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(54) **JOINT AND JOINT PARTS FOR DRILL STRING COMPONENTS AND COMPONENTS**

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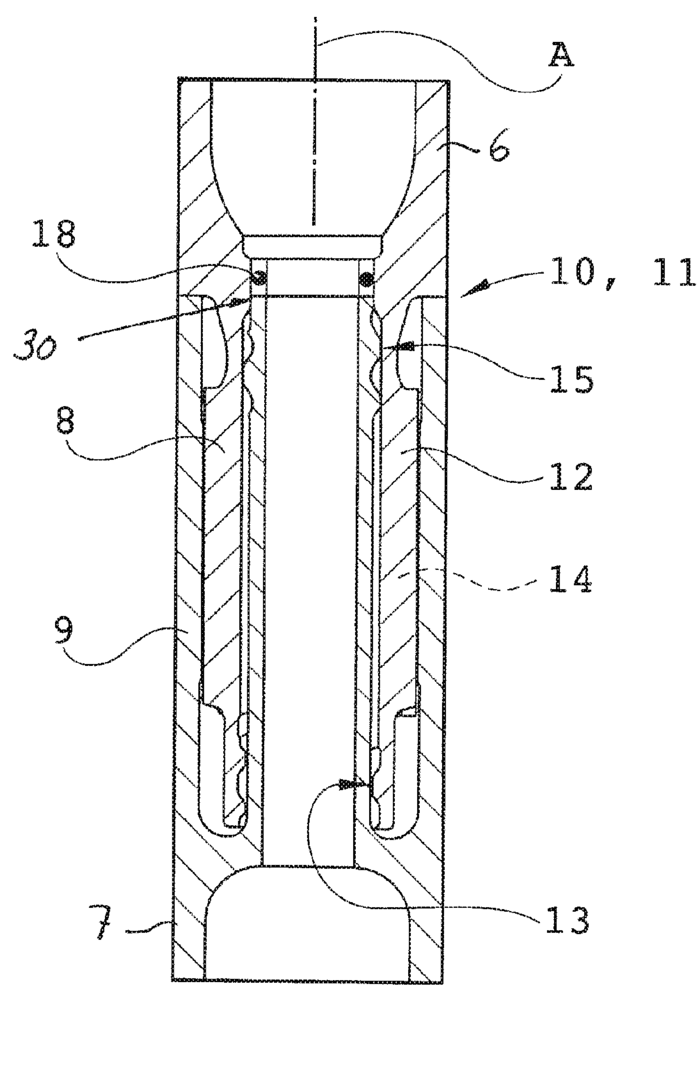
(57) **ABSTRACT**

A joint for joining together drill string components of a drill string for percussion drilling, the joint including a male part and a female part, wherein a first impact surface is arranged to co-operate with a second impact surface. When the drill string is in operation, relative axial movement is allowed between the male and the female parts when the first and the second impact surfaces are adjacent to each other. The invention also concerns a male joint part, a female joint part, a drill rod, a shank adapter, a drill head, a drill bit and a drill string component.



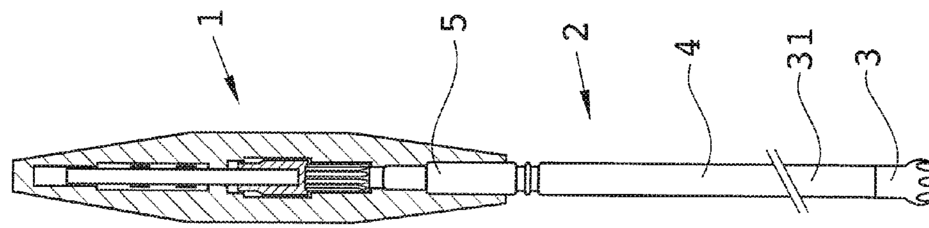


Fig 1

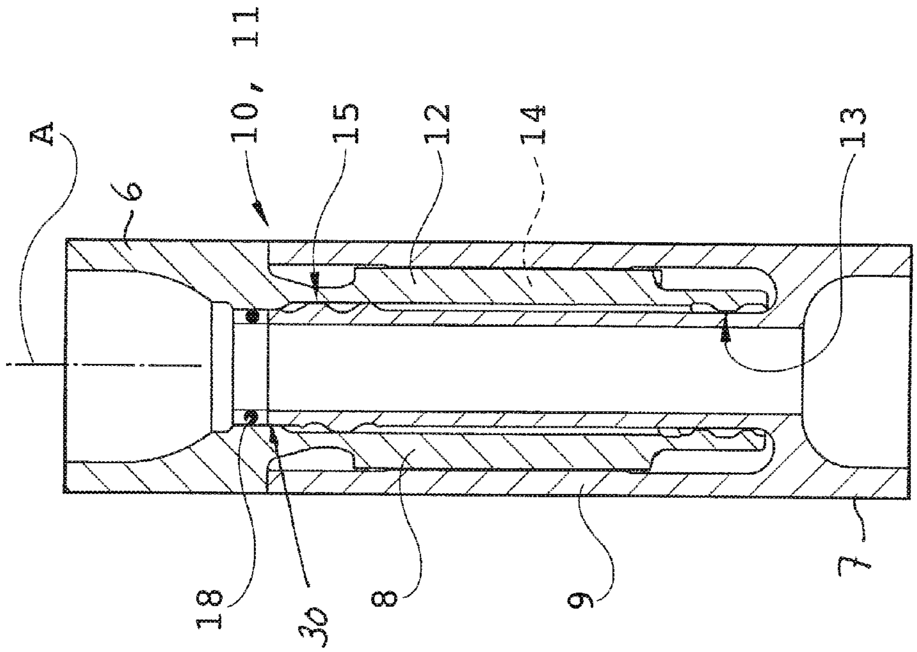


Fig 2C

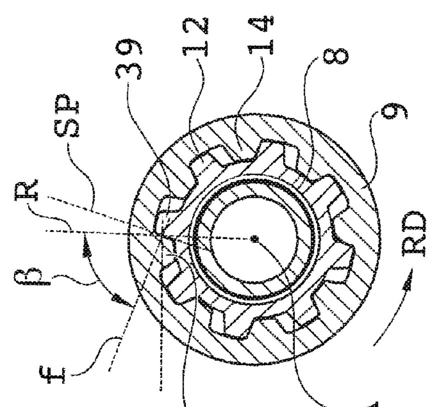


Fig 2C1

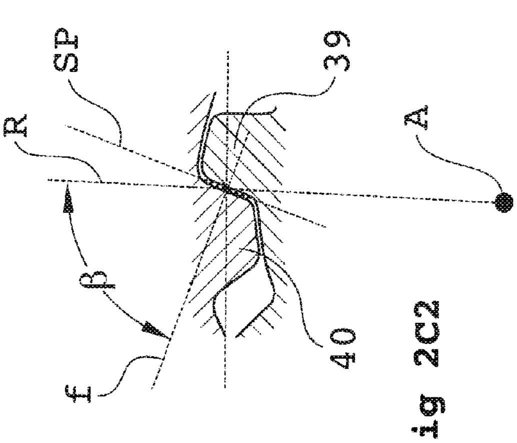


Fig 2C2

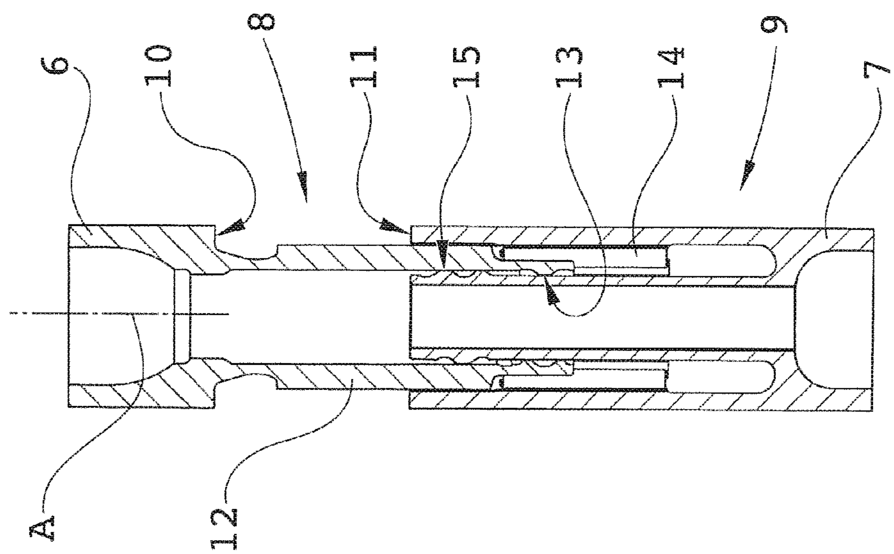


Fig.2b

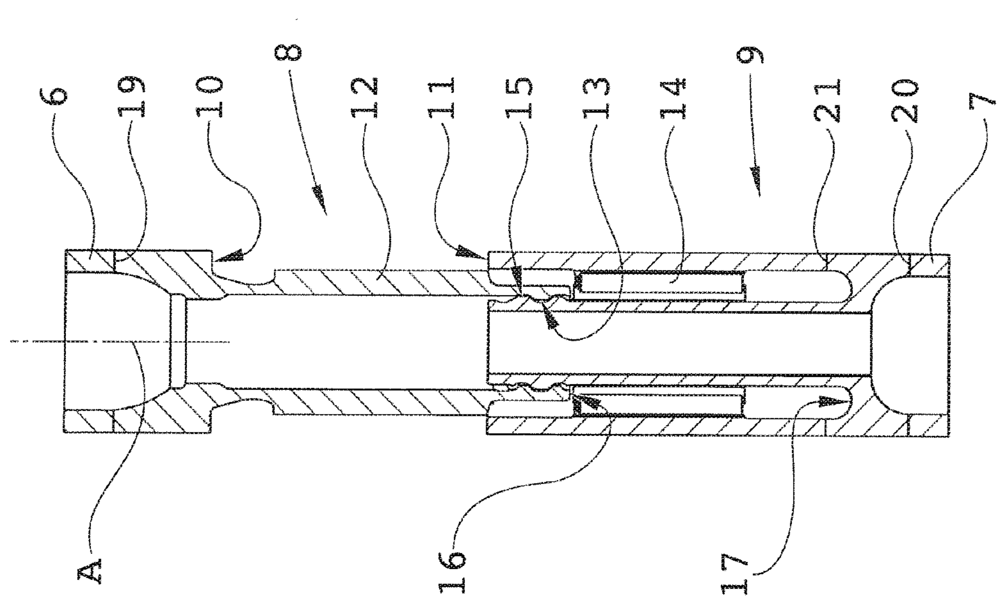


Fig.2a

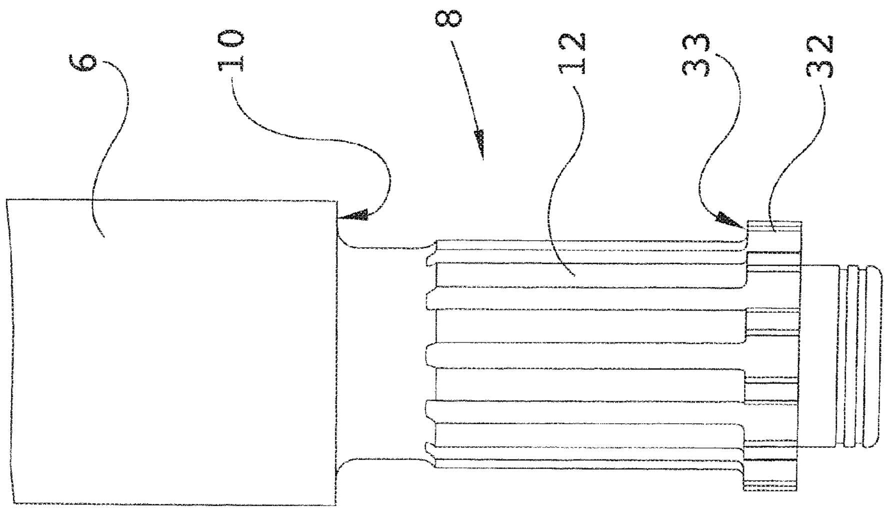


Fig.3a

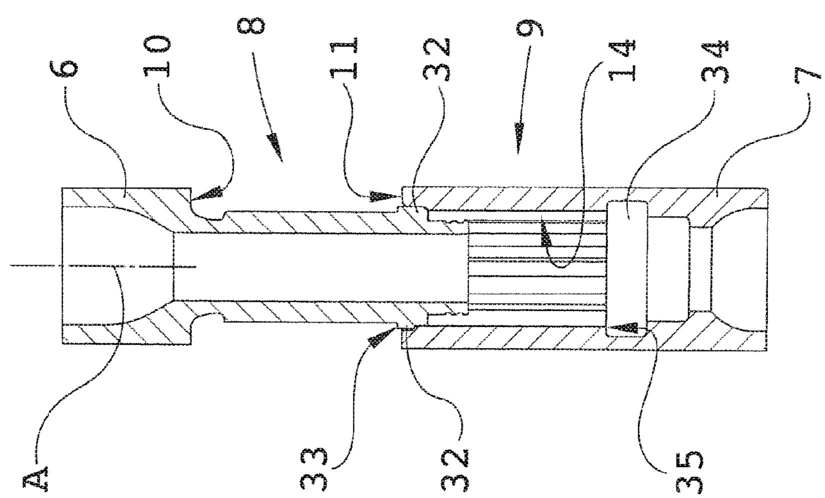


Fig.3b

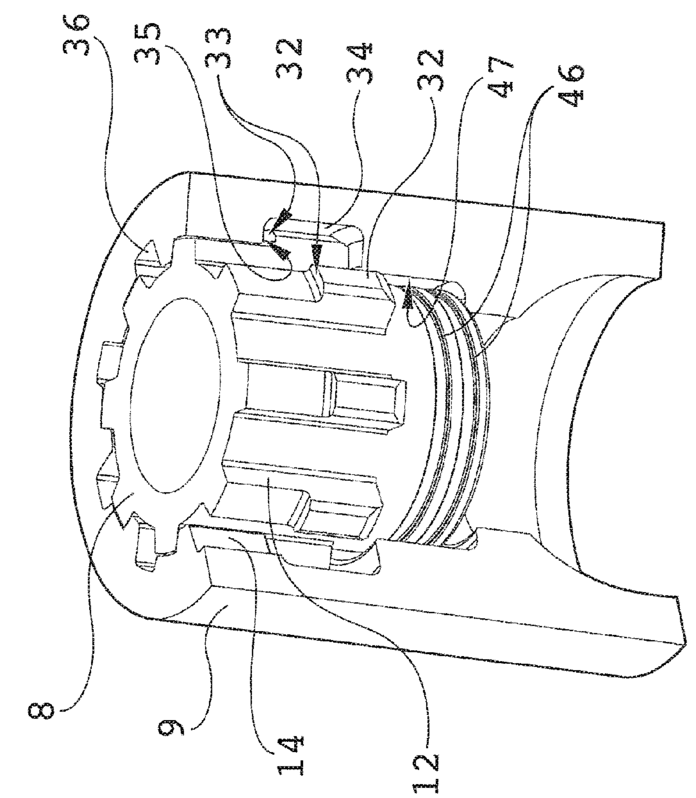


Fig.3d

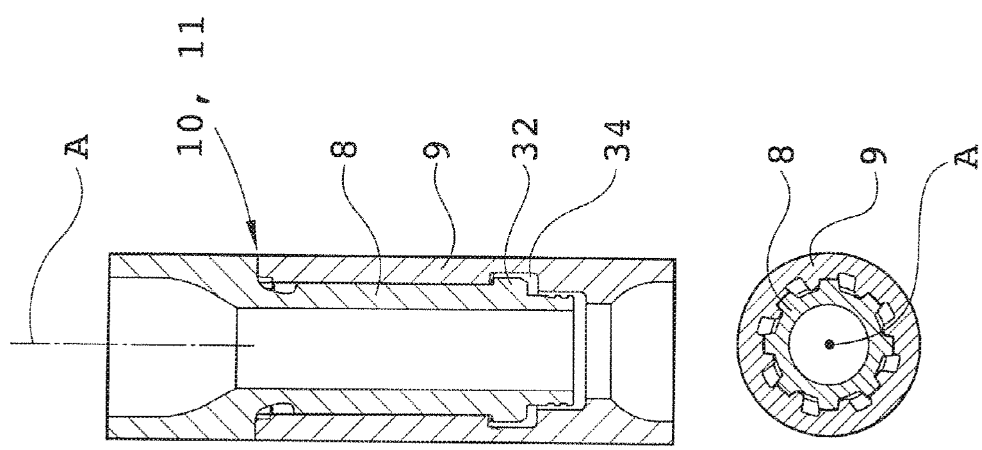


Fig.3c

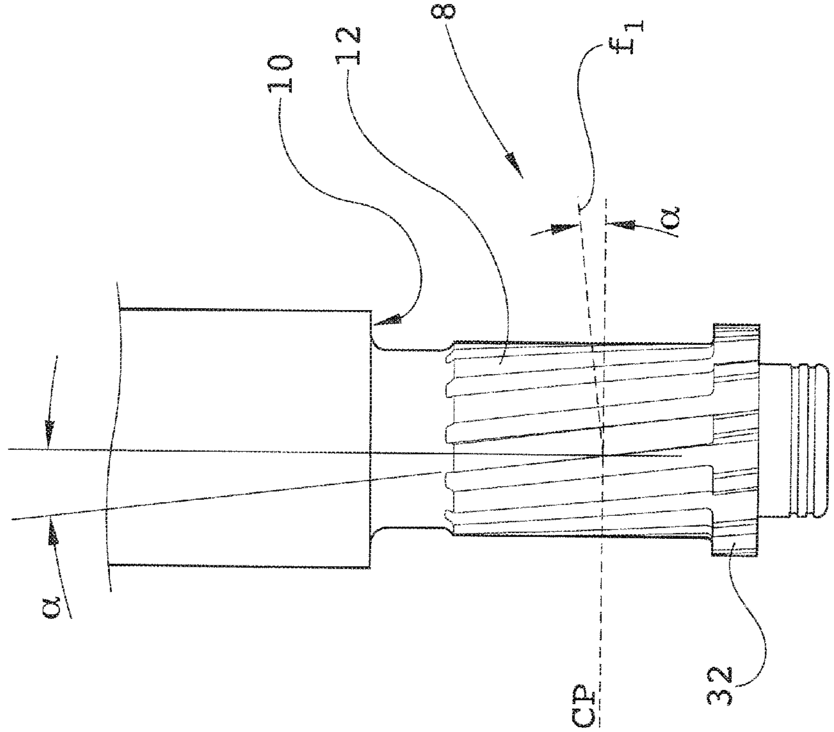


Fig.4

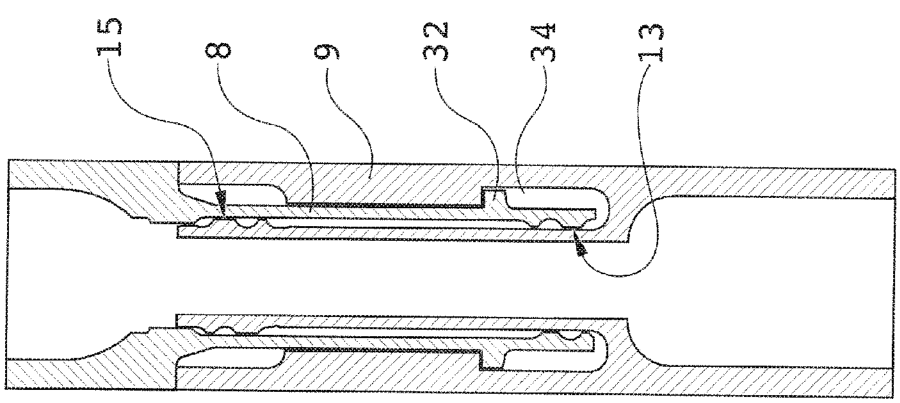


Fig. 6

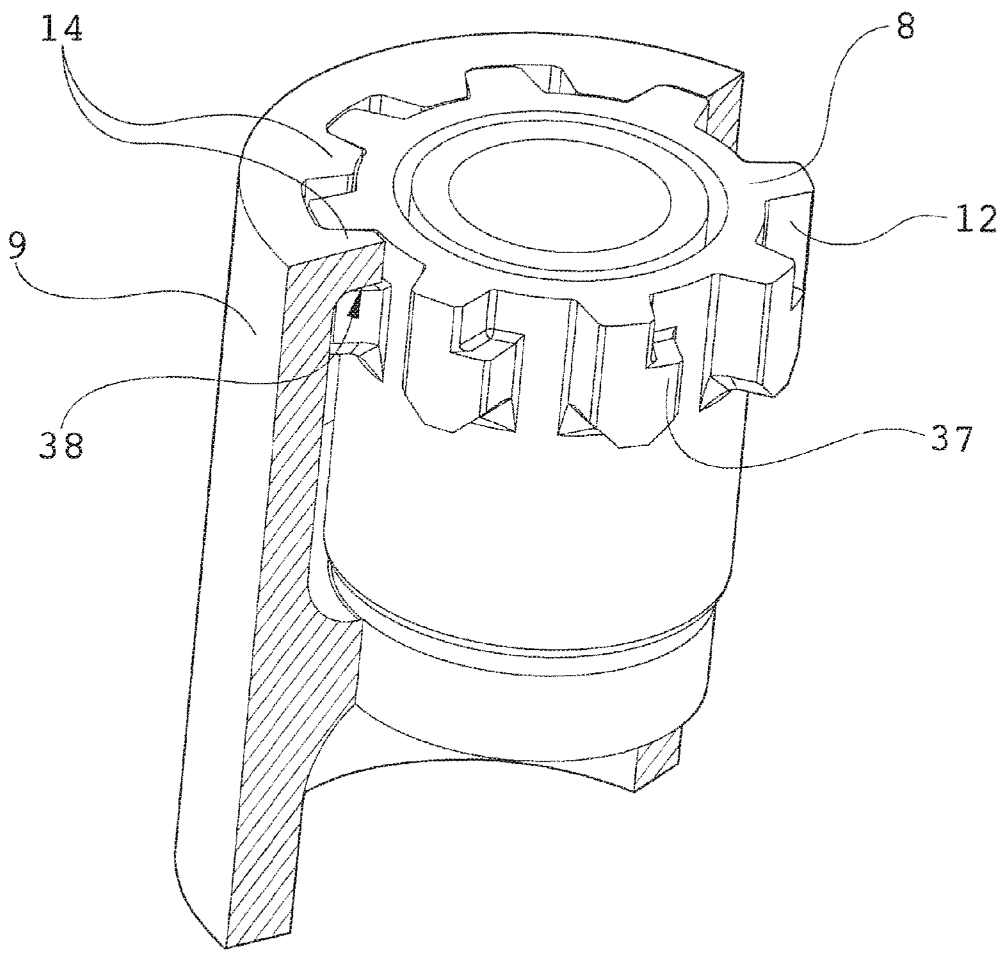


Fig.5a

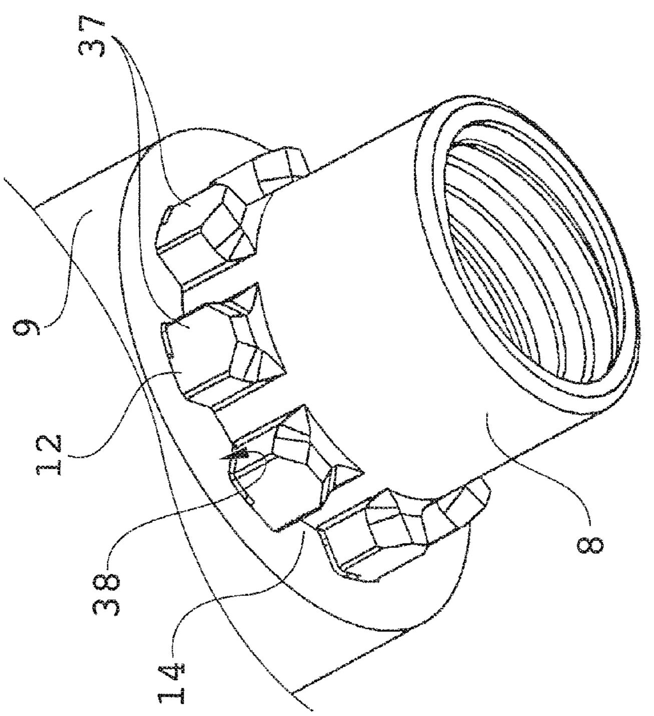


Fig.5c

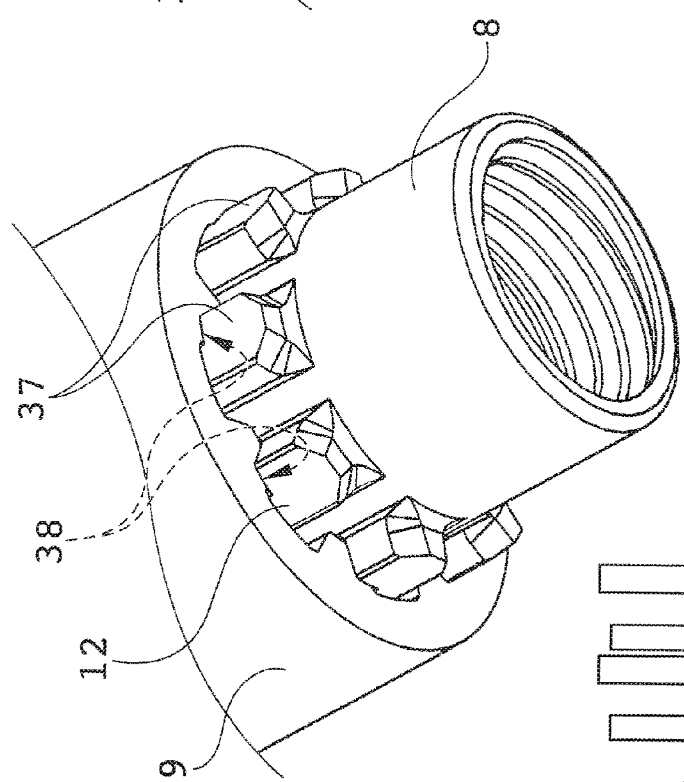


Fig.5b

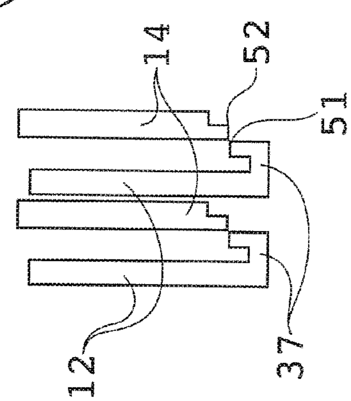


Fig.5d

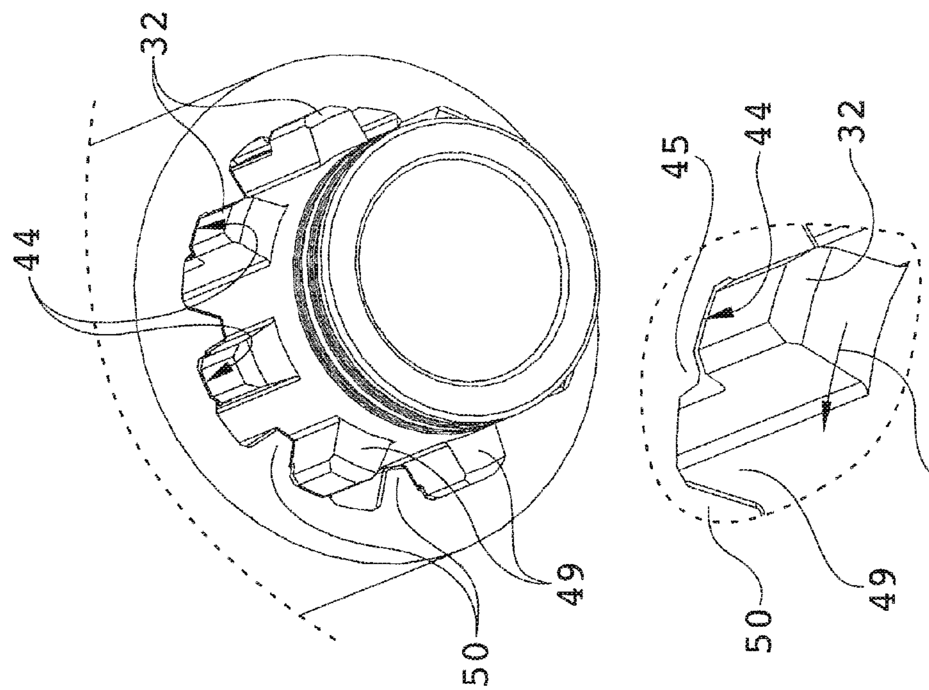


Fig.7a

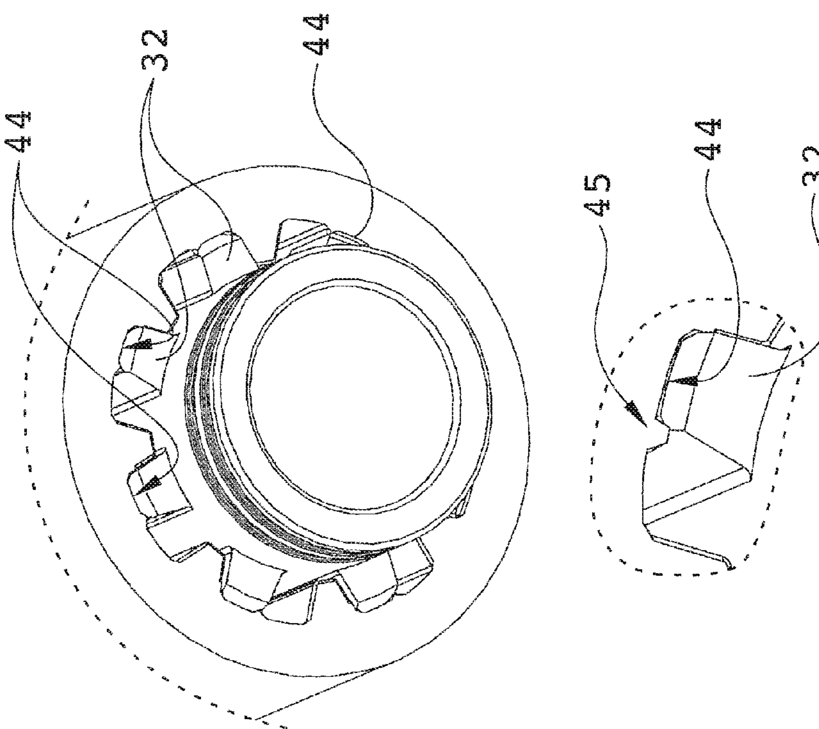


Fig.7b

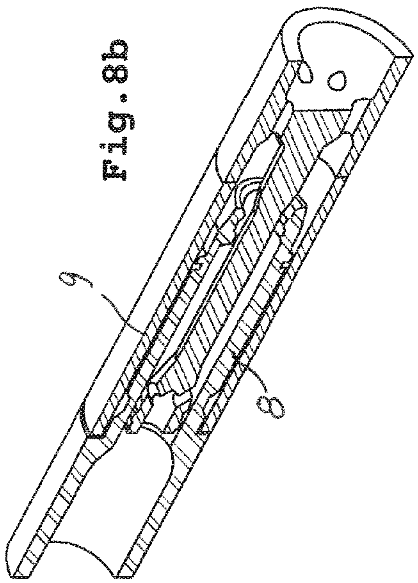


Fig.8b

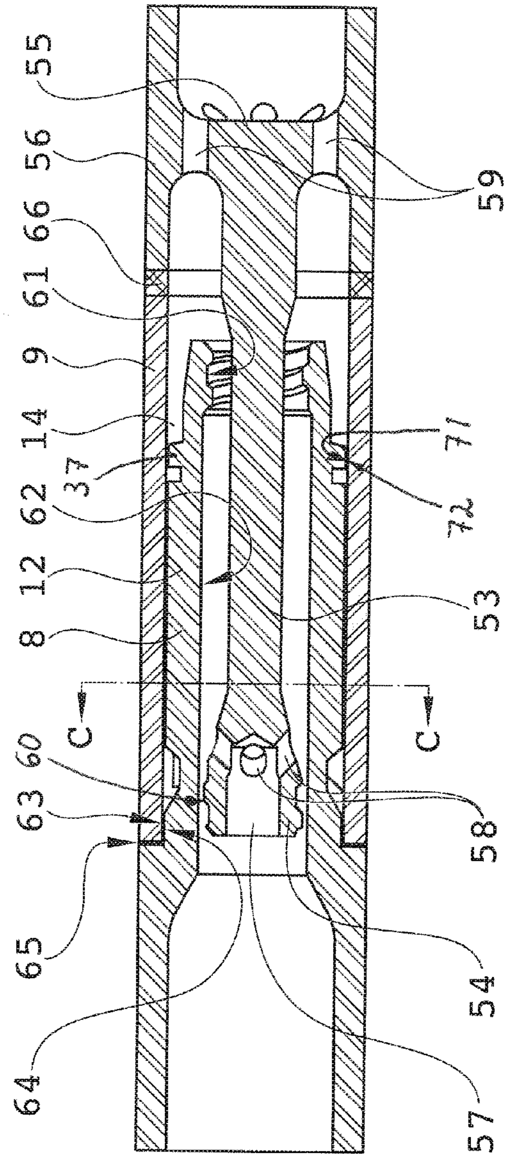


Fig.8a

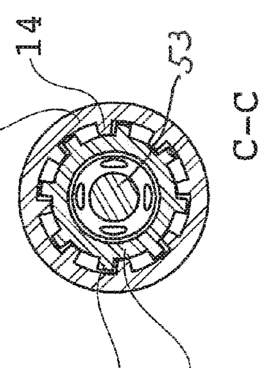


Fig.8c

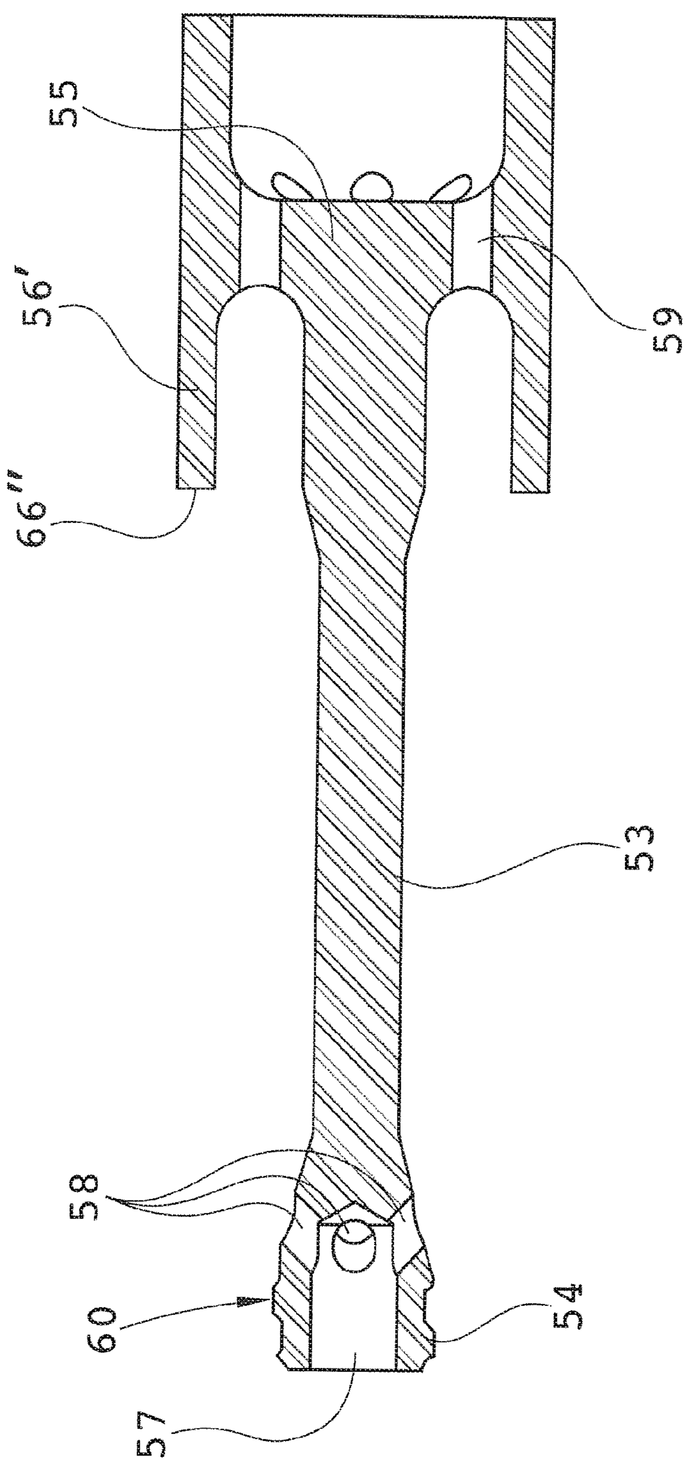


Fig. 8d

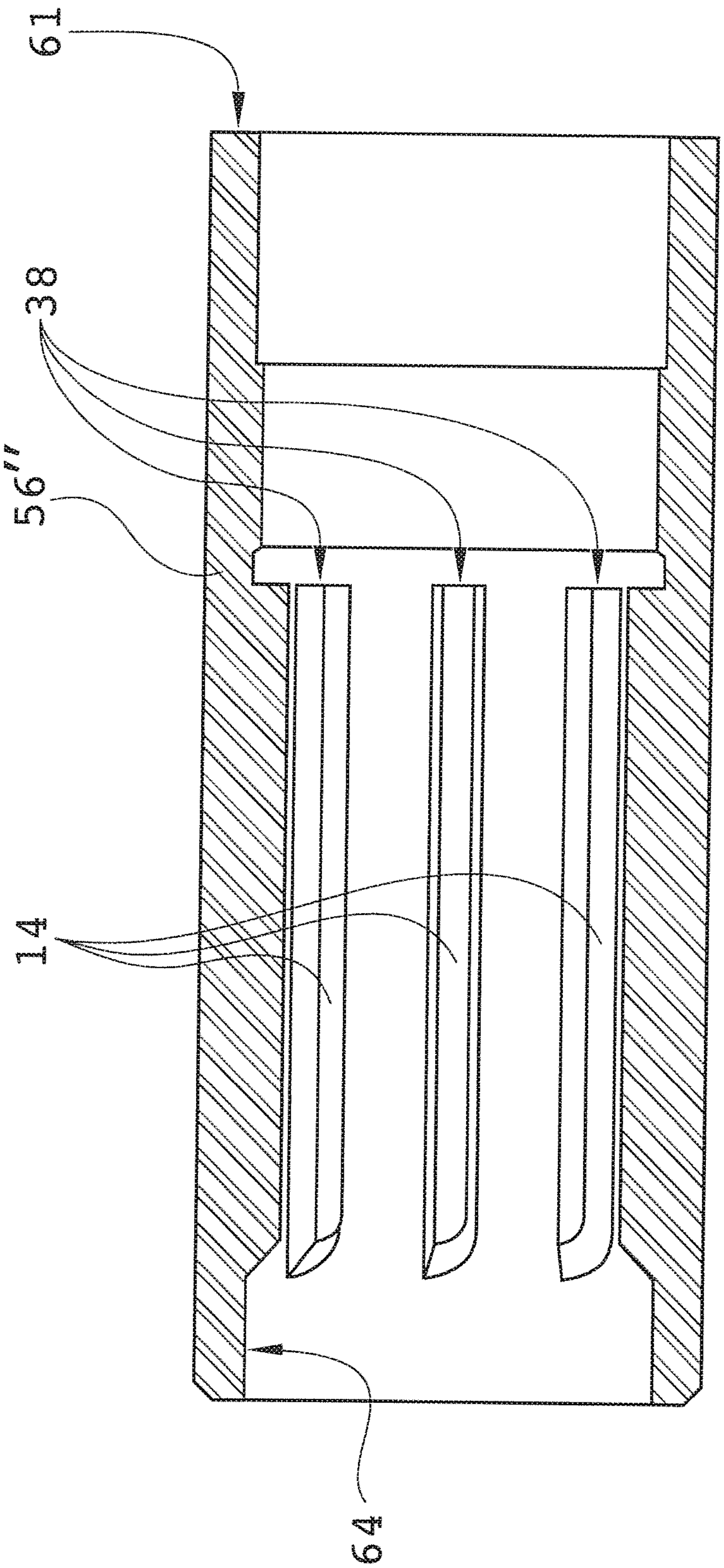


Fig. 8e

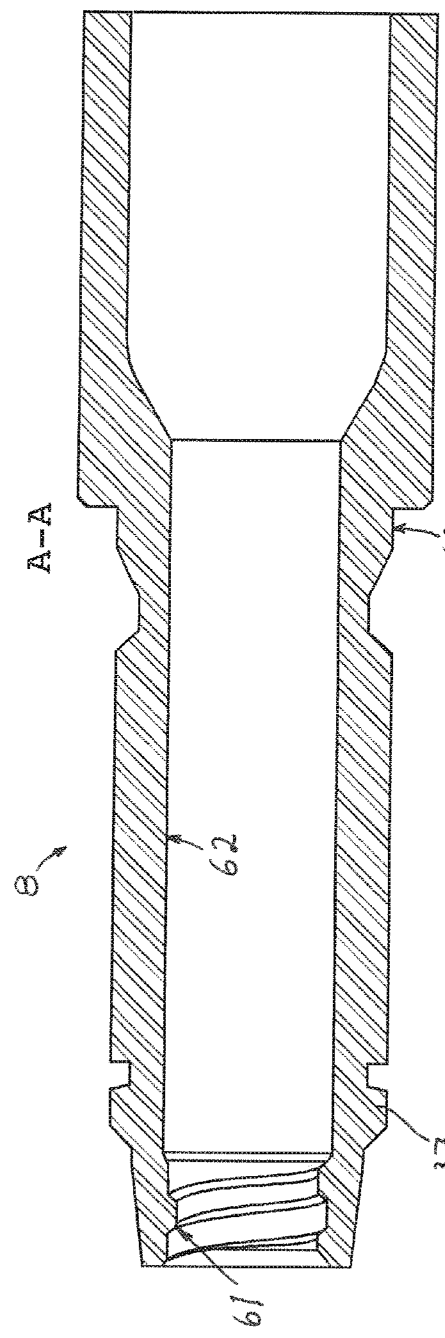


Fig.9a

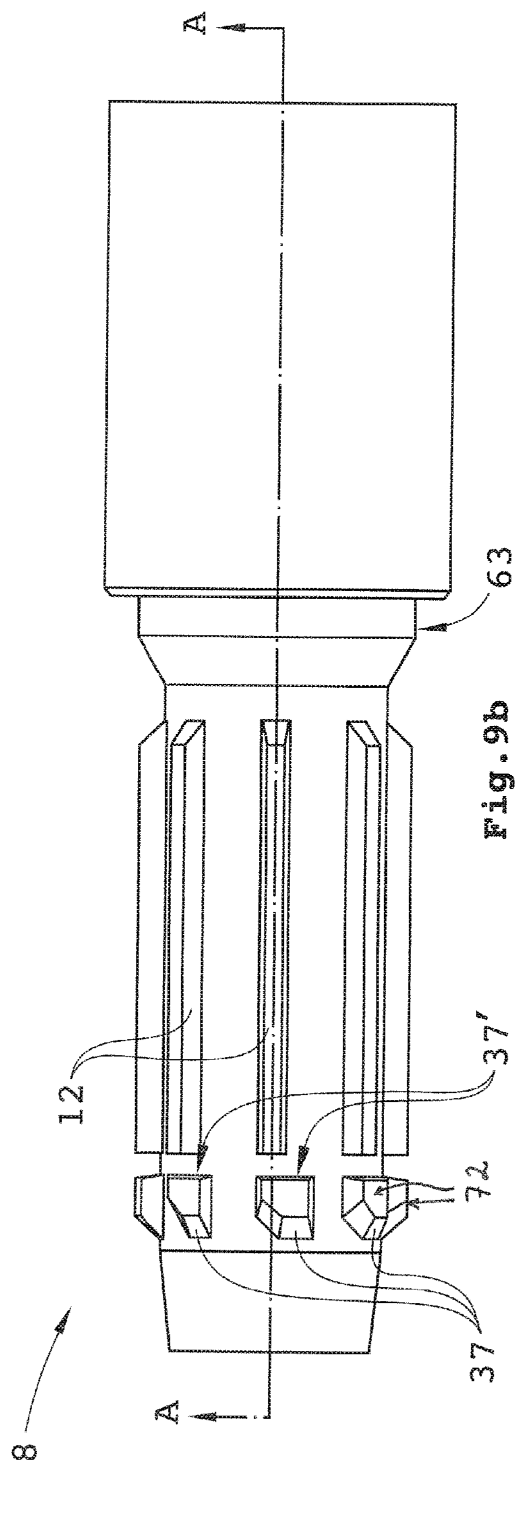


Fig.9b

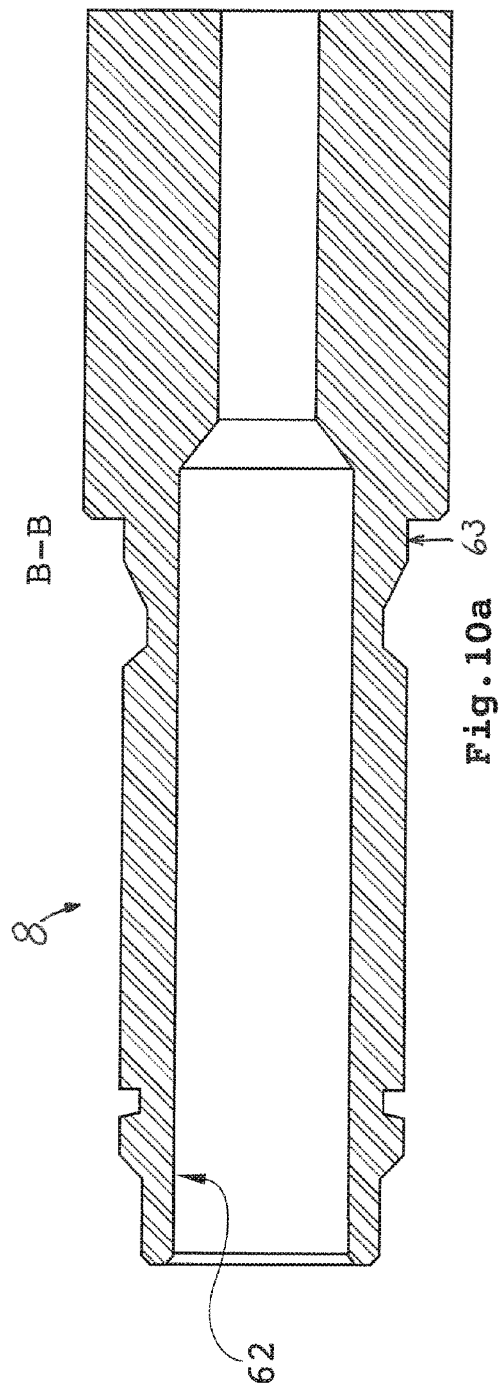


Fig.10a

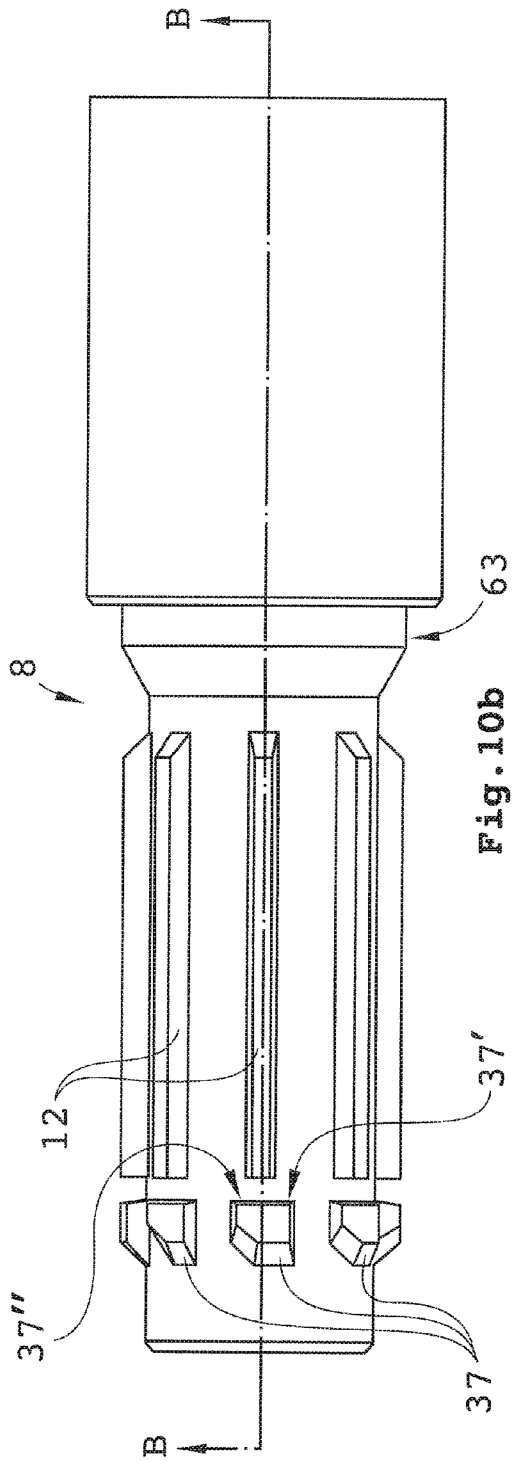


Fig.10b

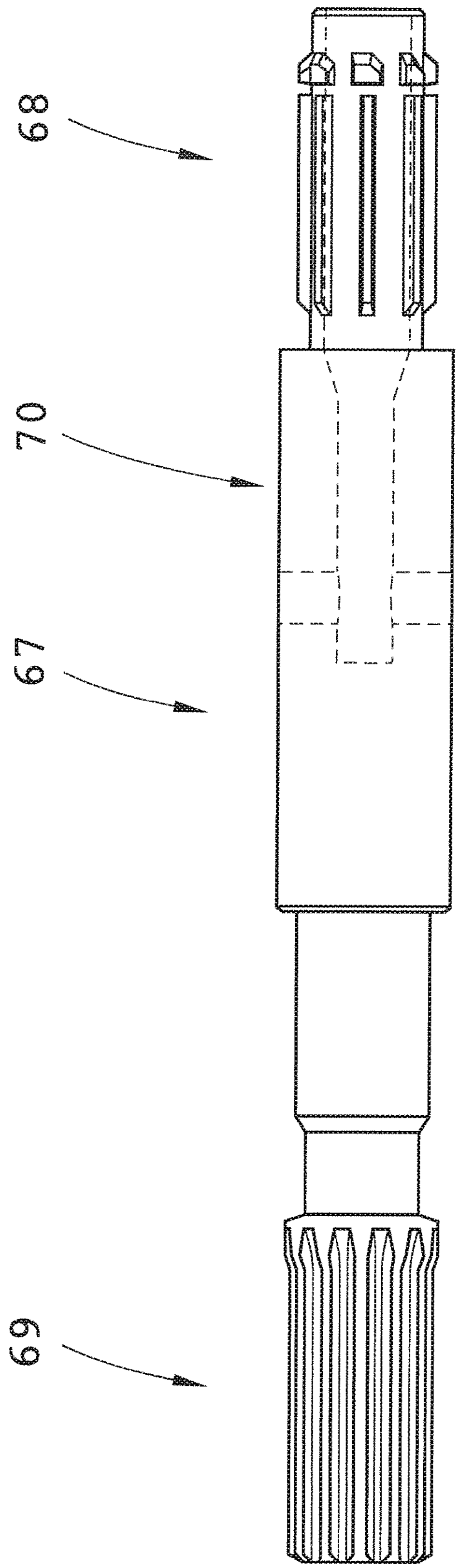


Fig. 11

JOINT AND JOINT PARTS FOR DRILL STRING COMPONENTS AND COMPONENTS

FIELD OF THE INVENTION

[0001] The invention relates to a joint for a drill rod. The invention also relates to parts of such a joint and a drill rod and other drill string components including such parts.

BACKGROUND OF THE INVENTION

[0002] Drill strings for percussion drilling are typically composed of a number of drill string components, such as drill rods, that are connected to each other via a threaded joint. The function of the drill rods is to transmit rotation, feed force and percussive impacts from the percussive rock drilling machine to the drill bit. Flushing medium is also transmitted through the drill rods.

[0003] When the bore hole is completed or in case the drill hit has to be replaced prematurely, the drill string has to be retrieved by pulling it out of the bore hole and be successively disassembled.

[0004] Today's conventional drill rods are simple to use and associated with low tooling costs. There are, however, drawbacks associated with the use of today's drill rods such as hole deviation and zig-zag-shaped hole walls. The requirement for skilled and experienced operators in order to obtain acceptable quality results is also a problem.

[0005] The threaded joints limit the working life of the rods since the threads are frequently subjected to wear and different kinds of failures such as breakages. Furthermore, in order to ensure secure drilling, the threaded joints have to be continuously tightened so as to ensure proper shock wave transmission all the way through the drill string.

[0006] In order to loosen threads prior to disassembly, the drill string has to be frequently rattled.

[0007] When it comes to operator skills, an experienced driller is required in order to most optimally tune feed force and rotation and be careful and observant during start of drilling and to adapt drilling parameters to rock properties, encountered rock formations, start angles vis-à-vis drilling direction etc.

[0008] The thread joints are subject to wear and are exposed to risk of failure for many reasons. Meeting threads are subject to relatively sliding or rubbing wear longitudinally due to percussion waves and reflections as well as laterally because of torsional shock waves generated when the bit cuts into the rock to the extent that thereby rotation is drastically slowed momentarily.

[0009] In the root of the last turn of the male thread, the stress concentration factor can be greater than three, thus setting an upper limit to the allowed percussive stress level.

[0010] The virtually universal non-linearity of bore holes produced with conventional drill rods in the drill string results in pulsating bending moments affecting the threaded joints. A threaded joint has potential for high stress concentration resulting from such bending moments. Added to bending moment resulting from hole-deviation and human error, premature fatal failures occur frequently.

[0011] Finally, so-called "drilling loose" and also extensive rattling to loosen joints upon completion at a hole will induce excess damage to the joint. If not performed correctly, severe damage or even breakage can occur.

[0012] In respect of a drill rod system intending to reduce problems with conventional drill string components there has been suggested to have the percussive shock waves by-passing the threads vis a separate stack of rods provided in the centre of a series of tubers which are interconnected with threads. This system delivers high top-hammer penetration rates with quality corresponding to a down-the-hole drilling system and long service life. Because of relatively high investment costs, this system has so far reached only a high end market.

[0013] EP0387218 describes a background art drill string component having a central rod surrounded by a tube. WO03097881 A1, U.S. Pat. No. 6,293,360 and U.S. Pat. No. 4,687,368 describe threaded drill string components, WO2008/004937 A1 describes a non-threaded joint for drill string components.

AIM AND MOST IMPORTANT FEATURES OF THE INVENTION

[0014] It is an aim of the present invention to provide a system that solves or at least reduces the problems mentioned above.

[0015] This aim is obtained in a joint for joining together drill string components for percussion drilling, wherein each drill string component extends along an axial direction, and wherein, in operation, impact shook waves and rotation torque are arranged to be transferred via the joint, the joint including a male part and a female part having meeting impact surfaces. The invention is distinguished in—that the male part exhibits: i. first rotation torque transfer means, and ii. first axial coupling means,—that the female part exhibits: iii. second rotation torque transfer means, and iv. second axial coupling means,—wherein the first and second rotation torque transfer means extend on the respective male and female parts such, and—wherein the first and second axial coupling means are positioned such—that when the drill string is subjected to rotation torque for drilling, relative axial movement is allowed between the male and the female parts when being in an interconnected state of co-operation between the first and second rotation torque transfer means, which is when the first and the second impact surfaces are adjacent to each other.

[0016] Hereby several advantages over the background art are achieved. The invention makes it possible to transmit both rotation and percussive shock waves through the drill string over only two meeting elements in the joint. This is achieved with a hole quality being comparable to a system as described above (Coprod®), wherein transmission of rotation and of percussive shock waves is separated in two separate elements for each drill string component unit.

[0017] A drill string component including one or two parts of a joint according to the invention is hereby comparatively easy and cost-effective to produce and with a weight being about half that of a corresponding Coprod®—element. In order to separate the individual components, there will no longer be required to rattle the drill string and since a joint can be produced such that bending forces are greatly reduced, the expected working life of the components goes far beyond that of conventional one piece drill rods.

[0018] In order to drill high quality holes there is less demand on skilled and experienced drillers, and altogether it has been made possible to drill holes of high quality at a low cost.

[0019] According to the invention, the first and the second rotation torque transfer means are laid out such as to allow a relative axial movement between the male and the female parts in the interconnected state in a region close to where the first and the second impact surfaces contact each other. In particular, a minor relative displacement between the male and female parts is allowed subsequent to an impact shock wave passage.

[0020] The magnitude of the relative axial movement or separation between the parts of the joint is normally expected to be from about 0.2 to about 0.6 mm during drilling. The separation between the parts of the joint can, however in case of drilling in vary hard rock and with a drill hammer without damping even be expected to be as high as between about 1.2-1.6 mm. Drilling in rock with cavities could result in even greater separation than that.

[0021] For that reason the joint is preferably constructed for allowing at least 1 mm separation and preferably 2 mm or more of separation. It should, however be understood that the inventive joint can be constructed for considerably higher degree of separation such as even up to about 100 mm.

[0022] Hereby it is avoided that high forces that otherwise would affect the components subsequent to a percussive shock wave passing the joint have to be received by elements of threads belonging to the joint parts.

[0023] Instead these forces are counteracted by the feed force provided through the drill string. This is a great advantage, since it is no longer necessary to dimension joint parts, such as thread ridges, for receiving and counteracting these forces. Therefore a significantly longer service life is possible for an inventive joint. It is also possible to produce the inventive joints for allowing certain mutual misalignment between adjacent string components without inducing particular bending moments corresponding to what is being so harmful for conventional threaded joints.

[0024] Another advantage is that the inventive joint provides greater energy transmission efficiency than that of conventional threaded connections.

[0025] It is important to understand that, during percussion drilling, the drill hammer subjects the drill string to intense repeated impacts in the order of 200 MPa, whereby shock waves are transmitted from drill string component to drill string component, passing via the joints of the drill string all the way to the drill bit. This initial shock wave is in the form of a compressional wave propagating through the material of the drill string.

[0026] As a result of reflexion at the bit end of the drill string of the initial shock wave, either a tensile wave or a compressional wave is generated propagating back through the drill string. Passage via a joint of these reflected waves has a separating effect to impact surfaces of the joints.

[0027] In a threaded joint, separation is counteracted by the thread ridges resulting in subsequent fatigue problems and wear. Such a threaded joint is pre-loaded. In the case of bottom-drive the female part is in tension and the male part is in compression. In the case of shoulder-drive the situation is the opposite. When an impact wave arrives, the pre-loaded joint undergoes a partial or even a full release. Upon the passing of the shock wave, the joint regains its full pre-load.

[0028] The drill string is also subjected to repeated reflected shock waves, either tensile or compressional. These reflected shock waves will either increase or decrease the degree of the pre-loading, adding more releasing and reloading effect to the joint. The elastic deformation associated with all these releasing and reloading effects causes relative movements of the two parts being connected, but there should be no rigid-body separation between them at any time. I.e. the impact surface of the male part is in constant contact with the impact surface of the female part.

[0029] A feed force applied to the drill string depends on various parameters but can be said to be in the region up to about 5 MPa, i.e. only a minute fraction of the shock wave value.

[0030] No realistic feed force can in any joint construction prevent shock wave passage induced influence to the joint parts. According to the invention, the problem associated with such influence in solved through the inventive completely new approach in allowing a certain relative axial movement between the parts. Hereby the intense but very short-lasting forces induced by the shock wave passage can be effectively absorbed by being counteracted by the teed force over a relatively longer period during the relative axial movement between the parts.

[0031] In order to ensure that a relative axial movement between the parts can be obtained in practice during drilling, the inventive joint per se is free from pretension in either rotational or axial direction when being subjected to rotation for drilling. Any such pretension would result in mutually locking parts, wear because of relative micro-movements and fatigue problems.

[0032] It is therefore important that co-operating, meeting, surfaces of the first and second rotation torque transfer means are arranged to contact each other in a rotational direction such that self-locking and pretensioning of the joint can not occur. This is achieved in that an angle between a flank direction and a radius where the contact occurs between two meeting surfaces of the first and second rotation torque transfer means is great enough to avoid self-locking and pretensioning of the joint. The angle is preferably at lease 45°, more preferred over 60° and most preferred over 70°. Hereby no tendencies of self-locking occurs.

[0033] An important purpose of the first and the second axial coupling means of the male and the female parts is basically to ensure safe retrieval of the drill string. It is important to understand that in the interconnected state of two adjacent drill string components, the first and the second axial coupling means do not obstruct the relative axial movement between the joint parts. For that reason, at least in a state where the drill string is subjected to rotation torque or drilling, the first and the second axial coupling means allow and do not obstruct said relative axial movement.

[0034] With "joint for joining together drill string components", here is in particular intended joints between tubular components that are to be positioned between a percussive rock drilling machine and a drill bit for percussion drilling since the invention is particularly advantageous for such components often referred to as a drill rod. This definition also includes a joint between the shank adapter and the first drill rod.

[0035] The first and second rotation torque transfer means are preferably mating splines that are preferably comprised, for each one of the male and the female parts, of at least six ridges that are elongated and that extend along each one of the male and the female parts. Ridges are protruding radially inwards from an inside wall of a cylindrical member to form female splines. Ridges are protruding radially outwards from an outside wall of a cylindrical member to form male splines.

[0036] It is in principle undesirable to have rotation inducing considerable contractive effect in the joint, because of the above mentioned force reception as well as the creation of undesired rigidity in the joint resulting in risk of fatal failure problems. Contacting surfaces therefore preferably extend in parallel with said axial direction on the respective male and female parts.

[0037] It is, however, in some instances advantageous to have the contacting surfaces extending slightly helically in the direction of contraction on the respective male and female parts of the joint when the drill string is subjected to the normal forward rotation during drilling. This contraction must, however, be limited and contacting surfaces must extend so as not to prevent relative movements between the male and the female joint parts which could result in tendencies of the above problems. For that reason the helix angle of the contacting surfaces should preferably normally be from −20° up to about 20° to the axial direction. Negative values means that separation of the impact surfaces because of the above described effect results in separation between meeting first and second rotation torque transfer means.

[0038] Forming the rotation torque transfer means helically is more complicated and expensive compared to forming these surfaces axially extending, but gives a somewhat softer rotation torque transfer between adjacent components.

[0039] The joint is obviously not preloaded as a conventional threaded joint for drill string components.

[0040] In case the contacting surfaces extend axially, basically no force inducted by the joint itself restricts the relative axial movement between the joint parts.

[0041] The first and second axial coupling means advantageously include axial engagement means formed by radially directed protrusions on one of the male and the female parts.

[0042] Axial engagement means advantageously includes radially directed protrusions in the form of hook elements or abutments on one of the male and the female parts for engagement with abutment surface portions on the other one of tine male and the female parts. The axial engagement means are intended for temporary axial locking so as to limit and prevent exaggerated separation between the joint parts. One example when this is required is for allowing quick lifting of the drill string for clearing the bore hole from stuck drill cuttings.

[0043] The axial engagement means can be arranged such that the first and the second axial coupling means, in an interconnected state of the joint, are made to engage in a positive, forward, rotation direction, i.e. in the normal rotation direction used during rock drilling or in the opposite, reverse, direction, whereby the connection is locked during reverse rotation but not locked during drilling. In the latter case, it will not be required to have an auto rod changer on the rig. It is also possible to have a joint arranged for locking in both forward rotation direction and in the opposite, reverse, direction. This embodiment is particularly advantageous for use for a shank adapter whereby faster operation is achieved. In all locking, axial movements between the parts is limited according to the above.

[0044] It is preferred that one of the first and second axial coupling means, is constituted by end surfaces of splines on the male or female part for co-operation with the above mentioned hook elements or abutments. No extra elements have to be provided with this embodiment.

[0045] It is preferred that the first and second axial coupling means include axial security coupling means. This provides for safe prevention against any accidental release of the joined components. Most preferred the axial security coupling means includes a thread coupling or a bayonet coupling.

[0046] Advantageously, second axial security coupling means in the form of outside threads are positioned at a distal portion of a sleeve-shaped or rod-shaped element extending centrally of the female part and that mating first axial security coupling means in the form of inside threads are positioned at a distal portion of the male part. Suitably a distal portion of the rod-shaped element is cup-shaped with holes for flushing fluid and a rod base has holes for flushing fluid in order to ensure advantageous fluid transfer through the drill string during operation.

[0047] It should be noted that it is advantageous to provide the one and the same inventive joint with first and second axial coupling means including axial security coupling means as well as axial engagement means for both safe drill string retrieval and enhanced functionality according to the above.

[0048] The first and second axial coupling means can be arranged in various ways and for example as threaded means engaging only during a first stage of connection of two adjacent components. Hereby, upon termination of that first stage, free movement along the mating first and second rotation torque transfer means is allowed all the way to the operational position where the impact surfaces of the two adjacent components meet. In order to avoid that meeting end surfaces of splines initially abut each other axially and obstruct the connection phase, the end surfaces can be made pointed.

[0049] Alternatively, bayonet coupling means can be used or intermeshing hooks on the inside of one of the first and second rotation torque transfer means that engage with inside ends of the second of the first and the second rotation torque transfer means or hooks or lugs on an outside of one of the first rotation torque transfer means for engagement with the outside of the other one of the first and second rotation torque transfer means. Said hooks or lugs make up the first and a second axial coupling means.

[0050] In a preferred variant, the female part includes an inner and an outer, dial-wall construction, the walls being sleeve-shaped together to define an annular compartment for the reception of a sleeve-formed (portion of a) male part.

[0051] The first rotation torque transfer means can be positioned on one of the inside and the outside of the sleeve-formed male part, whereas the first axial coupling means can be positioned on one the same side or on the opposite side from the first rotation torque transfer means.

[0052] It is preferred that a sealing arrangement is positioned at an inside opening slot formed between the male and the female parts, as seen in an operative position with the first and second impact surfaces close to each other.

[0053] The first and second impact surfaces can be arranged for either shoulder drive, bottom drive or dual drive (both shoulder and bottom drive).

[0054] For clarifying purposes: In shoulder drive, impact surface shoulders are ring-shaped and are positioned radially outside the first and second rotation torque transfer means and the first and second axial coupling means.

[0055] Shoulder drive has proved to be most advantageous for use with respect to the invention, since shoulder drive joints tend to be less subjected to wear because the transfer of the shock wave outside and in parallel with the portions of the joint parts supporting the rotation transfer means. Another important advantage with shoulder drive is that it makes it more easy to provide for a virtually closed continuous outside surface for the entire drill string. In particular it is possible to make the entire drill string or at least the regions of the joints between the individual drill string components forming a continuous cylindrical envelope surface. This reduces ware.

[0056] It is also important that during the small relative axial movements in the joint in operation, impurities are prevented to enter into the joint. The risk for that is minimized by using shoulder drive and having mating co-operating circular cylindrical guiding surfaces closest to the meeting impact surfaces of two joining drill string components. Flushing fluid leaking between the impact surfaces when they are slightly separated adds to reduction of the risk for impurities entering the joint.

[0057] It is advantageous in a more easily produced variant that the female part is sleeve-shaped with one wall, having both the second rotation torque transfer means and the second axial coupling means being oriented on an inside sleeve wall.

[0058] Advantageously an angle between a radius of the joint parts and a flank direction forming a right angle against a main surface of the rotation torque transfer means is 60°-90° and more preferably 70°-90°. Hereby unwanted self-locking of the parts in a rotational direction is avoided and wear during drilling reduced to a minimum.

[0059] It is highly advantageous that the male part externally has a proximal, cylindrical guide portion for co-operation with an internal, cylindrical guide surface at a distal portion of the female part. Advantageously, the male part at a distal region has part cylindrical outside guide surfaces for co-operation with an internal, cylindrical guide surface at a proximal portion of the female part. Hereby advantageous alignment of the joint is achieved.

[0060] The invention also relates to a male part of a joint for joining together tubular drill string components to be positioned between a percussive rock drilling machine and a drill bit of a drill string for percussion drilling, wherein each drill string component extends along an axial direction, and wherein, in operation, impact shock waves and rotation torque are arranged to be transferred via the joint, wherein the male part is part of a first drill string component and is arranged to co-operate with a female part of a second drill string component, and wherein a first impact surface on the male part is arranged to co-operate with a second impact surface on the female part. The inventive male part exhibits: i. first rotation torque transfer means, and ii. first axial coupling means, for co-operation with iii. second rotation torque transfer means, and iv. second axial coupling means on the female part,—wherein the first rotation torque transfer means for contacting the second rotation torque transfer means extend on the male part such, and—wherein the first axial coupling means for co-operation with the second axial coupling means is positioned such—that when the drill string is subjected to rotation torque for drilling, relative axial movement is allowed between the male and the female parts when being in an interconnected state of co-operation between the first and second rotation torque transfer means, being when the first and the second impact surfaces are adjacent to each other.

[0061] Preferably, the first rotation torque transfer means are splines having contacting surfaces that extend in parallel with said axial direction on the male part or extend helically on the respective male parts, at a helix angle (α) between 0° and 20° to the axial direction.

[0062] Suitably, the first axial coupling means include axial engagement means formed by radially directed protrusions on the male part.

[0063] Preferably, the axial engagement means includes radially directed protrusions in the form of hook elements or abutments on the male pare for engagement with abutment surface portions on the female part.

[0064] When the male and the female parts are interconnected, the axial engagement means are arranged to engage in forward rotation of the drill string and/or reverse rotation of the drill string and thereby limit relative axial movement between the male and the female part.

[0065] Preferably, the first axial coupling means, is constituted by end surfaces of splines on the male part.

[0066] Preferably, the first axial coupling means include axial security coupling means. Hereby the axial security coupling means preferably includes a thread coupling or a bayonet coupling.

[0067] When second axial security coupling means in the form of outside threads are positioned at a distal portion of a sleeve-shaped or rod-shaped element extending centrally of the female part, mating first axial security coupling means in the form of inside threads are advantageously positioned at a distal portion of the male part.

[0068] The first rotation torque transfer means is preferably positioned on one of the inside and the outside of the sleeve-formed male part.

[0069] The first axial coupling means is preferably positioned on one of the inside and the outside of the sleeve-formed male part.

[0070] A sealing arrangement is preferably positioned at an inside opening slot formed between the male and the female parts, as seen in an operative position with the first and second impact surfaces close to each other.

[0071] The first impact surface is preferably arranged for one from the group: shoulder drive, bottom drive and dual drive.

[0072] When the first impact surface is arranged for shoulder drive, outside surfaces of meeting drill string components, at least in the region of the joint, form an essentially continuous envelops surface.

[0073] An angle (β) between a radius (R) of the joint parts and a flank direction (f) forming a right angle against a main surface of the rotation torque transfer means is preferably 60°-90° and more preferably 70°-90°.

[0074] The male part has preferably externally a proximal, cylindrical guide portion for co-operation with an internal, cylindrical guide surface at a distal portion of the female part.

[0075] The male part has preferably at a distal region part cylindrical outside guide surfaces for co-operation with an internal, cylindrical guide surface at a proximal portion of the female part.

[0076] The invention also relates to a female part of a joint for joining together drill string components of a drill string for percussion drilling, wherein each drill string component extends along an axial direction, and wherein, in operation, impact shock waves and rotation torque from a percussion drilling machine at one end of the drill string is arranged to be transferred via the joint to a drill bit at an opposite end of the drill string, wherein the female part is part of a second drill string component and is arranged to co-operate with a male part of a first drill string component, wherein a second impact surface on the female part is arranged to co-operate with a first impact surface on the male part. The inventive female part exhibits: i. second rotation torque transfer means, and ii. second axial coupling means for co-operation with iii. first rotation torque transfer means, and iv. first axial coupling means, on the male part,—wherein the second rotation torque transfer means for contacting the first rotation torque transfer means extend on the female part such, and—wherein, the second axial coupling means tor co-operation with the first axial coupling means is positioned such—that when the drill string is subjected to rotation torque for drilling, relative axial movement is allowed between the male and the female parts when being in an interconnected state of co-operation between the first and second rotation torque transfer means, which is when the first and the second impact surfaces are adjacent to each other.

[0077] Preferably, the second rotation torque transfer means is splines having contacting surfaces that extend in parallel with said axial direction on the female part or extend helically on the female part, at a helix angle (α) between 0° and 20° to the axial direction.

[0078] The second axial coupling means preferably include axial engagement means formed by radially directed protrusions on one of the female parts.

[0079] The axial engagement means preferably includes radially directed protrusions in the form of hook elements or abutments on the female part for engagement with abutment surface portions one the male part.

[0080] When the male and the female parts are interconnected, the axial engagement means are arranged to engage in forward rotation of the drill string and/or reverse rotation of the drill string and thereby limit relative axial movement between the male and the female part.

[0081] Preferably the second axial coupling means is constituted by end surfaces of splines on female part.

[0082] Preferably the second axial coupling means include axial security coupling means.

[0083] Preferably the axial security coupling means includes a thread coupling or a bayonet coupling.

[0084] Second axial security coupling means in the form of outside threads are positioned at a distal portion of a sleeve-shaped or rod-shaped element extending centrally of the female part for mating with first axial security coupling means in the form of inside threads that axe positioned at a distal port ion of the male part.

[0085] The female part preferably includes an inner and an outer wall, together defining as annular compartment for the reception of a sleeve-formed male part.

[0086] A sealing arrangement is preferably positioned at an inside opening slot formed between the male and the female parts, as seen in an operative position with the first and second impact surfaces close to each other.

[0087] The second impact surface is arranged for one from the group: shoulder drive, bottom drive and dual drive.

[0088] When the second impact surface is arranged for shoulder drive, outside surfaces of meeting drill string components, at least in the region of the joint, preferably form an essentially continuous envelope surface.

[0089] The female part is preferably sleeve-shaped having both the second rotation torque transfer means and the second axial coupling means being oriented on an inside sleeve wall.

[0090] Advantageously, an angle (β) between a radius (R) of the joint parts and a flank direction (f) forming a right angle against a main surface of the rotation torque transfer means is 60°- 90° and more preferably 70°-90°.

[0091] When the male part externally has a proximal, cylindrical guide portion, it preferably co-operates with an internal, cylindrical guide surface at a distal portion of the female part.

[0092] It is preferred that when the male part at a distal region has part cylindrical outside guide surfaces, it co-operates with an internal, cylindrical guide surface at a proximal portion of the female part.

[0093] Shoulder drive is preferred because the shock wave can be transferred past the joint outside the very coupling elements making up the rotation torque transfer means and the axial coupling means. Hereby wear is reduced compared to what is the case with respect to a bottom drive solution, see also the above for more advantages of shoulder drive.

[0094] The advantages explained above that are relating to the inventive joint are correspondingly achieved in respect of the male and the female parts. Subordinate optional features relating to the inventive joint are applicable also in respect of the inventive male and female parts.

[0095] An inventive drill rod includes one such male part or/and one such female part or two such male parts or two such female parts.

[0096] An inventive shank adapter for a took drilling machine includes one such male part or one such female part.

[0097] There ere numerous ways in producing drill string components according to the invention. One method frequently used for producing drill rods is to friction weld the male and female parts onto a pipe-shaped rod blank. When it comes to female parts having the dual-wall construction, an inner sleeve making up the inner wall or an outer sleeve making up the outer wall may be friction welded to a base part including the other one of the walls.

[0098] The drill rod according to the invention is also advantageous for use in drill strings for down the hole hammers that produce impacts at the end of a drill string as well as for drill strings for rotational drilling (e.g. tricone) only.

[0099] The invention also relates to a method for joining together tubular drill string components to be positioned between a percussive rock drilling machine and a drill bit for percussion drilling, wherein each drill string component extends along an axial direction, and wherein impact shock waves and rotation torque are transferred via a joint, including the steps of:—initiating axial insertion of a male part of a first drill string component into a female part of a second drill string component,—rotate the first drill string component relative to the second drill string component to ensure engagement of axial security coupling means in the form of a thread coupling or a bayonet coupling,—continue axial insertion of the male part into the female part a determined distance whereby the first drill string component is allowed to rotate relative to the second drill string component to ensure engagement of axial engagement means and to ensure engagement of first and second rotation torque transfer means arranged on the respective male and female part.

[0100] Further details and advantages are explained in the below detailed description of embodiments.

BRIEF DESCRIPTION OF DRAWINGS

[0101] The invention will now be described in greater detail at the background of embodiments and with reference to the annexed drawings, wherein:
[0102] FIG. **1** shows, in a simplified side view, partly in section, a top hammer with a drill string including drill rods and drill bit,
[0103] FIGS. **2***a, b* and *c* show in axial views a first embodiment of a joint with joint parts of a first and a second drill rod in three different states of connection,
[0104] FIG. **2***c***1** shows a cross section of the first embodiment and FIG. **2***c***2** shows in a greater scale a contact region between two meeting splines,
[0105] FIGS. **3***a-d* show in different views a aecord embodiment of a joint according to the invention,
[0106] FIG. **4** shows a different joint part,
[0107] FIGS. **5***a-d* show a details of different joint part in different positions,
[0108] FIG. **6** illustrates an alternatively constructed joint,
[0109] FIGS. **7***a* and *b* show further different joint parts,
[0110] FIGS. **8***a- e* show a further different joint and joint parts,
[0111] FIGS. **9***a* and *b* show an alternative male joint part,
[0112] FIGS. **10***a* and *b* show a further alternative male joint part,
[0113] FIG. **11** shows a shank adapter in a side view.

DESCRIPTION OF EMBODIMENTS

[0114] Similar and like elements are indicated with same reference numerals in different figures.
[0115] The top hammer **1** in FIG. **1** is movably supported by a (not shown) feed beam of a drill rig and is arranged to deliver impacts and a rotational movement to a drill bit **3** in order to disintegrate rock.
[0116] A shank adapter **5**, partly inside a front end region of the top hammer **1**, connects to a drill string component being a drill rod of the drill string **2**, said drill string being composed of a number of drill string components such as individual drill rods **4** that are connected via joints.
[0117] The drill bit **3** is connected to the lowermost drill rod **4** of the drill string **2** via a drill bead **31**.
[0118] An example of an inventive joint for joining together drill rods according to the invention is shown in FIGS. **2***a,* **2***b* and **2***c.* A first drill rod **6** has a male part **8** to be connected to a female part **9** of a second drill rod **7**. The male part **8** is in this embodiment formed tubular as a sleeve having a free, distal, end and a proximal end being fastened to a tubular main part of the first drill rod **6**.
[0119] The drill rods have an axially extending flushing channel for allowing a flow of flushing fluid from the top hammer to the drill bit.
[0120] The joint in FIG. **2***a-c* is constructed for shoulder drive and **10** indicates a first impact surface at a shoulder being included at a proximal end of the male part and being directed, axially for co-operation with a second impact surface **11** at a most distal end of the second drill rod **7**. In this case there is provided shoulder drive impact between the drill rods **6** and **7** such that the impact waves pass radially outside the elements securing connection of the drill rods to each other.
[0121] It is also possible tor have bottom drive, in which case an alternative impact surface at the distal end of the male part would have been arranged for co-operation with an alternative impact surface an (a bottom portion of) the female part. In so called "dual drive", shoulder drive as well as bottom drive would be active.
[0122] The male part **8** exhibits first rotation torque transfer means being in the form of splines **12** in to this embodiment. The splines **12** extend axially in parallel with an axis A of the drill rods **6** and **7**, and are arranged evenly distributed on an outside surface of the sleeve-formed male part.
[0123] In an interconnected state of the male and female parts, the first rotation torque transfer means **12** co-operate with mating second rotation torque transfer means **14** being arranged on an inside surface of a portion of the female part **9**.
[0124] The male part **8** further includes first axial coupling means **13** in the form of a short screw thread on an inside surface of and at a distal region of the sleeve-formed male part **8**. The first axial coupling means **13** is arranged to co-operate with mating second axial coupling means **15**, also in the form of a short screw thread on a portion of the female part **9** being positioned radially inside the second rotation torque transfer means **14** and directed radially outward.
[0125] The female part **9** in this embodiment includes two sleeve-shaped coaxial members together forming an annular space or compartment for more or less completely receiving the coupling elements of the male part **8**. Hereby the female part has an inner and an outer, dual-wall construction, to define said annular compartment for the reception of the sleeve-formed (portion of the) male part. In the shown embodiment according to FIGS. **2***a*-**2***c,* the second axial coupling means being a short male screw tread is arranged at a distal region of an inner one of the sleeve-shaped coaxial members that together forming an annular space or compartment for receiving the coupling elements of the male part **8**.
[0126] In FIG. **3***a,* the male part a and the female part **9** are shown in a state where the male part **8** has been inserted into the annular space of the female part **9** and the first axial coupling means **13** engage the second axial coupling means **15** by the short screw threads being threaded together with each other.
[0127] In the state shown in FIG. **2***b,* the male part **8** has been threaded further with respect to the female part **9** in that the short screw threads being the first and second axial coupling means **13** and **15** have been through-threaded, passed their relatively short axial lengths. The male part **8** can now basically be free to move axially into said annular space or compartment being formed in the female part **9**, whereupon the splines being the first and second rotation torque transfer means **12** and **14**, can come into engagement with each other so as to transfer rotation torque between the first and the second drill rods.
[0128] A state where the first and second rotation torque transfer means **12** and **14** have come into engagement with each other is illustrated in an axial and a radial sections in FIG. **2***c,* wherein the coupling elements of the male part **8** has been completely pushed into said annular space inside the female part **9** such that the first and second impact surfaces **10** and **11** contact each other.

[0129] The position shown in FIG. **2***c* is the operative position, wherein, during drilling, impact shock waves can be transmitted over the joint from the first drill rod **6** to the second drill rod **7** over the meeting impact surfaces **10** and **11**.

[0130] Since the rotation torque transfer means **12** and **14** are also in engagement in this position, rotation induced by the top hammer can also be transferred from the first drill rod **6** to the second drill rod **7**.

[0131] According to the invention it is provided that tendencies to separate the impact surfaces **10** and **11** occurring immediately upon impact and also upon possible shock wave reflections passing the joint are not counteracted by the elements making up the joint. On the contrary, a relative movement of the male part **8** and the female part **9** is possible which is counteracted neither by the co-operating rotation torque transfer means nor by the axial coupling means.

[0132] It is also ensured, according to the invention, that relative bending of the first and second drill rods does not essentially affect the male and the female parts of the joint, since also a limited relative bending movement is allowed. Altogether, the joint parts are not at ail affected by harmful forces to the extent that normally affect joint parts of background art threaded joints.

[0133] FIG. **2***a* illustrates a drill rod **6** being produced by a tubular member being friction welded together with an element essentially making up the male part **8** via a friction weld **19**, which can be produced in a per se known manner. **20** indicates a second friction weld between a female joint part and a similar tubular member together making up the second drill rod **7**.

[0134] Normally a drill rod includes a tubular part having a male part at one end and a female part at the other end. It is, however, also possible that drill rods have exclusively male parts or female parts at both ends.

[0135] **21** indicates a third friction weld, wherein the member to be connected to the second drill rod **7** is a part of the female joint part only.

[0136] The steps of welding together different parts into a completed drill rod is advantageous, since a relatively small complicated part of a component can be manufactured separately in a conventional machine in a conventional machining process.

[0137] Numeral **18** in FIG. **2***c* indicates a sealing arrangement in the form of a sealing ring, for example of a synthetic material, which is arranged to seal an inside opening slot **30** being formed between the two drill rods **6** and **7** during operation. It is also possible to arrange a similar or different seal at an outside opening slot being formed between the joint parts. The sealing arrangement can be arranged with a slit (or slits) or diminutive holes for allowing a minor leakage of flushing fluid flowing in the central flushing channel for providing limited flushing of the coupling parts of the joint.

[0138] It is possible to arrange and position both the axial coupling means and the rotation torque transfer means inverted such that the first rotation torque transfer means are arranged at the inside of the male part and the second rotation torque transfer means are arranged at an outside of a portion of the female part (but inside said annular space or compartment) receiving the male part. The first axial coupling means can be arranged at the outside of the male part and the second axial coupling means at the inside of the female part.

[0139] It is also possible to arrange the female and male parts such that both the axial coupling means and the rotation torque transfer means of one of the parts are on the same side. In that case, the female part can be constructed without an annular space or compartment receiving the male part.

[0140] FIGS. **3***a-d* show another joint embodiment, wherein the axial coupling means are constructed differently. As can be seen on FIG. **3***a,* a male part **8** of a drill string component **6** has a plurality of axialiy extending splines constituting (first) rotation torque transfer means. The plural splines are evenly distributed around part of the length of the male part and ae adapted for co-operation with corresponding plural splines constituting second rotation torque transfer means in an inside or a female part (**7** in FIGS. **3***b-d*).

[0141] At a distal region of the male part **8**, from the main parts of the splines, there are radialiy protruding portions **32** constituting (first) axial coupling means. These (first) axial coupling means in the form of protruding portions are adapted for co-operation between surfaces **33**, directed axially from the distal end of the male part, and corresponding surface portions **35** in a recess or recesses **34**, constituting second axial coupling means, formed inside of a mating female part (see in particular FIG. **3***d*).

[0142] FIG. **3***b* shows the male part **8** slightly entered into the female part **9**, the protruding portions **32** being entered between ridges of the splines **14**. Grooves between the spline ridges are deepened and measured to allow the protruding portions to be moved all the way to the completed interconnected state prevailing during drilling when the impact surfaces **10** and **11** meet. This state is shown on FIG. **3***c* and more clearly yet on the partly cut perspective view FIG. **3***d.* One such deepened groove is referenced with **36** on FIG. **3***d.*

[0143] FIGS. **3***a-d* basically Illustrate a variant having a bayonet-like coupling being used instead of a threaded coupling making up the first and second axial coupling means as illustrated in FIGS. **2***a-c.* In order to reach the position in FIG. **3***d,* after having been fully inserted into the female part the male part **8** has been, rotated such that the surfaces **33** face the surfaces **35** inside the recess **34**. Further rotation is prevented because of contact between the splines **12** on the male part reaching contract with sirs splines **14** inside the female part.

[0144] The bayonet-like coupling can be arranged for interlocking axial coupling means either as a result of forward rotation, used during drilling or as a result of reverse rotation. Interlock of the axial coupling means results in that the drill string can be extracted from rhe hole after completed drilling.

[0145] **46** indicates two sealing rings that are received in surrounding grooves being provided on a circular cylindrical extension at a distal end region of the male joint part **8**. The sealing rings **46** constitute a sealing arrangement in this embodiment, where the female part is of a one wall type. The sealing rings contact and provide sealing co-operation together with a circular cylindrical sealing surface **47** inside a proximal portion of the female joint part **9**.

[0146] In case of interlocking axial coupling means as a result of forward rotation, used during drilling, it is important chat there is sufficient play between the surfaces **33** and

35 such that relative movement between the male and female parts is not obstructed or even come into contact with each other for the reasons explained above.

[0147] An important feature of the invention is shown in the radial section FIG. **2***c***1**, wherein an angle β is illustrated, being an angle between a radius R of the joint and a flank direction f, being a line forming a right angle against a main, or central, flank surface of the rotation torque transfer means (here being splines) as seen in a radial section.

[0148] Two meeting splines are indicated **39** and **40**. The radius R extends through a contact region of meeting surfaces contacting each other at an angle β as defined above through the region of contact between the two meeting flank surfaces of the splines **39** and **40** and a plane SP along the surfaces at the region of contact. A rotational direction is indicated with RD. The angle β is great enough and preferably 45°-90° more preferred 60°- 90° and most preferred 70°-90° to avoid excessive wear as well as self locking tendencies in a rotational direction when the joint is subjected to rotation torque for drilling.

[0149] The embodiment in FIGS. **2***a-c* is an example, wherein a considerable axial separation of for example 100 mm is possible after having established the axial coupling through the axial coupling means. The embodiment in FIGS. **3***a-d* is an example of forward locking (locking during forward rotation), wherein a smaller axial separation of for example 2-4 mm is possible after having established the axial locking through the axial coupling means.

[0150] FIG. **4** shows splines **12** extending on a male part **8** forming a helix angle α with respect to an axial direction. This may be advantageous in order to obtain a very slight contracting effect onto meeting drill rods as an effect of forward rotation. The helix angle α must, however, be small enough such that the mutual movement between tte parts is not at all restricted or leading to wear, limited working life or fatigue failure.

[0151] For that reason the helix angle α must be so small that there is no risk of inducing any self-locking effect between the first and second rotation torque transfer means in order to avoid reduction of the beneficial effects of the invention. This is normally achieved when the helix angle α is between 0° and 20°.

[0152] As is illustrated in FIG. **4**, for variants of splines having a helical path, the flank direction f_1 also forms an angle α to a cross sectional plane CP through the joint part (-s). The resulting angle of the flank direction has to be calculated considering both α and β.

[0153] FIGS. **5***a, b* and *c* show a variant where the splines **12** on a male pert **8** are arranged with hook-like abutments **37** for preventing separation when the drill string components are rotated in one direction. The hook-like abutments **37** co-operate with contact surfaces **38** at ends of splines **14** inside the female part **9**, which is shown partially cut, so as together make up the first and the second axial coupling means. FIG. **5***b* shows a relative rotational position between the male and the female part constituting a locked position, where the hook-like abutments **37** co-operate with contact surfaces **38**. FIG. **5***c* shows a relative rotational position between the male and the female part constituting an unlocked position, where the hook-like abutments **37** are free from contact with the contact surfaces **38**.

[0154] FIG. **5***d* diagrammatically illustrates a further variant where the splines **12** on a male part are arranged with hook-like abutments **37** being completed with upstanding lugs **51** so as to give an inverted J-shape. This prevents separation when the drill string components are relatively rotated in both directions when a corresponding lug **52** at the bottom end of each female part spline **14** is engaged in a compartment limited by the lug **51** on the male part.

[0155] In advantageous and preferred embodiments, the arrangements in FIGS. **3***a-d* , **4** and **5** with differently shaped and functioning co-operating hook-like abutments and contact surfaces are combined with the arrangement described in relation to FIGS. **2***a*-**2***c*.

[0156] One example of this is illustrated on FIG. **6**, wherein the joint parts on the one hand are provided with short threads **13**, **15** constituting first axial security coupling means on the male part and second axial security coupling means on the female part, furthermore, and on the other hand, there is also arranged co-operating hook-like abutments and contact surfaces on protruding portions **32** and in recesses **34** constituting first and second axial engagement means on the male and the female part respectively. Hereby the combinatory effect of the first and second axial coupling means including axial security coupling means as well as axial engagement means, the significance of which being explained above, is obtained.

[0157] FIGS. **7***a* and *b* illustrate a variant of axial coupling means shown in FIGS. **3***a-d* being axial security coupling means. After the joint parts have been rotated relative to each other, to the position illustrated in FIG. **7***a,* and have been axialiy displaced relative each other to the position illustrated in FIG. **7***b,* each protruding portion **32** is positioned in a seat **44** having an axial stop (not shown) for the protruding portion **32** and a rim element **45** preventing unintentional rotational movement of the protruding portion **32** and thereby rotational displacemexit of the joint parts. During lifting of the drill string, this embodiment provides increased security against unintentional disassembly compared to the common embodiment of FIGS. **3***a-d.*

[0158] When the parts are being pressed together again (back to FIG. **7***a*) and the male part has been rotated in a release direction according to the arrow **48** in respect of the female part, the parts can be dismounted by the protruding portions **32** being free to pass the full grooves **49** between the splines **50**.

[0159] FIG. **8***a* shows an axial section, FIG. **8***b* a sectioned perspective view and FIG. **8***c* a cross section of an assembled joint with the male part **8** fully inserted into the female part **9** and the mala splines **12** in engagement with the female splines **14**.

[0160] In this embodiment, a rod-shaped element **53** extends from a rod base **55** adjoining to the inside of the pipe-shaped part **56** of the female part. This is in contrast to the embodiment shown in FIG. **6** and described above where an inner sleeve-shaped member of the female part at a distal region provides a male tread.

[0161] Furthermore regarding the embodiment in FIG. **8***a,* at it distal region, the rod-shaped element **53** is formed with a cup-shaped structure **54** with a cavity **57**, an opening of which facing away from the rod base. At its outside, the cup-shaped structure **54** carries a male thread **60** being female part (second) axial security coupling means of the second axial coupling means.

[0162] The cup-shaped structure **54** is provided with a plurality of first through holes **58** for flushing fluid. The rod base, which extends from the rod-shaped element radially outwards to pass over to the inside of the tubular outside of the pipe-shaped part **56**, as provided with a plurality of second through holes **59** for flushing fluid.

[0163] The male part **8** exhibits a sleeve shape and extends from a proximal region being adjoining to the evenly pipe-shaped part of a drill string component to a distal region having on its inside a female thread **61** corresponding to the male thread **60** (male part (first) axial security coupling means of the first axial coupling means) together forming the axial security coupling means of the second axial coupling means. The passage between the female thread **61**, the inside **62** of the sleeve shape and the outside surface of the rod-shaped elements form together with the holes **58** and **59** an effective flushing fluid path. During operation, small amounts of flushing fluid leaks out in each and every joint passed the splines **12**, **14** for cooling purposes, and out between a an outside surface of a cylindrical guiding part **63** most proximal on the on the male part and an inside surface of a cylindrical guiding part **64** most distal on the on pipe-shaped part of the female part and subsequently between shoulder contact surfaces at **65** between impacts.

[0164] These inside and outside surfaces **63** and **64** of the male and the female parts respectively contribute to the alignment of the joint during operation. Furthermore, alignment of the joint is also advantageously effected through cooperation between radially outwardly directed surfaces **72** on the abutments **37** and an inside surface **71** inside the pipe-shaped part of the female part (see FIGS. **8***a*, **8***e*, **9***b* and **10***b*). The radially outwardly directed surfaces **72** of the abutments **37** together form an interrupted annular envelope surface.

[0165] Ensuring proper contact between the surfaces **71** and **72** can be arranged by having a slightly smaller inside diameter of a portion of the female part forming the inside surface **71**. Ensuring proper contact between the surfaces **71** and **72** can alternatively be arranged by having a slightly larger outside diameter of the abutments (and the radially outwardly directed surfaces **72**).

[0166] This combined guiding arrangement at two axially separated positions of the joint is advantageous for achieving stable alignment.

[0167] The complete female part includes a rod portion comprising the rod-shaped element **53**, the rod base **55** and a portion **56'** of the pipe-shaped part as shown in FIG. **8***d* together with a continuation **56"** of the pipe-shaped part as shown in FIG. **8***e*. The portion **56'** is friction, welded at **66"** to a meeting surface at **66'** of the continuation **56"** to form a weld **66** of the complete female part. The female part is subsequently in turn friction welded to a pipe of the drill string component.

[0168] Furthermore, inside the continuation **56"** there are positioned female part splines **14**. At the inside end of each spline **14** there are provided contact surfaces **38** constituting female part axial engagement means (compare **38** in FIGS. **5***a-c*).

[0169] FIGS. **9***a* and *b* illustrates the male part of the embodiment of FIG. **8***a*. From the side view in FIG. **9***b* is evident that abutment a **37** are arranged free from the splines such that an annular groove can be said to be provided therebetween. This facilitates production and tine machining of contact surfaces on the abutments **37**. The contact surfaces **37'** axe arranged for engagement in one rotational, direction only with contact surfaces **38** constituting female part axial engagement means (see FIG. **8***e*). It is referred to the description .above of different elements for fnll understanding of the male part. The male part is friction welded to a pipe forming the main part of a drill string component.

[0170] FIGS. **10***a* and *b* illustrates an alternatively configured male part. From the side view in FIG. **9***b* is evident that abutments **37** have contact surfaces **37'** are arranged for engagement in a first rotational direction with contact surfaces **38** constituting female part axial engagement means (see FIG. **8***e*). This alternatively configured male part, however, has abutments **37** arranged so as to have contact surfaces **37"** that are arranged for engagement also in a second rotational direction with contact surfaces **38** constituting female part axial engagement means (see FIG. **8***e*).

[0171] Furthermore, in this male part embodiment, there is no inner female thread making up a male part axial, security coupling means most distally inside the surface **62**. Axial engagement thus relies fully on the axial engagement means.

[0172] The embodiment in FIGS. **10***a* and *b* is particularly applicable for a shank adapter **67**, see FIG. **11**, where axial security coupling means would be an obstacle because of the repeated assembly, disassembly taking place between the shank adapter and the most adjacent drill string component. **68** indicates a male part as shown and described with reference to FIGS. **10***a* and *b*, **69** indicates a drilling machine end of the shank adapter and **70** indicates an inside component of a swivel.

[0173] It is possible to use other means preventing rotation between interconnected parts besides splines as first and second rotation torque transfer means. Basically, interconnected parts having rotation preventing means that engage each other can be made in various configurations when they fulfill the requirements explained above. Use of splines is, however, preferred for a number of reasons such as ease of production and reliability. The number of splines can be adapted to the situation and if the joint parts have to be relatively rotated for achieving axial locking. The axial length of the splines is chosen so as to reach an acceptable surface load on the flanks of the splines.

[0174] The embodiments shown in the Figs. illustrate drill strings having the male joint part of a joint being carried by a drill string component being closest to the drill hammer but it should be evident that the opposite situation with the female joint part being carried by the drill string component being closest to the drill hammer is fully possible.

[0175] The term comprised is here intended as an open (and not closed) definition which is not restricted to the feature following the term. Also other features can be present.

1. Joint for joining together drill string components for percussion drilling, wherein each drill string component extends along an axial direction, and wherein, in operation, impact shock waves and rotation torque are arranged to be transferred via the joint, the joint including a male part and a female part having meeting impact surfaces, wherein

that the male part exhibits:

i. first rotation torque transfer means, and

ii. first axial coupling means,

that the female part exhibits:

iii. second rotation torque transfer means, and

iv. second axial coupling means,

wherein the first and second rotation torque transfer means extend on the respective male and female parts such, and

wherein the first and second axial coupling means are positioned such, that when the drill string is subjected to rotation torque for drilling, relative axial movement is allowed between the male and the female parts when being in an interconnected state of co-operation between the first and second rotation torque transfer means.

2. Joint according to claim **1**, wherein the first and second rotation torque transfer means are mating splines having contacting surfaces that extend in parallel with said axial direction on the respective male and female parts or extend helically on the respective male and female parts, at a helix angle (α) between 0° and 20° to the axial direction.

3. Joint according to claim **2**, wherein the first and second axial coupling means include axial engagement means formed by radially directed protrusions on one of the male and the female parts.

4. Joint according to claim **3**, wherein the axial engagement means includes radially directed protrusions in the form of hook elements or abutments on one of the male and the female parts for engagement with abutment surface portions on the other one of the male and the female parts.

5. Joint according to claim **3**, wherein when the male and the female parts are interconnected, the axial engagement means are arranged to engage in forward rotation of the drill string and/or reverse rotation of the drill string and thereby limit relative axial movement between the male and the female part.

6. Joint according to claim **2** wherein one of the first and second axial coupling means, is constituted by end surfaces of splines on the male or female part.

7. Joint according to claim **1**, wherein the first and second axial coupling means include axial security coupling means.

8. Joint according to claim **7**, wherein the axial security coupling means includes a thread coupling or a bayonet coupling.

9. Joint according to claim **7**, wherein second axial security coupling means in the form of outside threads are positioned at a distal portion of a sleeve-shaped or rod-shaped element extending centrally of the female part and that mating first axial security coupling means in the form of inside threads are positioned at a distal portion of the male part.

10. Joint according to claim **1**, wherein the female part includes an inner and an outer wall, together defining an annular compartment for the reception of a sleeve-formed male part.

11. Joint according to claim **10**, wherein the first rotation torque transfer means is positioned on one of the inside and the outside of the sleeve-formed male part.

12. Joint according to claim **10**, wherein the first axial coupling means is positioned on one of the inside and the outside of the sleeve-formed male part.

13. Joint according to claim **1**, where a sealing arrangement is positioned at an inside opening slot formed between the male and the female parts, as seen in an operative position with the first and second impact surfaces close to each other.

14. Joint according to claim **1**, wherein the first and second impact surfaces are arranged for one from the group: shoulder drive, bottom drive and dual drive.

15. Joint according to claim **14**, wherein the first and second impact surfaces are arranged for shoulder drive, wherein outside surfaces of meeting drill string components, at least in the region of the joint, form an essentially continuous envelope surface.

16. Joint according to claim **1**, wherein the female part is sleeve-shaped having both the second rotation torque transfer means and the second axial coupling means being oriented on an inside sleeve wall.

17. Joint according to claim **1**, wherein an angle (β) between a radius (R) of the joint parts and a flank direction (f) forming a right angle against a main surface of the rotation torque transfer means is 60°-90° and more preferably 70°-90°.

18. Joint according to claim **1**, wherein the male part externally has a proximal, cylindrical guide portion for co-operation with an internal, cylindrical guide surface at a distal portion of the female part.

19. Joint according to claim **1**, wherein the male part at a distal region has part cylindrical outside guide surfaces for co-operation with an internal, cylindrical guide surface at a proximal portion of the female part.

20. Male part of a joint for joining together drill string components for percussion drilling, wherein each drill string component extends along an axial direction, and wherein, in operation, impact shock waves and rotation torque are arranged to be transferred via the joint, wherein the male part is part of a first drill string component and is arranged to co-operate with a female part of a second drill string component, and wherein an impact surface on the male part is arranged to co-operate with an impact surface on the female part,

wherein

that the male part exhibits:

i. first rotation torque transfer means, and

ii. first axial coupling means,

for co-operation with

iii. second rotation torque transfer means, and

iv. second axial coupling means,

on the female part,

wherein the first rotation torque transfer means for contacting the second rotation torque transfer means extend on the male part such, and

wherein the first axial coupling means for co-operation with the second axial coupling means is positioned such,

that when the drill string is subjected to rotation torque for drilling, relative axial movement is allowed between the male and the female parts when being in an interconnected state of co-operation between the first and second rotation torque transfer means.

21. Female part of a joint for joining together drill string components for percussion drilling, wherein each drill string component extends along an axial direction, and wherein, in operation, impact shock waves and rotation torque are arranged to be transferred via the joint, wherein the female part is part of a second drill string component and is arranged to co-operate with a male part of a first drill string component, wherein a second impact surface on the female part is arranged to co-operate with a first impact surface on the male part,

characterized in wherein

that the female part exhibits:

i. second rotation torque transfer means, and

ii. second axial coupling means,

for co-operation with

iii. first rotation torque transfer means, and

iv. first axial coupling means,

on the male part,

wherein the second rotation torque transfer means for contacting the first rotation torque transfer means extends on the female part such, and

wherein the second axial coupling means for co-operation with the first axial coupling means is positioned such,

that, when the drill string is subjected to rotation torque for drilling, relative axial movement is allowed between the male and the female parts when being in an interconnected state of co-operation between the first and second rotation torque transfer means.

22. Drill rod for percussion rock drilling, wherein the drill rod includes at least one male part of a joint according to claim **20**.

23. Drill rod for percussion rock drilling, wherein the drill rod includes at least one female part of a joint according to claim **21**.

24. Drill rod according to claim **22**, wherein the first and second impact surfaces are arranged for shoulder drive, wherein outside surfaces of joint parts of co-operating drill rods are formed such that at least in the region of the joint they form an essentially continuous envelope surface.

25. Shank adapter for a rock drilling machine, wherein the shank adapter includes a male part of a joint according to claim **23**.

26. Shank adapter according to claim **25**, wherein the shank adapter is provided with axial engagement means that are arranged to engage in forward as well as reverse rotation of the drill string and thereby limit relative axial movement relative to an attached and engaged drill string component.

27. Method for joining together drill string components for percussion drilling, wherein each drill string component extends along an axial direction, and wherein, in operation, impact shock waves and rotation torque are transferred via a joint, including the steps of:

initiating axial insertion of a male part of a first drill string component into a female part of a second drill string component,

rotate the first drill string component relative to the second drill string component to ensure engagement of axial security coupling means in the form of a thread coupling or a bayonet coupling,

continue axial insertion of the male part into the female part a determined distance whereby the first drill string component is allowed to rotate relative to the second drill string component to ensure engagement of axial engagement means and to ensure engagement of first and second rotation torque transfer means arranged on the respective male and female part.

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