

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: 81304896.4

(51) Int. Cl.³: **E 21 B 4/16**
E 21 D 1/06

(22) Date of filing: 20.10.81

(30) Priority: 23.10.80 GB 8034241

(43) Date of publication of application:
05.05.82 Bulletin 82/18

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

(71) Applicant: **CEMENTATION RESEARCH LIMITED**
981 Mitcham Road
Croydon Surrey CR9 3AP(GB)

(72) Inventor: **Winder, Richard Bryan**
Cobbins Halfacre Hill
Chalfont St.Peter Buckinghamshire(GB)

(72) Inventor: **Miller, Roy Bruce**
25 Loudham Road
Little Chalfont Amersham Buckinghamshire(GB)

(72) Inventor: **Salter, Martin De Gaudrion**
7005 North Stardust Circle
Tucson Arizona 85704(US)

(74) Representative: **Abrams, Michael John et al,**
HASELTINE LAKE & CO. Hazlitt House 28 Southampton
Buildings Chancery Lane
London WC2A 1AT(GB)

(54) **Boring tools.**

(57) Apparatus for boring holes in the ground is provided, the apparatus comprising two cutting heads (1.1, 1.14) arranged coaxially and separated by an elongate tubular member (1.4). The first cutting head (1.14) is carried by the elongate tubular member itself, and acts as a pilot boring head. The second cutting head (1.1) is annular and serves to form the bore proper. The apparatus also includes means (1.7) carried externally by the elongate tubular member for collecting debris produced in the course of a boring operation, or for deflecting debris away from the first (i.e. lower) cutting head. In one development, the elongate tubular member is cut away in part so that the interior of the tubular member is exposed to part of the earth surface within the pilot bore.

The debris collecting means can be in the form of a collar located about the elongate tubular member, or it may be in the form of a helical ledge or scroll (1.7) which carries debris along when the first cutting head is rotated.

Embodiments of the apparatus provide a large degree of working space within the elongate tubular member (1.4) which allows the provision of other functional units, such as debris removal means, pumping means, and grouting means, as well as allowing adequate space for inspection of the earth surfaces which are being worked.

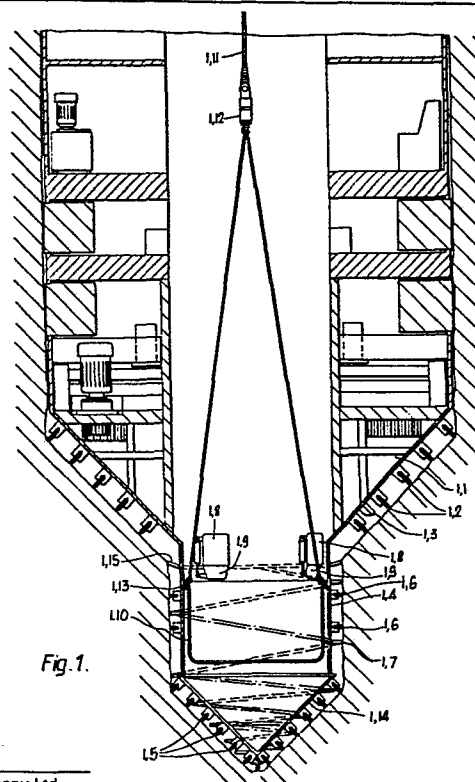


Fig. 1.

- 1 -

BORING TOOLS

This invention relates to apparatus for making holes in the ground particularly but not exclusively for mining purposes. The apparatus of the invention is particularly valuable in circumstances where it is not possible to
5 provide prior access in the form of, for example, a smaller diameter hole (known as a pilot hole) drilled on the same line before the main hole in order to connect with existing underground workings for the purpose of disposing of debris generated by the main boring operation.
10 Such a prior drilling is sometimes referred to as a pilot hole.

Drilling without such prior access is commonly referred to as "blind boring" and poses difficult problems in removing debris generated in the process, particularly
15 in the case of large-diameter holes such as those which are to be used as mineshafts. In the absence of a pilot hole unexpected ground conditions such as unstable, discontinuous, or water-logged strata may be encountered, demanding special treatment, such as grouting or high-

- 2 -

capacity pumping, and therefore requiring access for special treatment equipment to the ground beneath the main boring machine.

Existing methods for blind hole boring are frequently
5 based upon conventional drilling practice using fluids to flush debris from the boring tools and bring it to the surface, such fluids completely filling the hole. Reverse-circulation drilling using a mud-flush is one such practice, the mud also being used to support the walls of
10 the hole until such time as lining or casing can be installed. In large-diameter borings the quantities of mud required may be very large and expensive and mud may be lost into cavities or conduits in the ground. The use of drilling fluids in this way also precludes the presence
15 of men in the excavation so that the operation has to be carried out under remote control from the surface to the detriment of flexibility and the capacity to deal with unexpected or difficult ground conditions. The exclusion of men also precludes the application of conventional
20 shaft-lining methods following closely behind the borer which are normally employed to secure the excavation as soon as possible in the interests of safety and of ground control.

Existing methods for blind bole boring without the use
25 of drilling fluids include boring tools incorporating mechanical means for removing debris from the cut face immediately beneath the boring head, such as chain conveyors adapted to scrape debris from the face to lift it

- 3 -

through a small height and to deliver it to a main conveying system, which may be in the form of hoisted buckets or a pneumatic elevator, for removal to the surface.

Such mechanical means are not easily accommodated in the
5 confines of a boring tool structure, tending to compete with the space required for the cutting devices and their supporting structures; and they are difficult to control and to power, being located in a rotating head. They are also vulnerable to damage from the large forces employed
10 to propel and rotate the boring head particularly in the event of debris accumulating or jamming in the bottom of the excavation. One such apparatus is described in U.S. Patent 3,379,264 to Cox. This prior apparatus has a rotary cutting frame carrying dish-like cutter wheels
15 whose peripheries are wedge-shaped. These cutter wheels project forwardly from the frame in a manner such that they move in concentric circles about the axis of rotation and they are arranged helically so that cutter wheels in adjacent concentric circles are spaced in a regular
20 angular progression. These cutter wheels act to remove debris which is then allowed to fall downwardly into a previously formed pilot hole. The debris is then removed from the pilot hole by an elevator bucket arrangement (as shown in Figure 1) or by a pneumatic conveyor (as shown
25 in Figures 2 to 6 thereof). In the arrangements shown in Figures 2 and 5, cutters 70 or 122 are provided at the tip of the apparatus ahead of the main cutters 65 or 124. These serve to form a vertical rim D which in effect

- 4 -

constitutes a shallow pilot bore. In this arrangement, the cutters 70 or 122 act as a downward continuation of the main cutters as is clear from the drawings and thus there is no real axial separation between the main cutters and the pilot
5 cutters.

A further development by Cox is described in U.S. Patent 4,186,808. Here the pilot cutters such as 70 and 122 in Figures 2 and 5, respectively of U.S. Patent 3,379,264 are replaced by crushing rollers. A barrier is also provided
10 to prevent oversize debris reaching the pneumatic extraction system which terminates adjacent the crushing rollers.

While the apparatus described above may be used in the blind boring technique, it suffers serious disadvantages when so used because the provision of pilot cutters or
15 crushers close to the main cutting head greatly restricts the working space within the apparatus and may eliminate it altogether. The debris extraction system in these apparatus exacerbates this difficulty since it is located within the working area of the main cutters.

20 Other existing methods depend upon the drilling of a smaller-diameter blind hole prior to the introduction of the main machine, on a line corresponding approximately with the intended centreline of the main excavation, into which debris may be dropped during the main boring. In
25 the case of mineshafts in particular, it is not normally possible to drill the blind pilot hole with a directional accuracy equal to or better than that required of the shaft except at considerable expense. Discrepancies may then develop during the main boring in the relative loca-

tion of the pilot and main bores causing considerable difficulty in the employment of the pilot hole for its intended purpose of debris removal. If, as is sometimes the case, the pilot hole is used to guide the main borer, 5 the accuracy of the main borer is unlikely to be better than the accuracy of the pilot bore unless means are provided for adjusting the one bore relative to the other. Such means tend to be complicated and difficult to accommodate in the confines and environmental conditions 10 of a main boring head.

One apparatus of the above general type is described in U.K. Patent Application 2028897A by Paurat and Paurat. Their apparatus comprises a main cutting appliance incorporating at least one milling roller and a pilot boring 15 head attached to a screw conveyor for debris removal. Debris formed by the main cutting head travels to the shallow pilot bore from which it is removed by the screw conveyor. The provision of milling rollers greatly complicates the mechanical arrangements within the 20 apparatus and again limits the available space.

An object of the present invention is to provide apparatus for the sinking of shafts which does not require the preliminary sinking of a separate pilot bore and which is relatively simple to control and to power.

25 Another object of the invention is to provide such apparatus in which there is internal space available which permits the introduction of auxiliary equipment such as grouting equipment into the interior of the

apparatus.

According to one aspect of the present invention, there is provided apparatus for boring holes in the ground, which comprises a first cutting head carried by an elongate
5 tubular member; a second, annular cutting head located co-axially with the first cutting head; and means, externally carried by said elongate tubular member, for collecting debris produced in the course of a hole boring operation.
10 The debris collecting means can be in the form of one or more collars located about the elongate tubular member which, when the apparatus is in use, co-operate with the side walls of the bore which is being formed so as to collect debris which then enters a port provided in the
15 wall of the elongate tubular member at the level of the collar or which falls to the bottom of the pilot hole for collection there. With an arrangement of this type, the collar can have a conical upper section which acts to comminute debris as it falls downwardly into the progressively tighter nip formed by co-operation of the
20 conical section of the collar and the sidewall of the bore.

Alternatively, the debris collecting means can be in the form of an external guideway, e.g. a helical ledge (which can be termed a scroll), provided on the surface
25 of the elongate tubular member. Here, the tubular member is preferably hollow. Thus according to a second aspect of the present invention, there is provided apparatus for boring holes in the ground, which comprises a first

cutting head mounted on an elongate hollow tubular member;
a second, annular cutting head located co-axially with the
first cutting head; and means for conveying debris along
the external surface of said elongate hollow tubular mem-
5 ber to a port or window communicating with the interior
of said elongate hollow tubular member.

Preferably the means for conveying debris is in the
form of a helical ledge secured to the external surface of
the elongate hollow tubular member.

10 In use, the first cutting head acts as a pilot boring
tool for the main cutting head (i.e. the second, annular
cutting head in the above terminology).

According to a third aspect of the present invention,
there is provided apparatus for boring holes in the ground,
15 which comprises a first cutting head mounted on an
elongate hollow tubular member and serving to form a
pilot hole; a second, annular cutting head located or
locatable co-axially with the first cutting head and
spaced axially therefrom and serving to form the hole
20 proper; and means for removing debris which comprises
(i) a helical ledge formed on the outside of at least a
part of the elongate hollow tubular member, and (ii) a
window formed in the body of said elongate hollow tubular
member adjacent the upper end of said helical ledge.

25

The helical ledge can continue downwardly from the
elongate hollow tubular member so as to girdle the surface
of the first cutting head.

- 8 -

Preferably the debris removal means also serves to collect debris from the second, annular cutting head. This can be achieved by provision of a barrier adjacent the window providing access to the interior of the hollow tubular member whereby debris falls onto the barrier and from there passes through said window. The barrier can be dispensed with if the helical ledge is able to cope with the volume of debris produced by both cutting heads: in such a case, debris from the main cutting head (i.e. the second, annular cutting head) falls down until it reaches the helical ledge, which then conveys the debris up toward the window.

The elongate hollow tubular member is preferably a closed body except for the provision of a window (or several windows) for debris removal. This enables the interior thereof to act as a working space which is flexible as to its usage. Conveniently the working space can be adapted to receive a bucket for debris entering the space via the window, although other debris removal arrangements (e.g. a pneumatic system) may be provided if required.

The length of the elongate hollow tubular member may be fixed or variable. Preferably its axial length (or its minimum axial length) is greater than its radius. In a variable-length arrangement, extension of the tubular member may be achieved by securing together a succession of similar cylindrical sections.

The two heads can be formed integrally or they can be

- 9 -

separable the one from the other. In some embodiments of the invention, the two heads are mutually reciprocable along their mutual axis; this allows the axial separation of the two cutting heads to be varied to give the optimum results for a given working condition. The spacing of the cutting heads, and the hollow interior of the first cutting head, make it possible to create space for accommodating, as required, debris removal means, pumping means, grouting means, inspection means, or any other means required for assisting the progress of a boring operation. Such means are preferably accommodated within the interior of the hollow body on the forward end of which the first cutting head is mounted. The first cutting head preferably is constructed so that it can be used to cut transversely of the main axis of the apparatus, thus making it possible to perform a sideways cutting action together with the main (second) cutting head in the course of a boring operation, e.g. for adjusting the line of the bore.

20 In a development of the invention described above, we have found that the elongate tubular member can be modified so as to be cut away over its entire length; this leaves the interior of the tubular member exposed to a substantial portion of the cut or bored earth surface within the pilot bore. The first cutting head can likewise be cut away over a corresponding area. With this development, the leading edge of the cut-away tubular member (and the leading edge of the first cutting head if this is

- 10 -

Similarly cut away) is provided with a debris deflecting device, e.g. a plough blade or a scraper blade or a toothed (serrated) blade, the purpose of which is to prevent debris reaching the area where the first cutting head is actively cutting away material during the formation of the pilot bore. The blade or blades thus sweep up or collect debris and the accumulated debris is thereby pushed into the interior space within the cut-away tubular member. A suitably shaped debris collecting bucket may be provided within this space, and such a bucket preferably has a port in the sidewall thereof through which debris can pass. Such a bucket will generally be dimensioned so as to be a close fit within the tubular member.

15 Accordingly, in a fourth aspect, the present invention provides apparatus for boring holes in the ground, which comprises a first cutting head mounted on an elongate hollow tubular member which is cut away in part; a second, annular cutting head located co-axially with the first cutting head; and means for collecting or deflecting debris away from the first cutting head, said means being in the form of one or more blades or scrapers carried by the cut-away tubular member and optionally by the first cutting head itself. The invention likewise provides a combination of the apparatus just defined and a debris collecting bucket adapted to fit into the interior of the cut-away tubular member and having a port in a side-wall thereof for admitting debris.

- 11 -

In those embodiments of the invention where the two cutting heads are separable, it may be convenient from time to time to remove the first cutting head and then either to use the tool in this form (e.g. to facilitate
5 repair or maintenance of an existing hole) or to incorporate into the tool another functional unit which may be, for example, for the purpose of debris removal, grouting, pumping, inspection or instrumentation. Accordingly, the invention provides, in a fifth aspect, a tool for boring
10 holes in the ground, which comprises an annular cutting head secured to or forming part of an annular body, the central aperture of which is elongate and is adapted to receive a further functional unit. The further functional unit will be selected according to the use to which the
15 tool is to be put, e.g. boring and grouting or boring and continuous monitoring of the progress of the bore.

For convenience, the first cutting head will hereinafter be referred to as the pilot head or pilot tool, while the second, annular cutting head will be referred
20 to as the main cutting head.

By way of example, the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a view of a large diameter boring apparatus
25 in accordance with the invention and accommodating internal means for the removal of debris, external cutting tools (in this example of the rolling disc type) for cutting the pilot bore, and external helical scrolls (i.e. ledges)

for lifting the debris produced by the action of the said cutting tools;

Figure 2 is a diagrammatic view of a large diameter boring tool incorporating a detachable pilot boring tool
5 otherwise generally similar to that illustrated in Figure 1;

Figures 3a and 3b together form a diagrammatic view of a detachable pilot tool provided with a rotary drive independent of the drive to the main boring head, and means
10 for removing the tool to the surface together with any debris it may contain;

Figures 4a and 4b taken together illustrate a pilot tool equipped with internal fluid means for transporting debris either to the surface or to an intermediate
15 loading station;

Figures 5a, 5b and 5c taken together illustrate a pilot tool equipped with conventional fluid means for transporting debris;

Figure 6 illustrates a further embodiment of a large
20 diameter boring tool equipped with an integral pilot boring tool; and

Figure 7 illustrates a debris removal bucket adapted to operate within the boring tool of Figure 6.

Referring now to Figure 1, the shaft sinking apparatus
25 comprises a main large-diameter boring head 1.1 and a pilot head integrally formed of an elongate hollow tubular member 1.4 and a cutting head 1.14. The main head 1.1 is equipped with cutting tools 1.2 and is of a

a generally frusto-conical form with a semi-vertical angle (i.e. the angle between the axis of the cone and the wall of the cone measured in a plane containing the axis) chosen to allow debris produced by the cutting tools 1.2 to move under the influence of gravity towards the centre of the bore, propelled if necessary by suitably orientated plough blades 1.3 or similar means. The central portion of the main head 1.1 is extended in the boring direction by the tubular member 1.4. The head 1.14 carries cutters 1.5 for boring in the axial direction, while side-cutters 1.6 to facilitate transverse, i.e. sideways, movement when required for adjusting the line of bore are carried on the external wall of the elongate hollow tubular member 1.4. A debris collecting device in the form of a helical ledge or scroll 1.7 is likewise provided on the external wall of the member 1.4. The scroll serves to lift debris from the pilot bore upwardly towards the main bore whence it may fall, or be propelled, through windows 1.8 into the hollow interior of the pilot tool 1.4. Debris from the main cutters 1.2 also passes through the windows 1.8 after falling downwardly to a collecting ledge 1.15. Retractable chutes 1.9 are provided in order to minimise spillage of debris, to direct it as required, and to close the windows 1.8 when it is desirable to halt the movement of debris.

Inside the hollow tube 1.4 of the pilot boring tool there is accommodated a hoist bucket 1.10 to receive debris from the chutes 1.9 and to transport it as required

either to the surface or to another debris transporting system. The bucket 1.10 is raised or lowered by a hoist rope 1.11 which is winched either by shaft winding equipment or by a winch carried in the body of the boring machine. A swivel coupling 1.12 in the rope permits the bucket 1.10 to rotate during boring without applying torsion to the main upper part of the rope 1.11. The body of the boring machine is provided with a hollow central core to allow passage of the bucket 1.10.

10 Sealing means 1.13 are provided inside the pilot boring tool 1.4 to engage with appropriate external surfaces of the bucket 1.10 in order to minimise spillage of material entering the bucket 1.10.

15 To facilitate description of the various embodiments of the invention, detailed descriptions and explanations will be omitted in relation to Figures 2 to 7 except where there are differences in construction or mode of operation compared to the embodiment shown in Figure 1.

20 Referring now to Figure 2, the apparatus comprises a main large-diameter boring head 2.1 substantially as described above with reference to Figure 1 and which is provided with a central axial opening extending upwardly the full height of the main boring machine. The cylindrical walls 2.2 of the said opening form part of, and rotate with, the main boring head 2.1.

25 Into the axial opening there is inserted a hollow pilot boring tool 2.3, equipped with an external scroll or scrolls 2.4 and windows 2.5 substantially as described

- 15 -

above with reference to Figure 1. In addition the upper part of the body of the pilot boring tool is provided with a heavy collar 2.6 adapted to fit slideably in the central opening of the main boring machine in order to
5 hold the pilot tool concentric and in axial alignment with the main boring head. Retractable power-operated latches 2.7 attached to the main boring head are adapted to engage with recesses in the collar 2.6 so as to cause the pilot boring tool to rotate with the main boring tool.

10 When the pilot boring tool has been filled by debris entering via the windows 2.5 (or at any other time) the latches 2.7 may be disengaged and the pilot boring tool lifted by hoist rope 2.8 for emptying or for replacement by another tool, or to permit access for other equipment
15 to the pilot bore.

A further embodiment of the invention is shown in Figures 3a and 3b. In this embodiment, a removable pilot boring tool 3.1 substantially as hereinbefore described is guided concentrically within a main boring tool 3.2
20 also substantially as already described, but in this embodiment the pilot boring head is adapted to be independently powered, rotated, and advanced or retracted. It is accordingly linked via a kelly bar 3.3 with a rotary-power unit 3.4 and with a cross-head 3.5 attached
25 to rams 3.6. The kelly bar 3.3 is slideably linked with the rotary power unit 3.4 via keys of a rectangular cross-section in a rectangular hole arrangement so that it may receive rotary drive whilst remaining free to move up or

- 16 -

down under the impetus of the rams 3.6. Furthermore the upper end of the kelly bar 3.3 is attached via a swivel coupling 3.7 to a hoist rope 3.8 activated by a winch 3.9. Between the swivel 3.7 and the winch 3.9 the hoist rope
5 passes over a sheave or pulley located in the hole or shaft being bored at a height sufficient to allow the complete assembly comprising the pilot boring tool 3.1, the kelly bar 3.3, the rotating drive 3.4, the cross-head 3.5 and the rams 3.6 to be hoisted through the centre of the
10 main boring machine in order to facilitate access to it for maintenance purposes, or to leave the pilot bore clear for the installation of pumping, inspection, drilling, grouting or other equipment. The same hoisting arrangement may also be employed during boring to lift the
15 pilot boring tool 3.1 to a height at which it may be removed from the kelly bar 3.3 and transferred to a container 3.10 for hoisting to the surface where its content of drilling debris is discharged or where it may be maintained, repaired, or replaced. Meanwhile a second pilot
20 boring tool 3.11 may be moved in from a second container 3.12 located in the upper cavity area of the main boring tool 3.2 and attached to the kelly bar 3.3 so that boring may continue during the absence of the first boring tool. In this way substantially continuous boring may be sus-
25 tained by the alternating use of two pilot boring tools. During boring the rotary drive 3.4 and the rams 3.6 are securely locked in position to enable them to provide the torques and forces required for boring, and are unlocked

only during the hoisting operation described above.

During boring the direction of the pilot boring tool 3.1 coaxial with the main boring head 3.2 is maintained by a piston 3.13 which is a close slideable fit against the wall
5 3.14 of the central aperture of the main boring machine and is attached to the kelly bar 3.3 for which it provides guidance for the pilot boring tool 3.1.

In an alternative arrangement of this embodiment of the invention the kelly bar 3.3, the rotating drive 3.4,
10 the cross-head 3.5 and the rams 3.6 are all omitted and the swivel 3.7 is attached directly to the piston 3.13 which is in turn temporarily locked to the wall 3.14. The piston and the attached pilot boring tool 3.1 are then obliged to rotate and to advance with the main boring
15 head 3.2 thus constituting a simpler although less flexible boring arrangement than that described in the preceding paragraphs. When the pilot boring tool 3.1 is full of debris it is removed to a container for transport to the surface and replaced by a second pilot boring tool in the
20 manner already described.

This embodiment of the invention thus provides for the removal and replacement of pilot boring tools that are either driven and advanced independently of the main boring head or are driven and advanced by the main boring
25 head.

In another embodiment of the invention illustrated by Figure 4, a pilot boring tool 4.1 substantially as described above in relation to Figure 1, is rotated and advanced

- 18 -

independently of the main boring head and is provided with one or more apertures 4.2 through which debris generated by it and by the main boring head may pass to a fluid-transport hoisting system of conventional design. The
5 trailing edge of the aperture 4.2 may be provided with a blade 4.3 adapted to urge debris into the aperture. The sides and floor of the aperture may be horizontal or vertical or inclined or curved according to the nature of the debris to be handled, and the aperture may
10 converge to an opening 4.4 giving access to a rotating or reciprocating fluid valving or locking arrangement of conventional design adapted to admit debris to a fluid transport duct 4.5. Alternatively, the opening 4.4 may give access to a transport duct in which the fluid
15 pressure is less than that outside the duct, as in a vacuum conveying system, so that valving may not be necessary. Water in the bottom of the bore may be transferred to the fluid transport system in substantially the same way as described in connection with the transfer of
20 debris.

After entering the transport duct 4.5 the debris (or water) is entrained in the flow of transport fluid and is conveyed by it either to the surface for discharge or to some intermediate point in the bore for transfer to
25 another hoisting system. The duct 4.5 is provided as required with slideably extensible or rotary couplings such as 4.6 provided to accommodate movement of the pilot boring tool 4.1 relative to the main fixed length 4.7 of

- 19 -

the said duct. Similar accommodation may be provided for a downcoming duct 4.8 supplying transport fluid to the system.

In order to facilitate removal of the pilot boring tool 4.1 from the main boring head for maintenance purposes, or in order to gain access to the pilot bore, the assembly comprising the ducting 4.5 and 4.8 and the components of the fluid valving or locking equipment may be detached and lifted from the pilot boring tool.

10 In another embodiment of the invention as illustrated by Figure 5, a pilot boring tool 5.1 similar to a conventional drill is rotated and advanced independently of a main boring tool 5.2 by means of an elongate hollow tubular member or drill tube 5.3 suspended from a yoke 15 5.4 supported by lifting cylinders 5.5. The drill tube 5.3 is rotated by a power unit 5.6 via conventional sliding key means (not shown). In a variation of this embodiment of the invention, the tube 5.3 is rotated by a power unit carried upon the yoke 5.4.

20 The drill tube 5.3 is joined as shown at 5.7 to enable its length to be modified to suit particularly ground conditions or to facilitate its removal from the hole. In most applications the tube 5.3 will incorporate a second concentric tube 5.8, the annular space between 25 tubes 5.3 and 5.8 being employed to carry fluid under pressure downwards into the hole to be used in order to generate a movement of fluid up the inner tube 5.8, the said fluid being drawn from the bore created by the pilot

- 20 -

boring tool 5.1 past the cutters of the said tool in order to entrain and remove debris from the vicinity of the tool. Such a system is commonly used in drilling and is generally referred to as a reverse-circulation system.

5 In general (but not exclusively) the fluid filling the bore is water, sometimes mixed with mud or other materials in order to enhance its debris-carrying capacity, and the pressure fluid employed to urge it up the inner tube 5.8 may conventionally be air or water. In some cases
10 the fluid in the pilot bore may be air.

In the vicinity of the yoke 5.4 a tube 5.9 is attached via a swivel 5.10 to the head of the inner tube 5.8 in order to receive the ascending fluid and to direct it to a hoistable container 5.11. The container 5.11 may incor-
15 porate screening means adapted to retain solids while permitting liquid to escape from the container and return down the hole to the pilot bore via appropriate ducting. Alternatively the screening means may be inserted between the tube 5.9 and the container 5.11 in order to separate
20 solids and liquid, before the former enter the container.

The tube 5.9 may, when the container 5.11 is full, be diverted to a second container 5.12 thus leaving the first container free to be hoisted to the surface and emptied without significant interruption of the drilling
25 process.

It is anticipated that the main boring head 5.2 may be partially immersed in a liquid used to fill and clear the pilot bore. If air alone is used in the pilot bore

- 21 -

then the main boring head will also obviously be immersed in it. Liquid used in the pilot bore is replenished by liquid returning from the entry to the hoisting system already described and maintained at a level in the bore chosen to optimise drill progress.

Debris from the main boring head 5.2 falls, as already described in relation to other embodiments of the invention, towards (and in this case into) the pilot bore. Stabilising or reaming tools of a conventional form are attached to the drill tube 5.3 at locations 5.13 and 5.14 in order to guide it during drilling but, in accordance with this embodiment of the invention, they are adapted by the addition of collars 5.15 to restrict the passage of debris from the main boring head until it has been reduced to a particle size compatible with the debris transporting system already described. The collars thus constitute the debris collecting means attached to the tubular part 5.8. The reduction in size is effected by grinding the debris in the tapering annulus between the rotating collars 5.15 and the static wall of the pilot bore, such grinding action being facilitated by appropriate shaping of the generally conical surfaces of the collars 5.15 and the provision of ribs or protrusions as required on the said surfaces. Obstructions may be inserted in the gap between the collars 5.15 and the walls of the pilot bore in order to regulate the downward movement of debris to a rate consistent with the capacity of the fluid transport system. The said regulatory means

may be adjustable so that the optimum rate of flow of debris might be varied for different kinds of debris. For example, dense debris might require a lower rate of feed and might have to be reduced to a smaller size in order to avoid the risk of blockage in the tube 5.8 or in the passage leading thereto.

The whole assembly of pilot boring tool, its tubing and its driving and guiding means is removable from the pilot bore in order to permit access for the ground treatment and other purposes as described hereinbefore.

In another embodiment of the invention illustrated by Figure 6, a pilot boring tool 6.1 is rigidly attached to a main boring tool 6.2. The main boring tool 6.2 is substantially as heretofore described, but the pilot boring tool 6.1 is no longer in the form of a complete cylinder, being cut away over a substantial portion of its circumference and a corresponding portion of its base 6.5, so as to leave its interior exposed to a substantial portion of the cut or bored surface of the pilot hole. Its remaining base area is provided with cutting tools 6.3 sufficient in number and form to enable it to bore at the same rate as the main boring tool.

The leading edge of the base of the pilot boring tool 6.1 is provided with a plough blade or scraping blade or toothed blade 6.4 so angled and orientated as to prevent, so far as possible, debris in the pilot bore from entering the space between the pilot boring tool base 6.5 and the base 6.6 of the pilot hole. The blade 6.4

- 23 -

thus serves to keep the pilot cutting tools 6.3 as free as possible from previously cut debris.

Another blade 6.7 is attached to the leading edge of the rest of the pilot boring tool 6.1 in order, in similar
5 fashion, to exclude debris from the annular gap 6.8 between the part-cylindrical surface 6.9 of the pilot boring tool 6.1 and the walls 6.10 of the pilot hole.

Other blades such as blade 6.11 may be attached to the main boring tool 6.2 in order to deflect debris
10 descending from the main boring cutters 6.12 away from the said annular gap 6.8.

Debris from the main cutters 6.12 and the pilot cutters 6.3 accumulated in the pilot bore may be removed by mechanical grabs (not illustrated), or by fluid
15 transport means substantially as heretofore described, or by bucket means substantially as heretofore described.

In a preferred form of this embodiment of the invention, there is used a debris removal bucket 7.1 illustrated in Figure 7 having a shape adapted to fit
20 closely within the pilot boring tool 6.1 and provided with one or more apertures 7.2 in its base for the purpose of admitting debris from the lower portion of the pilot bore. Debris descending from the main bore is permitted to flow into the bucket 7.1 over its top
25 edge 7.3, the height of the bucket being chosen so as not to obstruct such flow.

The apertures 7.2 are provided with hinged covers 7.4 so that they may be closed in order to prevent spillage when

the bucket 7.1 is hoisted to discharge its debris either on the surface or at some transfer point in or above the boring machine. Closure of the hinged covers 7.4 may be effected by mechanical, electrical, or hydraulic means.

5 When open, the covers 7.4 may serve as scrapers directing debris into the apertures 7.2 thus permitting the bucket 7.1 to work its way into an existing heap of debris as it is lowered. In this respect the bucket 7.1 may function as a temporary boring tool of a type in common use for

10 boring holes in weak ground.

To ensure that the bucket 7.1 adopts a proper rotational position in relation to the pilot boring tool 6.1 as it enters the tool and is rotated as it receives debris, latches, which may or may not be retractable, are provided

15 on the bucket 7.1 to engage projections or edges or recesses in the pilot boring tool 6.1 so as to receive appropriate locational, rotational and thrusting forces from it. In the particular example illustrated by Figure 7, the latch 7.5 is intended to engage beneath the

20 inclined leading edge 6.13 of the pilot boring tool 6.1 in order to receive rotational and downward thrusting forces. The latch 7.5 may be retracted in order to release the bucket 7.1 prior to hoisting.

Claims:

1. Apparatus for boring holes in the ground, which comprises a first cutting head(1.14; 2.3; 4.1; 5.1; 6.5) carried by an elongate tubular member (1.4; 3.1; 5.8; 6.1); a second, annular cutting head (1.1; 2.1; 3.2; 5.2; 6.2) located coaxially with the first cutting head; and means (1.7; 2.4; 5.13, 5.15; 6.7, 6.4), carried externally by said elongate tubular member, for collecting debris produced in the course of a hole boring operation.

2. Apparatus as claimed in claim 1, wherein the debris collecting means comprises one or more collars (5.13) located about the elongate tubular member (5.8) which, when the apparatus is in use, co-operate(s) with the side walls of the bore which is being formed so as to collect debris.

3. Apparatus as claimed in claim 2, wherein the collar, or at least one of the collars, has a conical upper section (5.15) which acts to comminute debris as the debris falls downwardly into the progressively tighter nip formed by co-operation of the conical section (5.15) and the side wall of the bore.

4. Apparatus as claimed in claim 1, 2 or 3, wherein at least one port (1.8; 2.5; 4.2) is provided in the wall of the elongate tubular member for admission of debris into the interior of the elongate tubular member.

5. Apparatus for boring holes in the ground, which comprises a first cutting head (1.14; 2.3; 4.1; 6.5) mounted on an elongate hollow tubular member (1.4; 3.1; 6.1); a second, annular cutting head 1.1; 2.1; 3.2; 6.2) located coaxially with the first cutting head; and means (1.7; 2.4; 6.7) for conveying debris along the external surface of said elongate hollow tubular member to a port or window (1.8; 2.5; 4.2; 6.13) communicating with the interior of said elongate hollow tubular member (1.4; 3.2; 6.1).

6. Apparatus as claimed in claim 5, wherein the means for conveying debris is in the form of an external

guideway (1.7; 2.4) provided on the surface of the elongate hollow tubular member.

7. Apparatus as claimed in claim 6, wherein said external guideway is in the form of at least one helical ledge (1.7; 2.4).

8. Apparatus for boring holes in the ground, which comprises a first cutting head (1.14; 2.3; 4.1) mounted on an elongate hollow tubular member (1.4; 3.1) and serving to form a pilot hole; a second, annular cutting head (1.1; 2.1; 3.2) located or locatable coaxially with the first cutting head and spaced axially therefrom and serving to form the hole proper; and means for removing debris which comprises (1) a helical ledge (1.7; 2.4) formed on the outside of at least a part of the elongate hollow tubular member, and (2) a window (1.8; 2.5; 4.2) formed in the body of said elongate hollow tubular member adjacent the upper end of said helical ledge.

9. Apparatus as claimed in claim 5, 6, 7 or 8, which also includes a barrier (1.15) adjacent the window whereby debris falling onto the barrier is able to pass through said window (1.8) into the interior of the elongate hollow tubular member (1.4).

10. Apparatus as claimed in claim 7 or 8, wherein the helical ledge (1.7) continues downwardly from the elongate hollow tubular member (1.4) so as to girdle the surface of the first cutting head (1.14).

11. Apparatus as claimed in any preceding claim, which further includes means (1.10; 4.5, 4.8; 5.3; 7.1) for removing debris from the interior of the elongate tubular member.

12. Apparatus as claimed in claim 11, wherein the interior of the elongate hollow tubular member contains, or is adapted to receive, a bucket (1.10; 7.1) for debris entering the elongate tubular member via a port or window.

13. Apparatus as claimed in claim 11, wherein a fluid, pneumatic or vacuum transfer system (4.5, 4.8; 5.3) is provided for conveying debris from the interior of the

- 27 -

elongate tubular member.

14. Apparatus as claimed in any preceding claim, wherein the length of the elongate tubular member is variable.

15. Apparatus as claimed in claim 14, wherein the elongate tubular member can be increased in axial length by securing together a succession of similar cylindrical sections (5.7).

16. Apparatus as claimed in any preceding claim, wherein the axial or minimum axial length of the elongate tubular member is greater than the radius thereof.

17. Apparatus as claimed in any preceding claim, wherein the first cutting head (2.3; 3.1; 4.1; 5.1) and the second, annular cutting head (2.1; 3.2; 5.2) are separable from one another.

18. Apparatus as claimed in claim 1, 5 or 8, wherein the first cutting head (1.14; 6.5), the elongate tubular member (1.4; 6.1) and the second, annular cutting head (1.1; 6.2) are formed integrally.

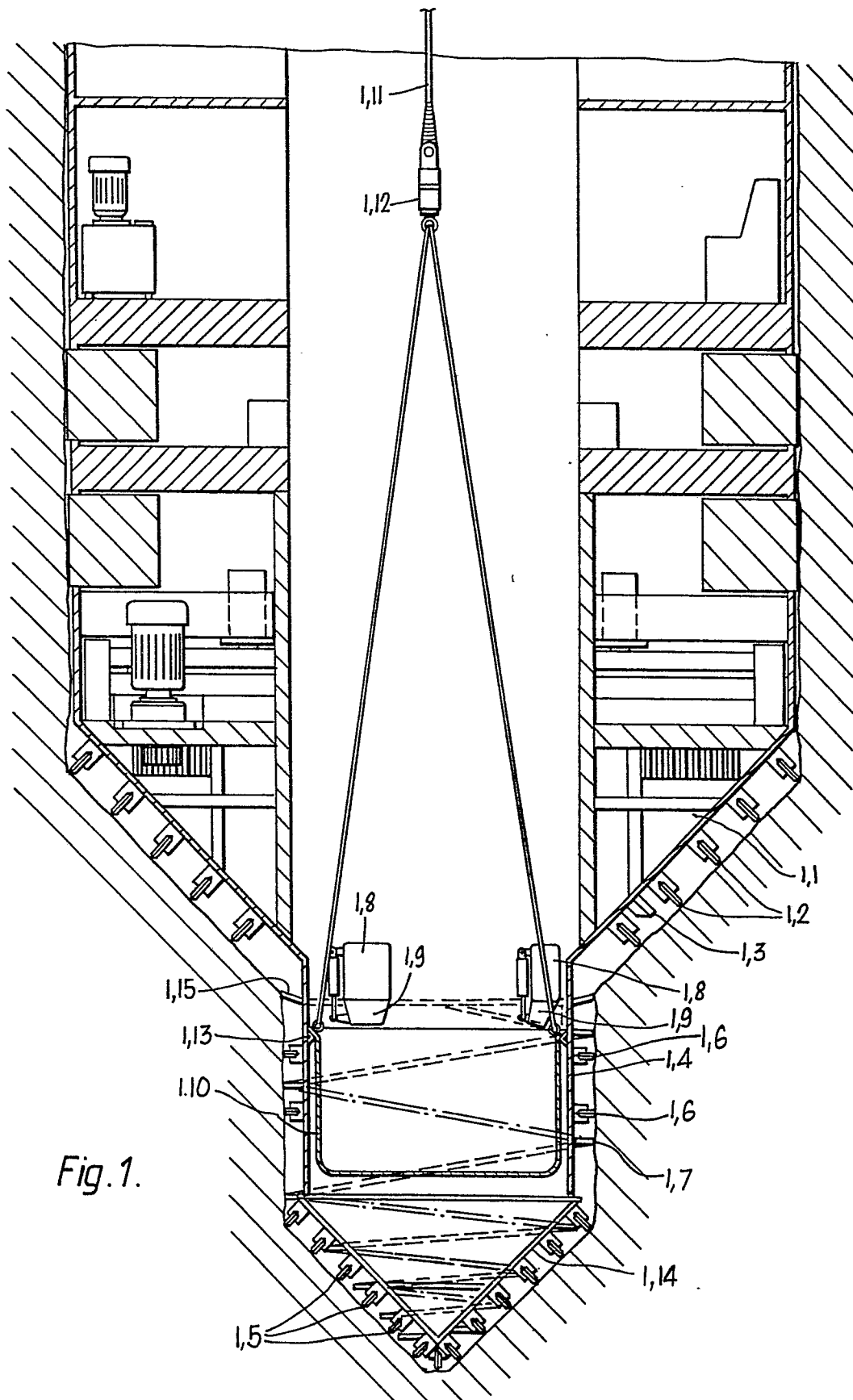
19. Apparatus as claimed in claim 17, wherein the two cutting heads (2.3, 2.2; 3.1, 3.2) are mutually reciprocable along their mutual axis.

20. Apparatus for boring holes in the ground, which comprises a first cutting head (6.5) mounted on an elongate hollow tubular member (6.1) which is cut away (6.13) in part; a second, annular cutting head (6.2) located coaxially with the first cutting head (6.5); and means (6.7, 6.4) for collecting debris or for deflecting debris away from the first cutting head, said means being in the form of one or more blades or scrapers (6.7) carried by the cut-away tubular member (6.1) and optionally (6.4) by the first cutting head itself.

21. Apparatus as claimed in claim 20, which further comprises a debris collecting bucket (7.1) adapted to fit into the interior of the cut-away elongate hollow tubular member (6.1) and having a port (7.2) in a side wall thereof for admitting debris.

- 28 -

22. A tool for boring holes in the ground, which comprises an annular cutting head secured to or forming part of an annular body, the central aperture of which is elongate and is adapted to receive a further functional unit.



2/11

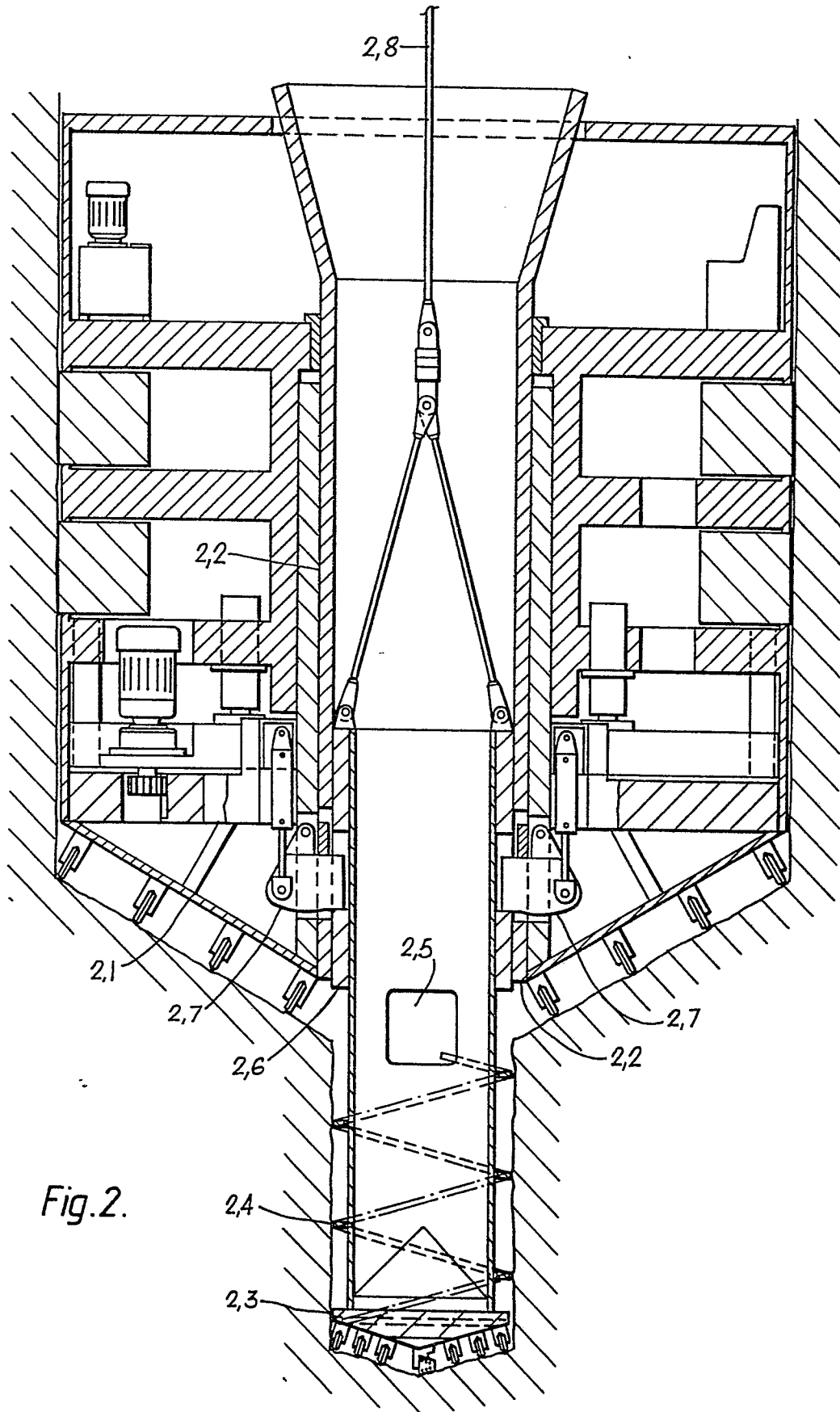
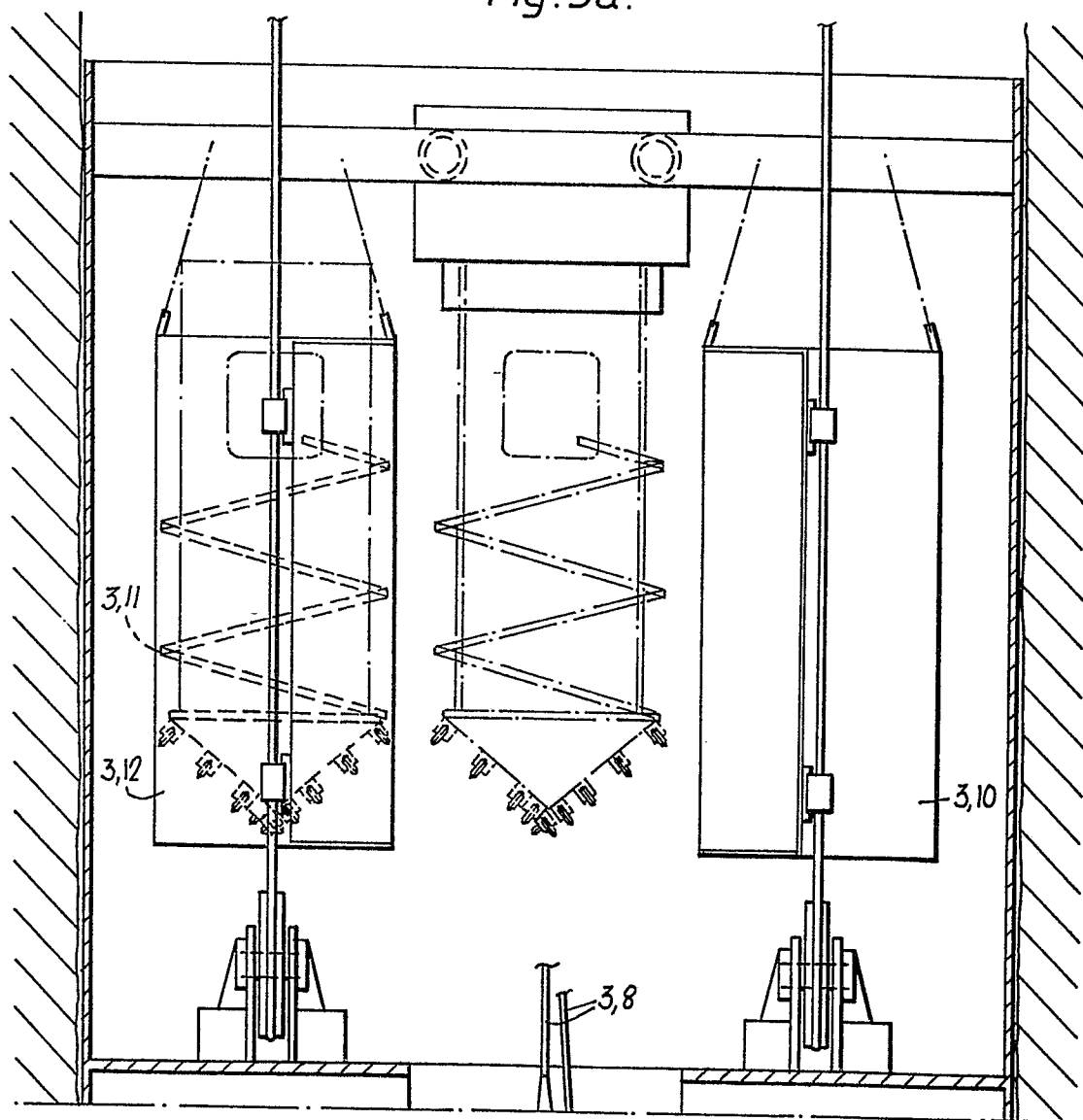


Fig. 2.

3/11

Fig. 3a.



4/11

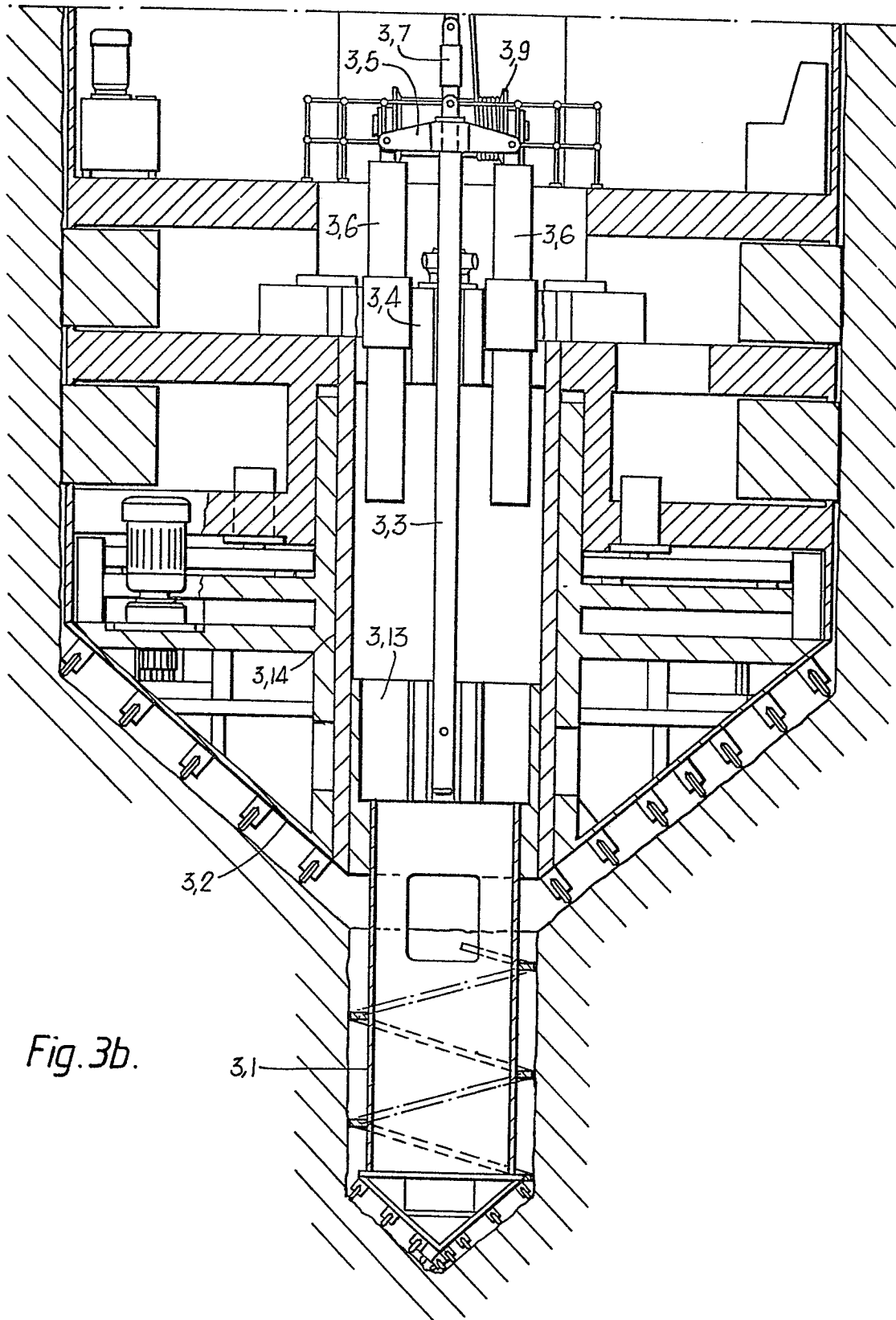
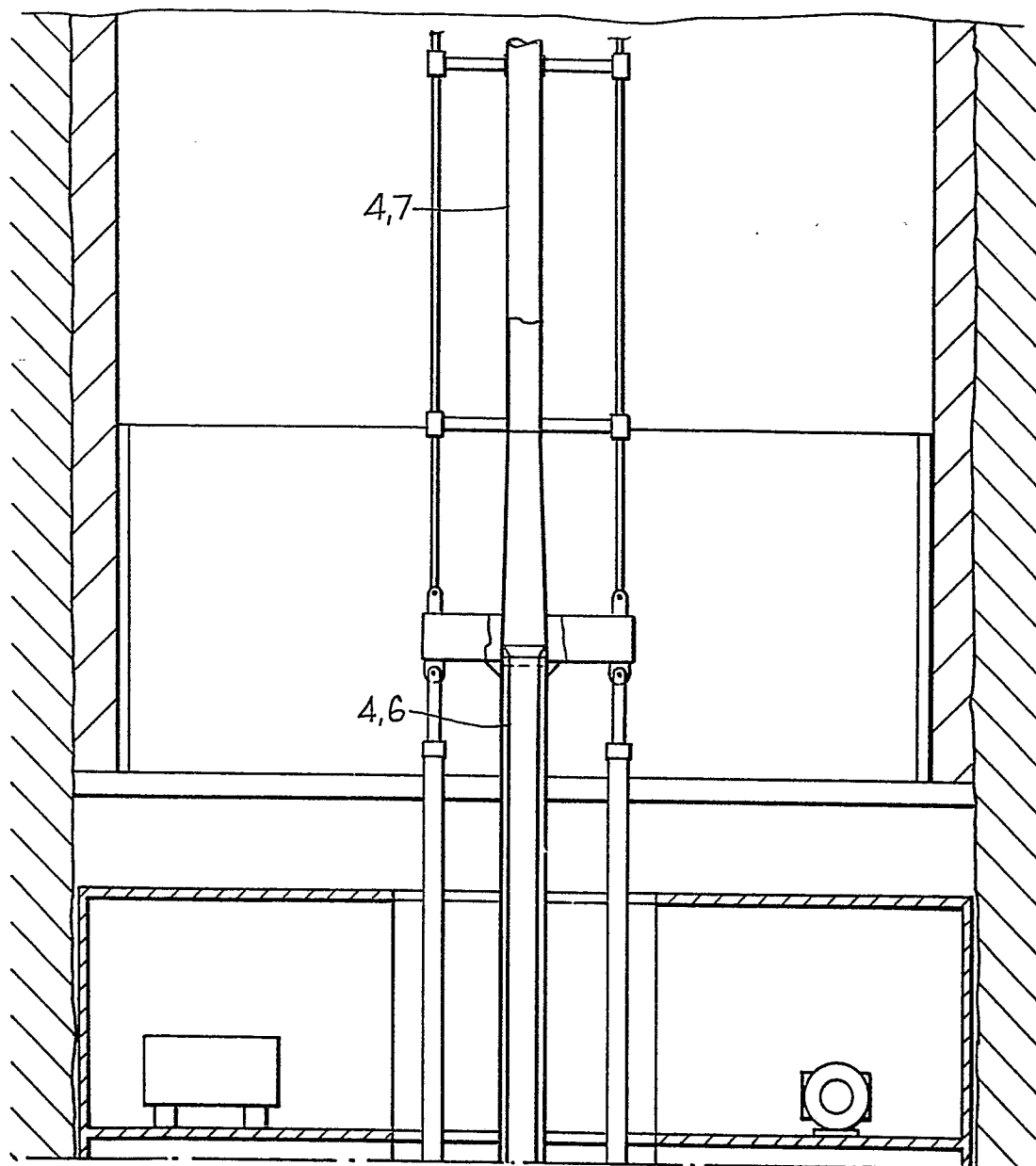


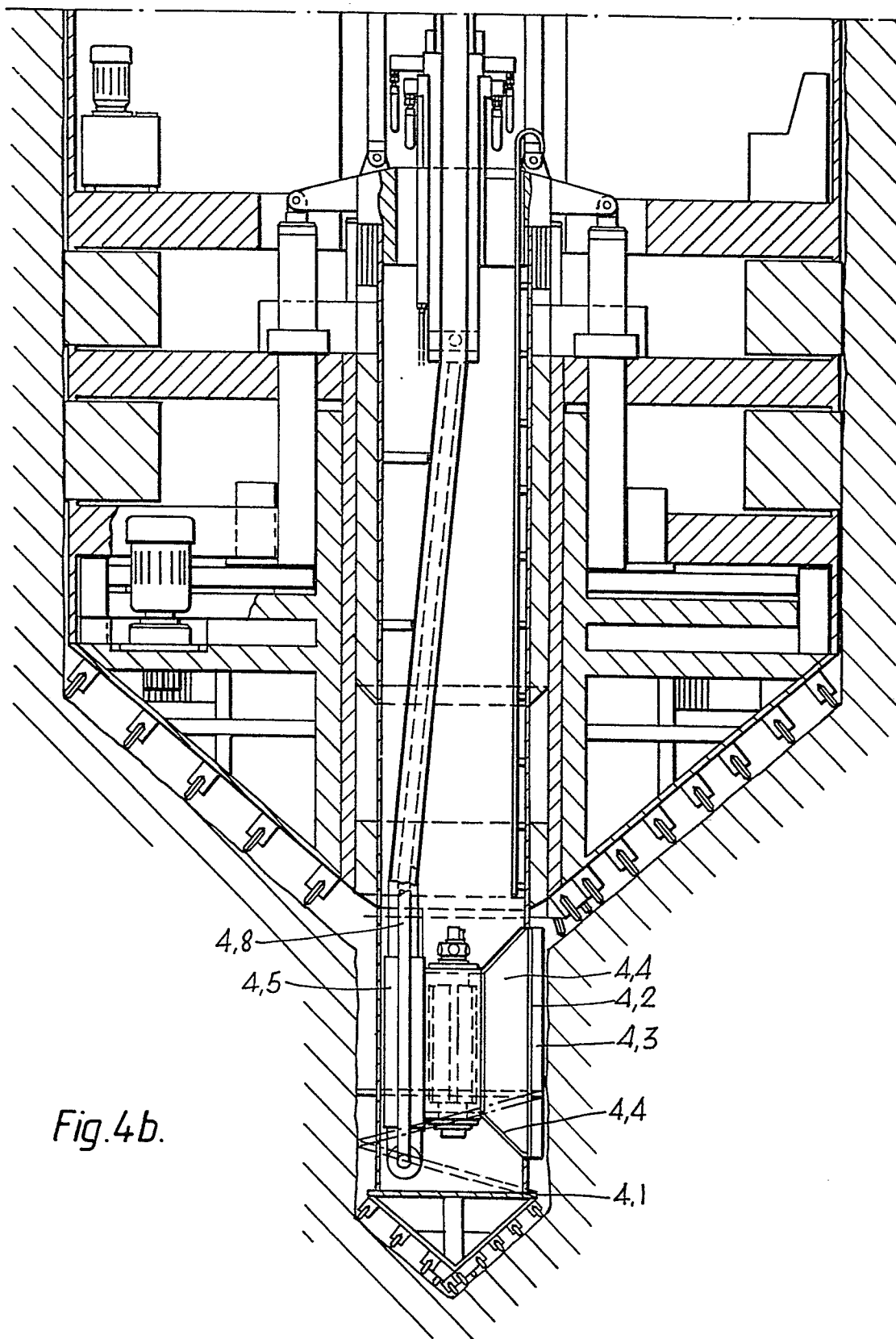
Fig. 3b.

5/11

Fig. 4a.

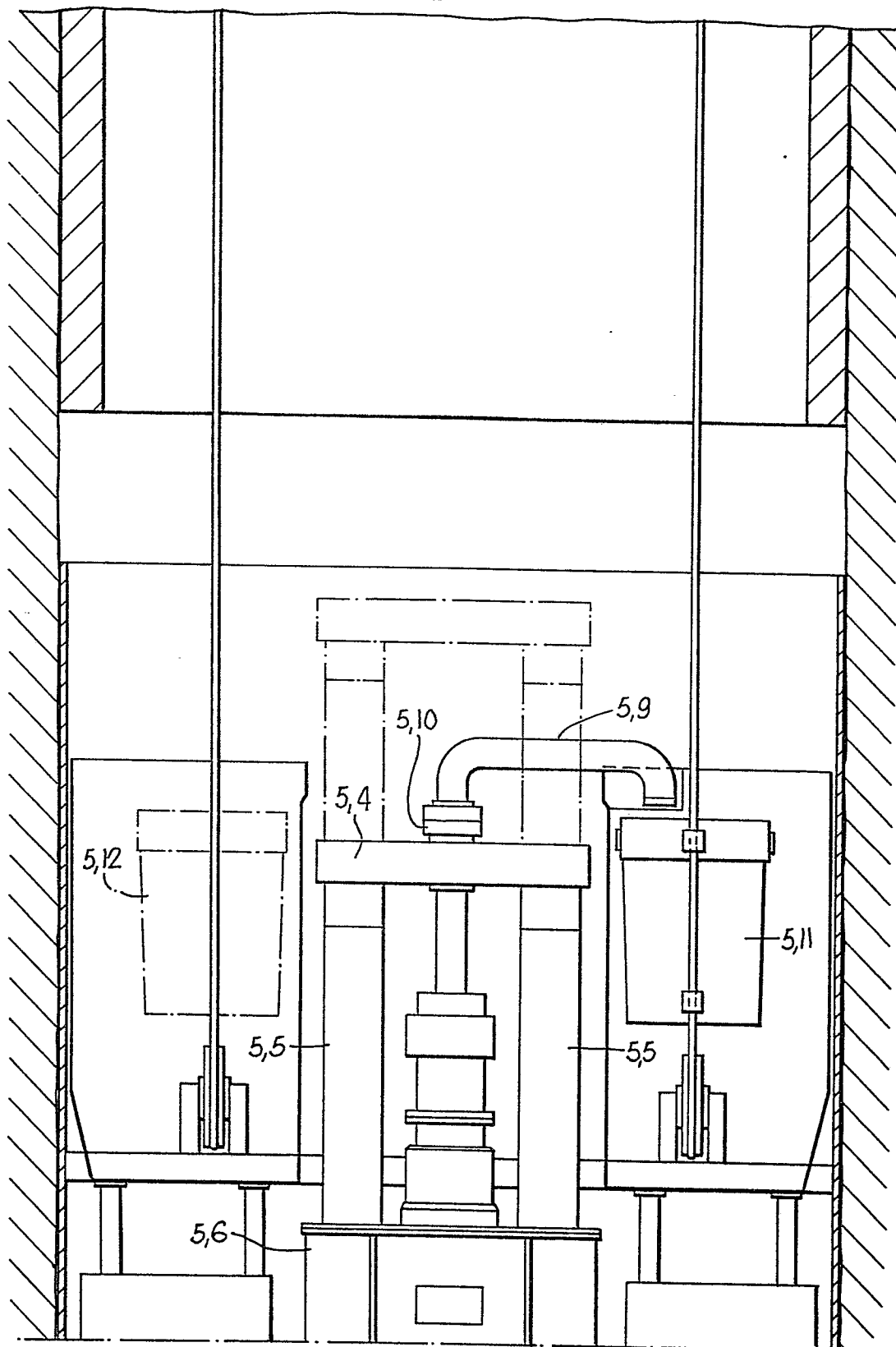


6/11



7/11

Fig. 5a.



8/11

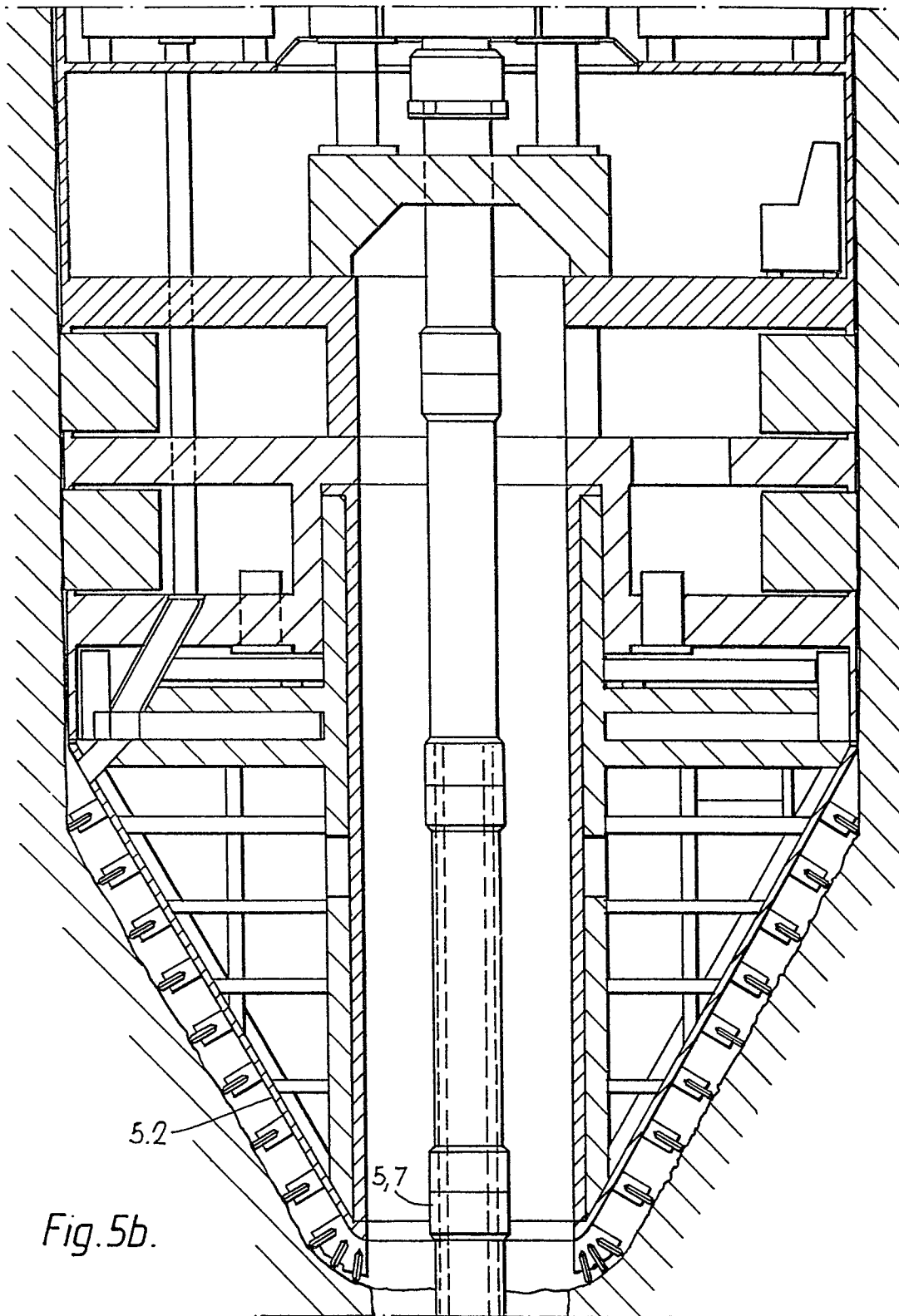
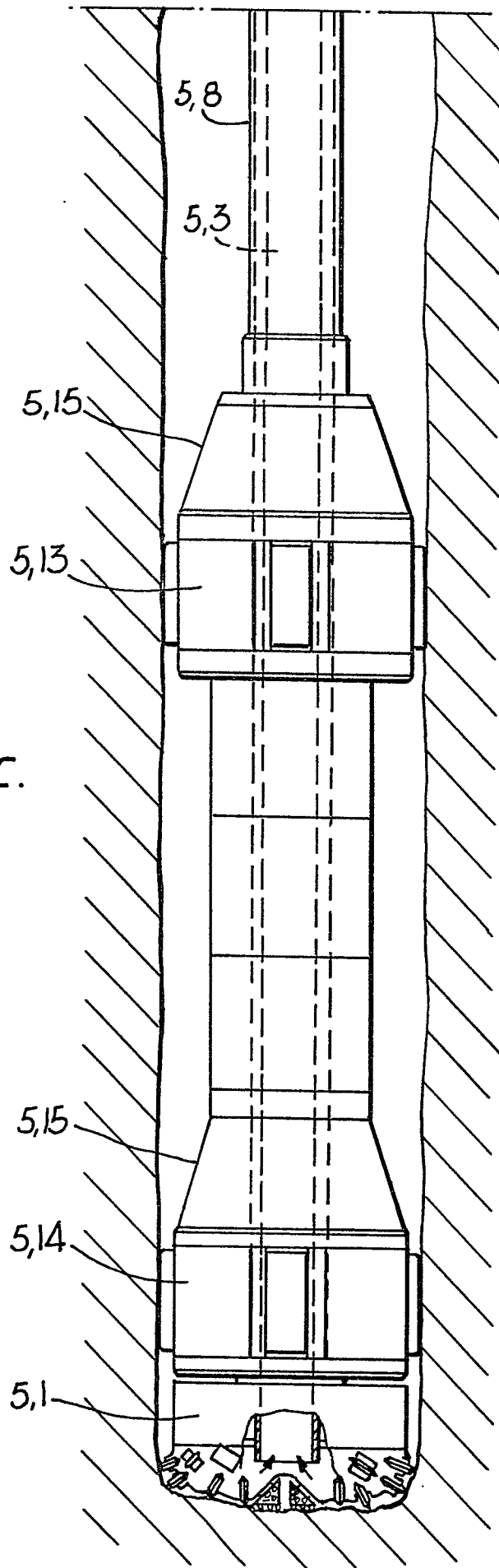


Fig. 5b.

9/11

*Fig. 5c.*

10/11

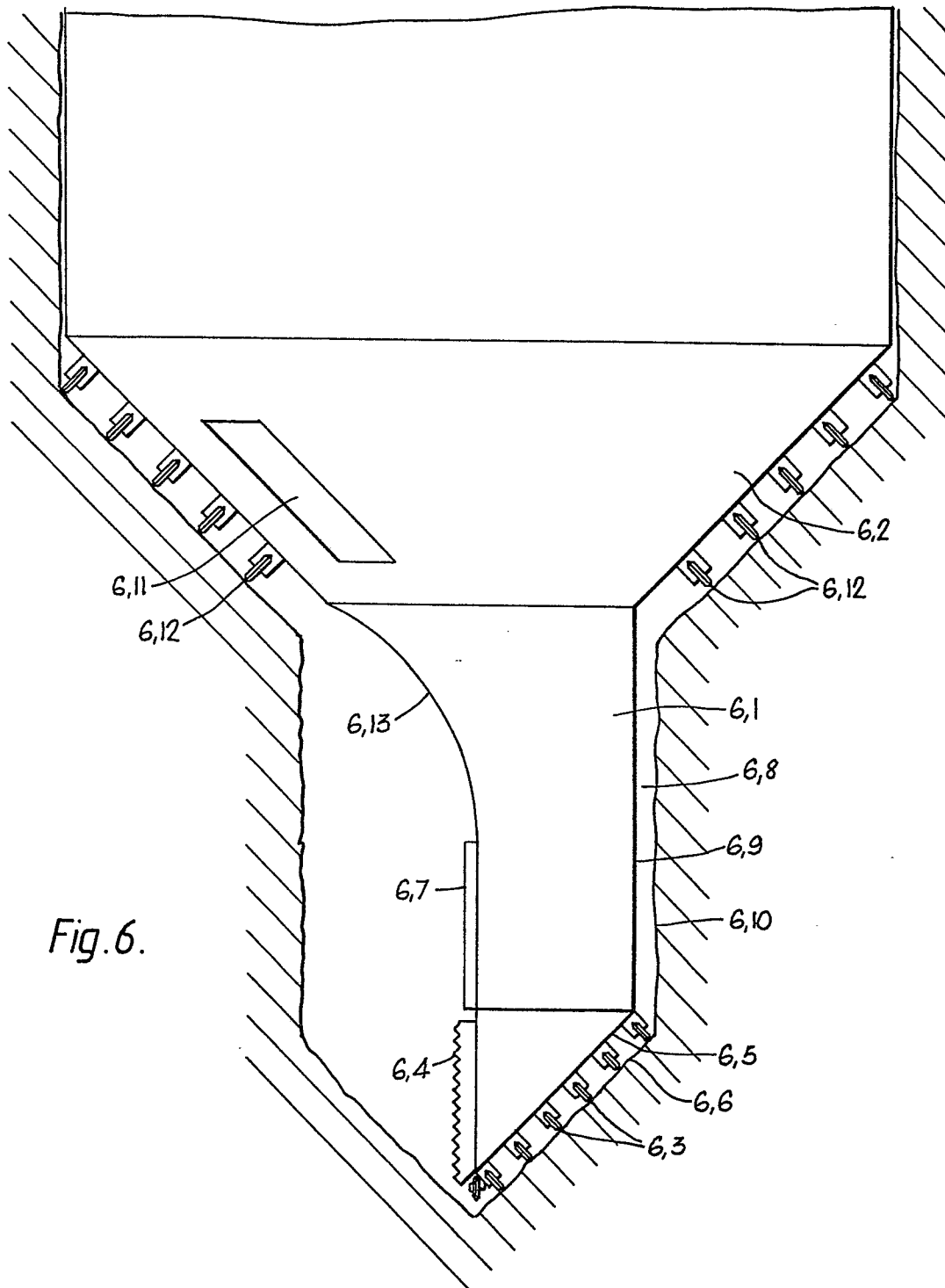
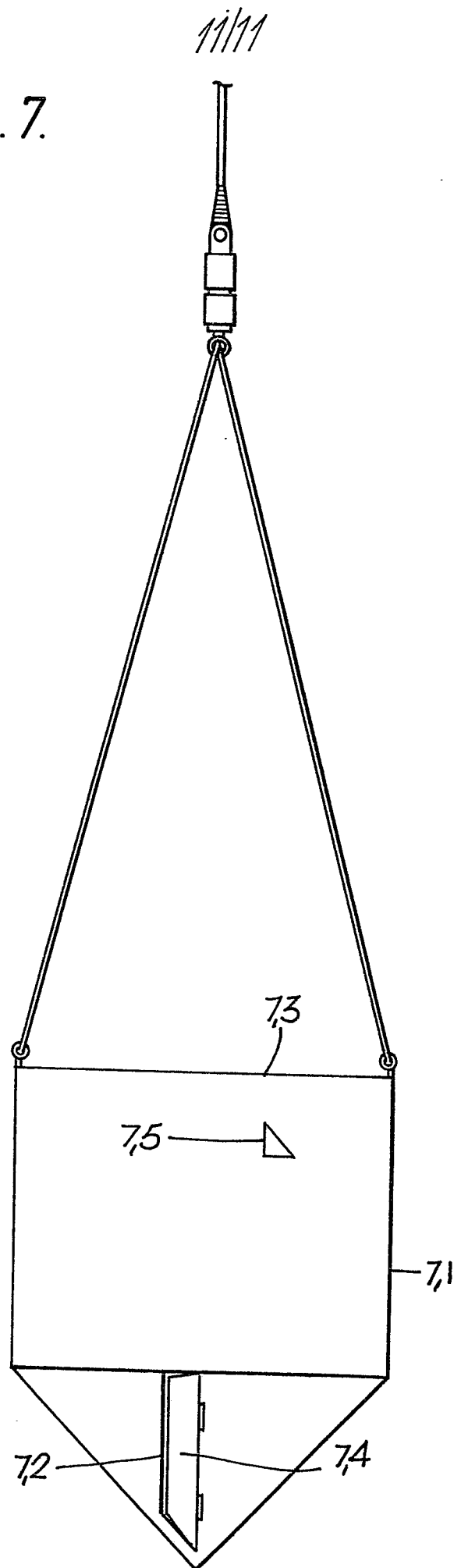


Fig. 6.

Fig. 7.



0050954



European Patent
Office

EUROPEAN SEARCH REPORT

Application number
EP 81 30 4896

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	GB - A - 801 615 (STEIN KOHLEN-BERGWERK) * Whole document *	1, 5, 11, 12, 17, 19	E 21 B 4/16 E 21 D 1/06
	US - A - 1 391 626 (S.C. GILTHORPE) * Whole document *	1-3, 14-17	
	FR - A - 337 785 (SFFRM) * Whole document *	1, 4, 5, 11, 17, 18	TECHNICAL FIELDS SEARCHED (Int.Cl. ³)
	FR - A - 2 367 723 (VNIPIRUDMASH) * Page 11, line 10 to page 13, line 15; figures 1, 4-7 *	14, 17, 19	E 21 B E 21 D
A	US - A - 1 803 228 (W.P. BEAVER)		
A	US - A - 4 078 622 (R.W. TAYLOR-MYERS)		
A	US - A - 1 521 596 (C. CASEY)		
A	DE - C - 159 349 (C. BREAKERS)		
A	DE - C - 97 706 (F. HONIGMANN)		
A	US - A - 3 491 843 (J.M. RODRIGUEZ)		
DA	US - A - 3 379 264 (K.C. COX)		
DA	US - A - 4 186 808 (K.C. COX)		
DA	GB - A - 2 028 897 (W.H. PAURAT)		
The present search report has been drawn up for all claims			CATEGORY OF CITED DOCUMENTS X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons &: member of the same patent family, corresponding document
Place of search The Hague		Date of completion of the search 28-01-1982	Examiner JAUNEZ