(12) PATENT
(19) AUSTRALIAN PATENT OFFICE

(11) Application No. AU 199878704 B2
(10) Patent No. 740287

(54) Title

Surgical instrument with means to display torque and torsional angle

(51)[6] International Patent Classification(s)
A61B 017/88 A61C 008/00

(21) Application No: 199878704 (22) Application Date: 1997.12.15

(87) WIPO No: WO98/27886

(30) Priority Data

(31) Number	(32) Date	(33) Country
9604717	1996.12.20	SE

(43) Publication Date : 1998.07.17
(43) Publication Journal Date : 1998.09.10
(44) Accepted Journal Date : 2001.11.01

(71) Applicant(s)
Nobel Biocare AB

(72) Inventor(s)
Lennart Carlsson; Anders Petersson

(74) Agent/Attorney
WATERMARK PATENT and TRADEMARK ATTORNEYS,Locked Bag 5,HAWTHORN VIC 3122

(56) Related Art
GB 2286127
GB 2098740

OPI DATE 17/07/98 APPLN. ID 78704/98
AOJP DATE 10/09/98 PCT NUMBER PCT/SE97/02096
AU9878704
IN

(51) International Patent Classification 6 :
A61B 17/88, A61C 8/00

A1

(11) International Publication Number: WO 98/27886

(43) International Publication Date: 2 July 1998 (02.07.98)

(21) International Application Number: PCT/SE97/02096

(22) International Filing Date: 15 December 1997 (15.12.97)

(30) Priority Data:
9604717-0 20 December 1996 (20.12.96) SE

(71) Applicant *(for all designated States except US)*: NOBEL BIOCARE AB (publ) [SE/SE]; P.O. Box 5190, S-402 26 Göteborg (SE).

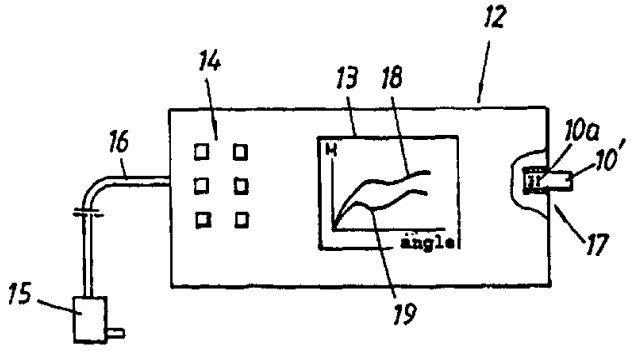
(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: CARLSSON, Lennart [SE/SE]; Matildebergsgatan 36, S-431 38 Mölndal (SE). PETERSSON, Anders [SE/SE]; Munkebäcksgatan 32A, S-416 54 Göteborg (SE).

(74) Agent: OLSSON, Gunnar; Nobel Biocare AB (publ), P.O. Box 5190, S-402 26 Göteborg (SE).

(81) Designated States: AU, CA, JP, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
In English translation (filed in Swedish).

(54) Title: SURGICAL INSTRUMENT WITH MEANS TO DISPLAY TORQUE AND TORSIONAL ANGLE



(57) Abstract

A surgical instrument (12) includes a tool for screwing in a surgical implant or for cutting a thread in human bone tissue with thread tap. Also included is a unit (2) for supplying power and controlling the speed of an electric motor included in the tool, for example a d.c. motor (1). Detection members (7, 8) transmit signals (i1), dependent on the torque of the tool, to display members which comprise a computer unit (9) with screen (10). Displayed on the screen is a curve which shows the torque in relation to the torsional angle position. A curve or curves displayed in this way form(s) the basis for assessing the quality of the implant or of the bone tissue.

TITLE

SURGICAL INSTRUMENT WITH MEANS TO DISPLAY TORQUE AND TORSIONAL ANGLE

TECHNICAL FIELD

The present invention relates to a surgical instrument which comprises, inter alia, a tool for screwing in a surgical implant or for cutting a thread in human bone tissue with thread tap. Also included is a unit for supplying power and controlling the speed of an electric motor included in the tool, and detection and display members, the detection members transmitting signals, dependent on the torque and torsional angle of the tool, to the display members. The latter comprise a computer unit, for example a microprocessor, with associated display and memory members, which respectively display and store a torque curve effected by the tool on the basis of the screwing-in or thread-cutting. This curve shows the torque as a function of the torsional angle. The display member can in this case be of the type which comprises a computer screen, VDU, etc. The invention also relates to an arrangement in which the above surgical instrument is included.

PRIOR ART

It is already known, for example from PCT publication WO 95/20146, to use, in screwing tools, a unit for supplying power to an electric motor. An amplifier is connected to the current supply circuit of the electric motor, and this amplifier is followed by an analog/digital converter. The latter is in turn connected to a computer unit with VDU. It is also already known per se to investigate various bone qualities of the human body and to draw up statistics on these bone qualities. In this case it is possible to detect the capacity of a particular tool to penetrate the respective bone/bone tissue, and to relate the penetration capacity to the bone quality. It is also known to use torque-controlled tools for screwing and thread-cutting in conjunction with

dental work using implants, dental bridge structures, etc. Different evaluations of bone quality for different persons of different ages are known per se.

DESCRIPTION OF THE INVENTION

TECHNICAL PROBLEM

There is a need for effective means for aiding surgeons, dentists and equivalent personnel performing advanced dental work. For example, when cutting a thread and fitting a screw, the surgeon or equivalent person must have complete control of the work being carried out. The implant and dental structure in question must be applied optimally. This optimal application is to a large extent dependent on the quality of the bone tissue in each individual case, which quality is not always entirely apparent from external inspection. Hitherto, a good result has been associated with professional skill and experience. The present invention addresses the problem by indicating with great precision, for example, the bone quality, strength of the screw material, etc.

When drawing up statistics and other information, it is important to be able, in a simple manner, to document the respective work performed in respect of bone quality, patient type, age, type of structure, implant application, etc. The invention addresses this problem too.

It is also important that the operating function of the tool in question can be given a simple and well proven function and component design. The invention addresses these problems too. The invention uses the fact that the torsional angle is known.

SOLUTION

One aspect of the present invention provides a surgical instrument including a tool for screwing in a surgical implant or for cutting a thread in bone tissue with a thread tap, a unit for supplying power and controlling the speed of an electric motor included in the tool, and detection and display members, wherein the detection members transmit signals, dependent on the torque and angle position(s) of the tool, to the display members which include a computer unit, for example a microprocessor, which, besides the display member, includes memory members, and wherein the display member is arranged to display a

torque/torsional angle curve, which forms the basis for assessing the quality of the bone tissue.

In one embodiment, the unit for supplying power and controlling the speed is arranged to provide the electric motor with an essentially constant speed of rotation or a variable speed of rotation.

With the torque/torsional angle curve it is also possible to check if the screw material is of good quality and that the elasticity limits in question are not being exceeded. The said storage member/members is/are arranged to store one or more torque curves which can be related to different screwing-in and/or thread-cutting cases.

In one embodiment, the detection member comprises an amplifier and, connected-in downstream of this, an analog/digital converter which converts the signals of the detection member into corresponding data signals. The said data signals are shown, with the aid of low-pass filtering, as a histogram on the display member's screen, where each column corresponds to a number of mean values of the torque in order that rapid variations or ripples will not disturb production.

Another aspect of the present invention provides an arrangement comprising a surgical instrument with electric motor and power and speed control for or on the motor, wherein detection members detect torque(s) effected by the tool relative to torsional angle position(s), wherein a display member or display members is/are arranged to display a torque/torsional angle curve which shows the torque variation as a function of the angle position, wherein the display member includes or is connected to one or more storage members, wherein the arrangement also includes an evaluation system for bone quality, statistics on bone qualities, etc., wherein said storage member/members is/are arranged to store one or more torque/torsional angle curves, and wherein the stored curves are arranged such that they can be transferred to the evaluation system.

In a preferred embodiment, a removable storage member is used as storage member. The storage member can here have the form of a card which can be loaded with data (cf. credit card, electronic wallet card, etc.). The respective curve formation for one or more patients is fed into the card in question. After the data information has been loaded, the card can be removed for use, i.e. insertion, in the evaluation system.

ADVANTAGES

With the above functions built into a surgical instrument, which additionally has facilities for cooling, speed control, direction of rotation control, torque control, etc., a very attractive technical support instrument for the surgeon or equivalent is obtained.

DESCRIPTION OF THE FIGURES

A presently proposed embodiment of a surgical instrument and arrangement according to the invention will be described below with reference to the attached drawings, in which:

Figure 1 shows, in a basic circuit diagram, the functions of the tool's electric motor, its power and speed control, detection members for the electric motor's torque/torsional angle curve, and display members and storage members for the curve or curves in question,

Figure 2 shows, from the front, an example of a surgical instrument,

Figure 3 shows, in a basic circuit diagram, the input functions for a card which can be loaded with data on torque/torsional angle curves,

Figure 4 shows, in a horizontal view, an evaluation system,

Figure 5 shows, in a basic circuit diagram, a speed control for the electric motor in question in the tool, and

Figure 5a shows, in a basic circuit diagram, speed control and information on the torsional angle of the rotor by means of magnet and Hall elements and a

calculator coupled to the computer.

DETAILED EMBODIMENT

In Figure 1, an electric motor is symbolized by 1. The motor is of a type known per se and can be of the brushless EC 032 type which is sold on the open market by Stork AB. A combined electrical power and speed control unit is shown by 2. The unit is arranged, inter alia, so that it can provide the motor 1 with a constant speed of rotation independently of the torque of the motor. Alternatively, or in addition to this, it can measure the torsional angle in a known manner with the aid of Hall elements and a magnet on the rotor. Arranged in the current supply circuit 3 of the motor there is an element 4, preferably in the form of a resistor. An amplifier 7 of known type is connected at contact points 5, 6 across the resistor. The output 7a of the amplifier is connected to an analog/digital converter 8 whose output 8a is connected to a computer unit 9, for example a micro-processor, which comprises a storage member 10 and a display screen 11, for example in the form of a VDU.

The motor 1 comprises in a known manner a gear and rotates in accordance with the above at a constant speed of rotation or with a rotor position 1 which is known at each instant. The supply current through the resistor is shown by i1. The amplifier detects the voltage V across the resistor and conveys a current i1/voltage V1 dependent on the changes to the analog/digital converter, which effects a pulse train i2 dependent on the detection. The computer unit 9 receives the said pulse train.

In this way, when threading-in an implant or screwing-in a screw in dental constructions, the voltage drop across the resistor is displayed in real time on the said display. As the motor current is proportional to the voltage drop and the current is in turn proportional to the transmitted torque, a direct display of the latter is obtained. The torque is shown on the display as a function of the time. Data (i2) is shown as an analog

curve (torque as a function of torsional angle). The curve undergoes low-pass filtering so that the rapid variations or electrical ripple will not be seen. The said ripple, which consists of small irregularities superimposed on the curve, is caused by irregularities in the gearbox and motor commutations.

Figure 2 shows a surgical instrument 12 in its entirety. The instrument display (i.e. the computer screen in accordance with the above) is shown by 13. The instrument has a keyboard/indication panel 14 for different functions, cf. above. The tool is indicated by 15, and a connection to the tool is indicated by 16. The storage member in accordance with the above has here been designated 10'. The storage member is designed as a credit card (cf. electronic wallet) which can be loaded with data. The card can be inserted into and removed from a card-reading unit 17 in a known manner. The card has an integrated circuit 10a which can be provided in a known manner with data, i.e. in this case torque data as a function of the tool position (angle).

In the figure, two torque curves 18, 19 are shown on the screen 13, these curves each representing thread-cutting or screwing-in of the implant in the jaw/bone tissue. The curves indicate the moment M as a function of the position of rotation/torsional angle. The higher the torque values, the higher the shearing force, which can be linked to bone quality.

The card 10 is shown from the side in Figure 3, where the loading members/circuits have been symbolized by 20, 21. A bus connection is shown by 22, and a micro-processor (CPU) in accordance with the above, indicated by 9', is connected to this bus connection 22. A terminal 23 connected to the bus connection can also be included, on which terminal 23 it is possible to input data supplementing the torque curves, for example in the form of date, patient type, age, etc. The pulse train i2' is received via an adaptor circuit 24 connected to the bus connection. Also included are an associated fixed memory 25 and an adaptor member 26 for the loadable memory 10',

10a'. The components 25 and 26 are also connected to the bus connection.

According to Figure 4, the card/memory 10''' can be introduced into a card reader 27 of known type on or in the evaluation system. Statistics, assessment of bone quality, etc. can be carried out in the latter and collected. The information on this can be obtained at the outputs 29, 30.

In Figure 5, a combined supply and speed control unit (for example, in the form of Hall elements-magnet-calculator-computer, cf. 2 above) for the motor 1' is shown by 31. A position indication feedback is shown by 32, and the resistor in accordance with the above is shown by 4'. The speed of rotation is measured with Hall elements.

Speed control and information on the angle position of the rotor 1a are obtained, for example, by using a magnet 1b on the rotor of the motor, and three Hall elements 1c which detect the position of the magnet. The Hall elements are coupled via a feedback circuit 33 to a calculator circuit 34 which in turn is coupled to a computer. For example, the control circuit MMC-EC050 (Stork AB) which is coupled to a calculator circuit. The motor is, for example, EC032 (Stork AB).

The invention is not limited to the embodiment shown above by way of example, but can be modified within the scope of the attached patent claims and the inventive concept.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Surgical instrument including a tool for screwing in a surgical implant or for cutting a thread in bone tissue with a thread tap, a unit for supplying power and controlling the speed of an electric motor included in the tool, and detection and display members, wherein the detection members transmit signals, dependent on the torque and angle position(s) of the tool, to the display members which include a computer unit, for example a microprocessor, which, besides the display member, includes memory members, and wherein the display member is arranged to display a torque/torsional angle curve, which forms the basis for assessing the quality of the bone tissue.

2. Surgical instruments according to Patent Claim 1, characterized in that the unit for supplying power and controlling the speed is arranged to provide the electric motor with an essentially constant speed of rotation or a variable speed of rotation.

3. Surgical instrument according to Patent Claim 1 or 2, characterized in that the storage member is arranged to store one or more torque/torsional angle curves which can be related to different screwing-in and/or thread-cutting cases.

4. Surgical instrument according to Patent Claim 1, 2 or 3, characterized in that the detection member includes an amplifier and, connected-in downstream of this, an A/D converter which converts the signals of the detection member into corresponding data signals, and in that the said data signals are shown as a histogram on the display member's screen, where each column corresponds to a number of mean values of the torque dependent on the torsional angle position in order that rapid variations or ripples will not be seen.

5. Surgical instrument according to any of the preceding patent claims, characterized in that speed control and information on the position/rotational

position of the electric motor's rotor are carried out by magnet, Hall elements, calculator and the said computer.

6. Arrangement comprising a surgical instrument with electric motor and power and speed control for or on the motor, wherein detection members detect torque(s) effected by the tool relative to torsional angle position(s), wherein a display member or display members is/are arranged to display a torque/torsional angle curve which shows the torque variation as a function of the angle position, wherein the display member includes or is connected to one or more storage members, wherein the arrangement also includes an evaluation system for bone quality, statistics on bone qualities, etc., wherein said storage member/members is/are arranged to store one or more torque/torsional angle curves, and wherein the stored curves are arranged such that they can be transferred to the evaluation system.

7. Arrangement according to Patent Claim 6, characterized in that the storage member can be arranged with a card which can be loaded with data and into which card curve formation(s) for one or more patients can be fed, and in that after the data information has been loaded, the card can be removed for use in the evaluation system.

8. Surgical instrument substantially as herein described with reference to the accompanying drawings.

DATED this 20th day of August 2001

NOBEL BIOCARE AB

WATERMARK PATENT & TRADEMARK ATTORNEYS
290 BURWOOD ROAD
HAWTHORN VICTORIA 3122
AUSTRALIA

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Fig. 1

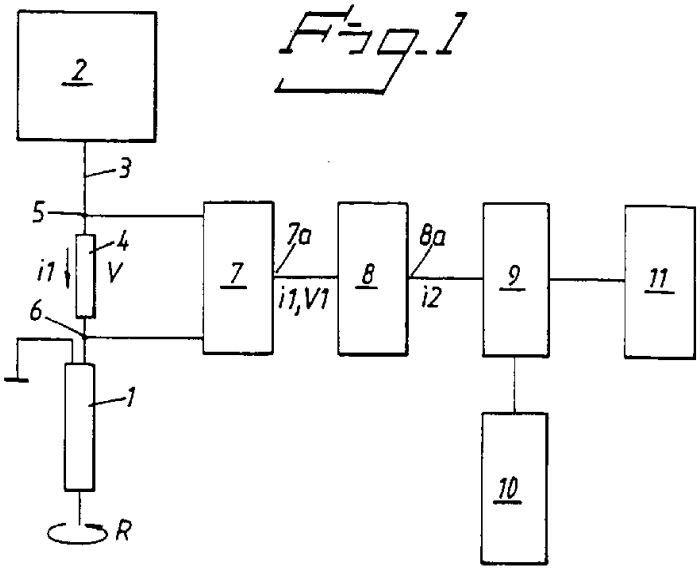

Fig. 2

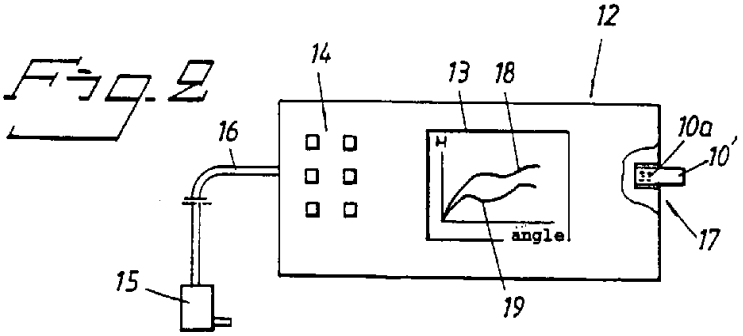

Fig. 3

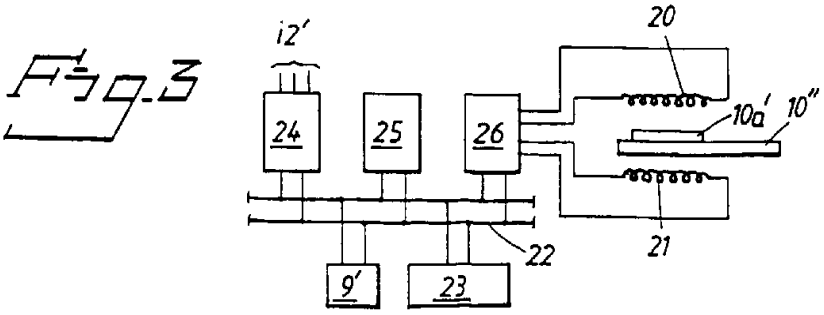

Fig. 4

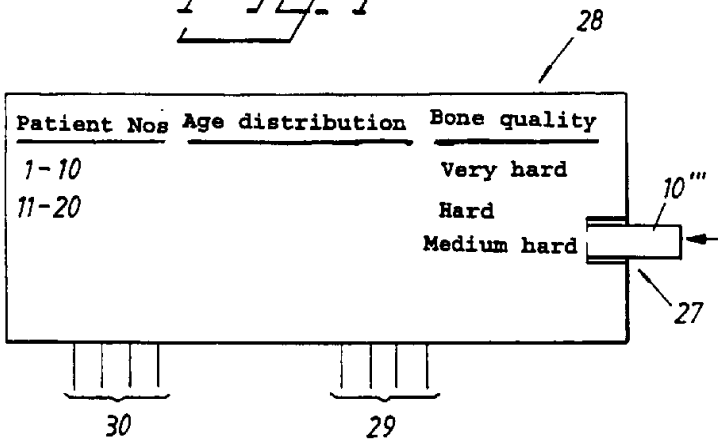

Fig. 5

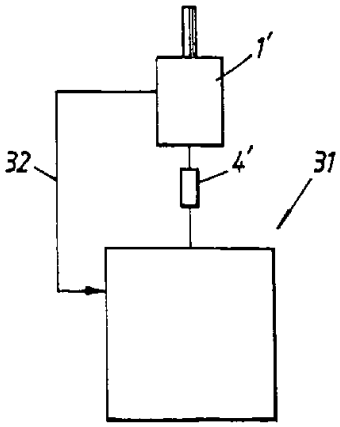

Fig. 5a