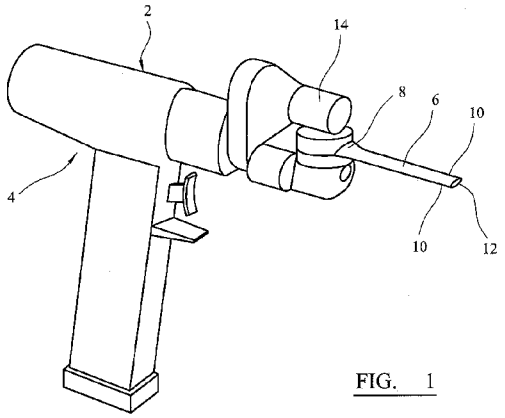

FIG. 1

(57) Abstract: An assembly for use in cutting a bone during a surgical procedure comprises a cutting tool and a guide block. The cutting tool includes a blade and a drive unit for imparting a cutting motion to the blade. The guide block can be positioned against the bone and has a reference surface for guiding the blade during the cutting step, the guide block having a screen surface which provides a point of reference to indicate proper alignment of the blade. The cutting tool includes means for directing a collimated beam of light in a direction parallel to the blade, on to the screen surface on the guide block when the blade is in contact with the guide surface, the distance between the blade axis and the light beam being equal to the distance between the reference surface and the point of reference on the screen surface.

BONE CUTTING ASSEMBLY

This invention relates to an assembly for use in cutting a bone during a surgical procedure.

The outcome of an orthopaedic surgery procedure, such as a procedure to replace an orthopaedic joint prosthesis, depends on the accuracy with which the bone is prepared. Bone preparation frequently involves cutting the bone, for example using a tool such as a saw or a drill or a burr cutting tool. Accuracy requires that the cut should be located accurately and oriented accurately.

It is common to use a cutting guide to locate a cut accurately. A cutting guide can be fastened to a bone in a step to prepare the bone for the subsequent cutting step, for example by means of pins. The cutting guide provides a guide surface which can support the blade of a cutting tool during the cutting step. For example, when the cutting tool is a saw with a reciprocating blade, the guide surface will usually be planar, for example in the form of an exposed planar surface or a slot. When the cutting tool is a drill or a burr cutter with a rotating bit, the guide surface can be a bore.

It is desirable to minimise inaccuracies which result from application of a force to the cutting tool which has a component which is not parallel to the axis of the blade. Such forces can tilt a blade introducing inaccuracy into the location or orientation or both of the blade, especially when the blade is not a tight fit in a guide slot or bore. Such forces might also tend to bend the blade.

The present invention provides an assembly in which a beam of light is directed from the cutting tool in a direction parallel to the cutting blade on to a screen surface on a cutting guide, the surface providing a point of reference to indicate proper alignment of the blade.

Accordingly, in one aspect, the invention provides an assembly for use in cutting a bone during a surgical procedure, which comprises:

a. a cutting tool which includes a blade and a drive unit for imparting a cutting motion to the blade, and

b. a guide block which can be positioned against the bone and which has a reference surface for guiding the blade during the cutting step, the guide block having a screen surface which provides a point of reference to indicate proper alignment of the blade,

in which the cutting tool includes means for directing a collimated beam of light in a direction parallel to the blade, on to the screen surface on the guide block when the blade is in contact with the guide surface, the distance between the blade axis and the light beam being equal to the distance between the reference surface and the point of reference on the screen surface.

The assembly of the invention provides a surgeon with a visible indication that a force is applied to a cutting blade having a component in a direction which is perpendicular to the axis of the blade. The indication that a force is applied to the blade, having a component in a direction which is perpendicular to the blade's axis, is apparent through the relative positions of the point of incidence of the light beam on the screen and the reference mark. Such forces might tend to cause the blade to bear preferentially against one or more edges of the reference surface or to bend the blade or both. Such applied forces can introduce inaccuracy into the location or the orientation or both of the cut which is created by the blade, especially when the reference surface is open (rather than being closed in the form of a slot or bore) or the blade is a loose fit in a slot or bore. The bending forces can cause additional friction between the blade and the reference surface, possibly leading to wear of the blade or the reference surface or each of them and generation of undesirable wear debris. Vibration can lead to undesirable movement of the guide block on pins or other components which are used to fix it to the bone, or to loosening of such pins.

The invention uses a reference surface on a cutting guide to locate the blade of a cutting tool. The light source, with the reference surface, provides information concerning alignment of the blade when positioned in relation to the reference surface.

The point of reference can be a reference mark on the screen surface, for example in the form of an indented or raised profile on the surface, or a mark which is printed on the

screen surface in a colour which contrasts with that of the surrounding surface, or a combination of an indented or raised profile and a printed mark.

The point of reference can be provided by an edge of the screen.

The reference surface on the guide block can be generally planar, for example provided by an exposed surface of the block or by a slot. It can be used to guide a saw blade or the rotating bit of a burr cutter. The point of reference can be in the form of a line which extends parallel to the reference surface. Preferably, the line is continuous. However, it might be discontinuous, for example provided by a line of dots or dashes. The line which provides the point of reference can be defined by an edge of the screen.

The reference surface can be provided by a bore. It can be used to guide a bore forming tool such as the rotating bit of a drill, which can slide in the bore. The reference mark can mark a point which is located a pre-determined distance from the bore in the guide block.

The assembly can include a light source which provides the source of the beam of light. The light source can be mounted on the cutting tool so that it is or forms part of the means for directing the beam of light. The light source might be a laser. The selection of the laser source should be made taking account of the visibility of the emitted light. It can be preferred for some applications for the laser source to emit light which is coloured green. Other factors which should be taken into account include supply of power, the generation of heat, and other safety issues. Suitable light sources are commercially available.

The assembly can include a fibre optic light conduit for conveying light from a source to the cutting tool. The fibre optic light conduit can have a free end from which the collimated beam of light is directed and which is fastened at the said end to the cutting tool so that it is or forms part of the means for directing the beam of light. The fibre optic light conduit has the advantage that a light source can be located remote from the cutting tool, so that the tool can be less bulky and it is not necessary to supply power for the light source to the cutting tool. The fibre optic light conduit and the light source might both be provided on the cutting tool so that the two components are or form part of the means for directing

the beam of light. The assembly can include a light source which is remote from the cutting tool, which is connected to the cutting tool by means of the fibre optic light conduit.

The means for directing the collimated beam of light should be fastened to the cutting tool so that the beam is directed parallel to the axis of the blade when the blade is in use. When the blade is a saw blade, it might be made to reciprocate side-to-side in a plane by the drive unit. The beam of light should be directed parallel to that plane. The source of the light beam can reciprocate with the blade. Preferably however the beam of light is fixed as the blade reciprocates, for example to the drive body which imparts the reciprocating motion to the blade. When the blade is a bit (for example a drill bit or the bit of a burr cutter) which rotates about an axis, the beam of light should be directed parallel to the axis. The means for directing the light beam should be fastened to the cutting tool sufficiently rigidly that it does not move when the cutting tool is in use, for example by means of clamps. For example, a clamp might encircle the cutting tool body or might be screwed into the cutting tool body.

Preferably, the screen surface is provided by a screen which can be mounted detachably on the guide block. A detachable screen surface can be removed from the guide block after the cutting step. This has the advantage of reducing obstructions to viewing the surgery site. The screen surface should be fastened to the guide block sufficiently rigidly to prevent it from moving significantly during the cutting step. It can be fastened to the guide block by means of fasteners such as screws. However, it is preferred that it can be fastened to the guide block by means of resilient clips which facilitate attachment and subsequent removal.

The screen surface can be provided by a surface of the cutting guide which is formed as one piece with the cutting guide, or formed as separately from the cutting guide but fastened to the guide so that it would not be expected to be separated from the guide during use.

When the screen surface is provided by a screen which can be detached from the cutting guide, it can be formed from a material which is different from that of the cutting guide.

The screen might be made from a polymeric material or from a metal. The use of a polymeric material can be preferred for ease of manufacture and cost, especially if the screen includes features which can be deformed resiliently to aid fixation to the cutting guide.

The cutting guide can be made from materials which are conventionally used in the manufacture of surgical instruments. Examples of suitable materials include metals such as stainless steels and polymeric materials. It can be preferred for some applications that at least the reference surface is provided by a metal because of its resistance to damage as a result of abrasion.

The reference mark should be such that it can be observed clearly during the surgical procedure. It might be provided as a profile feature, for example raised or indented, which can be moulded or machined. It might be provided by a marking having a contrasting colour, for example by printing. The reference mark might be provided by a combination of a profile feature and a contrasting colour.

The reference mark should be provided so that it is readily visible to a surgeon who is using the assembly. For example, it will generally be appropriate for the reference mark to have a transverse dimension of at least about 0.5 mm.

The light beam should be readily visible to a surgeon who is using the assembly. The visibility of the beam will depend on the frequency of the light in the beam, its intensity, and the size of the beam. Preferably, the transverse dimension of the beam is at least about 0.5 mm. The wavelength of the light should be such that it is visible against the screen, through its colour contrasting with that of the screen.

The reference surface in the cutting guide can be provided by an opening such as a slot or a bore. The blade (which might be a saw blade or a rotating bit of a drill or burr cutting tool) should be a sliding fit in the opening, as is known.

The reference surface can be provided by an exposed surface of the cutting guide.

The cutting guide should be fixed relative to the bone before the cutting step. The cutting guide can have bores formed in it for receiving fasteners such as pins or screws. The cutting guide can be fastened to other components of a surgical instrument set which can locate the cutting guide as required, such as for example an extramedullary rod. The cutting guide can be positioned relative to the bone using conventional techniques including references to anatomical landmarks using alignment instruments, and image guided surgery techniques.

The assembly of the invention can be used to position a tibial cutting guide relative to the tibia in a procedure to implant the tibial component of a knee joint prosthesis. It can be used to position a cutting guide relative to other bones in other procedures, for example in procedures to implant components of other orthopaedic joints such as the hip, ankle, shoulder and elbow.

Embodiments of the invention are described below by way of example with reference to the accompanying drawings, in which:

Figure 1 is an isometric view of a reciprocating bone saw, having a light source fastened to it.

Figure 2 is an isometric view of a cutting guide which can be used with the bone saw shown in Figure 1.

Figure 3 is a front view partially in section of a cutting guide, together with a screen which can be fastened to the cutting guide.

Figures 4 and 5 are side views of the lower leg, illustrating the use of the bone saw and cutting guide which are shown in Figures 1 and 2.

Referring to the drawings, Figure 1 shows a powered bone saw 2 which can be used to cut a bone. It comprises a drive body 4 and a blade 6. The blade is fixed between two chuck plates 8 through which the reciprocating side-to-side motion is imparted to the blade. The

blade is formed from sheet stainless steel. It is planar with two long parallel edges 10. The short edge 12 at the end of the blade which is remote from the drive body has cutting teeth formed in it. The blade is arranged in the chuck so that the plane in which it is moved by the drive contains the two parallel edges of the blade.

The bone saw has a laser unit 14 fastened to it. The laser unit generates a collimated beam of visible light in a direction which is parallel to the plane defined by the blade 6. The distance between the centre line of the blade and the centre of the beam is 20 mm.

Figure 2 shows a cutting guide 20 which includes a body 21 formed from a block of stainless steel such as is conventionally used in the manufacture of surgical instruments. It has three fixation holes 22 at each side. It has a slot 24 formed in it in which the blade 6 of the bone saw is a sliding fit.

The cutting guide includes a screen 26 which extends upwardly from the upper face of the cutting guide body. The screen has a line 28 extending across it. The distance between the centre of the line and the centre of the saw slot 24 is 20 mm. The line is defined by a groove in the screen. The groove can contain a paint whose colour contrasts with that of the surrounding material of the screen.

Figure 3 shows features of a screen and cutting guide body which allow the screen to be mounted detachably on the cutting guide body. The screen is made from a polypropylene by moulding. The screen has a pair of feet 30 at opposite corners. Each foot has a retaining clip 32 associated with it.

The cutting guide body has a pair of sockets 40 formed in its top face. Each of the sockets can receive one of the feet 30 on the screen with its respective retaining clip. Each of the sockets is defined by an outwardly facing end wall 42 and an inwardly facing end wall. The inwardly facing end wall defines an undercut 46. Fitting the screen on to the cutting guide body involves locating one of the feet with its respective retaining clip in the opening to one of the sockets. Application of an assembly force causes the retaining clip to be deformed until the clip can spring back into the undercut. The clip then retains the screen

in position on the cutting guide body. When the screen is assembled in place on the cutting block body, the distance from the saw guide slot 24 to the line 28 on the screen is 20 mm.

The screen can be separated from the cutting guide body by application of a separating force. This force causes the retaining clips to be deformed by the inwardly facing walls of the sockets so that the feet with their respective retaining clips can be withdrawn from the sockets.

Figure 4 illustrates correct alignment of the blade 6 with the slot 24 in the cutting guide. The drawing shows the cutting guide 20 fastened to the anterior face of the tibia 48, towards the proximal end thereof. It can be positioned on the tibia using alignment instrumentation as is known. The beam 50 from the laser unit 14 extends parallel to the blade and is incident on the screen 26, in the groove 28, so that movement of the saw within the slot causes the beam to move along the groove 28 but not to deviate from the groove.

If the bone saw is tipped so that the blade is no longer parallel to the plane of the saw slot in the cutting guide, as shown in Figure 6, the light from the laser unit will not longer be coincident with the groove 28 in the screen 26. This will be apparent visibly to the surgeon who will be able to correct the orientation of the saw. Correction of the orientation of the saw will help to reduce wear of the saw blade and the cutting guide, and to reduce vibration of the cutting guide which might cause it to loosen or otherwise to move.

The drawings illustrate embodiments of the invention in which the cutting tool is a saw. The invention is applicable to other instruments such as a burr cutting tool, and a bone drill (in which the cutting guide provides a bore for the drill bit).

CLAIMS:

1. An assembly for use in cutting a bone during a surgical procedure, which comprises:

a. a cutting tool which includes a blade and a drive unit for imparting a cutting motion to the blade, and

b. a guide block which can be positioned against the bone and which has a reference surface for guiding the blade during the cutting step, the guide block having a screen surface which provides a point of reference to indicate proper alignment of the blade,

in which the cutting tool includes means for directing a collimated beam of light in a direction parallel to the blade, on to the screen surface on the guide block when the blade is in contact with the guide surface, the distance between the blade axis and the light beam being equal to the distance between the reference surface and the point of reference on the screen surface.

2. An assembly as claimed in claim 1, in which the point of reference is a reference mark on the screen surface.

3. An assembly as claimed in claim 1, in which the blade is a saw blade and the reference surface is planar, and the point of reference is a line which extends parallel to the reference surface.

4. An assembly as claimed in claim 1, in which the blade is a rotating bit and the reference surface is a bore, and the point of reference marks a point.

5. An assembly as claimed in claim 1, which includes a light source mounted on the cutting tool.

6. An assembly as claimed in claim 1, which includes a fibre optic light conduit for conveying light from a source to the cutting tool, having a free end from which the collimated beam of light is directed and which is fastened at the said end to the cutting tool.

7. An assembly as claimed in claim 1, in which the screen surface is provided by a screen which can be mounted detachably on the guide block.

8. A method of cutting a bone, which comprises:

a. positioning a guide block against the bone, the guide block having a reference surface for guiding a blade during a cutting step, and a screen surface which provides a point of reference to indicate proper alignment of the blade,

b. positioning a cutting tool which includes a blade and a drive unit for imparting a cutting motion to the blade so that the blade is positioned against the reference surface, the cutting tool including means for directing a collimated beam of light in a direction parallel to the blade, on to the screen surface on the guide block when the blade is in contact with the guide surface, the distance between the blade axis and the light beam being equal to the distance between the reference surface and the point of reference on the screen surface,

c. activating the drive unit so as to cause the blade to move so that it cuts the bone, and

d. maintaining the position of the light beam relative to the point of reference during the step in which the blade cuts the bone.

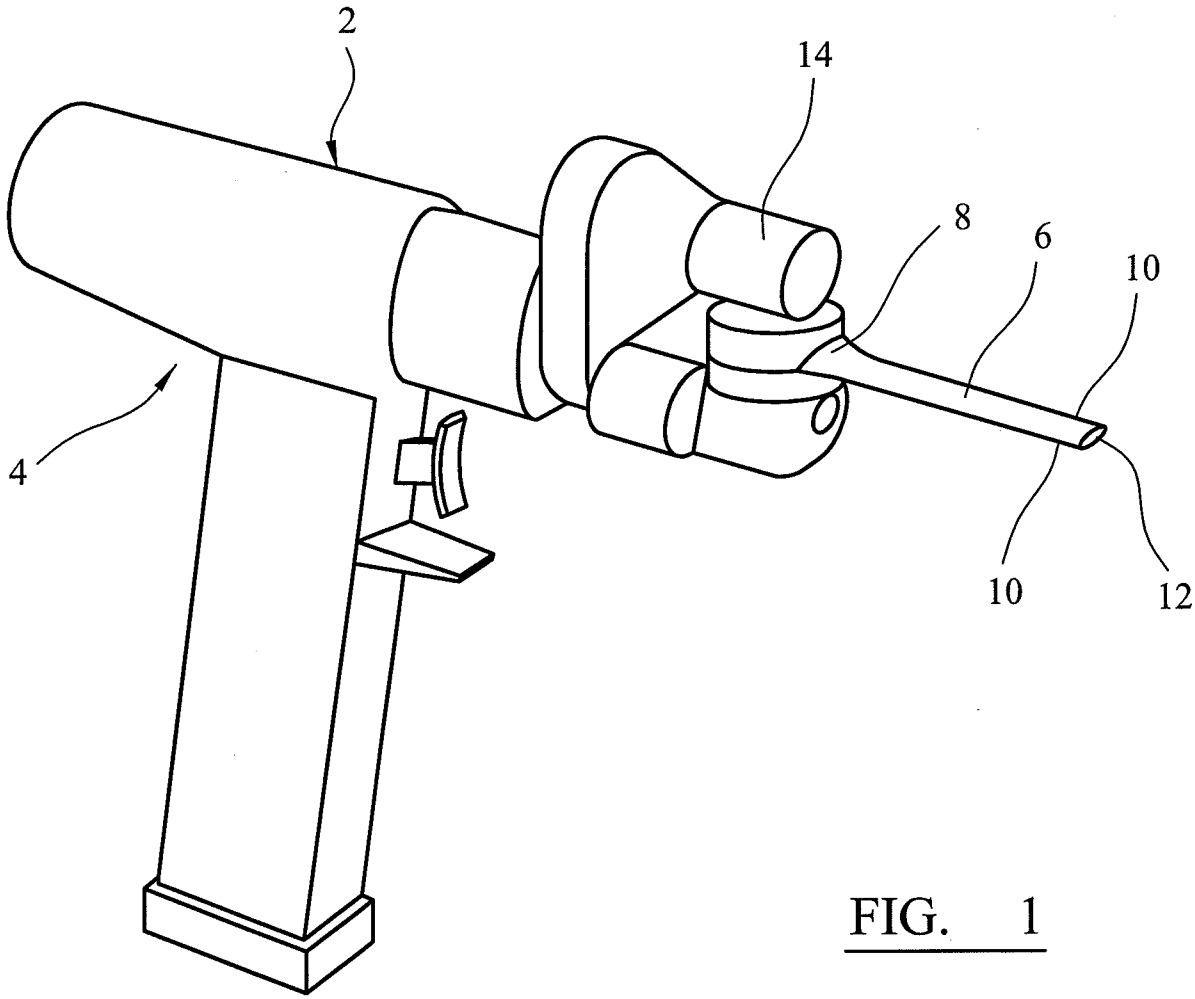

FIG. 1

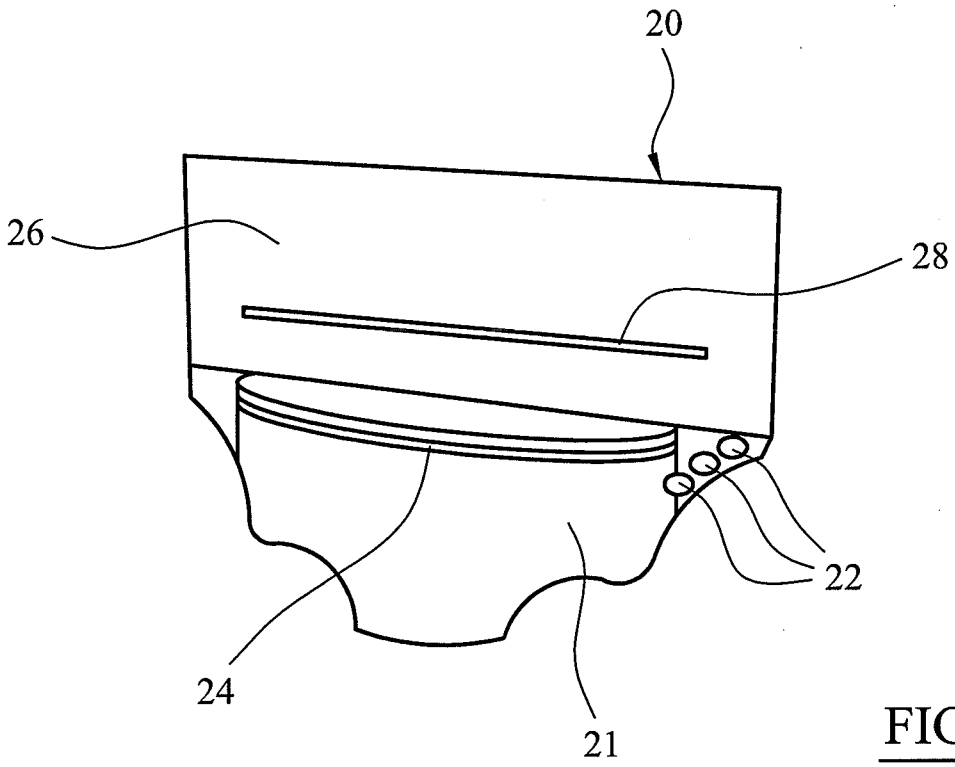

FIG. 2

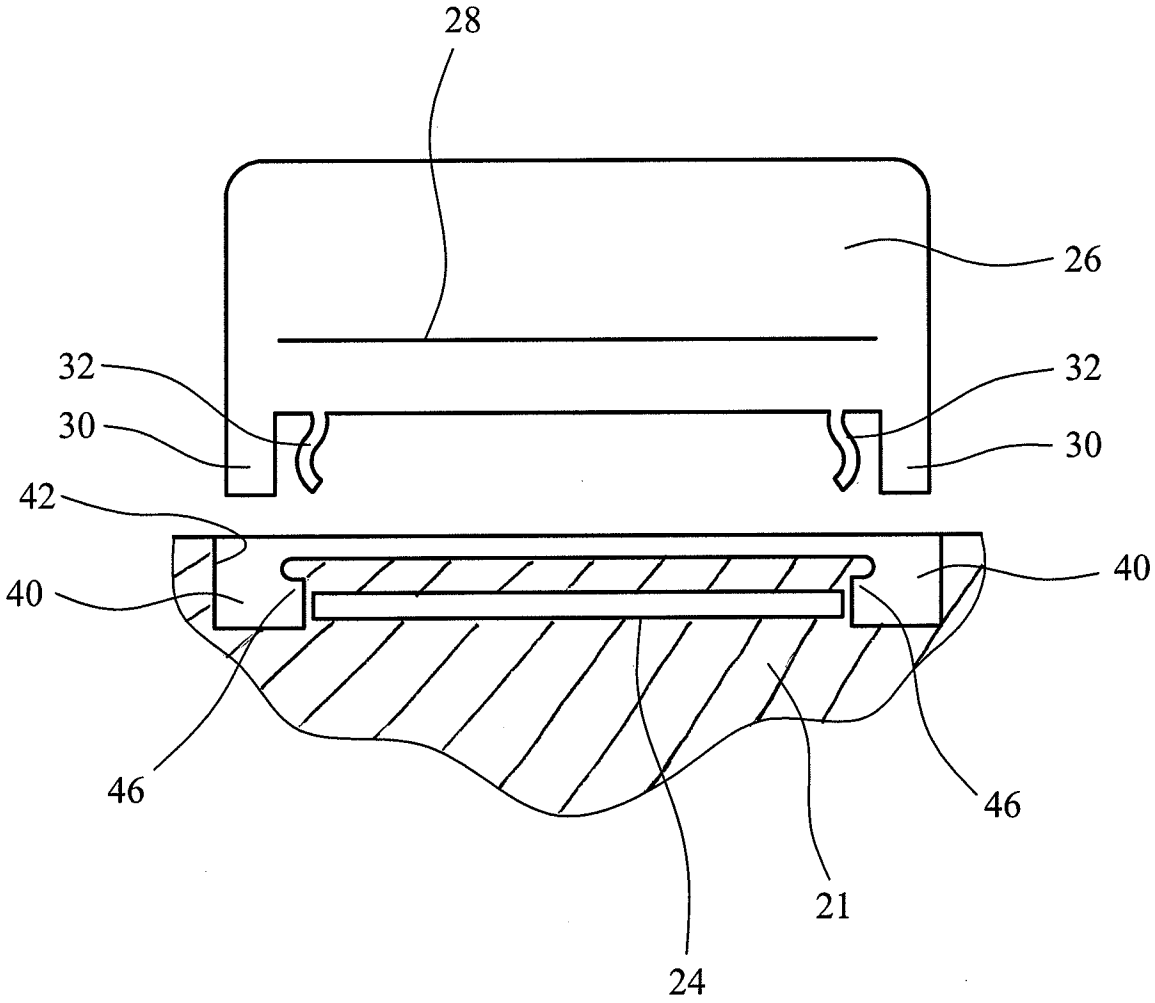

FIG. 3

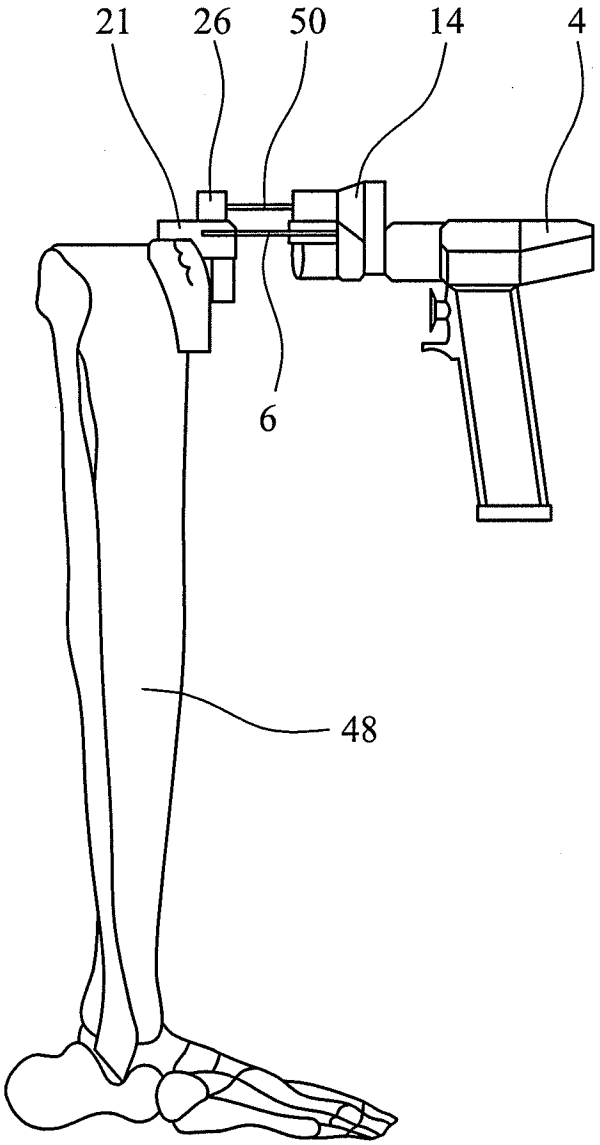

FIG. 4

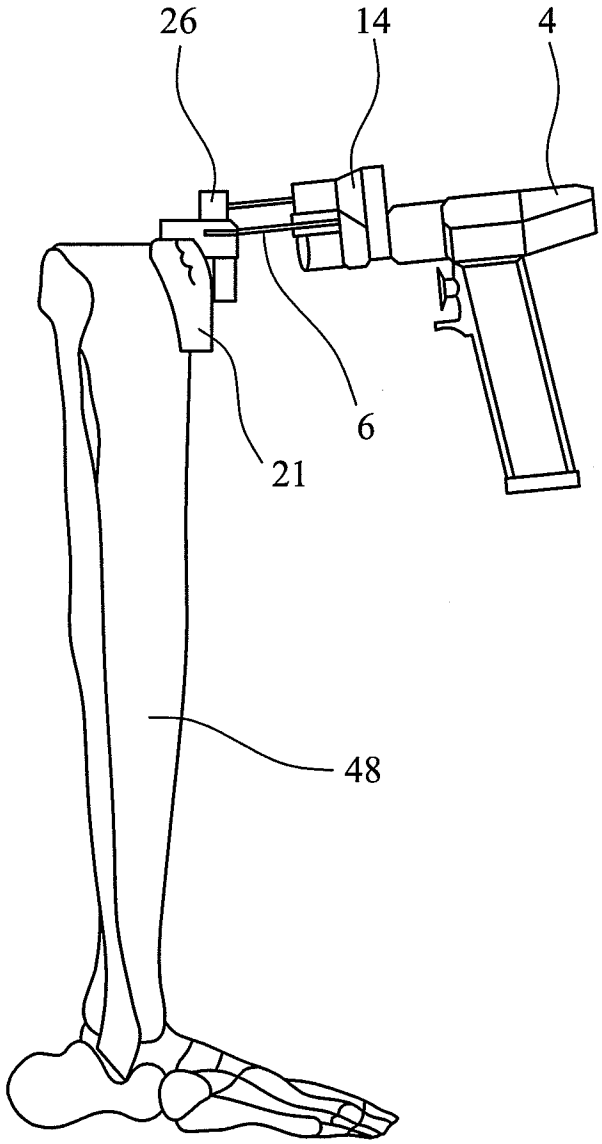

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2010/050701

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B17/14 A61B17/15
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/028196 A1 (BONUTTI PETER M [US]) 6 February 2003 (2003-02-06)	1-4,7
A	figure 17	5,6
A	DE 200 08 871 U1 (AESCULAP AG & CO KG [DE]) 20 July 2000 (2000-07-20) figures 1, 2	1
A	US 5 426 687 A (GOODALL JOHN D [GB] ET AL) 20 June 1995 (1995-06-20) figure 1	1

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 July 2010	05/08/2010

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Fax: (+31–70) 340–3016	Fernández Arillo, J

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2010/050701

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.: 8
because they relate to subject matter not required to be searched by this Authority, namely:

Pursuant to Rule 39.1(iv) PCT, the subject-matter of claim 8 has not been searched, since it is directed to a method for treatment of the human body by surgery.

2. [ ] Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

[ ] The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

[ ] No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2010/050701

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2003028196 A1	06-02-2003	US 7510557 B1	31-03-2009
		US 7749229 B1	06-07-2010
		US 7708740 B1	04-05-2010
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US 5426687 A	20-06-1995	NONE	