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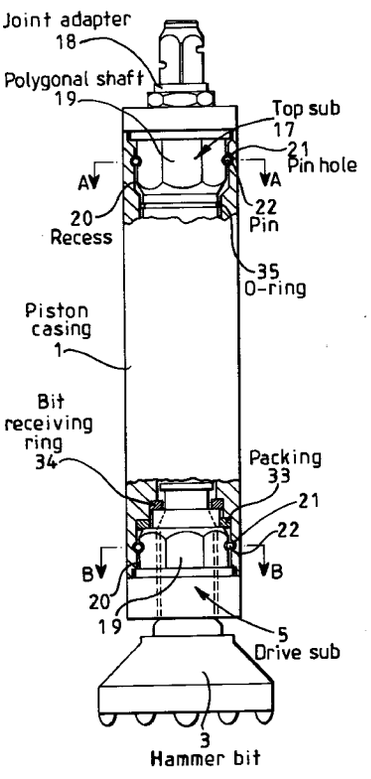
(54) DOWN-THE-HOLE HAMMER

(57) A down-the-hole hammer in which a top sub connected to a joint adapter is connected to the upper end of a piston-containing piston case and a driver thumb in which a hammer bit is housed movably to and fro is connected to the lower end of the piston case, characterized in that there is no possibility that the connected members are loosened even when they are turned forward or reversely, the connecting and disconnecting of parts can be done simply without using any special jig and tool during part replacement. A joint adapter (18) and a top sub (17) are formed to one body. The coupling of the piston case (1) and the top sub (]7) together and the coupling of the piston case (1) and the drive sub (5) together are done by engaging the joint portions of the top sub (17) and drive sub (5) formed into polygonal shafts (19) or spline shafts with the joint portions of the piston case (1) formed into recesses (20) into which these polygonal shafts (19) or spline shafts are fitted. Pins(22), which serve as keys, are removably inserted into pin holes formed in boundary parts between tbese engaged joint portions so that the pin holes(21) extend over both of the joint portions.

FIG 1



EP 0 851 090 A1

Description

Background of the Invention

1. Field of the Invention

The present invention relates to a down-the-hole hammer for excavating a pile hole for a foundation work in the building or civil-engineering field.

2. Description of the Related Art

The down-the-hole hammer which moves a hammer up and down in association with the motion of a piston, as well-known, in order to carry out excavation through hitting, has a construction shown in Figs. 15 and 16 in which reference numeral 1 denotes a piston casing incorporating a piston 2, 3 denotes a hammer bit, a drive sub 5 in which the upper end part of the hammer bit 3 is extendably received, being coupled with the lower end part of the piston casing 1 through the intermediary of a thread structure.

The middle part of the above-mentioned hammer bit 3 is formed into a spline shaft which is fitted in a drive sub 5 having an inner peripheral wall in which concave and convex engaging grooves are formed. In the figures, reference numeral 6, 7, 8 and 9 denote a foot valve, O-ring, a bit retainer ring and a piston retainer ring, respectively.

In the upper part of the piston 2, there are arranged a rigid valve 11 fitted at its outer periphery with an O-ring 10 and holding at its center a choke 14, a make-up ring 12, a valve guide 13, a valve spring 15 and a check valve 16, and a top sub 17 serving as a valve seat for the check valve 16 is screwed in the upper part of the casing 1.

Further, the top sub 17 is formed at its center with a thread hole in which a truncated conical shape thread part formed in the lower part of a joint adapter 18 for coupling to an auger shaft is screwed.

That is, the joint adapter 18 and the top sub 17, the top sub 17 and the piston casing 1, and the piston casing 1 and the drive sub 5 are joined by means of threads.

The down-the-hole hammer is connected to the front end part of an auger shaft such as a screw shaft, serving as an excavator, through the intermediary of the above-mentioned joint adapter 18, and excavates the ground while it is rotated together with the auger shaft.

This rotation is made mainly in the clockwise direction for excavation, and an earth pressure is applied to the peripheral surface of the excavator in a weak stratum of the ground. Accordingly, the outer periphery of the down-the-hole hammer would possibly be caught. In such a case, the rotation is made not only in the clockwise direction but also in the counterclockwise direction so as to repeat the clockwise and counterclockwise directions in order to overcome the friction at the outer periphery of the hammer.

Should the above-mentioned counterclockwise rotation be taken, the parts joined through the above-mentioned threads would be loosened so as to come off from one another.

Further, should excavation under the counterclockwise rotation be continued for a long time due to a long time use, the threads would be inadvertently tightly fastened. As a result, the replacement of the hammer bit 3 to be replaced with another cannot be made in a job-site without no special tool. Thus, special exclusive removing and attaching jigs (hydraulic chuck and the like) are required therefor, that is, the replacement in the job site cannot be made, the hammer has to be brought into its maker's firm in order to replace them.

One object of the present invention is to provide a down-the-hole hammer which can eliminate the above-mentioned disadvantages inherent to the prior art, so as to eliminate such a risk that the coupling between components are loosened even though the normal and reverse rotations are made, and in which components are simply connected with one another or disconnected from each other without using special jigs even during replacement of the components.

Summary of the Invention

To the end, according to the present invention, there is provided a down-the-hole hammer in which a piston casing incorporating a piston is connected thereto at its upper end with a top sub coupled to a joint adapter, and at its lower end with a drive sub extendably receiving therein a hammer bit, characterized in that the joint adapter and the top sub coupled to the former are formed as one unit body, the coupling between the piston casing and the top sub, and the coupling between the piston casing the drive sub is made such that the connection on the top sub or drive sub side is formed into a polygonal shaft or a spline shaft, and the connection on the piston casing side is formed into a recess in which the polygonal shaft or the spline shaft is fitted so as to fit them each other, and a pin hole is formed in the boundary zone of the fitting, bridging therebetween, and a pin serving as a key is removably inserted in the pin hole.

Second, the pin hole is formed horizontally, third, stop rings are arranged in front and rear of the inserted pin in order to prevent the pin from coming off or the front end of a bolt is pressed against the side part of the inserted pin in order to prevent the pin from coming off, and fourth, four in total of pin holes are formed in two groups each consisting of two upper and lower pin holes arranged in parallel with each other so that the locking is made by four pins inserted in these pin holes.

According to the invention stated in claim 1, the joint adapter and the top sub coupled to the former are integrally formed, and accordingly, they are never loosened from each other since it is not the case of thread

engagement therebetween as in the conventional case. Further, the connection between the piston casing and the top sub and connection between the piston casing and the drive sub are made such that the polygonal shaft or the spline shaft is fitted in the complementary recess, the locking is made by a pin hole formed in the boundary zone of the fitting and bridging therebetween and a pin serving as a key, and accordingly, they are never loosened since it is not the case of thread connection as in the conventional case.

Further, in the case of replacement of components, when the pin is removed from the pin hole, the polygonal shaft or the spline shaft fitted in the recess, can be directly pulled out therefrom, thereby the replacement can be made simply and rapidly in a job side without using special jigs.

According to the invention stated in claim 2, in addiction to the above-mentioned technical effects and advantages, since the pin hole is horizontally formed and the pin serving as a key is horizontally inserted, the length of the pin can be effectively used for surely and firmly locking the components together in a horizontal direction.

According to the invention stated in claim 3, the coming-off of the pin can be simply prevented by the stop rings, and according to the invention stated in claim 4, the coming-off of the pin can be simply prevented by pressing the front end of the bolt against the side part of the inserted pin.

According to the invention stated in claim 5, four, in total, of the pin arranged up and down and accordingly, the locking can be surely and firmly made.

Brief Description of the Drawings

Fig. 1 is a partly cut-off front view illustrating an embodiment of a down-the-hole hammer according to the present invention;

Fig. 2 is a sectional view along line A-A in Fig. 1;

Fig. 3 is a sectional view along line B-B in Fig. 1;

Fig. 4 is a cross-sectioned plan view illustrating another example of the coupling between a top sub and a piston casing;

Fig. 5 is a cross-sectioned plan view illustrating another example of the coupling between the top sub and the piston casing;

Fig. 6 is a transverse sectioned view illustrating such a case that a hammer cover is provided;

Fig. 7 is a sectional view along line C-C in Fig. 6:

Fig. 8 is a plan view illustrating a pin used in the first embodiment;

Fig. 9 is a plan view illustrating a stop ring used in the first embodiment;

Fig. 10 is a plan view illustrating a pin used in a second embodiment;

Fig. 11 is a cross-sectioned plan view illustrating an essential part used in the second embodiment;

Fig. 12 is a plan view illustrating a pin used in a third embodiment;

Fig. 13 is a cross-sectioned plan view illustrating essential part shown in the third embodiment;

Fig. 14 is a transverse sectioned side view illustrating an essential part shown in a fourth embodiment;

Fig. 15 is a transverse sectional side view illustrating a conventional down-the-hole hammer; and

Fig. 16 is an exploded perspective view illustrating the conventional down-the-hole hammer.

Detailed Description of the Preferred Embodiments

Detailed explanation will be hereinbelow made of embodiments of the invention with reference to the drawings. Fig. 1 is a partly broken front view illustrating an embodiment of a down-the-hole hammer according to the present invention, Fig. 2 is a sectional view along line A-A in Fig. 1, and Fig. 3 is a sectional view illustrating line B-B as mentioned above. In these figures, like reference numerals are used to denote like parts shown in Figs. 15 and 16 which show the conventional example.

In the down-the-hole hammer according to the present invention, as is similar to the conventional example, a top sub 17 coupled to a joint adapter 18 is connected to the upper end of a piston casing 1 incorporating a piston, and a drive sub 5 in which a hammer bit 3 is extendably received is connected to the lower end of the piston casing 1.

At first, the connection part (joint) of the top sub 17 is formed into a polygonal shaft 19 (a hexagonal shaft in this example as shown in the figures), and the connection part of the piston casing 1 is formed into a polygonal recess 20 in which the polygonal shaft 19 is fitted, and which is complementary with the latter. In the figure, reference numeral 35 denotes an O-ring serving as a seal laid under the polygonal shaft 19 of the above-mentioned top sub 17.

Further, the boundary zones of the fitting between the polygonal shaft 19 and the recess 20 are formed therein with two horizontal grooves having a semi-circular shape, which are mated with each other so as to define circular pin holes 21 bridging between the top sub 17 and the piston casing 1 in a horizontal direction.

This pin holes are opened externally, and pins 22 serving as keys are removably inserted in the pin holes 21 through the openings of the latter.

Grooves are formed in the peripheral direction of the pin holes at positions in front and rear of the inserted pins 22, and stop rings having outer peripheral edge parts fitted in the grooves are arranged so as to prevent the pins 22 from coming off. Referring to Figs. 8 and 9 which show the pin 22 and the stop ring 23, the pin 22 has no heads at its opposite ends, the stop rings 23 has a partly cut-off shape and is a doughnut ring which can be pressed so as to reduce its diameter.

The connection part (join) in the upper part of the top sub 5 is also formed into a polygonal shaft 19 (a

hexagonal shaft in this example as shown) , the connection part on the stop ring 23 side is formed into a recess 20 in which the polygonal shaft 19 is fitted, and which is complementary with the latter. Further, circular pin holes 21 similar to the pin holesas mentioned above are horizontally formed in the boundary zones of the fitting of the both components, and pins 22 serving as keys are removably inserted in the pin hole 21. Further, stop rings 23 for preventing the pins 22 from coming off are arranged at positions in front and rear of the inserted pins 22. Reference numeral 33 in the figures denotes a packing, and 34 denotes a bit receiving ring composed of two half-split members which are assembled together so as to form a ring shape.

The connection between the drive sub 5 and the hammer bit 3 is similar to that of the conventional one, the center part of the hammer bit 3 is formed into a spline shaft which is fitted in a recess 24 formed in the drive sub 5 and having the inner peripheral wall in which concave and convex engaging grooves are formed.

Thus, the connection between the top sub 17 and the piston casing 1 and the connection between the piston casing 1 and the drive sub 5 hold its integrity against either counterclockwise or clockwise rotation due to the fitting between the polygonal shaft 19 and the complementary polygonal recess 20, and further, they can be prevented from being disengaged from each other by means of the pins 22 serving as keys.

Further, when the disconnection between them is made in order to replace a component, the stop rings 23 are removed so that the pin 22 can be removed, and accordingly, the polygonal shafts 19 of the top sub 17 and the drive sub 5 are pulled from the piston casing 1 after the pins 22 are pulled off, the disconnection can be simply made.

It is noted that the connection part (joint) of the top sub 17 and the drive sub 5 is formed into a spline shaft 25 as shown in Figs. 4 and 5, instead of the polygonal shape, and spline grooves are formed in the recess 26 on the piston casing 1 side so that the spline shaft can be fitted thereinto.

Further, in a second embodiment of the present invention, the pin 22 has a head 22a, as shown in Figs. 10 and 11, for preventing coming-off of the pin 22, and a recess 22b having a flat contact surface is formed in the side part of the intermediate part of the pin. Further, a stop bolt 27 is inserted from the outside so that the front end of the bolt 27 is pressed against the recess 22b.

In second embodiment of the present invention, a pin 22 having a head 22a to which spring steel 32 is provided and having a type which has been use in general in an earth auger or the like is used.

Further, although a set of left and right parallel pin holes 21 is used in the above-mentioned embodiments, in a fourth embodiment, upper and lower groups each composed of left and right parallel pin holes 21 are formed up and down, and accordingly, four, in total, of the pin holes are provided so that the upper pin holes are orthogonal to the lower pin holes. Further, four, in total, of pins 22 are inserted into the pin holes 21 so as to effect the locking.

With this arrangement in which several pins are used for the locking, the locking can be made to be more surely and firmly.

Referring to Fig. 6 which shows a case such that the down-the-hole hammer is covered with a hammer cover 28 which is adapted to be replaced with another in accordance with an excavating diameter, and in the upper part of which a casing 29 or a screw shaft 31 in one configuration of an auger shaft is located. Vertical ridges 30 are formed on the hammer cover 28 at suitable intervals so as to ensure vertical grooves defining gaps through which air can flow, at the outer periphery of the hammer cover 28 on rotation.

It is noted that the excavator may have such a type that a rod itself is slid while the rod is chucked at its outer periphery by a drive shaft, in addition to an earth auger type in which a drive device is moved up and down along a leader mast. Accordingly, it is possible to provide such a method that the connection to the upper part of the down-the-hole hammer is made by using an auger shaft formed into a polygonal rod, instead of the above-mentioned upper casing 29 or the screw shaft 31, as a clutch adapted to be rotated.

Industrial Availability

As mentioned above, the down-the-hole hammer according to the present invention, can prevent occurrence of such a risk that the connection between components are loosened, even though it is normally and reversely rotated, and can simply connect and disconnect components to and from each other without using special jigs in the case of replacement of a component.

Claims

1. A down-the-hole hammer in which a piston casing incorporating a piston is connected thereto at its upper end with a top sub coupled to a joint adapter, and at its the other end with a drive sub extendably incorporating a hammer bit, characterized in that the joint adapter and the top sub are formed as a one unit body, the connection between the piston casing and the sop sub, and the connection between the piston casing and the drive sub are made such that the connection part on the drive sub side or the tope sub side is formed into a polygonal shaft or a spline shaft, the connection part on the piston casing side is formed into a recess fitted therein with the polygonal shaft or the spline shaft so that they are fitted together, and a pin hole is formed in the boundary part of the fitting, bridging therebetween, and a pin serving as a key is removably inserted in the pin hole.

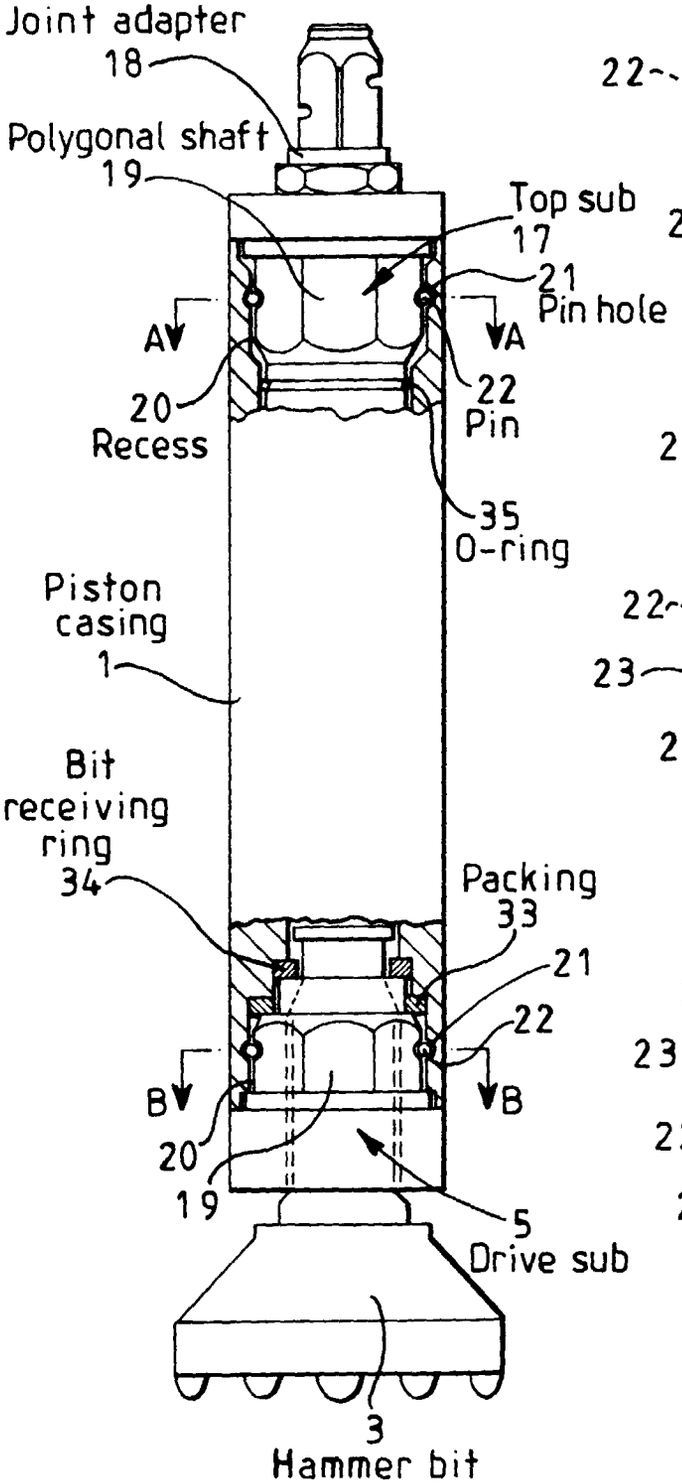
2. A down-the-hole hammer as set forth in claim 1, wherein the pin hole is horizontally formed.

3. A down-the-hole hammer as set forth in claim 1 or 2, wherein stop rings for preventing the pin from coming off are provided in front and rear of the inserted pin.

4. A down-the-hole hammer as set forth in claim 1 or 2, wherein the front end of a stop bolt for preventing the pin from coming off, is pressed against a side part of the inserted pin.

5. A down-the-hole hammer as set forth in any one of claims 1 to 4 wherein four , in total, of pin holes are formed in two groups each composed of two upper and lower pin holes laid in parallel with each other, and the locking is made by four, in total, of pins inserted in the pin holes.

FIG 1



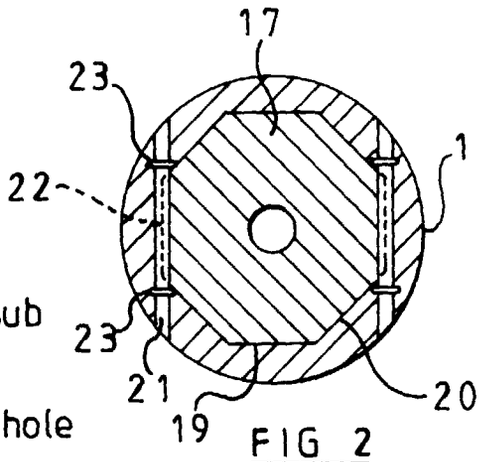


FIG 2

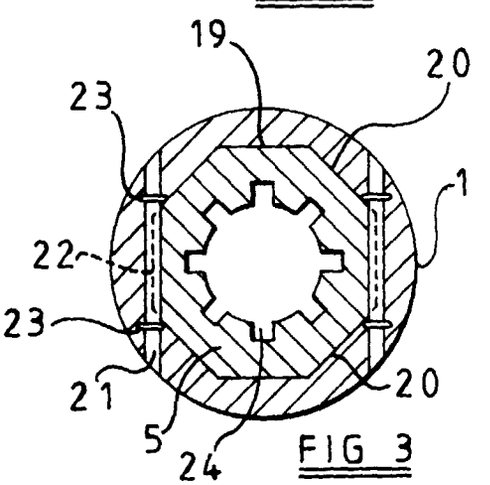


FIG 3

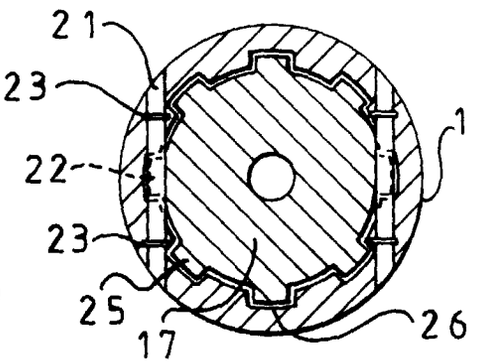


FIG 4

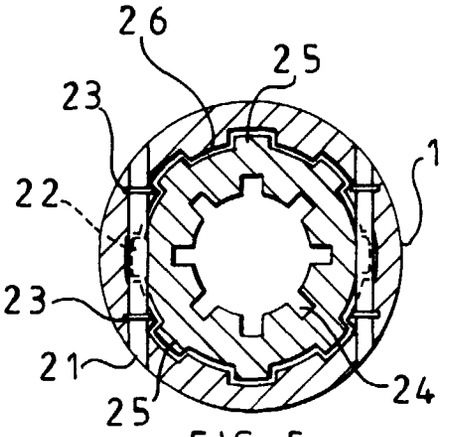


FIG 5

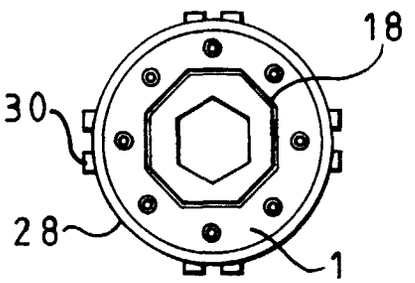


FIG 7

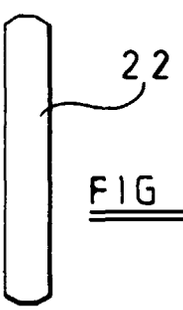


FIG 8

FIG 9

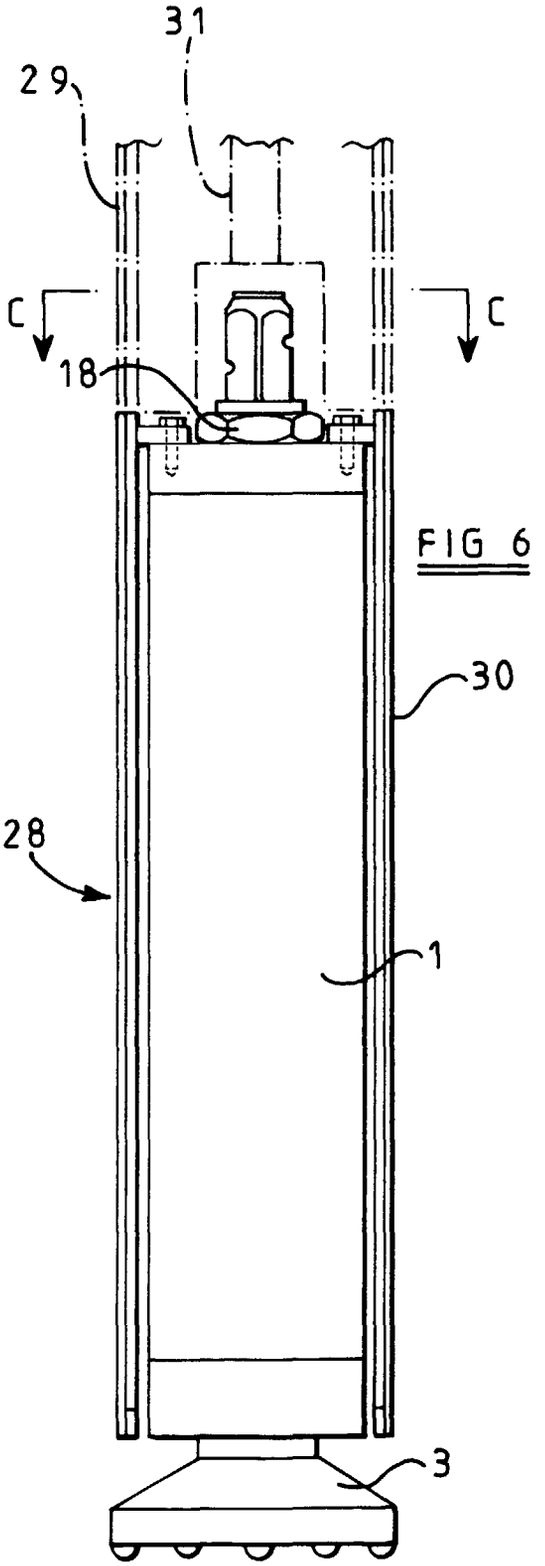


FIG 6

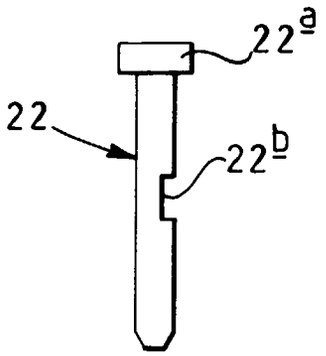


FIG 10

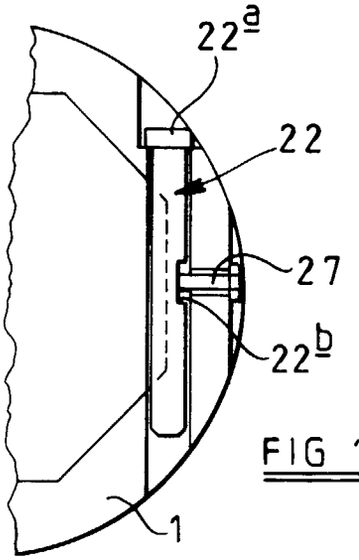


FIG 11

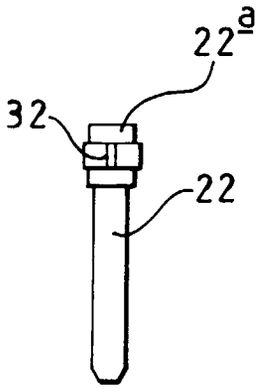


FIG 12

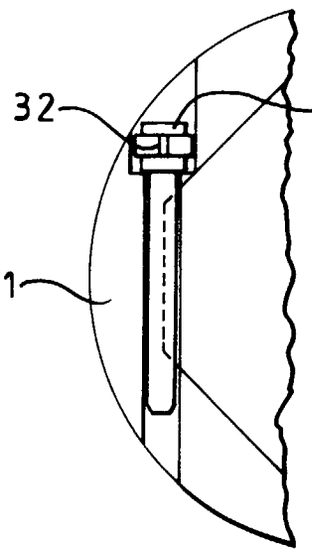


FIG 13

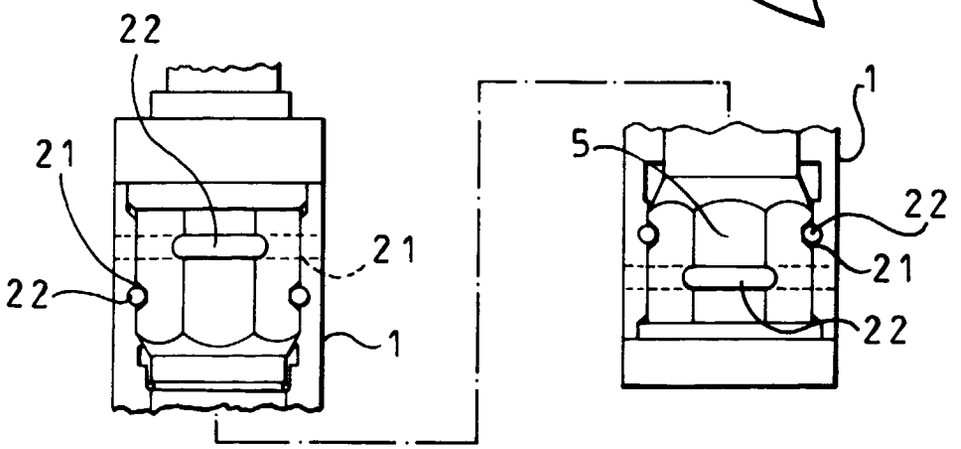


FIG 14

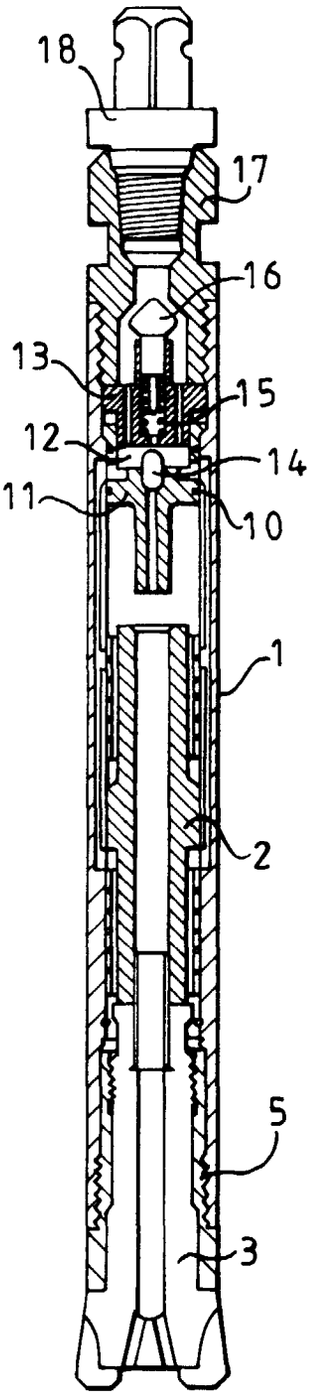


FIG 15

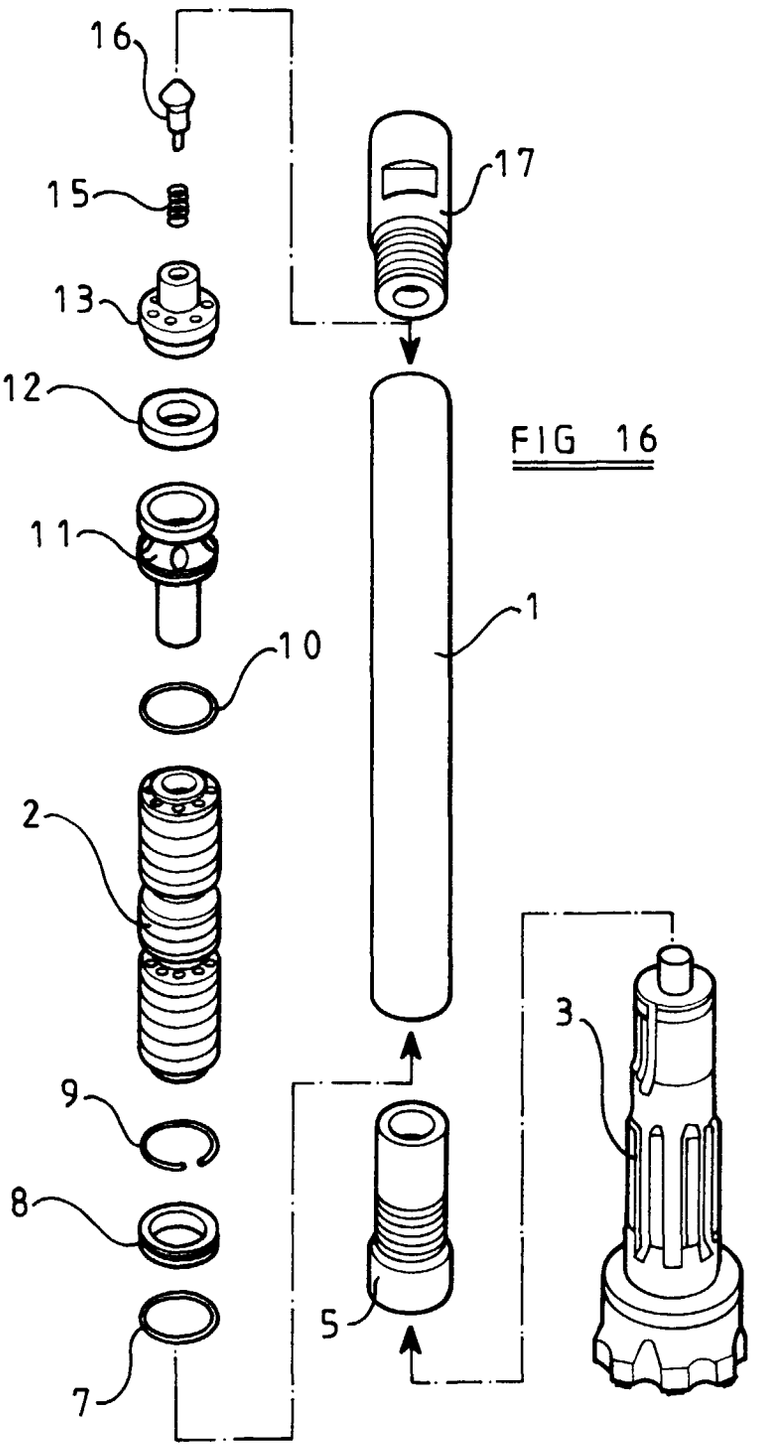


FIG 16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP97/02089

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl^6 E21B4/06

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)
Int. Cl^6 E21B4/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926 - 1997
Kokai Jitsuyo Shinan Koho 1971 - 1997

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 7-42145, A (Shin-ei Tekku K.K.), February 10, 1995 (10. 02. 95), Fig. 16 (Family: none)	1 - 3
A	JP, 53-29701, U (K.K. Tone Boringu), March 14, 1978 (14. 03. 78), Figs. 1, 2 (Family: none)	4
A	JP, 8-13974, A (K.K. Kencho Kobe), January 16, 1996 (16. 01. 96), Figs. 2, 5 (Family: none)	5

☐ 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
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"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
September 3, 1997 (03. 09. 97)	September 24, 1997 (24. 09. 97)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)