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(54) TOOL FOR SCREWING A THREADED BODY INTO A SKULL

(71) We, SIEMENS AKTIENGESELLSCHAFT, a German company, of Berlin and Munich, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

The invention relates to a tool, for screwing a threaded body or adapter into a skull.

In addition to cerebrospinal pressure measurement in the lateral ventricle via a catheter with an external pressure transducer, methods for cerebral pressure measurement have succeeded in which commercial miniature pressure transducers are implanted in the epidural skull cavity. In this method it is important that the pressure sensitive membrane of the pressure receptor rests on the 'dura mater' in coplanar manner. An adapter which is screwable into the patient's skull to hold and position the pressure transducer must be flush with the inside surface of the cranial bone and must be sealed off from the environment. Adapters of this type are screwed into a prepared bore in the skull by means of a tool. The tool generally takes the form of a box spanner which can be connected to the adapter by a transverse pin or a polygon profile at one end of the tool. Since the thickness of the cranium bone can vary, the required screw in depth of the adapter must generally be matched to the individual bone thickness. It is also desirable to control the screw-in depth, i.e. the distance of the lower adapter surface from the underside of the bone, during the screwing-in operation.

According to the present invention there is provided a tool, for screwing a threaded body or adapter into a skull, the tool comprising a hollow tube, one end of which is connectible, in use, to a threaded body or adapter and the other end of which is provided with a handle means so that a torque can be applied to the tube, an elongate measuring element which is disposed inside the tube so as to be free to move axially relative to the tube, an abutment member secured to or forming part of one end of the measuring element and having an external diameter greater than the internal diameter of the hollow tube and means enabling the relative axial displacement between the hollow tube and the elongate measuring element to be monitored.

Preferably the means enabling the relative axial displacement to be monitored comprises a surface surrounding an opening for the measuring element in the handle means or said other end of the tube, and the other end of the measuring element. The means can also include one or more openings in the tube and markings or projections on a portion of the measuring element which, in use, is visible through the or each opening. Preferably the means enabling the relative axial displacement to be monitored indicate, in use, the position in which the abutment member is flush with the one end of the adapter or threaded body.

Conveniently, the arrangement is such that, in use, the other end of the measuring element is flush with the opening in the handle means or the other end of the tube, when the abutment member is flush with the other end of the adapter or threaded body.

Advantageously, the one or more markings on the measuring element indicate various different axial displacements of the measuring element relative to the tube. The tube can also include markings for indicating various relative axial displacements between the tube and the measuring element.

Preferably the abutment member is a disc the diameter of which is the same as the outside diameter of the one end region of the tube.

In a preferred embodiment there is pro-

vided two openings in the tube and a pin passing through the measuring element for manipulation of the measuring element, the ends of the pin being located in said openings.

Advantageously, the axial length of the openings corresponds to the depth of the average adult human skull.

The transverse pin also serves to limit the axial displacement of the measuring element and, together with the openings, comprises means enabling the relative axial displacement of the tube and the measuring element to be monitored.

Conveniently the measuring element is a rod.

In the tool according to the invention, the tube with the axially displaceable measuring element forms a compact structural element the handling of which is particularly simple. Further measuring instruments, such as separate depth gauges and similar devices, are thereby made superfluous. The instrument according to the invention now makes exact screwing-in of the adapter into the cranial bone possible in a single operation. The adapter can be connected to the tool in a force locking manner and is screwed into a bore prepared in the skull which has a slightly smaller diameter than the adapter or threaded body which during the screwing-in operation cuts a thread in a self-tapping manner. The axially displaceable element is first displaced in an axial direction until the abutment surface of the abutment member lies plane on the 'dura mater'. The axially displaceable element does not alter its position relative to the skull during the screwing-in operation. The actual screw-in depth can be controlled from outside by viewing the relative axial displacement of the tube and the axially displaceable measuring element, and the adapter or threaded body can be positioned as desired.

For a better understanding of the present invention and to show more clearly how the same may be carried into effect reference will now be made, by way of example, to the accompanying drawings in which:

Figure 1 shows a longitudinal section through a tool according to the invention, which is shown connected to an adapter already screwed into a skull;

Figure 1a shows a view in the direction of the arrow 1a of Figure 1;

Figure 2 shows a longitudinal section of a tool according to the invention, the section being similar to that of Figure 1 except that the adapter is shown at the beginning of the screwing-in operation;

Figure 2a shows a view in the direction IIa of Figure 2; and

Figures 3, 4a and *4b* show different views of an adapter which may be inserted into a skull by a tool according to the invention which is claimed broadly and described in detail in corresponding British Patent Application No. 8643/78 Serial No. 1598378.

The same tool and adapter are represented in the Figures 1 and 2 in different stages of insertion and the details of each drawing are therefore given the same reference numerals. A cranial bone 1 of a patient has a preformed bore 2. On the underside of the cranial bone 1 there is the 'dura mater' on which during pressure measurement the pressure sensitive membrane of the pressure transducer must lie in a coplanar manner. On top of the cranial bone is the scalp 4 which can be closed over the adapter again after the pressure transducer has been inserted. Located in the bore 2 of the cranial bone 1 is the adapter or threaded body 5. A threaded body or adapter as described in British Patent Application No. 8643/78 Serial No. 1598378 is preferably used as the adapter 5, and it is not described in more detail here. Connected to the adapter 5 is a tool 6 acting as the screwing-in tool. The tool 6 includes a hollow tube 7 one end of which is connected to the adapter 5 and a hand or screw grip 8 attached to the other end of the tube 7. Two fixing pins 9 secure the lower end of the tube 7 to the adapter 5. The lower end of the hollow tube 7 is inserted in a form- and force-locking manner into the adapter 5 with the corresponding recesses for the pins 9 and is secured by a screw cap 10. Instead of the force-locking connection by means of pin and recesses, the lower end of the tube 7 could be provided with a polygonal profile which engages with a corresponding profile on the inside of the upper end of the adapter 5. Inside the hollow tube 7 there is an axially displaceable measuring element 11 which is formed as a rod. Attached to the lower end of the measuring element 11 is a flat disc 12 which forms an abutment member. The diameter of the disc 12 is the same as the diameter of the lower end region of the hollow tube 7 and corresponds to the inside diameter of the adapter 5. At an adequate distance from the lower end (preferably in the lower third) the hollow tube 7 has two openings 13 on opposite sides of the tube 7. These openings 13 are preferably round or oval in construction. Through the openings 13 the position of the axially displaceable measuring element 11 may be observed by the operator. At the same height as the openings 13 the axially displaceable measuring element 11 has a transverse pin 14 with a greater length than the diameter of the tube 7. The transverse pin 14 acts as a limitation for the axial displacement of the measuring element 11 and as a handle for manipulation of the measuring element 11 so that the measuring element 11 can be manipulated so as to bring the abutment member 12 up to

the 'dura mater'. The transverse pin 14 can also be used as a visual and marking indicator, which is shown in Figure 1*a*. With a round opening 13 and a round pin 14, the central disposition of the pin 14 in the round recess 13 marks the position of the adapter 5 when it is flush with the underside of the bone. If exact data about the bone thickness, screw-in depth etc., are to be given, it is useful to make the opening 13 oblong and to apply additional longitudinal marks to the opening 13 and/or axially displaceable measuring element 11. In the embodiment shown the measuring element 11 is of a length such that the end 16 of the measuring element 11 facing away from the abutment member seals flush with the edge of the hand grip 8 if the abutment surface of the disc 12 and the lower surface of the adapter are coplanar. For exact control the hand grip 8 has a window shoulder 15 in the area of the hollow tube 7. Alternatively the tube 7 could extend through the hand grip 8 and the window shoulder 15 could be provided by the tube 7.

Figure 1 shows the adapter 5 after it has been screwed into the bone 1. The underside of the adapter 5 and the edge of the cranial bone 1 are flush if the adapter has been inserted correctly. The tool 6 may then be removed and a pressure transducer inserted. The pressure transducer can then be secured with a similar screw cap. In Figure 2, on the other hand, the adapter 5 and the tool 6 are shown before the screwing-in operation is commenced. The adapter 5 connected to the tool 6 is inserted with its conical end into the prepared bore 2. The axially displaceable measuring element 11 is displaced downwards by means of the transverse pin 14 until the disc 12 lies with its lower surface on the 'dura mater'. The measuring element 11 is then displaced axially with with respect to the tube 7 by the depth *d*, which is also the displacement between the shoulder 15 and the end 16 of the measuring element 11. In this position the transverse pin 14 is similarly at a distance *d* from the centre of the opening 13, for example it may be at the outside end of the opening 13. The screw cap 10 for fixing the tool 6 in position is shown in Figure 2 in the disconnected state. After the screwing-in tool 6 has been connected to the adapter 5 by means of the screw cap 10, the screwing-in operation of the adapter 5 may begin. During the screwing-in operation the hollow tube 7 and the pin 11 are axially displaced relative to one another. After the adapter 5 has been screwed in by the distance *d* the window shoulder 15 and the end 16 of the pin are flush with one another.

Preferably the tool 6 with the adapter 5 is operated carefully and precisely over the last part of the screwing-in operation so as to ensure that the adapter 5 is positioned accurately. Once the adapter 5 is positioned flush with the inside surface of the bone 1, the transverse pin 14 is again central in the opening 13.

WHAT WE CLAIM IS:-

1. A tool, for screwing a threaded body or adapter into a skull, the tool comprising a hollow tube, one end of which is connectible, in use, to a threaded body or adapter and the other end of which is provided with a handle means so that a torque can be applied to the tube, an elongate measuring element which is disposed inside the tube so as to be free to move axially relative to the tube, an abutment member secured to or forming part of one end of the measuring element and having an external diameter greater than the internal diameter of the hollow tube and means enabling the relative axial displacement between the hollow tube and the elongate measuring element to be monitored.

2. A tool as claimed in claim 1, wherein said means enabling the relative axial displacement to be monitored comprises a surface surrounding an opening for the measuring element in the handle means or said other end of the tube, and the other end of the measuring element.

3. A tool as claimed in claim 1 or 2 wherein said means enabling the relative axial displacement to be monitored includes one or more openings in the tube and markings or projections on a portion of the measuring element which, in use, is visible through the or each opening.

4. A tool as claimed in claim 3 wherein the one or more markings on the measuring element indicate various different axial displacements of the measuring element relative to the tube.

5. A tool as claimed in claim 4, wherein the tube also includes markings for indicating various relative axial displacements, between the tube and the measuring element.

6. A tool as claimed in any one of claims 3, 4 and 5 wherein there are provided two openings on either side of the tube and the projections comprise a pin passing through the measuring element which enables the measuring element to be manipulated, the end of the pin being located in said openings.

7. A tool as claimed in claim 6, wherein the axial length of the openings corresponds to the depth of the average adult human skull.

8. A tool as claimed in any one of the preceding claims wherein the means enabling the relative axial displacement to be monitored indicate, in use, the position in which the abutment member is flush with the one end of the adapter or threaded

body.

9. A tool as claimed in claim 2, or claim 3, 4, 5, 6, 7, or 8, when appendant directly or indirectly to claim 2, wherein the arrangement is such that, in use, the other end of the measuring element is flush with the opening in the handle means or the other end of the tube, when the abutment member is flush with the one end of the adapter or threaded body.

10. A tool as claimed in any one of the preceding claims, wherein the abutment member is a disc the diameter of which is the same as the outside diameter of the one end region of the tube.

11. A tool as claimed in any one of the preceding claims, wherein the measuring element is a rod.

12. A tool substantially as hereinbefore described with reference to and as shown in Figures 1 and 2 of the accompanying drawings.

13. A combination of a tool as claimed in any one of the preceding claims and an adapter substantially as hereinbefore described with reference to and as shown in Figures 3 and 4 of the accompanying drawings, the adapter being connected to or connectible to the tool.

14. A combination of a tool as claimed in any one of the preceding claims and a threaded body as claimed in claim 1 of our co-pending Application No. 8643/78. Serial No. 1598378.

HASELTINE LAKE & CO.,
Chartered Patent Agents
28 Southampton Buildings,
Chancery Lane,
London WC2A 1AT.
- and -
Temple Gate House,
Temple Gate,
Bristol BS1 6PT.
- and -
9 Park Square,
Leeds LS1 2LH,
Yorks

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1598379 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

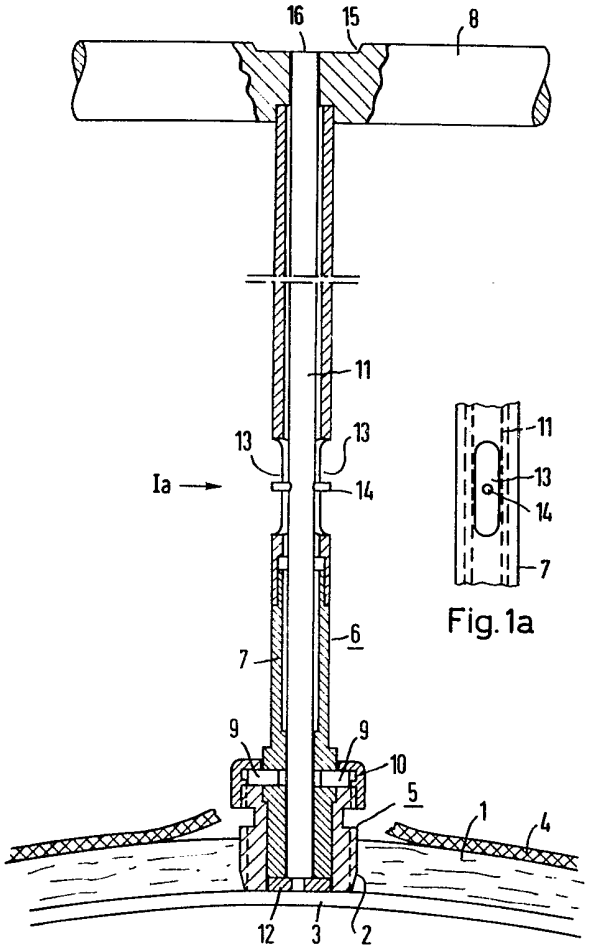

Fig. 1

Fig. 1a

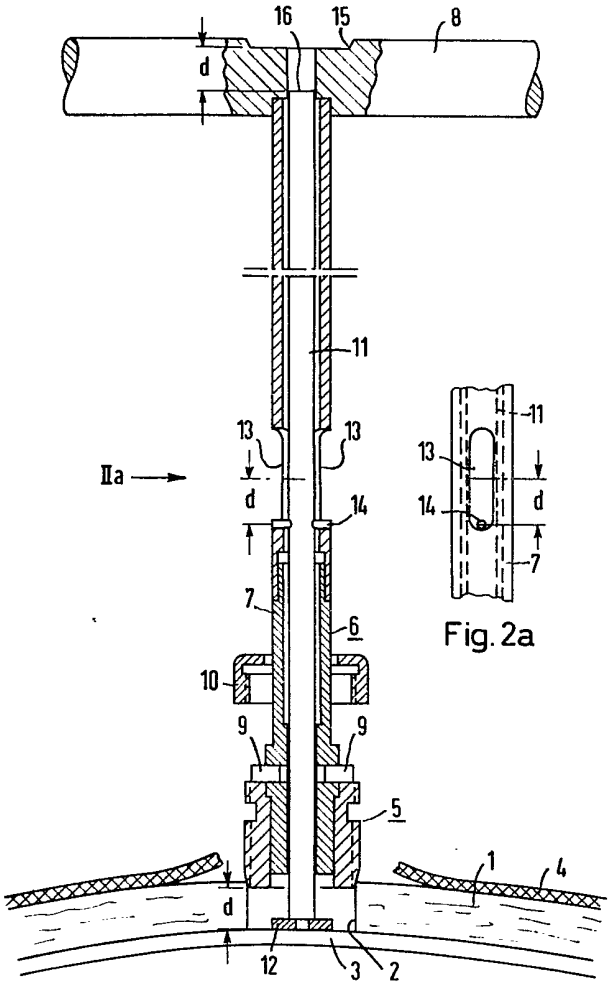

Fig. 2

Fig. 2a

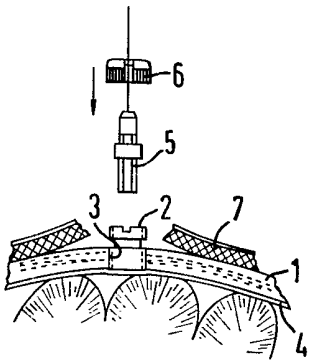

FIG. 3

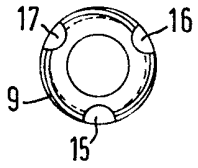

FIG. 4a

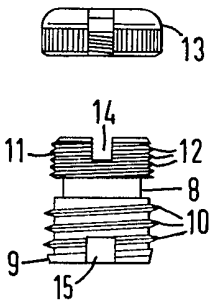

FIG. 4b