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(54) **Percussive core barrel**

Schlagkernbehälter

Tube carottier à percussion

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EP 0 990 765 B1

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Description

[0001] The present invention relates to an equipment for boring large diameter holes into rocks.

[0002] In the present specification, large diameter holes mean holes having a diameter within the range of 1 to 3 metres and a depth within the range of one to 10 metres into the rock. Such holes are to be bored in the rock for foundation piles or other similar purposes.

[0003] The surface of the rock may be at ground level or may be covered by up to 50 metres or more of soil. Where there is soil lying over the rock, a hole will be bored down to the rock by some other means, and held open by a steel casing or support fluid, or a combination of both. Then a specific equipment is used to drill the rock itself.

[0004] Several methods of boring large diameter holes into rock are in common use at the present time :

[0005] Boring with a rock roller bit with the rollers arranged in such a way as to bore out the rock over the entire diameter of the hole as disclosed for instance in DE2602550.

[0006] A rock roller bit requires considerable downward force to be applied to the rollers to penetrate into the rock. The bit is normally attached to a drill pipe which is rotated by a machine at the ground surface. Vertical force is applied to the bit either by hydraulic rams pressing down on the drill pipe or by heavy collars attached to the drill pipe on top of the bit. The rollers are equipped with teeth or hemispherical buttons which crush the rock as they pass over its surface. Discs are also used for this purpose in very strong rock.

[0007] Boring with a percussive drill, having a single large bit as disclosed in DE 3915 538 for instance in such a way as to bore out the rock over the entire diameter of the hole.

[0008] A percussive drill penetrates into the rock at a much faster rate than a rock roller bit or a rock roller core barrel. It is normally operated by compressed air which drives a single large hammer and bit or a number of smaller hammers and bits arranged together in a cluster. The drill is normally attached to a drill pipe which is rotated by a machine at the ground surface and is also used to convey the compressed air to the hammer or hammers. The energy required to operate a percussive drill is much higher than for a rock roller bit or rock roller core barrel, but is needed over a much shorter period.

[0009] Boring augers, toothed core barrels, digging buckets, cleaning buckets and chisels are used mainly for boring holes in weak rocks where acceptable progress can be made with this type of equipment. These tools, with the exception of the chisel, are normally attached to the Kelly bar of a piling rig. Chisels are raised and dropped in the hole either by a separate service crane or by the piling rig itself which may have hoisting facilities for this purpose.

[0010] Boring with a percussive cutting tools secured on a top plate which closes off a ring shaped housing and arranged in such a way as to bore out a ring of rock, leaving a core of rock in the centre to be removed later by some other means as disclosed in US 4526242 and DE 388463. Nonetheless, as the cutting tools are secured on a plate closing off the drill hole, the core of rock cannot penetrate deeper than the height of cutting tools.

[0011] The present invention relates to a drilling equipment which allows the cutting of an annular ring in the rock.

[0012] The object of the present invention is to provide a drilling equipment for boring large diameter holes into rock which combines the high speed of percussive drilling with the economy of boring out only a ring of rock around the perimeter of the hole instead of boring out the rock over its full diameter.

[0013] To achieve this object, according to the present invention, the equipment for boring large diameter holes into the rock comprises :

a cylindrical core tube having a vertical axis, an upper end and a lower end.

[0014] A plurality of hammer means provided with percussive bits (14b) for penetrating into the rock, each hammer means having a vertical axis and,

pressure fluid means for operating said hammer means,

pressure fluid feed means for supplying pressure fluid in the vicinity of the bits of said hammer means,

driving means connected to the upper end of said core tube for rotating said core tube about the vertical axis thereof,

the said equipment for boring large diameter holes is characterized in that the hammer means are secured to the outer face of the core tube close to the lower end thereof so that the bits project beneath the lower end of the tube, and in that exhaust means are connected to said core tube for collecting the pressure fluid supplied in the vicinity of the bits and the rock cuttings transported by said pressure fluid from the bottom of the hole to the ground surface,

whereby the said equipment can bore holes deeper than the average height of hammer means.

[0015] It will be understood that the drilling equipment which will be called a "percussive core barrel" in the following description, requires less energy than a percussive drill because it only bores out a ring of rock instead of rock over the entire diameter of the hole due to the fact that the hammers are rotated about the vertical axis of the core tube.

[0016] Moreover, the percussive core barrel will penetrate into the rock at a much faster rate than a rock roller bit or a rock roller core barrel.

[0017] Finally, little downward force has to be applied to the percussive core barrel compared to a rock roller bit or rock roller core barrel, enabling a lighter or less powerful machine to be used at the ground surface to supply the downward force.

[0018] According to a first embodiment, the hammer means are operated by compressed air and the pressure fluid supplied in the vicinity of the hammer bits is the compressed air for operating said hammer means.

[0019] According to a second embodiment, the hammer means are operated by a pressurised liquid and the pressure fluid supplied in the vicinity of the hammer bits is compressed air supplied by pipes extending down to the level of the hammer bits.

[0020] According to a third embodiment, the hammer means are operated by a pressurised liquid and the pressure fluid supplied in the vicinity of the hammer bits is-also the pressurised liquid used to operate the hammer means.

[0021] Other features and advantages of the present invention appear better on reading the following description of several embodiments of the invention given by way of examples.

[0022] The description refers to the accompanying figures in which :

- Figure 1 is a vertical section of the percussive core barrel on line I-I of figure 4 ;
- Figure 2 is a vertical section view of the machine on line II-II of figure 4 ;
- Figure 3 is a vertical section view of the machine on line III-III of figure 4 ;
- Figure 4 is an horizontal section view of the machine on line IV-IV of figure 1 ;
- Figure 5 is an horizontal section view of the machine on line V-V of figure 1 ;
- Figure 6 is an horizontal section view of the machine on line VI-VI of figure 1 ;
- Figure 7 is an horizontal section view of the machine on line VII-VII of figure 1 ; and
- Figure 8 is an horizontal section view of the machine on line VIII-VIII of figure 1.

[0023] Referring to the drawings, it will be seen that the percussive core barrel 10 comprises a cylindrical core barrel 12, a plurality of percussive hammers 14 and a drill pipe 16 which extends to the ground surface.

[0024] The core barrel 12 has a vertical axis XX', an upper end 12a, a lower end 12b and a free lower edge 12c. The diameter D of the barrel 12 is equal to 1 500 mm in the present example. More generally, this diameter is between 1 and 3 metres. The length L of the barrel is equal to 4 metres. More generally, this length is between 3 to 6 metres.

[0025] In the particular example, the machine comprises 8 hammers 14 having a vertical axis and including a body 14a secured to the outer face of the lower end 12b of the barrel and a percussive bit 14b, the bit 14b projecting below the lower edge 12c of the barrel. As better shown in figure 5, the hammers are regularly angularly disposed around the barrel 12.

[0026] In this example, the hammers have a diameter of about 20 cm. These hammers are operated by compressed air at a minimum air pressure of 14 bars. The total volume of air required for the 8 hammers is approximately 155 m^3/min. As explained hereinafter, the hammers can also be operated by pressurised water or liquid. Additionally, the number of hammers might be different.

[0027] The hammers 14 are located in an annular volume 17 limited by the lower end of the barrel 12, an outer cylindrical shell 18 and an horizontal annular plate 20. The compressed air is supplied to the hammers by means of feed pipes 22 which connect the hammers to a compressed air source (not shown) disposed at the ground surface.

[0028] The machine 10 also comprises exhaust pipes 24 which connect the annular volume 17 wherein the hammers are located to a tubular member 26 secured to the upper end of the barrel 12. This tubular member 26 is connected to a frusto conical tubular piece 28 which is secured to the drill pipe 16.

[0029] As better shown in figure 2, the machine also comprises a cylindrical spacer ring 30 secured to the barrel 12 and surrounding the upper end 12a of the barrel to act as a guide for the core barrel in the bore. Of course, the diameter of the outer shell 18 and the spacer ring 30 is slightly less than the diameter of the hole to be bored.

[0030] Figures 2 and 5 show that the machine is equipped with depth control plates 32. These plates 32 secured to the core barrel extend below the lower edge 12c of the barrel and they are located between the hammer bits 14b. The purpose of these plates is to prevent the bits 14b from penetrating too far into the rock if the hammers 14 are operated without the core barrel being rotated by the drill pipe 16.

[0031] The operation of this first embodiment of the percussive core barrel 10 will be now described in detail.

[0032] The core barrel 12 is rotated by the drill pipe 16 and the compressed air is supplied to the hammers to operate the bits 14b.

[0033] As a result, the bits 14b travel along a circular path around the core tube 12 and the bits 14b bore out a ring of rock, the width thereof corresponds to the size of the bits, leaving a core of rock inside the core tube 12.

[0034] When the desired annular bore is obtained, the core of rock may be removed by means of a heavy steel chisel, weighing several tons, which is dropped on to the core of rock to break it into small pieces which can be removed from the hole by a mechanical grab or similar tools. If the depth of the hole required in the rock is more than the internal length L of the barrel 12, boring will be carried out in several stages, the core of rock from each stage being removed before the next stage has begun.

[0035] The compressed air is expelled through the bits 14b and most will return to the ground surface via the exhaust pipes and the drill pipe 16. This air will transport most of the rock cuttings produced by the bits. Some of the air will escape up the outside of the core barrel past the outer shell 18 because the outside diam-

eter of the outer shell is slightly less than the outside diameter of the ring of rock bored out by the bits 14b. However, this will not have a significant detrimental effect on the performance of the percussive core barrel.

[0036] In the first embodiment above described, the hammers 14 are operated by compressed air.

[0037] According to a second embodiment, the hammers are operated by hydraulic power and the rock cuttings are still transported by compressed air from the bottom of the hole to the ground surface, therefore a smaller volume of air is required.

[0038] The compressed air feed pipes are detached from the hammers and extended down to the level of the bits, so that air to transport the rock cuttings can be fed down to the bottom of the hole. Most of the air and rock cuttings will return to the ground surface via the exhaust pipes but some will escape up the outside of the core barrel past the outer shell. Separate pipes (not shown in the figures) are attached to the hammers 14 to transport the hydraulic fluid used for their operation.

[0039] According to a third embodiment of the percussive core barrel, water is used as hydraulic fluid to operate the hammers and is fed down via the feed pipes to the hammers and expelled through the bits. The hole in which the percussive core barrel is being operated is kept full of water to the ground surface by means of a discharge pipe from a suitable water supply. Compressed air is fed into the lower part of the machine to cause water and rock cuttings to rise up the exhaust pipes 24 and drill pipe 16 to be discharged at the ground surface.

Claims

1. An equipment for boring large diameter holes into rocks comprising :

a cylindrical core tube (12) having a vertical axis, an upper end and a lower end.
A plurality of hammer means (14) provided with percussive bits (14b) for penetrating into the rock, each hammer means (14) having a vertical axis and,
pressure fluid means (22) for operating said hammer means (14),
pressure fluid feed means for supplying pressure fluid in the vicinity of the bits (14b) of said hammer means (14),
driving means connected to the upper end of said core tube (12) for rotating said core tube (12) about the vertical axis thereof,

characterizing in that the hammer means (14) are secured to the outer face of the core tube (12) close to the lower end thereof so that the bits (14b) project beneath the lower end of the tube, and **in that** exhaust means are connected to said core tube (12) for collecting the pressure fluid supplied in the vicinity of the bits (14b) and the rock cuttings transported by said pressure fluid from the bottom of the hole to the ground surface,
whereby the said equipment can bore holes deeper than the average height of hammer means (14).

2. An equipment according to claim 1 further comprising a cylindrical outer shell (18) secured to the core tube (12) and surrounding the lower end thereof, said hammer means (14) being located between said core tube (12) and said outer shell (18).

3. An equipment according to claim 2, wherein said exhaust means comprises a plurality of exhaust pipes (24) having lower ends, said lower ends opening into the upper portion of the annular volume limited by the core tube (12) and the outer shell (18).

4. An equipment according to claim 3 wherein said driving means (16) for rotating said core tube (12) comprises a vertical drill pipe (16) secured to the upper end of the core tube (12) and extending to the ground surface.

5. A surface equipment according to claim 4 wherein said exhaust means further comprises said vertical drill pipe (16).

6. An equipment according to anyone of claims 1 to 5 further comprising a cylindrical spacer ring secured to the outside face of said core tube (12) and surrounding the upper end thereof.

7. An equipment according to anyone of claims 1 to 6 further comprising a plurality of depth control means, said depth control means being secured to the core tube (12) and projecting out of the lower edge of said core tube (12), said depth control means being located between said hammer means (14).

8. An equipment according to anyone of claims 1 to 7 wherein the number of hammer means (14) is equal to 4 to 12.

9. An equipment according to anyone of claims 1 to 8 wherein the diameter of the core tube (12) is substantially equal to 1 500 mm.

10. An equipment according to anyone of claims 1 to 9 wherein the length of core tube (12) is substantially equal to 4 metres.

11. An equipment according to anyone of claims 1 to 10 wherein the hammer means (14) are operated by compressed air and the pressure fluid supplied in the vicinity of the hammer bits (14b) is the com-

pressed air for operating said hammer means (14).

12. An equipment according to anyone of claims 1 to 10 wherein the hammer means (14) are operated by a pressurised liquid and the pressure fluid supplied in the vicinity of the hammer bits (14b) is compressed air supplied by pipes extending down to the level of the hammer bits (14b).

13. An equipment according to anyone of claims 1 to 10 wherein the hammer means (14) are operated by a pressurised liquid and the pressure fluid supplied in the vicinity of the hammer bits (14b) is also the pressurised liquid used to operate the hammer means (14).

14. An equipment according to anyone of claims 1 to 13 wherein the length L of the core tube (12) is strictly superior to the average height of hammer means (14).

Patentansprüche

1. Ausrüstung zum Bohren von Löchern mit großem Durchmesser in Gestein mit:

einem zylindrischem Kemrohr (12), das eine vertikale Achse, ein oberes Ende und ein unteres Ende aufweist,

mehreren Hammermitteln (14), die mit Schlagbohrmeißeln (14b) versehen sind, um in das Gestein einzudringen, wobei jedes Hammermittel (14) eine vertikale Achse und

Mittel (22) zur Druckbeaufschlagung eines Fluids, um die Hammermittel (14)zu betreiben,

Druckfluid-Zuführungsmittel, die das druckbeaufschlagte Fluid in die Nähe der Bohrmeißel (14b) der Hammermittel (14) leiten,

Antriebsmittel, die mit dem oberen Ende des Kernrohrs (12) verbunden sind, um das Kernrohr um seine vertikale Achse zu drehen,

aufweist,
dadurch gekennzeichnet, dass die Hammermittel (14) an der Außenseite des Kernrohrs (12) nahe dem unteren Ende dieses so befestigt sind, dass die Bohrmeißel (14b) über das untere Ende des Rohrs überstehen, und dass Abzugsmittel mit dem Kernrohr (12) verbunden sind, um das druckbeaufschlagte Fluid, das in die Nähe der Bohrmeißel (14b) geliefert worden ist, und den Gesteinsabtrag, der von dem druckbeaufschlagten Fluid vom Grund des Bohrlochs zur Bodenoberfläche transportiert wird, zu sammeln,
wobei die Ausrüstung Löcher bohren kann, deren Tiefe größer als die durchschnittliche Höhe der Hammermittel (14) ist.

2. Ausrüstung nach Anspruch 1, die weiterhin einen zylindrischen äußeren Mantel (18) umfasst, der an dem Kernrohr (12) befestigt ist und dessen unteres Ende umgibt, wobei die Hammermittel (14) zwischen dem Kernrohr (12) und dem äußeren Mantel (18) angeordnet sind.

3. Ausrüstung nach Anspruch 2, bei der die Abzugsmittel mehrere Abzugsrohre (24) umfassen, die untere Enden aufweisen, die in den oberen Teil des ringförmigen Raumes münden, der durch das Kemrohr (12) und den äußeren Mantel (18) begrenzt ist.

4. Ausrüstung nach Anspruch 3, bei der die Antriebsmittel (16), die das Kernrohr (12) in Drehbewegung versetzen, ein vertikales Gestängerohr (16) umfassen, das am oberen Ende des Kernrohrs (12) befestigt ist und sich zur Bodenoberfläche erstreckt.

5. Oberflächenausrüstung nach Anspruch 4, bei der die Abzugsmittel weiterhin das vertikale Gestängerohr (16) umfassen.

6. Ausrüstung nach einem der Ansprüche 1 bis 5, die weiterhin einen zylindrischen Abstandsring umfasst, der an der Außenseite des Kernrohrs (12) befestigt ist und dessen oberes Ende umgibt.

7. Ausrüstung nach einem der Ansprüche 1 bis 6, die weiterhin mehrere Tiefensteuermittel umfasst, die am Kernrohr (12) befestigt sind und von der unteren Kante des Kernrohrs (12) überstehen, wobei die Tiefensteuermittel zwischen den Hammermitteln (14) angeordnet sind.

8. Ausrüstung nach einem der Ansprüche 1 bis 7, bei der die Anzahl der Hammermittel (14) gleich 4 bis 12 ist.

9. Ausrüstung nach einem der Ansprüche 1 bis 8, bei der der Durchmesser des Kernrohrs (12) im Wesentlichen gleich 1 500 mm beträgt.

10. Ausrüstung nach einem der Ansprüche 1 bis 9, bei der die Länge des Kernrohrs (12) im Wesentlichen gleich 4 m ist.

11. Ausrüstung nach einem der Ansprüche 1 bis 10, bei der die Hammermittel (14) mit Druckluft betrieben werden und das druckbeaufschlagte Fluid, das in die Nähe der Schlagbohrmeißel (14b) geliefert wird, Druckluft zum Betreiben der Hammermittel (14) ist.

12. Ausrüstung nach einem der Ansprüche 1 bis 10, bei der die Hammermittel (14) mit einer druckbeauf-

schlagten Flüssigkeit betrieben werden und das druckbeaufschlagte Fluid, das in die Nähe der Schlagbohrmeißel (14b) geliefert wird, Druckluft ist, die durch Rohrleitungen zugeführt wird, die sich nach unten bis zur Ebene der Schlagbohrmeißel (14b) erstrecken.

13. Ausrüstung nach einem der Ansprüche 1 bis 10, bei der die Hammermittel (14) mit einer druckbeaufschlagten Flüssigkeit betrieben werden und das druckbeaufschlagte Fluid, das in die Nähe der Schlagbohrmeißel (14b) geliefert wird, ebenfalls die druckbeaufschlagte Flüssigkeit ist, die verwendet wird, um die Hammermittel (14) zu betreiben.

14. Ausrüstung nach einem der Ansprüche 1 bis 13, bei der die Länge L des Kernrohrs (12) streng genommen größer als die durchschnittliche Höhe der Hammermittel (14) ist.

Revendications

1. Équipement pour forer des trous de grand diamètre dans des roches, comprenant :

un tube d'âme cylindrique (12) ayant un axe vertical, une extrémité supérieure et une extrémité inférieure ;

une pluralité de moyens formant marteaux (14) équipés de têtes de percussion (14b) pour pénétrer dans la roche, chaque moyen formant marteau (14) ayant un axe vertical ;

des moyens à fluide sous pression (22) pour faire fonctionner lesdits moyens formant marteaux (14) ;

des moyens d'alimentation de fluide sous pression pour fournir un fluide sous pression au voisinage des têtes (14b) desdits moyens formant marteaux (14) ; et

des moyens d'entraînement connectés à l'extrémité supérieure dudit tube d'âme (12) pour faire tourner ledit tube d'âme (12) autour de son axe vertical ;

caractérisé en ce que les moyens formant marteaux (14) sont fixés sur la face extérieure du tube d'âme (12) proche de son extrémité inférieure, de sorte que les têtes (14b) se projettent au-dessous de l'extrémité inférieure du tube, et **en ce que** des moyens d'échappement sont connectés audit tube d'âme (12) pour collecter le fluide sous pression fourni au voisinage des têtes (14b) et les débris de roche transportés par ledit fluide sous pression depuis le fond du trou vers la surface du sol,
grâce à quoi ledit équipement est en mesure de forer des trous plus profonds que la hauteur moyenne des moyens formant marteaux (14).

2. Équipement selon la revendication 1, comprenant en outre une coque extérieure cylindrique (18) fixée sur le tube d'âme (12) et entourant l'extrémité inférieure de celui-ci, lesdits moyens formant marteaux (14) étant situés entre ledit tube d'âme (12) et ladite coque extérieure (18).

3. Équipement selon la revendication 2, dans lequel lesdits moyens d'échappement comprennent une pluralité de tubes d'échappement (24) ayant des extrémités inférieures, lesdites extrémités inférieures s'ouvrant dans la portion supérieure du volume annulaire limité par le tube d'âme (12) et par la coque extérieure (18).

4. Équipement selon la revendication 3, dans lequel lesdits moyens d'entraînement (16) pour faire tourner ledit tube d'âme (12) comprennent un tube de forage vertical (16) fixé sur l'extrémité supérieure du tube d'âme (12) et s'étendant vers la surface du sol.

5. Équipement de surface selon la revendication 4, dans lequel lesdits moyens d'échappement comprennent en outre ledit tube de forage vertical (16).

6. Équipement selon l'une quelconque des revendications 1 à 5, comprenant en outre une bague d'espacement cylindrique fixée sur la face extérieure dudit tube d'âme (12) et entourant l'extrémité supérieure de celui-ci.

7. Équipement selon l'une quelconque des revendications 1 à 6, comprenant en outre une pluralité de moyens de commande de profondeur, lesdits moyens de commande de profondeur étant fixés sur le tube d'âme (12) et se projetant hors de la bordure inférieure dudit tube d'âme (12), lesdits moyens de commande de profondeur étant situés entre lesdits moyens formant marteaux (14).

8. Équipement selon l'une quelconque des revendications 1 à 7, dans lequel le nombre des moyens formant marteaux (14) est égal à 4 à 12.

9. Équipement selon l'une quelconque des revendications 1 à 8, dans lequel le diamètre du tube d'âme (12) est sensiblement égal à 1500 mm.

10. Équipement selon l'une quelconque des revendications 1 à 9, dans lequel la longueur du tube d'âme (12) est sensiblement égale à 4 m.

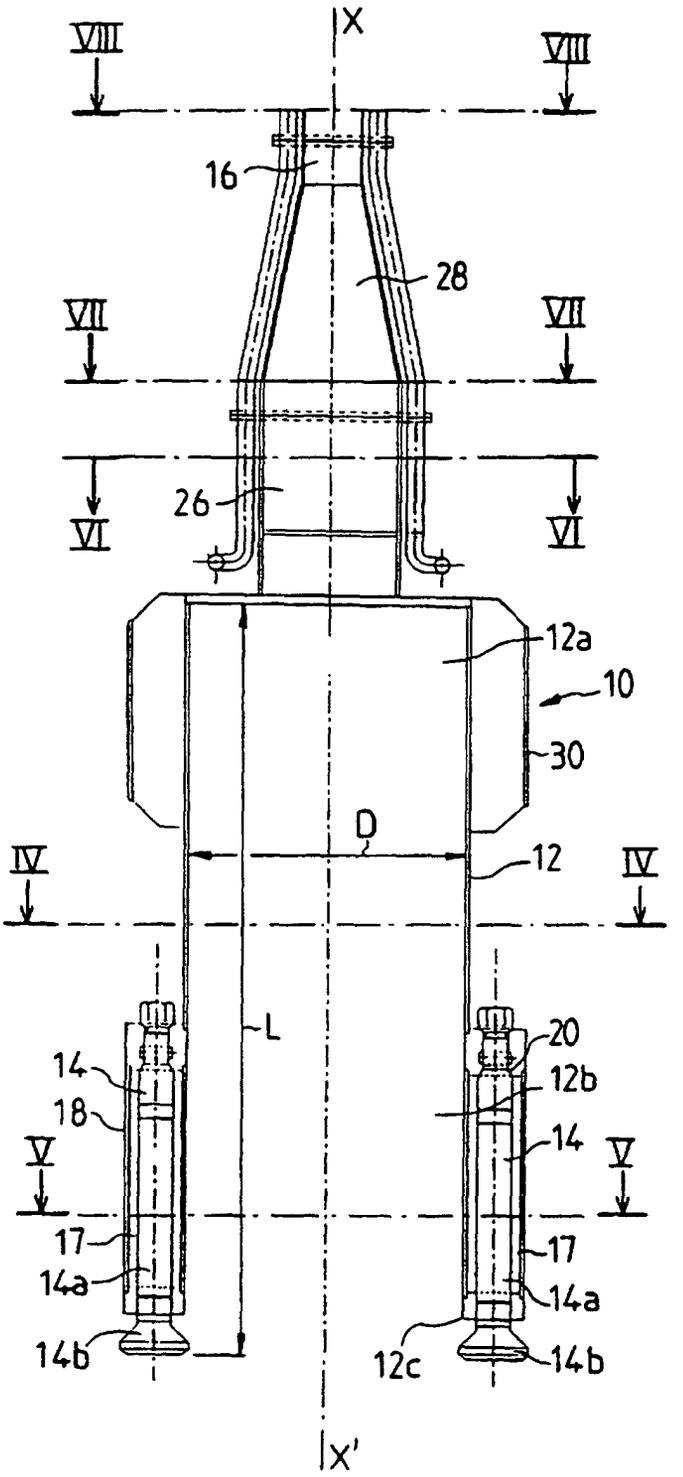
11. Équipement selon l'une quelconque des revendications 1 à 10, dans lequel les moyens formant marteaux (14) fonctionnent avec de l'air comprimé et le fluide sous pression fourni dans le voisinage des têtes de marteaux (14b) est l'air comprimé pour faire fonctionner lesdits moyens formant marteaux (14).

12. Équipement selon l'une quelconque des revendications 1 à 10, dans lequel les moyens formant marteaux (14) fonctionnent avec un liquide sous pression et le fluide sous pression fourni dans le voisinage des têtes de marteaux (14b) est l'air comprimé fourni par des tubes s'étendant vers le bas jusqu'au niveau des têtes de marteaux (14b).

13. Équipement selon l'une quelconque des revendications 1 à 10, dans lequel les moyens formant marteaux (14) fonctionnent avec un liquide sous pression et le fluide sous pression fourni dans le voisinage des têtes de marteaux (14b) est également le liquide sous pression utilisé pour faire fonctionner les moyens formant marteaux (14).

14. Équipement selon l'une quelconque des revendications 1 à 13, dans lequel la longueur L du tube d'âme (12) est strictement supérieure à la hauteur moyenne des moyens formant marteaux (14).

FIG.1


X
VIII
VIII
16
28
VII
VII
26
VI
VI
12a
10
30
D
IV
12
IV
L
20
14
12b
18
14
V
V
17
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14a
14a
14b
12c
14b
X'

FIG.2

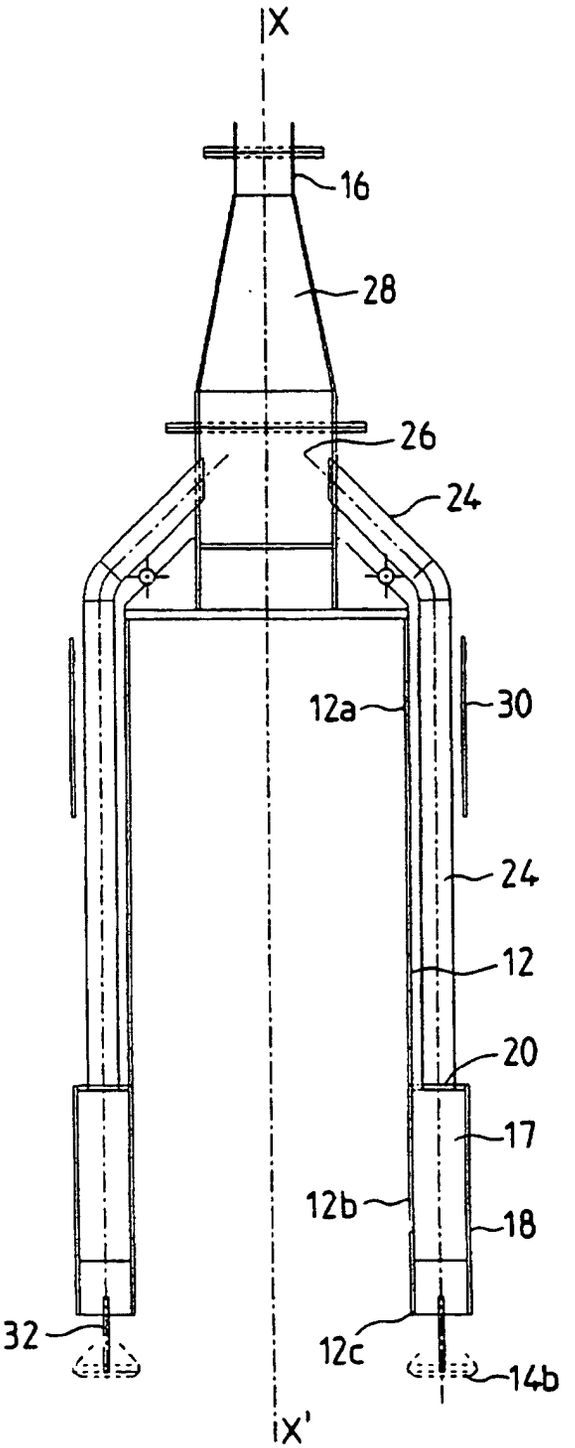
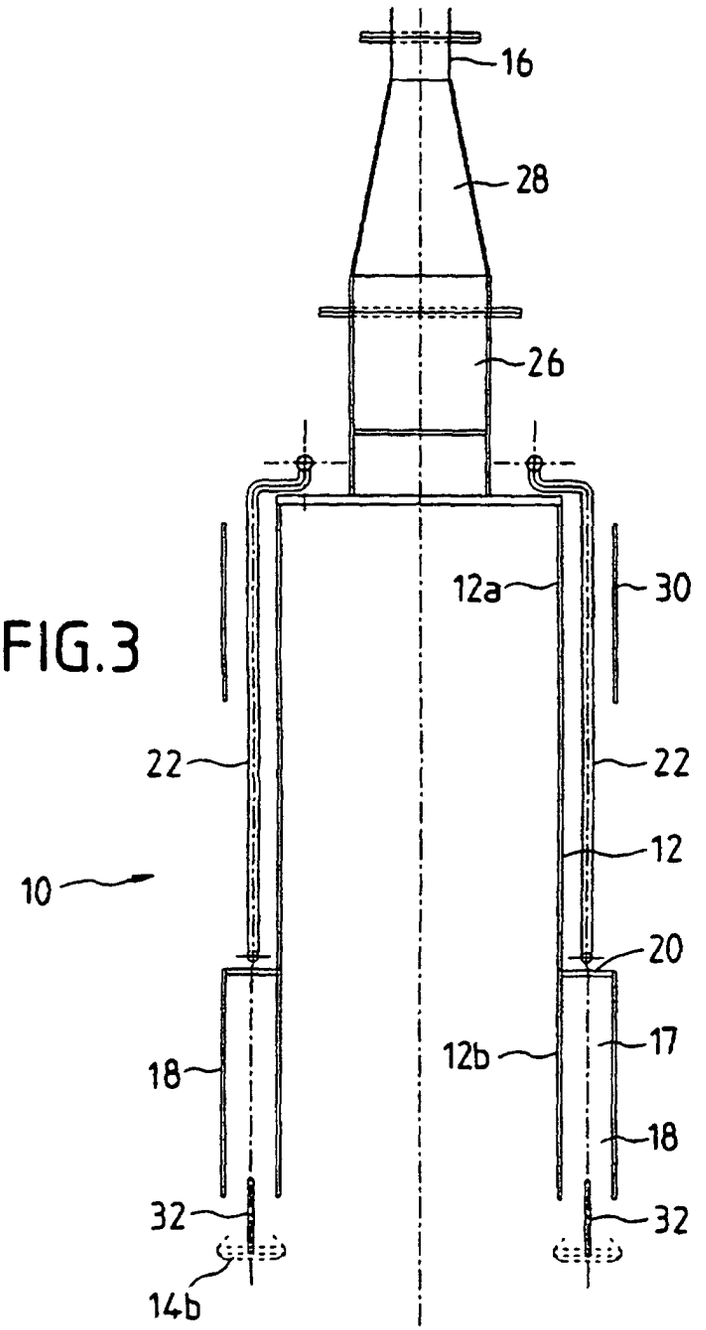


FIG.3



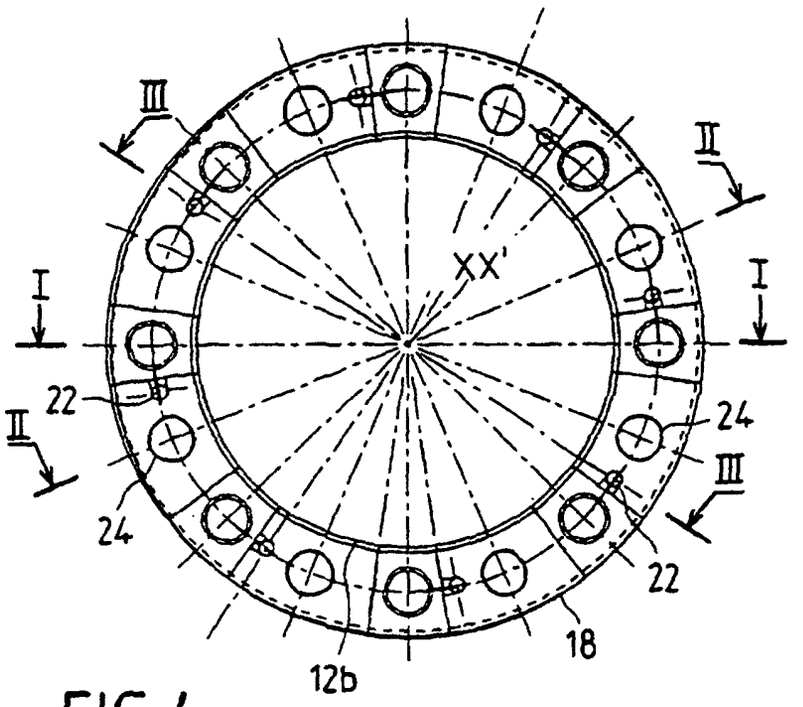

III
II
I
XX'
I
22
II
24
III
24
22
18
12b

FIG.4

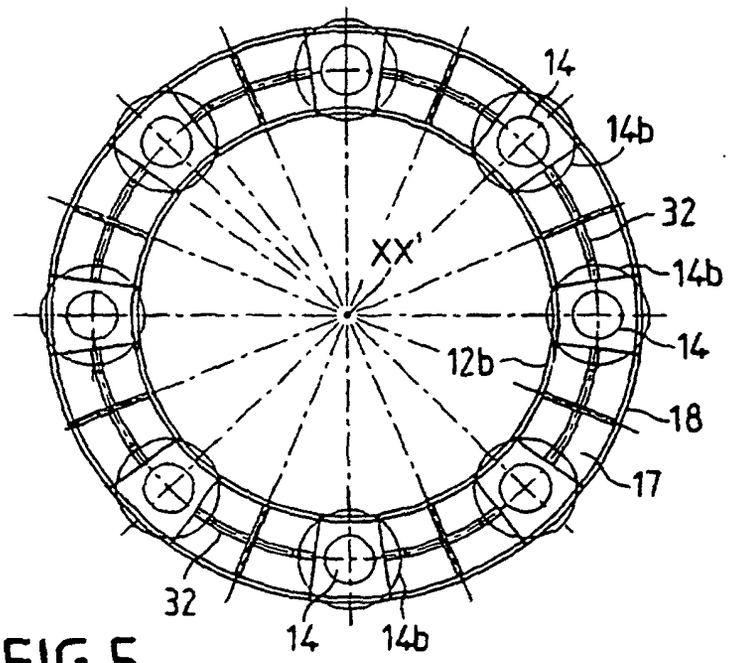

14
14b
32
XX'
14b
12b
14
18
17
32
14
14b

FIG.5

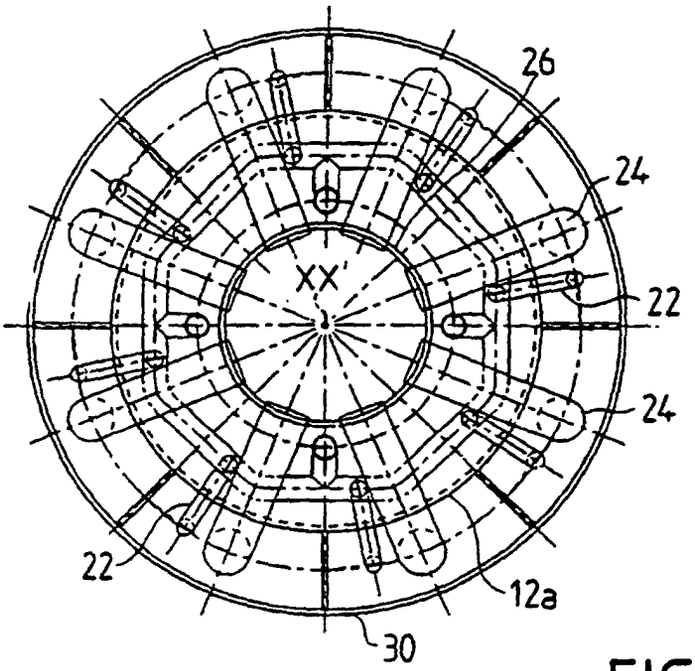


FIG.6

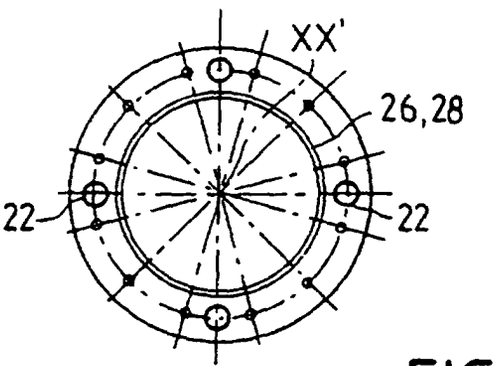


FIG.7

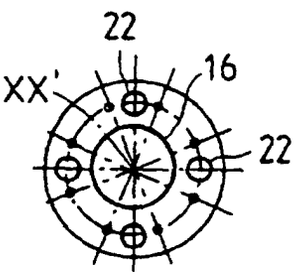


FIG.8