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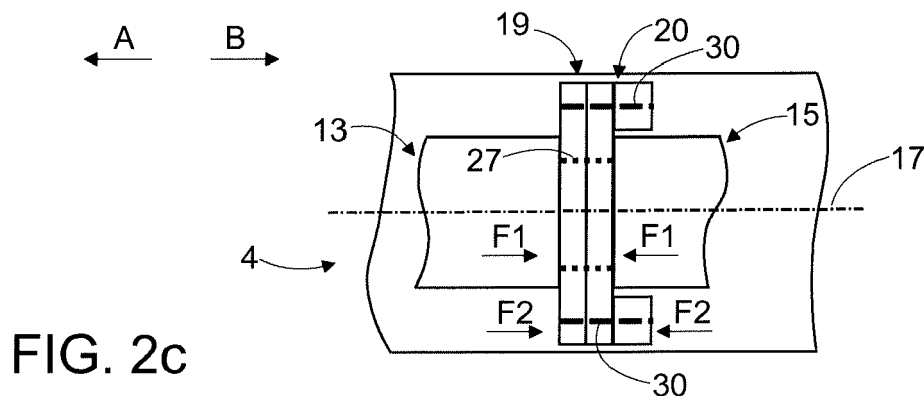
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(54) **ARRANGEMENT IN ROCK DRILLING MACHINE AND METHOD OF MOUNTING ROCK DRILLING MACHINE**

(57) The invention relates to an arrangement in a rock drilling machine and to a method of mounting the same. The rock drilling machine (4) comprises a gear module (13) and a percussion module (15), which are arranged on a same axial line (17). The modules are pressed towards each other by means of several first connecting means (27) and several second connecting

means (30). The connecting means generate first axial connecting forces (F1) and second axial connecting forces (F2) which receive axial operational forces of the rock drilling machine. The second connecting means also fasten the rock drilling machine to a carriage (5) provided with support surfaces (28).



Description

Background of the invention

[0001] The invention relates to an arrangement comprising a rock drilling machine, which is mounted on a carriage supportable to a feed beam of a rock drilling rig. The rock drilling machine comprises a gear module and a percussion module, which are arranged on a same axial line and are connected to each other by means of connecting means.

[0002] The invention further relates to a method of mounting a rock drilling machine.

[0003] The field of the invention is defined more specifically in the preambles of the independent claims.

[0004] In mines and at other work sites, rock drilling machines are used for drilling bore holes into rock surfaces and soil. The rock drilling machine comprises a rotating device for rotating a drilling tool during drilling around longitudinal axis of the drilling tool. The rock drilling machine also comprises a percussion device for generating impact pulses to the drilling tool. The rock drilling machine is typically connected to a carriage, which is supported to a feed beam of a rock drilling rig. During the operation of the rock drilling machine axial forces are directed to connecting means arranged between the rotating device and the percussion device. The present solutions have shown to contain some problems regarding durability of the connecting means.

Brief description of the invention

[0005] An object of the invention is to provide a novel and improved arrangement and method for mounting a rock drilling machine.

[0006] The arrangement according to the invention is characterized by the characterized features of the independent apparatus claim.

[0007] The method according to the invention is characterized by the characterized features of the independent method claim.

[0008] An idea of the disclosed solution is that the rock drilling machine comprises a gear module and a percussion module. The gear module comprises transmission elements, such as gear wheels, for transmitting rotation, and the percussion module comprises an impact element, such as a percussion piston, for generating impact pulses. The gear module and the percussion module are arranged on a same axial line, and they are pressed axially towards each other by means of first connecting means, which generate a first connecting force. In addition to the first connecting means and the generated first connecting force, the gear module and the percussion module are pressed towards each other by means of second connecting means, which generate a second connecting force. The second connecting means also have another purpose, namely to provide fastening of the rock drilling machine to a support surface of a car-

riage. In other words, the gear module and the percussion module may be coupled to each other before mounting to the carriage, and the connection to the carriage generates additional connecting forces ensuring that joint surfaces, which are located between the gear module and the percussion module, are properly fastened despite of separating forces directed to the modules during the operation of the rock drilling machine. Thus, in the disclosed solution the first connecting means and the second connecting means together ensure that the axial joint surfaces are pressed towards each other despite of operational forces pulling the joint surfaces away from each other. In other words, the axial forces directed to the connections of the modules are thereby shared with two connecting systems.

[0009] An advantage of the disclosed solution is that one or more joints between the gear module and the percussion module are more secure since two connecting systems are utilized. The operational forces that are pulling apart the gear module and the percussion module are received by the first connecting means and the second connecting means, whereby the stresses are shared with two different connecting systems, instead of one. Thanks to this, service life of the connecting means may be longer and failures may be decreased. This has a positive impact to productivity of the rock drilling machine. A further advantage is that wear and deformations of joint surfaces of the modules may be decreased because the modules are firmly mounted by means of the disclosed double-connecting system. Since the joint surfaces locating between the gear module and the percussion module are pressed continuously and firmly against each other, no relative movement occurs between opposing joint surfaces and wearing is decreased. Also, since the gear module and the percussion module are pre-coupled to each other by means of the first connecting system, the rock drilling machine may be easily dismantled for service and repair.

[0010] According to an embodiment, the carriage is provided with one or more axial first support surfaces, which are facing towards the front end portion of the rock drilling machine. The percussion module comprises one or more axial second support surfaces, which are facing towards the rear end portion of the rock drilling machine. The axial first support surfaces of the carriage and the axial second support surfaces of the percussion module are arranged against each other when the pre-assembled rock drilling machine is mounted to the carriage. The second connecting force presses the support surfaces against each other and keeps the rock drilling machine firmly connected to the carriage. The front directed axial first support surface of the carriage is advantageous since it provides a firm axial element for transmitting front directed feed forces from the carriage to the body of the rock drilling machine. The front directed axial first support surface of the carriage may also provide support against rearward directed forces caused by stress pulses reflecting backwards from the drilled material along the drilling

tool. Thus, the feed forces and the reflecting stress pulses do not cause extra loadings to the second connecting means. In this embodiment the second connecting means are configured to transmit backward directed forces from the carriage to the body of the rock drilling machine when the rock drilling machine is reversed on the feed beam.

[0011] According to an embodiment, the connection between the carriage and the percussion module comprises axial support surfaces, which are directed in an opposing manner compared to the previous embodiment disclosed above. Thereby, the carriage is provided with one or more axial first support surfaces facing rearward, and the percussion module comprises one or more axial second support surfaces facing forward. The support surfaces facing in opposing directions are arranged against each other and are secured by means of the second connecting force. In this solution the second connecting means are not subjected to extra loading when the rock drilling machine is reversed on the feed beam and the drilling equipment is retracted from the drill hole. This solution may be advantageous when long drill holes are drilled vertically and weight of the supported drilling equipment is great, or when the retracting of the drilling equipment is problematic because of any other reason.

[0012] According to an embodiment, the first and second connecting means comprise several axially directed connecting bolts. The use of connecting bolts and screwfastening is advantageous since they tolerate well fatigue loadings, and also because they are simple and inexpensive.

[0013] According to an embodiment, the first and second connecting means comprise several axially directed connecting bolts. Furthermore, the first connecting means, i.e. first connecting bolts and the second connecting means, i.e. second connecting bolts are located at different distances from a center line of the rock drilling machine. Thereby, a transverse first distance between longitudinal axis of the first connecting bolts and a central line is minor than a second distance between longitudinal axis of the second connecting bolts and the central line. Thanks to this embodiment, there is more space for placing the connecting bolts, whereby number of the first and second connecting bolts needs not to be restricted, and further, easy access is ensured whereby the mounting and dismounting of the connecting bolts are facilitated.

[0014] According to an embodiment, the first and second connecting means comprise several axially directed connecting bolts. The first connecting means comprise several pin bolts and the second connecting means comprise several through bolts. The pin bolts, or side bolts, are tightened to threaded blind holes, which are located at the rear directed first axial joint surface of the gear module. The front directed second axial joint surface of the percussion module comprises several through holes matching the positions of the pin bolts, whereby free ends of the pin bolts may pass through the through holes. The free ends of the pin bolts are provided with threads al-

lowing screwing of tightening nuts to the pin bolts for generating the first connecting force. The pin bolts facilitate mounting of the percussion module since they may guide the percussion module during the mounting measures. Since the pin bolts are tightened to the blind holes, there is no need to reserve space for any bolt heads at the gear module side. A further advantage is that the pin bolts may be placed close to the central line of the rock drilling machine, where they provide better support for the joint surfaces compared to situations where the support is directed at a longer distance from the central line. Furthermore, the arrangement comprises several through holes for the second connecting bolts. The second connecting bolts pass through first through holes of the first connecting surface of the gear module, through second through holes of the second connecting surface of the percussion module, and further through third through holes of the support surface of the carriage. The first, second and third through holes are parallel, so that the second connecting bolts may pass through them. The second connecting bolts have screw heads at their first end and the second ends are provided with screw threads for receiving tightening nuts. The second connecting force is generated by tightening the second bolts by means of the tightening nuts.

[0015] According to an embodiment, the rear directed first axial joint surface of the gear module and the front directed second axial joint surface of the percussion module are arranged directly against to each other. The opposing joint surfaces are pressed against each other by means of the two fastening systems, whereby the first connecting forces and second connecting forces keep the joint surfaces firmly against each other. Thus, in this embodiment, no other machine elements, devices or body parts are arranged between the first and second joint surfaces of the modules.

[0016] According to an embodiment, the rear directed first axial joint surface of the gear module and the front directed second axial joint surface of the percussion module are not arranged directly against to each other. Instead of the direct contact between the modules, the arrangement comprises at least one intermediate element arranged between them. The intermediate element may be a machine component or a body part, for example. The intermediate element comprises front directed third axial joint surfaces facing towards the gear module and rear directed fourth axial joint surfaces facing towards the percussion module. Since the intermediate element is arranged between the gear module and the percussion module, the rear directed first joint surfaces of the gear module and the front directed third joint surfaces of the intermediate element are arranged against each other. Correspondingly, the front directed second joint surfaces of the percussion module and the rear directed fourth joint surfaces of the intermediate element are arranged against each other. The mentioned opposing joint surfaces are pressed against each other by means of the first and second connecting means. The intermediate el-

ement may be an auxiliary device or module, such as an axial bearing module. Alternatively, the intermediate element may be a support flange, which is mountable to the carriage.

[0017] According to an embodiment, the gear module and the percussion module both comprise flanges provided with axial joint surfaces. Then, the rear end portion of the gear module comprises a first connecting flange provided with the first axial joint surfaces, and the front end portion of a cylindrical main body of the percussion module comprises a second connecting flange provided with the second axial joint surfaces. Thanks to the flanges, sufficient joint surface areas are provided for the main body parts of the modules. The use of the flanges is also beneficial regarding placement of the connecting bolts and the openings needed for them. The flanges allow the main body of the percussion module to be a relatively thin walled cylindrical element, for example. The second connecting bolts are located at the flanges so that they are at a transverse distance from an outer line passing along an outer surface of the cylindrical-shaped body part.

[0018] According to an embodiment, the carriage comprises a body part, which is an elongated base element arranged longitudinally relative to the rock drilling machine. The body part is intended to be arranged below the rock drilling machine and is provided with bearings for mounting it on a feed beam. The carriage further comprises two transverse fastenings lugs extending upwardly from the body part, and which lugs are located at a transverse distance from each other. Thereby, a free space exists at a central line of the carriage between the fastening lugs. The fastening lugs are provided with front directed axial support surfaces, and further, they also comprise through holes for receiving the second connecting bolts. The rock drilling machine is mounted at the longitudinal central line of the carriage, whereby the percussion module is located between the fastening lugs. The rear directed axial support surfaces of the percussion module are fastened against the front directed support surfaces of the fastening lugs, and the connection is secured by means of the second connecting bolts. Thanks to the disclosed fastening lugs, the joint between the gear module and the percussion module may be without supporting elements belonging to the structure of the carriage.

[0019] According to an embodiment, the front end portion of the gear module is supported to the carriage by means of a front support, and correspondingly the rear end portion of the percussion module is supported to the carriage by means of a rear support. Distal end portions of the bodies of the gear module and the percussion module may comprise support flanges. The front and rear support of the carriage may comprise upwardly directed surfaces, against which the support flanges may be supported and fastened by using transversal mounting bolts. The disclosed end supports have primary purpose for receiving vertical loads, since the axial forces are re-

ceived by the axial support surfaces of the carriage.

[0020] According to an embodiment, the rock drilling machine comprises a flushing housing at the front of the gear module. The flushing housing may comprise a rear flange connected against a frontal flange of the gear module by means of axial fastening screws. The flushing housing further comprises at least one feed port for feeding flushing fluid inside the flushing housing and further via a drilling tool to a bottom of a drill hole. The flushing housing may serve as a kind of a front cover for the rock drilling machine. The flushing housing may already be assembled on its place when the rock drilling machine is mounted on the carrier.

[0021] According to an embodiment, at the front end portion of the rock drilling machine is an axial shank, which is rotated by means of axial splines or corresponding rotation transmitting elements being in engagement with a gear system of the gear module. A rearmost end of the shank comprises an impact surface for receiving impact pulses from the percussion module. The shank is allowed to be moved axially during the drilling. In order to influence to the axial position of the shank and the impact surface, the rock drilling machine is provided with an axial bearing module. The axial bearing module comprises one or more axial pistons, which are axially movable and are arranged to affect to axial position of the shank. The axial pistons may be sleeve-like objects arranged around the percussion piston and they may be moved hydraulically. Alternatively, several axial shaft-like pistons may be placed around the percussion piston. The axial bearing module is located at the front end portion of the percussion module, whereby the axial piston of the bearing module reaches to the shank directly or by means of one or more axial transmitting elements. When the axial piston of the axial bearing module pushes the shank in the front direction, then the axial bearing module generates forces which endeavor to push the gear module away from the percussion module. The forces generated by the operation of the axial bearing module are received by the first and second connecting bolts.

[0022] According to an embodiment, the rock drilling rig comprises an axial bearing, which differs from the above disclosed embodiment in that it is not located inside the percussion module. Instead, the arrangement comprises an intermediate element arranged between the gear module and the percussion module, and the intermediate module comprises the axial bearing. Thus, intermediate element provided with the axial bearing may be easily removed and substituted as one complete element. Since the intermediate element is between the opposing joint surfaces of the gear module and the percussion module, the axial forces derived from the operation of the axial bearing are received by the two connecting means disclosed in this patent application. The intermediate element may be a flange-like element.

[0023] According to an embodiment, the body of the percussion module is an elongated cylindrically shaped piece comprising a transversal connecting flange at the

front end portion of the percussion module, and the connecting flange is provided with the axial second joint surfaces. Further, the rear end of the body of the percussion module is provided with a rear cover.

[0024] According to an embodiment, the percussion module comprises a pressure medium operated percussion device. Then, pressure medium under high pressure is fed to the percussion module in order to generate impact pulses by means of percussion piston, or utilizing any other type of impact element. The fed high pressurized hydraulic oil, or any other fluid, causes inside the rock drilling machine axial forces, which push the gear module and the percussion module towards opposing directions from each other. The generated internal pressure-based forces are received by the first and second connecting means. Thus, the double connecting system provides counterforces against the generated pressure-based internal forces.

[0025] According to an embodiment, the percussion module comprises a percussion piston supported inside the body of the percussion module, and the percussion piston being arranged to move axially in an impact direction towards the front end portion of the rock drilling machine and correspondingly in a return direction towards the rear end portion. Inside the gear module is a shank supported to the body of the gear module rotatable and axially movably. The gear module further comprises a gear transmission for transmitting rotation torque to the shank in order to rotate the shank around its longitudinal axis. The shank comprises connecting threads at a front end portion of the shank for connecting a drilling tool to the shank by means of a screw-mounting. In this embodiment the operation of the percussion module is based on reciprocating percussion piston, which strikes an impact surface of the shank at the end of the movement towards the impact direction and which moves in a reverse direction after the impact until the direction of movement again changes from the return movement to impact direction movement. The reciprocating movement of the percussion piston causes axial forces which may be received by means of the disclosed double connecting means. Accelerations and decelerations of the percussion piston cause axial forces, whereby the axial connecting means are subjected to axial stresses and fatigue. These loadings are shared with two connecting systems, whereby long service life may be ensured.

[0026] According to an embodiment, the percussion module comprises an impact element, which is not moving in reciprocating manner. Instead length of the impact element may be shortened, and when being suddenly released to the original length, an impact pulse is generated. Thereby, other type of percussion modules, than disclosed in more detailed in this patent application, may also be utilized in the disclosed arrangement.

[0027] According to an embodiment, the rotation device comprises a rotating motor, which is located above the axial connection arrangement of the gear module, fastening lugs and the percussion module. The rotating

motor may extend from the rear end of the gear module towards a rear end of the rock drilling machine. Thanks to this embodiment, the rotating motor does not increase sideward dimensions of the rock drilling machine.

[0028] According to an embodiment, the rotation device comprises a rotating motor, which is located on a side of the axial connection arrangement of the gear module, fastening lugs and the percussion module. Thanks to this embodiment, the rotating motor does not increase height dimensions of the rock drilling machine.

[0029] According to an embodiment, the disclosed arrangement is applied in a rock drilling rig, comprising a movable carrier, at least one drilling boom and a feed beam in the at least one drilling boom.

[0030] The above-disclosed embodiments may be combined to form suitable solutions provided with necessary features disclosed.

Brief description of the figures

[0031] Some embodiments are described in more detail in the accompanying drawings, in which

Figure 1 is a side view showing a rock drilling machine arranged on a feed beam,

Figures 2a - 2c are top views showing the basic principles of the present solution for assembling modules of a rock drilling machine and mounting the rock drilling machine to a carriage,

Figure 3 is a schematic side view showing a rock drilling machine comprising a gear module and a percussion module and being provided with a double connecting system between the modules,

Figure 4 is schematic top view of the rock drilling machine shown in Figure 3,

Figure 5 is a schematic and partly sectional side view showing a rock drilling machine provided with the disclosed fastening systems and an axial bearing at a front end portion of a percussion module,

Figure 6 is a schematic top view showing an alternative connection arrangement, wherein the rock drilling machine is fastened against rear directed support surfaces of fastening lugs of a carriage,

Figure 7 is a schematic side view of a rock drilling machine comprising an intermediate module between a gear module and a percussion module, and

Figure 8 is a schematic top view of the rock drilling machine shown in Figure 7 and it further illustrates that the intermediate module or element may be provided with an axial bearing for influencing axial position of a shank.

[0032] For the sake of clarity, the figures show some embodiments of the disclosed solution in a simplified manner. In the figures, like reference numerals identify like elements.

Detailed description of some embodiments

[0033] Figure 1 shows a feasible rock drilling unit 1 which may be connected by means of a boom 2 to a movable carrier of a rock drilling rig, which is not shown. The drilling unit 1 may comprise a feed beam 3 and a rock drilling machine 4 supported on it by means of a carriage 5. The rock drilling machine 4 may be moved in a drilling direction A and reversing direction B on the feed beam 3 by means of a feed device 6, which is connected to the carriage 5. The rock drilling machine 4 comprises a shank 7 at a front end portion of the rock drilling machine 4 for connecting a drilling tool 8. The drilling tool 8 may comprise one or more drill rods and a drill bit 9 located at a distal end of the drilling tool 8. The rock drilling machine 4 further comprises a rotating device 10 for rotating R the shank 7 and the drilling tool 8 connected to the shank 7. The rock drilling machine 4 is also provided with a percussion device 11 comprising an impact element, such as a reciprocating percussion piston for generating impact pulses P to the drilling tool 8.

[0034] Figure 1 further discloses that the rotating device 10 comprises a rotation motor 12, which may be a hydraulic motor, for example. Torque generated by the rotation motor 12 is transmitted via a gear module 13 to the shank 7. The gear module 13 comprises a gear system inside a body of the gear module 13. The front end of the gear module may comprise a flushing housing 14, and a rear end of the gear module 13 is connected to a percussion module 15 inside which the percussion piston 16 of corresponding impact element for producing impact pulses P is located. Thus, the percussion device 11 may be pressure fluid operated, typically hydraulically operated, whereby the percussion module 15 is connected to hydraulic circuit of the rock drilling rig. The rock drilling machine 4 may be pre-assembled before mounting it to the carriage 5, or at least the gear module 13 and the percussion module 15 are connected to each other, either directly, or via one or more intermediate elements. As can be seen, the gear module 13 and the percussion module 15 are arranged successively on a same axial line 17. The carriage 5 may comprise one or more fastening lugs 18 against which the rock drilling machine 4 may be supported axially. Joint 19 between the modules 13 and 15 is subjected to forces that are pulling the modules away from each other. These forces are generated when high pressurized fluid is fed to the percussion module, when the reciprocating percussion piston is accelerated and decelerated, and also when impact pulses P are reflecting back from the drilled material and are received as reflecting impact pulses RP. Axial forces are directed to the axial connection 20 between the rock drilling machine 4 and the fastening lugs or surfaces of the carriage 5 when forward directed feed force FA is generated during the drilling and when a rearward directed feed force FB is generated for retracting the rock drilling machine 4. Thus, the joint 19 and the axial connection 20 are subjected to axial forces wherefore the double fastening sys-

tem disclosed in this patent application is beneficial.

[0035] Let it be mentioned that the drilling direction A also indicates the front direction and the reversing direction B indicates the rear direction.

[0036] At a drilling site, one or more drill holes are drilled with the drilling unit 1. The drill holes may be drilled in a horizontal direction, as shown in Figure 1, or in a vertical direction. The disclosed solution is known as top-hammer drilling. The features disclosed in this application may be applied in such drilling machines.

[0037] Figures 2a - 2c illustrate in a simplified manner phases of assembly of the rock drilling machine 4 to a carriage 5. Figure 2a shows a gear module 13 provided with a rear directed first joint surface 21 and a percussion module 15 provided with a front directed second joint surface 22. The gear module 13 comprises a main body 23 a rear end of which may be provided with a flange 24, and correspondingly a main body 25 of the percussion module 15 may also comprise a flange 26. In Figure 2b the joint surfaces 21, 22 facing towards each other are arranged against each other and are connected by means of first connecting means 27, which generate first connecting forces F1. Thus, in Figure 2b a joint 19 is made between the modules 13 and 15. This means that, the rock drilling machine 4 may be pre-assembled, or at least partly pre-assembled before mounting it to the carriage 5. Figure 2b further shows that the fastening lugs 18 comprise front directed first axial support surfaces 28 against which rear directed second axial support surfaces 29 of the percussion module 15 may be fastened by means of second connecting means 30, which are shown in Figure 2c. Thereby an axial connection 20 is formed between the rock drilling machine 4 and the carrier 5.

[0038] In Figures 3 - 5, 7 and 8 small arrows are disclosed in connection with the connecting bolts for indicating connection forces generated.

[0039] Figure 3 and 4 disclose an arrangement wherein the above disclosed mounting principles are applied in the joint 19 and the axial connection 20. The axial joint surfaces of the gear module 13 and the percussion module 15 are pressed against each other by means of the first connecting forces F1 and the second connecting forces F2. The first connecting forces F1 are generated by means of first connecting bolts 31, which may be pin bolts screwed to threaded blind holes 32 of the gear module 13. The opposite ends of the pin bolts may be provided with tightening nuts 33. The second fastening forces F2 may be generated by means of second connecting bolts 34, which may pass through holes made to the flanges 24, 26 and to the fastening lugs 18.

[0040] Figures 3 and 4 further disclose that the main body 25 of the percussion module 15 may be substantially cylinder-shaped and that a rear end of the body may be provided with an end cover 35. Between a rear portion of the body 25 of the percussion module and the carriage 5 may be a vertical rear support 36, and correspondingly between a front portion of a main body 23 of the gear module 13 and the carriage 5 may be a vertical front

support 37. The vertical supports 36 and 37 may comprise vertical support surfaces and screw-fastening means.

[0041] Figure 5 shows a rock drilling machine provided with an axial bearing module 38 at a front end of the percussion module 15. The axial bearing module 38 may comprise a sleeve like axial piston 39 which may influence to axial position of the shank 7. The force generated by the axial piston 39 may be transmitted to the shank directly or via a transmitting element 40. The operation of the axial bearing module 38 causes axial support forces to the modules and these forces are received by the first connection bolts 31 and the second connection bolts 34. The disclosed embodiment of Figure 5 comprises substantially similar other features as disclosed in previous Figures 1 - 4.

[0042] Figure 6 discloses an alternative arrangement, wherein the gear module 13 comprises front directed support surfaces 41 arranged against rear directed support surfaces of the fastening lugs 18. All the other features may be in accordance with above disclosed embodiments.

[0043] Figures 7 and 8 show an arrangement, wherein between the gear module 13 and the percussion module 15 is an intermediate module 42. The intermediate module 42 may comprise a space 43 for an axial bearing module. Then the percussion module is without any axial bearing module. The bearing module may correspond to the one disclosed in Figure 5. A rear end of the intermediate module 42 may comprise a rearward protruding part and the front end of the percussion module may comprise a recess for receiving it. The intermediate element 42 comprises third axial joint surfaces 44 facing towards the gear module 13 and fourth axial joint surfaces 45 facing towards the percussion module 15. The first joint surfaces 21 of the gear module and the third joint surfaces 44 of the intermediate module 42 are arranged against each other, and correspondingly the second joint surfaces 22 of the percussion module and the fourth joint surfaces 45 of the intermediate module 42 are arranged against each other. First connecting bolts 31 and the second connecting bolts 34 press the mentioned axial joint surfaces against each other and keep them locked by means of axial connecting forces F1 and F2 generated by the double connecting system.

[0044] In Figures 5 and 8 an impact element, such as a reciprocating percussion piston 16 is shown in broken lines and highly simplified.

[0045] The drawings and the related description are only intended to illustrate the idea of the invention. In its details, the invention may vary within the scope of the claims.

Claims

1. An arrangement in a rock drilling machine, which arrangement comprises:

a rock drilling machine (4) comprising a gear module (13), which is located at a front end portion of the rock drilling machine and a percussion module (15), which is located at a rear end portion of the rock drilling machine, and the gear module (13) and the percussion module (15) are on a same axial line (17) and wherein a body (23) of the gear module (13) comprises a first axial joint surface (21) facing towards the rear end portion of the rock drilling machine, and whereby a body (25) of the percussion module (15) comprises a second axial joint surface (22) facing towards the front end portion of the rock drilling machine;

connecting means (31, 34) for connecting the gear module (13) and the percussion module (15); and

a carriage (5) supportable movably to a feed beam and comprising axial first support surfaces (28) for connecting the rock drilling machine (4);

characterized in that

the connecting means comprise a plurality of first connecting means (27) and a plurality of second connecting means (30);

the first connecting means (27) generate a first connecting force (F1) for pressing the first axial joint surface (21) of the gear module (13) and the second axial joint surface (22) of the percussion module (15) towards each other; and

the second connecting means (30) generate a second connecting force (F2) for pressing the first axial joint surface (21) of the gear module (13) and the second axial joint surface (22) of the percussion module (15) towards each other, and which second connecting force (F2) is configured to fasten the gear module (13) and the percussion module (15) to the axial first support surfaces (28) of the carriage (5).

2. The arrangement as claimed in claim 1, **characterized in that**

the axial first support surfaces (28) of the carriage (5) are facing towards the front end portion of the rock drilling machine (4);

the percussion module (15) comprises axial second support surfaces (29), which are facing towards the rear end portion of the rock drilling machine; and the axial first support surfaces (28) and the axial second support surfaces (29) are pressed towards each other under influence of the second connecting force (F2).

3. The arrangement as claimed in claim 1 or 2, **characterized in that**

the first connecting means (27) are axially directed first connecting bolts (31) and the second connecting means (30) are axially directed second connecting bolts (34); and

the first connecting bolts (31) are located at a shorter distance from a central line (17) of the rock drilling machine (4) compared to the second connecting bolts (34), whereby the first connecting bolts (31) and the second connecting bolts (34) are located at different positions relative to each other.

4. The arrangement as claimed in any one of the preceding claims 1 to 3, **characterized in that** the first connecting means (27) are axially directed first connecting bolts (31) and the second connecting means (30) are axially directed second connecting bolts (34);
the first axial joint surface (21) of the gear module (13) comprises several blind holes (32) provided with connection threads;
the first connecting bolts (31) are pin bolts connected to the blind holes (32);
the second axial joint surface (22) of the percussion module (15) comprises several through holes through which the pin bolts are passing;
outer ends of the pin bolts are provided with tightening nuts (33) for generating the first connecting force (F1);
the arrangement further comprises several axial through holes passing through the first connecting surface (21) of the gear module (13), the second connecting surface (22) of the percussion module (15) and the first support surfaces (28) of the carriage (5); and
the second connecting bolts (34) are configured to pass through the axial through holes and to generate the second connecting force (F2).
5. The arrangement as claimed in any one of the preceding claims 1 to 4, **characterized in that** the opposing first axial joint surface (21) of the gear module (13) and the second axial joint surface (22) of the percussion module (15) are arranged directly against to each other; and
the opposing joint surfaces (21, 22) are pressed against each other by means of the first connecting forces (F1) and second connecting forces (F2).
6. The arrangement as claimed in any one of the preceding claims 1 to 4, **characterized in that** the arrangement comprises at least one intermediate element (42) arranged between the gear module (13) and the percussion module (15), which intermediate element (42) comprises third axial joint surfaces (44) facing towards the gear module (13) and fourth axial joint surfaces (45) facing towards the percussion module (15); and
the first joint surfaces (21) and the third joint surfaces (44) are arranged against each other, and correspondingly the second joint surfaces (22) and the fourth joint surfaces (45) are arranged against each other, and are pressed against each other by means

of the first and second connecting forces (F1, F2).

7. The arrangement as claimed in any one of the preceding claims 1 to 6, **characterized in that** the rear end portion of the gear module (13) comprises a first connecting flange (24) provided with the first axial joint surfaces (21);
the body (25) of the percussion module (15) is cylinder-shaped and the front end port of the body comprises a second connecting flange (26) provided with the second axial joint surfaces (22); and
the second connecting means (30) are connecting bolts (34) which are located at a transverse distance from an outer line passing along an outer surface of the cylindrical-shaped body part.
8. The arrangement as claimed in any one of the preceding claims 1 to 7, **characterized in that** the carriage (5) comprises a body part, which is an elongated element arranged longitudinally relative to the rock drilling machine (4);
the carriage (5) comprise two transverse fastenings lugs (18) which are located at a transverse distance from each other;
the fastening lugs (18) are provided with axial support surfaces (28) facing towards the front end portion of the rock drilling machine; and
the percussion module (15) is located between the fastening lugs (18) at a longitudinal central line (17) of the carriage (5).
9. The arrangement as claimed in any one of the preceding claims 1 to 8, **characterized in that** the gear module (13) comprises an axial shank (7);
the rock drilling machine (4) comprises an axial bearing module (38) comprising at least one axial piston (39), which is axially movable and is configured to affect to axial position of the shank (7);
the axial bearing module (38) is located at the front end portion of the percussion module (15), and the operation of the axial bearing module (38) is configured to generate an axial force directed towards the front end of the rock drilling machine (4), whereby the force endeavors to push the gear module (13) away from the percussion module (15);
and wherein the first connecting means (27) and the second connecting means (30) are configured to receive the axial forces caused by the operational forces of the axial bearing module (38).
10. The arrangement as claimed in any one of the preceding claims 1 to 8, **characterized in that** the arrangement comprises at least one intermediate element (42) arranged between the gear module (13) and the percussion module (15);
the gear module (13) comprises an axial shank (7);
the rock drilling machine (4) comprises an axial bearing module (38) comprising at least one axial piston

(39), which is axially movable and is configured to affect to axial position of the shank (7);
 the axial bearing module (38) is located inside the intermediate element (42), and the operation of the axial bearing module (38) is configured to generate an axial force directed towards the front end of the rock drilling machine (4), the force endeavors to push the gear module (38) away from the intermediate element (42);
 and wherein the first connecting force (F1) and the second connecting force (F2) are configured to receive the operational forces of the axial bearing module (38) and to prevent the axial joint surfaces (21, 22, 44, 45) from being separated.

11. The arrangement as claimed in any one of the preceding claims 1 to 10, **characterized in that** the body (25) of the percussion module (15) is an elongated cylindrically shaped piece comprising a transversal connecting flange (26) at the front end portion of the percussion module (15), and the connecting flange (26) is provided with the axial second joint surfaces (22); and
 the rear end of the body of the percussion module (15) is provided with a rear cover (35).
12. The arrangement as claimed in any one of the preceding claims 1 to 11, **characterized in that** the percussion module (15) comprises a percussion piston (16) supported inside the body (25) of the percussion module (15), and the percussion piston (16) being arranged to move axially in an impact direction (A) towards the front end portion of the rock drilling machine (4) and correspondingly in a return direction (B) towards the rear end portion; and
 inside the gear module (13) is a shank (7) supported to a body (23) of the gear module (13) rotatable and axially movably;
 the gear module (13) further comprises a gear transmission for transmitting rotation torque to the shank (7) in order to rotate (R) the shank (7) around longitudinal axis of the shank; and
 wherein the shank (7) comprises connecting threads at a front end portion of the shank for connecting a drilling tool (8) to the shank (7) by means of a screw-mounting.
13. The arrangement as claimed in any one of the preceding claims 1 to 12, **characterized in that** the disclosed arrangement is applied in a rock drilling rig, comprising a movable carrier, at least one drilling boom and a feed beam in the at least one drilling boom.
14. A method of mounting a rock drilling machine, wherein the method comprises:

assembling the rock drilling machine (4) by con-

necting a gear module (13) and a percussion module (15) axially successively to each other by means of connecting elements;
 mounting the pre-assembled rock drilling machine (4) to a carriage (5) by means of fastening lugs (18), whereby the rock drilling machine (4) is supportable to a feed beam (3) of a rock drilling unit by means of the carriage (5);

characterized by

generating during the assembly of the rock drilling machine a first connecting force (F1) by means of several first connecting means (27) in order to press the gear module (13) and the percussion module (15) axially towards each other; mounting the rock drilling machine to the fastening lugs (18) of the carriage (5) by means of several second connecting means (30) and simultaneously generating a second connecting force (F2) for pressing the gear module (13) and the percussion module (15) axially towards each other; and

keeping during the operation of the rock drilling machine (4) axial joint surfaces (21, 22, 44, 45) between the gear module (13) and the percussion module (15) pressed against each other under influence of the first connecting forces (F1) and the second connecting forces (F2).

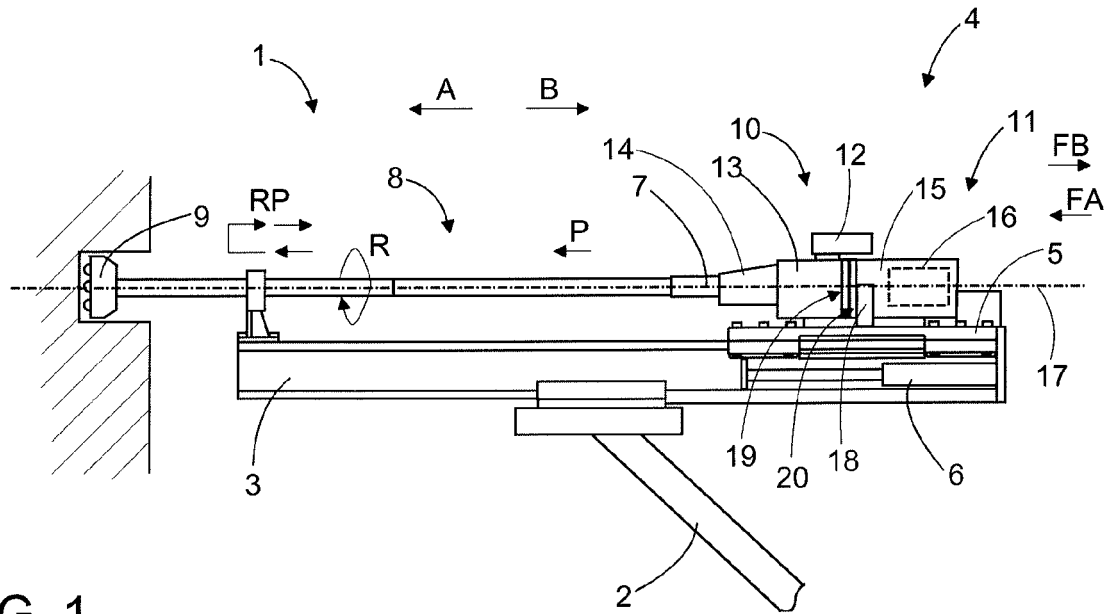


FIG. 1

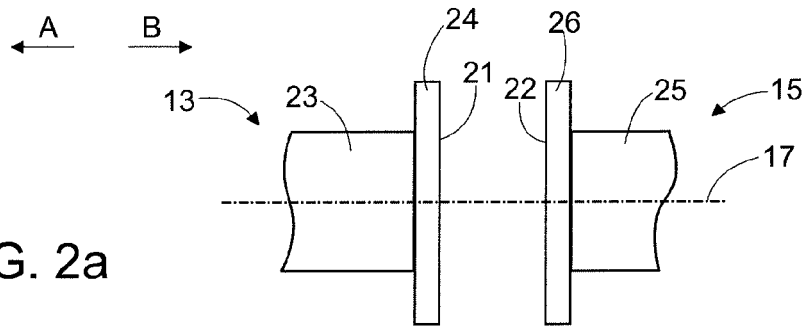


FIG. 2a

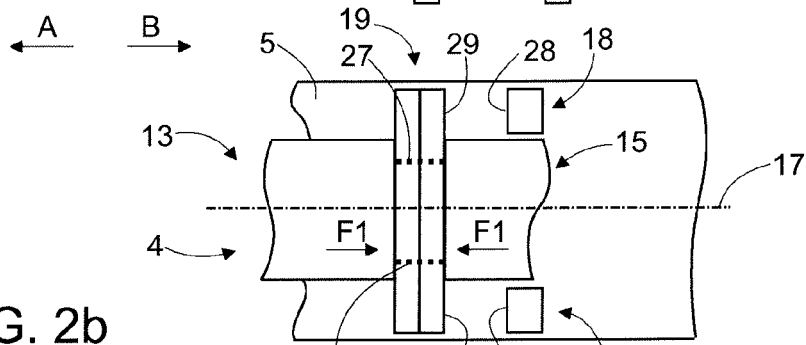


FIG. 2b

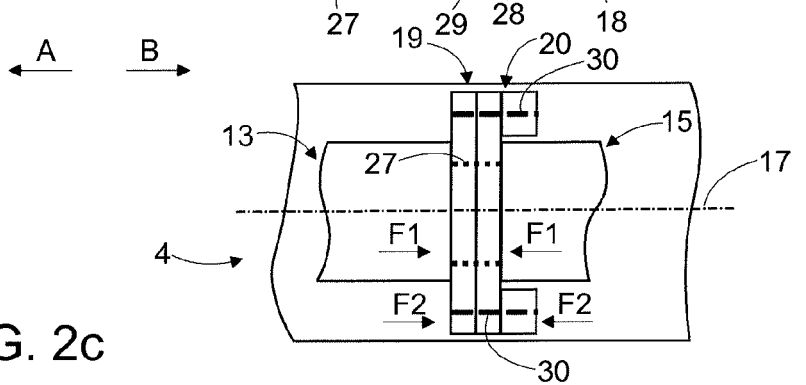


FIG. 2c

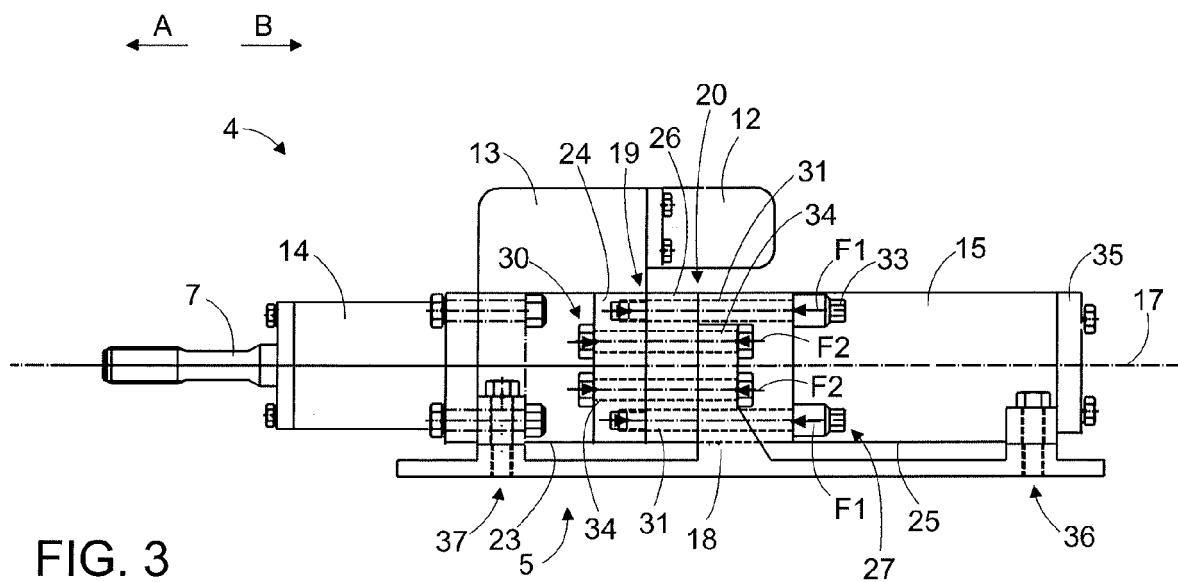


FIG. 3

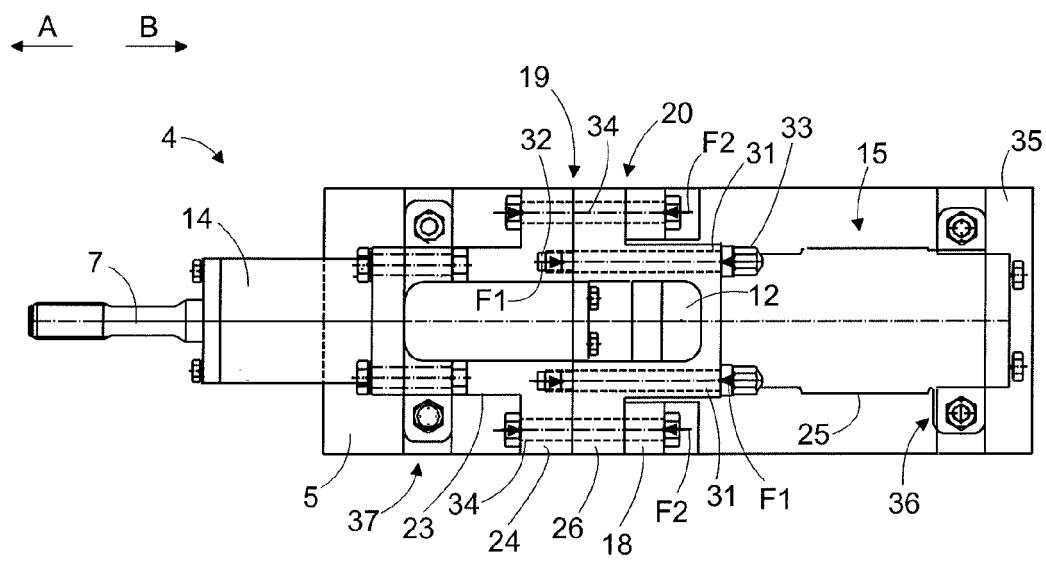


FIG. 4

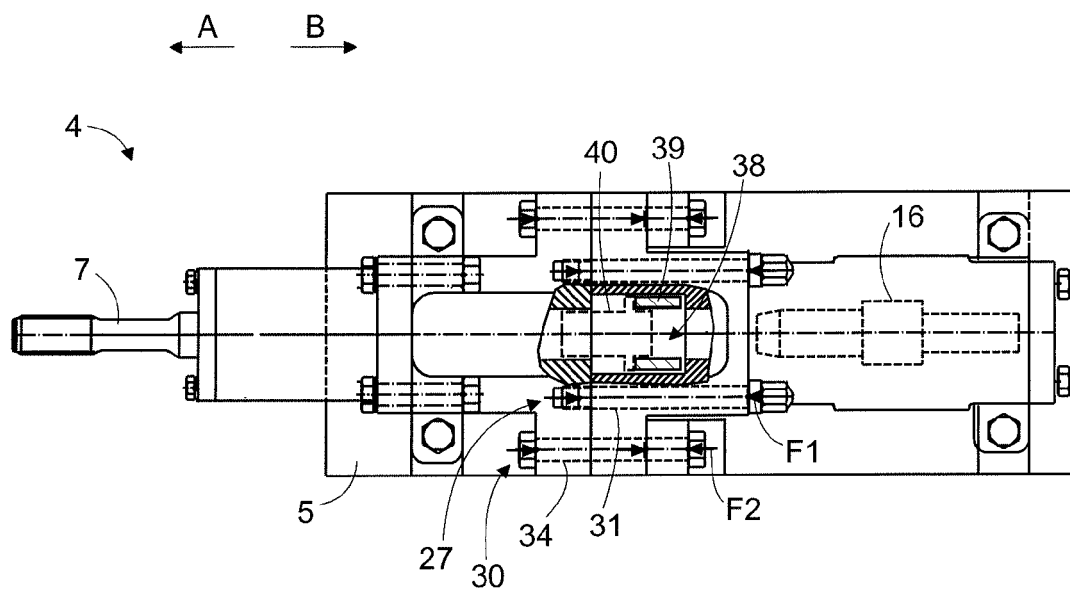


FIG. 5

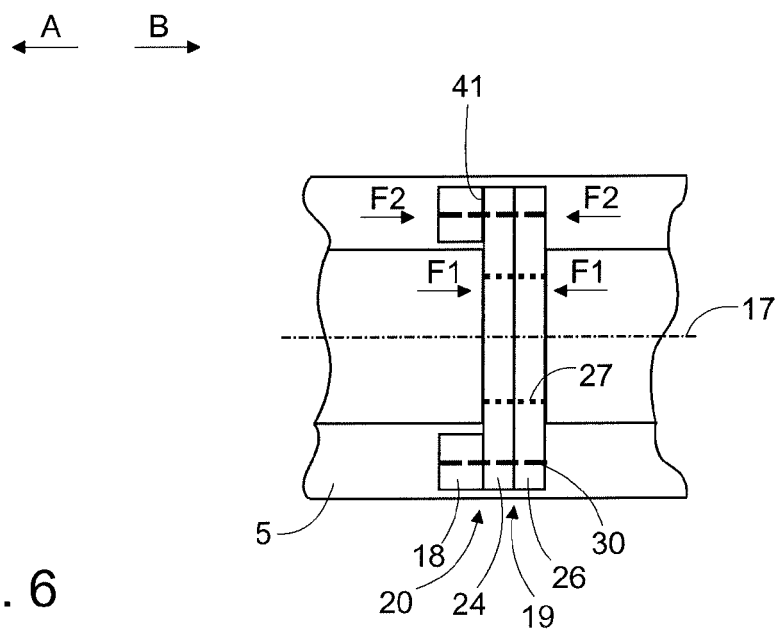


FIG. 6

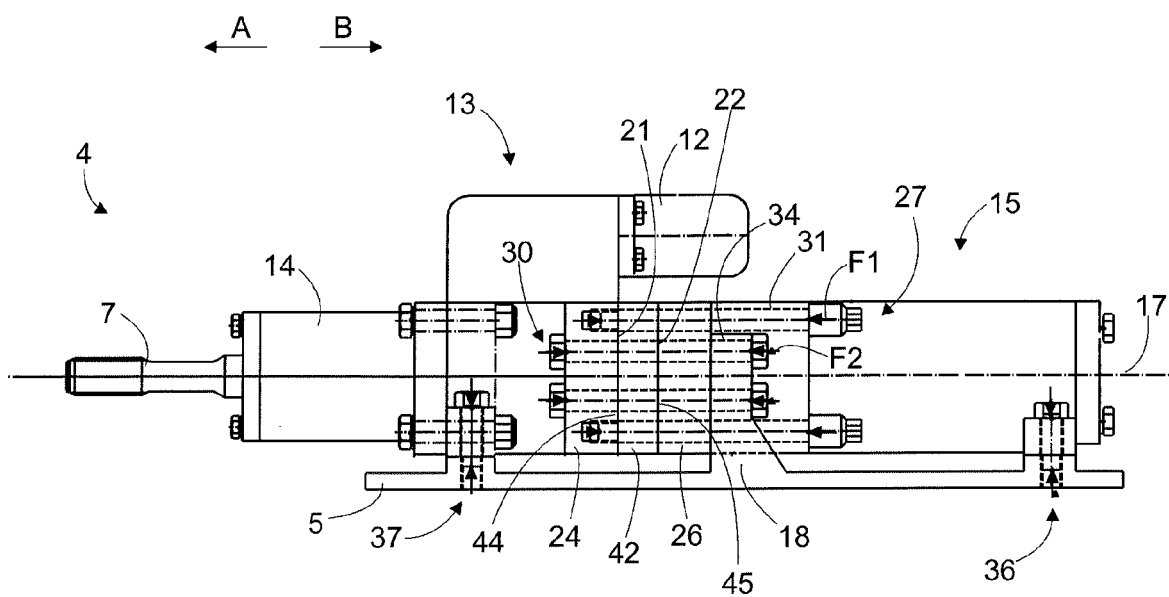


FIG. 7

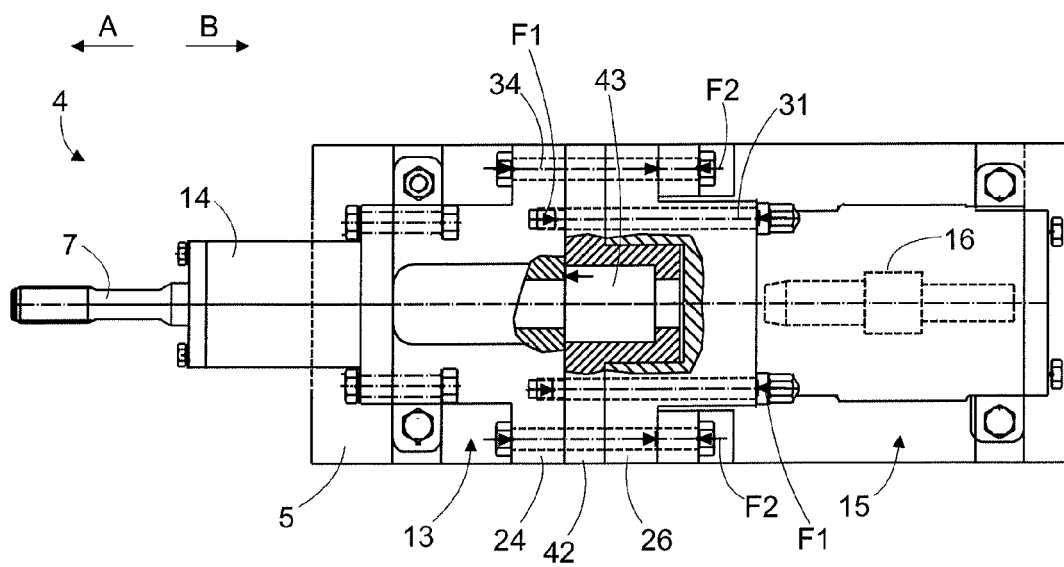


FIG. 8



EUROPEAN SEARCH REPORT

 Application Number
 EP 15 18 5209

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	US 2002/084110 A1 (HEINONEN JARMO [FI] ET AL) 4 July 2002 (2002-07-04) * the whole document *	1,3,6,7, 11-13 2,4,5, 8-10,14	INV. E21B6/04
A	----- US 4 846 289 A (HEINONEN JARMO [FI]) 11 July 1989 (1989-07-11) * the whole document *	1-14	
A	----- AU 2011 200 852 A1 (ROCKDRILL SERVICES AUSTRALIA PTY LTD) 1 March 2012 (2012-03-01) * page 10, line 5 - page 12, line 25 * * page 13, line 6 - line 11 * * figures *	1-14	
A	----- US 2014/360743 A1 (MUUTTONEN TIMO [FI]) 11 December 2014 (2014-12-11) * the whole document *	1-14	
			TECHNICAL FIELDS SEARCHED (IPC)
			E21B
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		15 February 2016	Dekker, Derk
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			

EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 15 18 5209

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 2002084110	A1	04-07-2002	AT	300659 T	15-08-2005
			AU	775489 B2	05-08-2004
			AU	5830700 A	22-01-2001
			CA	2375778 A1	11-01-2001
			CN	1357075 A	03-07-2002
			DE	60021573 D1	01-09-2005
			DE	60021573 T2	29-12-2005
			EP	1190155 A1	27-03-2002
			FI	991526 A	03-01-2001
			JP	4660044 B2	30-03-2011
			JP	2003503617 A	28-01-2003
			NO	20016417 A	27-02-2002
			PL	351613 A1	05-05-2003
			RU	2243346 C2	27-12-2004
			US	2002084110 A1	04-07-2002
			WO	0102691 A1	11-01-2001
			ZA	200109771 A	28-08-2002

US 4846289	A	11-07-1989	AT	396763 B	25-11-1993
			AU	592636 B2	18-01-1990
			AU	7189987 A	12-11-1987
			CA	1288762 C	10-09-1991
			CH	671900 A5	13-10-1989
			CN	87103327 A	25-11-1987
			DE	3714501 A1	12-11-1987
			FI	861939 A	10-11-1987
			FR	2598345 A1	13-11-1987
			GB	2190031 A	11-11-1987
			JP	H0686789 B2	02-11-1994
			JP	S62284883 A	10-12-1987
			SE	464771 B	10-06-1991
			US	4846289 A	11-07-1989
			ZA	8702886 A	15-10-1987

AU 2011200852	A1	01-03-2012	NONE		

US 2014360743	A1	11-12-2014	AU	2014202976 A1	15-01-2015
			CA	2851919 A1	07-12-2014
			CL	2014001453 A1	27-02-2015
			CN	104234620 A	24-12-2014
			EP	2811106 A1	10-12-2014
			JP	5844850 B2	20-01-2016
			JP	2014237999 A	18-12-2014
			KR	20140143717 A	17-12-2014
US	2014360743 A1	11-12-2014			

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82