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(54) Title: SAFETY RELEASE DEVICE

(57) Abstract: A safety release device comprising a first member and a second member insertable into and engageable to the first member, wherein disengagement of the first and second members requires pulling the first member away from the second member. The safety release device comprises a stop means configured to withstand a predetermined threshold of pull force on the first and second members and thereby prevent movement of the first member away from the second member unless the predetermined force is exceeded. The safety release device further comprises a release mechanism movable between a locking position in which it locks the first member to the stop means, and a release position in which it releases the first member from the stop means, wherein the release mechanism is configured to move from its locking position to its release position upon movement of the first member away from the second member.

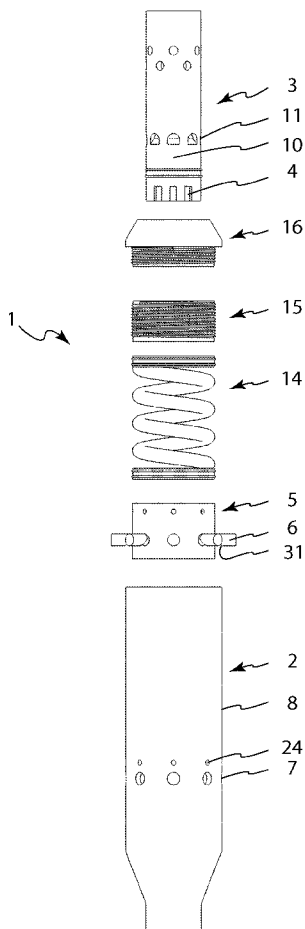


Fig. 1

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SAFETY RELEASE DEVICE

The present invention relates to a safety release device for any operation where a load is carried or pulled, e.g. drilling operations, lifting operations with the help of cranes, anchoring operations, tethering operations, towing operations and pulling operations. In each of these and corresponding cases, a drill pipe string, hoist rope, guy line, tether, pulling rope etc. is connected between at least to objects in order to drill, carry, lift, pull, anchor or tether.

In each of these cases the load on one or more parts of the system may reach such high magnitude that the integrity of the equipment or structures involved may be compromised, possibly resulting in equipment failure, operation delays, costly operation interruptions and health, safety and environment risks.

In operations like those mentioned above, there may be a need for a safety release device that will yield when some predetermined maximum force or load is reached or exceeded. One such device is a weak link, where a weakening or releasing function is provided in by the equipment used, and which is set to yield or release when a predetermined maximum force or load is reached or exceeded.

Conventional weak links typically comprise a weakening cut or the inclusion of a weaker material somewhere in the safety release mechanism, wherein the weak link breaks when the predetermined maximum load is reached or approached. This requires full scale qualification testing in order to document repeatability (since there will be a spread in obtained release load). The tested elements cannot be used afterwards. The tests are destructive. Concepts based on material failure (breakage) have to hold all normal loads that occur during normal operation, i.e. when the entire riser system and the compensation system work as they are supposed to. The design capacity is the load resistance the weak link has against defined error modes (material deformation, separation, leakage etc.) with a defined security margin. Material deformation is often a dimensioning error mode. The margin between material deformation and material failure often governs the magnitude of the release load, and frequently results in a release load that is larger than it has to or should be. In cases where the release load is larger than it has to be, the design load has to be reduced, which in turn closes the operational window. This "conflict" is aggravated in systems that are not pressure balanced.

There also exist various automatic and electronic systems that are arranged to release or yield when a predetermined maximum load is reached. These systems are prone to a number of failure modes that increases with increasing complexity.

A drawback with conventional weak links that rely on material failure to activate, is that it is difficult to achieve a system that fulfills normal safety margins against yielding or release during normal operations while at the same time releasing at a load below the maximum allowable load before the integrity of other components in the system is compromised. One reason that these two requirements are difficult to achieve is the spread in material properties making it difficult to predict exactly when the weak link relying on material failure will release. Due to material ductility and deformation, the range of tensile forces that is necessary to break the weak link may vary a great deal. One may easily get into a situation where the weak link should break, but doesn't. Also, the integrity of a weak link may have been compromised without actual breakage occurring, resulting in uncertainty during further operations. In addition, when or if a weak link has broken, the process of

weak link deformation and disintegration, may result in an unpredictable interface that may make it challenging to fish up (subsea use) the string, wire and/or tool that has been disconnected and thereby dropped or left behind.

5 The merits of these various conventional weak links vary, but there is a need for a safety release device that to a lesser degree is based on material failure to activate, that to a greater degree can be correctly and easily set to a predetermined release load in advance, that is not dependent on various more or less complicated and sensitive automatic and/or electronic systems, and that may provide a predictable and intact interface or connection point for reconnection of the lifting or pulling string and resumption of the lifting or pulling operation.

10 As an example of a scenario where conventional weak links may be used, subsea drilling operations may be mentioned. During operations where the drilling pipe or landing string from the drill rig or drilling ship is fixed to the well on the seabed the integrity of the system is relying on the functionality of the heave compensator system on the rig or ship. This system ensures that the vertical motions of the drilling rig or ship is not transferred into the drilling pipe or landing string. If a failure in the heave compensator system occurs, or if the vertical motion of the rig or ship exceeds
15 the compensating capacity of the heave compensator, the vertical motion of the ship will be transferred directly into the drilling pipe or landing string. During operations where the drill pipe or landing string is fixed to the seabed, a transfer of the vertical motions of the rig or ship into the pipe will induce enormous axial forces in the drill pipe or landing string assembly including the subsea well and its components. Situations where this may occur are e.g. heave compensator lock-up, heave
20 compensator stroke-out, rise stick-up etc. All these situations may occur at any time during an operation. Such scenarios may result in great risk for equipment damage, human injury and/or environmental pollution. Typical operations where a pipe string from the drilling rig or ship is fixed to the seabed and a safety release device may be required is; installation and testing of subsea
25 Christmas trees, running of tubing using a simplified landing string, using well intervention risers or workover risers to either run production tubing or to perform other intervention work on a subsea well. Many similar scenarios can be foreseen.

Similarly, one may envisage the need for safety release device in a crane system, where the safety release devices is connected in line with a wire line system. Such a release mechanism would drop
30 the load when the safety release device was activated. Other applications could be to avoid unintended high axial loads during towing operations and anchor handling operations and even during regular mooring of rigs and ships.

In one aspect, the present invention relates to a safety release device that primarily does not rely on material failure.

35 In another aspect, the present relates to a safety release device that more precisely can be set to the correct and desired release force in advance.

In a further aspect, the present relates to a safety release device that leaves a predictable connection interface after disconnect.

40 At least one of these aspects or aims is obtained by means of a device according to the independent claim 1. Further advantageous embodiments or features are mentioned in the dependent claims.

In the following, a detailed description of some possible embodiments of the present inventions is given with reference to the drawings, where:

Fig. 1 shows an exploded view of an embodiment of the present invention;

Fig. 2 shows an exploded sectional view of the same embodiment as fig. 1;

5 Fig. 3 shows in detail a possible embodiment of a release mechanism;

Fig. 4 shows in detail another possible embodiment of a release mechanism;

Fig. 5 shows a possible pressure equalizing arrangement according to one embodiment of the present invention;

10 Fig. 6 shows another embodiment of the present invention, where the safety release device is arranged in a wire line system;

Fig. 7 shows in detail another possible embodiment of a release mechanism;

Figs. 8 and 9 show first and second interlocking members for provision of a strong mode functionality, in which strong mode the safety release device cannot release.

| | | | |
|----|-------------------------------|----|---------------------------|
| 1 | safety release device | 17 | lower spring foot |
| 2 | drill pipe box connection | 18 | inner seal |
| 3 | drill pipe pin connection | 19 | upper spring foot |
| 4 | first spline | 20 | outer seal |
| 5 | locking sleeve | 21 | wire |
| 6 | latch bolts | 22 | wire pin connection |
| 7 | latch bolt ejection apertures | 23 | wire box connection |
| 8 | housing | 24 | through holes |
| 9 | intermediate space | 25 | second spline |
| 10 | pipe shaped end portion | 26 | first interlocking means |
| 11 | tapered grooves | 27 | second interlocking means |
| 12 | latch body | 28 | inner space |
| 13 | groove | 29 | first sealing member |
| 14 | spring | 30 | second sealing member |
| 15 | make-up sleeve | 31 | tapered portion |
| 16 | closing cap | 32 | passages or recesses |

15 **Table 1. Table of reference numerals**

20 Fig. 1 shows an exploded view of safety release device 1 according to an embodiment of the present invention where the safety release device 1 is arranged in-line in a drill string, comprising a drill pipe box connection 2 and a drill pipe pin connection 3. In this embodiment, the drill pipe box connection 2 comprises a first spline 4 which is arranged to mate with a corresponding second spline 25 (as shown in Fig. 2) inside the drill pipe box section 2, in order to transfer torque across the safety release device. In another alternative embodiment, the first and second splines 4, 25 may be omitted and first 26 and second 27 interlocking means (shown in Figs. 8-9) instead provided on the drill pipe pin connection 3 and the drill pipe box connection 2 respectively, for example integrated into the

closing cap, or another suitable member inside the safety release device 1. The first and second interlocking means 26, 27 are configured to be relatively rotatable such that in a first relative position, they interlock to prevent the drill pipe pin connection 3 to be moved away from the drill pipe box connection 2, and such that in a second relative position, the drill pipe pin connection 3 is movable away from the drill pipe box connection 2. The passages or recesses 32 allow the first interlocking means 26 to be axially moved when in the second position. In this embodiment, the second interlocking means 27 are provided on the closing cap 16, although in other embodiments, the first interlocking means 26 could be provided elsewhere on the drill pipe box connector 2.

The drill pipe pin connection 3 is arranged to be inserted into the drill pipe box connection 2 and be connected and fastened to a locking sleeve 5 by means of an appropriate number of latch bolts 6. In one embodiment, the latch bolts 6 comprise a tapered portion 31 and are arranged to mate into corresponding tapered grooves 11 in the drill pipe pin connection 3. This is shown in figures 1, 2 and 3. In a locking state of the safety release device 1, the latch bolts 6 are not aligned with latch bolt ejection apertures 7, such that the latch bolts 6 are trapped between the drill pipe box connection 2 and a drill pipe pin connection 3 to prevent the drill pipe pin connection 3 to be released. However, in a release state of the safety release device 1, the locking sleeve 5 has been forced to move such the latch bolts 6 are aligned with the with latch bolt ejection apertures 7, wherein the latch bolts 6 will move, or be ejected, radially outwards through the latch bolt ejection apertures 7, effectively releasing the drill pipe pin connection 3 from the pipe box connection 2. The ejection is in this embodiment effected by virtue of the interaction between the tapered portion 31 and the corresponding tapered grooves 11 together forcing the latch bolts 6 radially outwards, although other mechanisms for release of the drill pipe pin connection 3 according to other embodiments are feasible within the scope of the present invention, some embodiments of which will be further described below. At this point, the safety release device has been activated and the lower part of the drill string has been disconnected from the upper part of the drill string. Furthermore, drill pipe box connection 2 is intact and substantially undamaged, facilitating future reconnecting/fishing of the lower part of the drill string which now has been left unattached below the drilling rig either inside a marine riser or in open water, or above the drill floor on the drilling rig depending on where the safety release device was located at the time of release. The advantage of having an intact and undamaged connection point during later reconnecting/fishing operations will be appreciated by those who regularly have to conduct such operations.

Figure 3 shows one embodiment of a release mechanism, similar to the one of fig. 1. Figure 4 shows another possible embodiment of a release mechanism comprising at least one oval, circular, or egg shaped latch body 12 mating into at least one suitably shaped corresponding groove 13 in the drill pipe pin connection 3. When the drill pipe pin connection 3 is permitted to move axially upwards relative to the drill pipe box connection 2, the oval, circular, or egg shaped latch body 12 eventually will align with the ejection aperture 7, whereupon the shape of the groove 13 and the oval, circular, or egg shaped latch body 12 will ensure that the oval, circular, or egg shaped latch body 12 is ejected through the ejection aperture 7 and the drill pipe pin connection 3 is released from the drill pipe box connection 2.

Other possible embodiments for the release mechanism includes ratchet coupling (not shown), gear tooth coupling (See fig. 7), an over center latch (not shown) etc.

According to the embodiments shown in figures 1-4, the safety release device comprises a stop means configured to withstand a predetermined threshold of applied pull force and thereby prevent movement of the first member from its locking position towards its release position unless the predetermined force is exceeded. The stop means comprises a spring 14 configured to bias the first member in its locking position towards the second member. Hence, the stop means determines the release tensile force required to move the release mechanism, which comprises the latch bolts or latch bodies 6, 12, to the release position. The biased spring 14 acts as a solid, rigid body until the predetermined compression force in the spring 14 is exceeded, where after the spring 14 acts as a compliant and resilient member. In these embodiments, the predetermined threshold of applied pull force is adjustable by selecting a spring 14 with a suitable spring constant, i.e. a spring 14 that is correctly dimensioned for the forces involved, and then adjusting the preloading of the spring 14 by screwing a make-up sleeve 15 to a desired axial position within the drill pipe pin connection (the make-up sleeve 15 is provided with external threads and the drill pipe connection 3 is provided with corresponding threads). The preloaded spring 14 in the safety release device according to the embodiment shown in figures 1-4 with act as a solid, rigid body until a predetermined compression force is exceeded. Since the preloaded spring 14 is trapped between the locking sleeve 5 and the make-up sleeve 15 and closing cap 16, ref. figure 5, the axial tensile force on the drill string will correspond to the compression force on the preloaded spring 14. As long as the axial tensile force on the drill string, and thereby the compression force on the preloaded spring 14 is below the predetermined threshold, the preloaded spring 14 will act as a solid, rigid body, and the safety release device will remain in the locking position and not disconnect. If the axial tensile force on the drill string, and thereby the compression force on the preloaded spring 14 approaches the predetermined threshold, the preloaded spring 14 will start to compress, effectively permitting the drill pipe pin connection 3 to be drawn upwards in relation to the drill pipe box connection 2, ref. fig 3, until the latch bolts 6 eventually align with the with latch bolt ejection apertures 7, wherein the latch bolts 6 are ejected radially outwards through the latch bolt ejection apertures 7. At this point, the drill pipe pin connection 3 is released from the pipe box connection 2.

It is understood that the wording "string" in this context is meant to cover various alternatives, e.g. drill pipe landing string, workover riser, casing riser etc. Possible operations include installation and pulling of well production pipes, completion strings, tubing hanger, Christmas tree etc. Furthermore, operations where the string is attached to a subsea installation are also included, e.g. running/landing of casing hanger.

In other words, according to the present invention in a wider sense, the safety release device comprises a first member and a second member insertable into and engageable to the first member, wherein disengagement of the first and second members requires pulling the first member away from the second member, wherein the safety release device comprises a stop means configured to withstand a predetermined threshold of pull force on the first and second members and thereby prevent movement of the first member away from the second member unless the predetermined force is exceeded, wherein the safety release device further comprises a release mechanism movable between a locking position in which it locks the first member to the stop means, and an release position in which it releases the first member from the stop means, wherein the release mechanism is configured to move from its locking position to its release position upon movement of the first member away from the second member.

In an embodiment (not shown in figures) the stop means comprises an intermediate member configured to break when the applied pull force exceeds the predetermined threshold. Thus, in order to pull the first member away from the second member, the threshold force first has to be exceeded, where after the intermediate member breaks, such that the first member is free to move from its locking position to its release position. The intermediate member provides a clear distinction between released and normal operation of the safety release device, since it allows no movement until it breaks.

It is understood that with wording, and as compared to the specific embodiment described above with reference to figures 1-4, the first member and a second member may correspond to the drill pipe box connection 2 and a drill pipe pin connection 3, respectively, the stop means may correspond to the pre-loaded spring 14, the release mechanism may correspond to the latch mechanism 6, 7, 11, 12, 13 etc.

At normal use, the safety release device 1 allows a certain amount of pull force to be applied without releasing the first member 3 from the second member 2. Upon loading of the safety release device 1, the pull force applied to the first member 3 is transferred to the release mechanism which in turn transfers the force to the stop means 14 which normally prevents movement of the first member 3 away from the second member 2. However, when the pull force applied exceeds the predetermined threshold, the stop means 14 no longer stops the first member 3 from moving away from the second member 2, wherein the first member 3 starts moving away from the second member 2. After a certain amount of movement, the first member 3 reaches its release position, wherein the release mechanism is released from first member 3 such that the first member 3 can freely leave the rest of the safety release device 1 without causing any damage.

In an embodiment, the stop means 14 comprises a resilient member. In order to pull the first member away from the second member, the biasing force of the resilient member first has to be exceeded. Thus, the resilient member provides an easy way of controlling the predetermined threshold of applied pull force. Further, by changing the resilient member to another resilient member with different material properties/values, such as stiffness/resiliency, it is possible to control the biasing strength and thereby the threshold. In the above embodiment the resilient member is a pre-loaded spring. The spring is advantageous, since its biasing power can easily be controlled by altering the compression of the spring, by adjustment of the axial position of a support member 15 or other abutment portion, in the above embodiment being the make-up sleeve 15.

As a non-limiting example, if a drill string has been run down a marine riser and through a BOP with a tool hanging off its end, where the tool is latched to the inside of the casing somewhere below the BOP, it is crucial that the tool is not ripped out of its position because it acts as an important well barrier. If an emergency situation should arise where the heave compensators lock up, the safety release device must disconnect. Assuming the drill string is 300 m long and the maximum tensile force the tool can bear is 2500 kN, a spring constant of 16 700 kN/m can be chosen, wherein the predetermined threshold is achieved by preloading the spring 14 with 2000 kN. In this case an axial load of 2500kN will result in approximately 0.03m compression of the spring which for this design is sufficient to move the locking sleeve 5 to align the latch bolts 6 with the latch bolt ejection apertures 7, thereby causing a disconnect at 2500kN axial load.

The release load for the safety release device according to the present invention is highly adjustable, based on project specific needs for each application (load resistance, water depth, pressure, vessel, operation etc.). The release load is controlled by the pre-load in the system and is not dependent of other material properties than the module of elasticity in the element that is pre-loaded. The release load is testable, repeatable, and does not require extensive material testing. The release is non-destructive and allows for reuse. The safety release device may be pressure balanced, avoiding (a possible) pressure in the string affecting the release load (this feature is described in closer detail below).

This approach would make it possible for the operators to have a limited number of springs available on the rig, whereupon simple calculations or a table of guide numbers would help the operator to select the correct spring 14 and preload before the safety release device is assembled and run in-line with the drill string.

It is understood that other suitable spring elements could be used in the stop means 14 instead of the spring shown in the figures; For example a machined spring, a leaf spring, a stack of plate springs, compound spring, laminated spring, filament wound composite spring, rubber or elastomeric body or some other compliant and resilient member, or a combination thereof may be used, that acts as a mainly stiff member until a predetermined threshold of compression or tensile force is reached and/or exceeded. For example, rather than the stop means comprising a resilient member, such as a spring, the stop means may instead comprise a non-resilient body, such as a glass, ceramic or composite body, which is not necessarily biased, but which acts as a mainly stiff member until a predetermined threshold of compression or tensile force is reached and/or exceeded, wherein it breaks to allow movement of the release mechanism to the release position.

Figure 5 shows a sectional view of a fully assembled safety release device 1 according to the embodiments shown in figures 1-4. In figure 5, a spring 14 has been inserted into the drill pipe box connection 2 on top of a locking sleeve 5 and a lower spring foot 17, the lower spring foot 17 comprising inner and outer seals 18, 20 in order to prevent flow from passing the lower spring foot 17. The purpose of the inner and outer seals 18, 20, if present, will be explained in more detail below. On top of the spring 14, an upper spring foot 19, comprising inner and outer seals 18, 20 in order to prevent flow from passing the upper spring foot 19, is inserted before a threaded make-up sleeve 15 is threaded above the spring 14. The make-up sleeve 15 may be used to preload the spring 14. At last, a closing cap 16 is threaded on top of the make-up sleeve 15. The purpose of the closing cap 16 in this embodiment is to provide a tapered shoulder that prevents the drill string from getting stuck during tripping. It may also serve as a back-up for the make-up sleeve 15, e.g. in order to prevent the make-up sleeve 15 from unthreading/loosening.

Shown in figure 5 are also a number of apertures in the form of through holes 24 in the drill pipe pin connection 3, which allow for the fluid and pressure inside the drill string to be relayed into the annular intermediate space 9 that is in part occupied by the spring 14. Since the lower and upper spring feet 17, 19 both comprise inner and outer seals 18, 20, fluid leaks to/from the intermediate space 9 is mitigated. The lower and upper spring feet 17, 19 together with inner and outer sealing members 18, 20 form first and second sealing members 29, 30 having respective surface areas facing into the intermediate space 9. Said surface areas of the first and second sealing members 29, 30 provide a respective area onto which the pressure from the inside of the drill pipe will exert forces

that will counter the compression force that will act on the spring 14 due to pull apart of the drill pipe pin connection 3 and drill pipe box connection 2 and/or due to over pressure within the inner space 28 of the drill pipe pin connection 3. This feature may be particularly useful if the safety release device is lowered to a location with a high or strongly varying fluid column pressure or pumping pressure, resulting in forces acting between the drill pipe pin connection 3 and drill pipe box connection 2 to force them apart, which forces may approach or even exceed the rated threshold of the safety release device and thereby cause unwanted release of the safety release device 1. Regardless, the tensile forces in the drill pipe walls that are generated by the fluid column pressure inside the drill string, will scavenge on the initial rating of the safety release device. A carefully designed intermediate space 9 with correctly dimensioned surface area of the first and second sealing members 29, 30, will provide a means for equalizing or offsetting the effect of the fluid column pressure and/or pumping pressure, whereby the release force of the safety release device will not be affected or reduced. This is important when deciding what force the safety release device is to release at, and when choosing the correct spring and preload. Without such an equalizing feature, the force at which the safety release device is to release becomes unsure, and safety margins in the one or other direction has to be implemented. It is understood that such an equalizing feature is not necessary when the safety release device is implemented in applications without internal fluid pressure, such as the following embodiment.

Figure 6 shows an alternative embodiment of the present invention. In this embodiment, the safety release device is adapted for use on a wire line, hoist rope, guy line, tether, pulling rope or the like. Instead of a drill pipe pin connection 3, the safety release device is mounted in-line with a wire 21. One end of the wire 21 is provided with a box connection 23, whereas an outer end of the wire 21 comprises a pin connection 22. The pin connection 22 of the wire 21 may comprise a crimped sleeve provided with tapered latching grooves 11. In other respects the embodiment shown in figure 6 corresponds, both functionally and in terms of parts used, to the embodiments shown in figures 1-5. All the possible variations mentioned in respect to figures 1-5 are also possible and relevant for the embodiment shown in figure 6.

Patent Claims

1. A safety release device (1) comprising a first member (3) and a second member (2) insertable into and engageable to the first member (3), wherein disengagement of the first and second members requires pulling the first member (3) away from the second member (2),
 - 5 wherein the safety release device comprises a stop means (14) configured to withstand a predetermined threshold of pull force on the first and second members (3, 2) and thereby prevent movement of the first member (3) away from the second member unless the predetermined force is exceeded,
wherein the safety release device (1) further comprises a release mechanism (5, 6, 7) movable
10 between a locking position in which it locks the first member (3) to the stop means (14), and a release position in which it releases the first member (3) from the stop means (14), wherein the release mechanism (5, 6, 7) is configured to move from its locking position to its release position upon movement of the first member (3) away from the second member (2).
2. A safety release device according to claim 1, wherein the stop means (14) comprises a resilient
15 member configured to bias the first member (3) in its locking position towards the second member (2).
3. A safety release device according to claim 2, wherein the resilient member is a spring.
4. A safety release device according to any one of claims 2-3, wherein the stop means (14) comprises
20 a support member (15) provided on the first member (3) for limiting movement of the resilient member upon movement of the first member (3) from the locking position to the release position.
5. A safety release device according to claim 4, wherein the support member (15) is movably attached to the second member for adjustment of the biasing force of the spring.
6. A safety release device according to any one of the preceding claims,
25 where the second member comprises a housing (8) for receiving a pipe shaped end portion (10) of the first member (3),
wherein the stop means (14) is provided in an intermediate space (9) between the housing (8) and an outside of the pipe shaped end portion (10) of the first member (3),
and wherein the pipe shaped end portion (10) of the first member (3) is provided with transversal
30 through holes (24) enabling fluid communication between the intermediate space (9) and an inner space (28) inside the pipe shaped end portion (10) of the first member (3).
7. A safety release device according to claim 6, wherein the housing (8) and any sealing members (29,
30) between the housing (8) and the first and second members (3, 2) are such shaped and dimensioned that forces acting between the first and second members (3, 2) to push them together due to fluid pressure within the intermediate space (9), cancel out forces due to fluid pressure within
35 the inner space (28) inside the pipe shaped end portion (10) acting between the first and second members (3, 2) to push them apart.

8. A safety release device according to any one of claims 6-7 wherein first and second sealing members (29, 30) are provided for sealing between the housing (8) and the pipe shaped end portion (10) of the first member (3).
9. A safety release device according to claim 4-5, wherein the support member (15) is a ring provided with threads for engaging corresponding threads of the second member (2).
10. A safety release device according to claim 1, wherein the stop means (14) comprises an intermediate member configured to break when the applied pull force exceeds the predetermined threshold.
11. A safety release device according to any one of the preceding claims, further provided with first (26) and second (27) interlocking means provided on the drill pipe pin connection (3) and the drill pipe box connection (2) respectively, wherein the first and second interlocking means (26, 27) are configured to be relatively rotatable to a first and a second relative position, such that in the first relative position they interlock for preventing the drill pipe pin connection (3) to be moved away from the drill pipe box connection (2), and such that in the second relative position they are free to move axially relative to each other such that the drill pipe pin connection (3) is movable away from and detachable from the drill pipe box connection (2).

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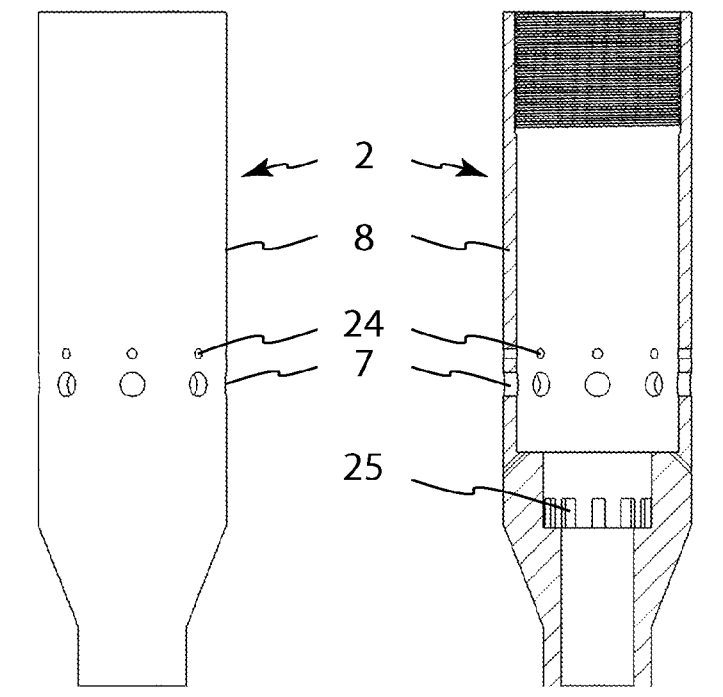
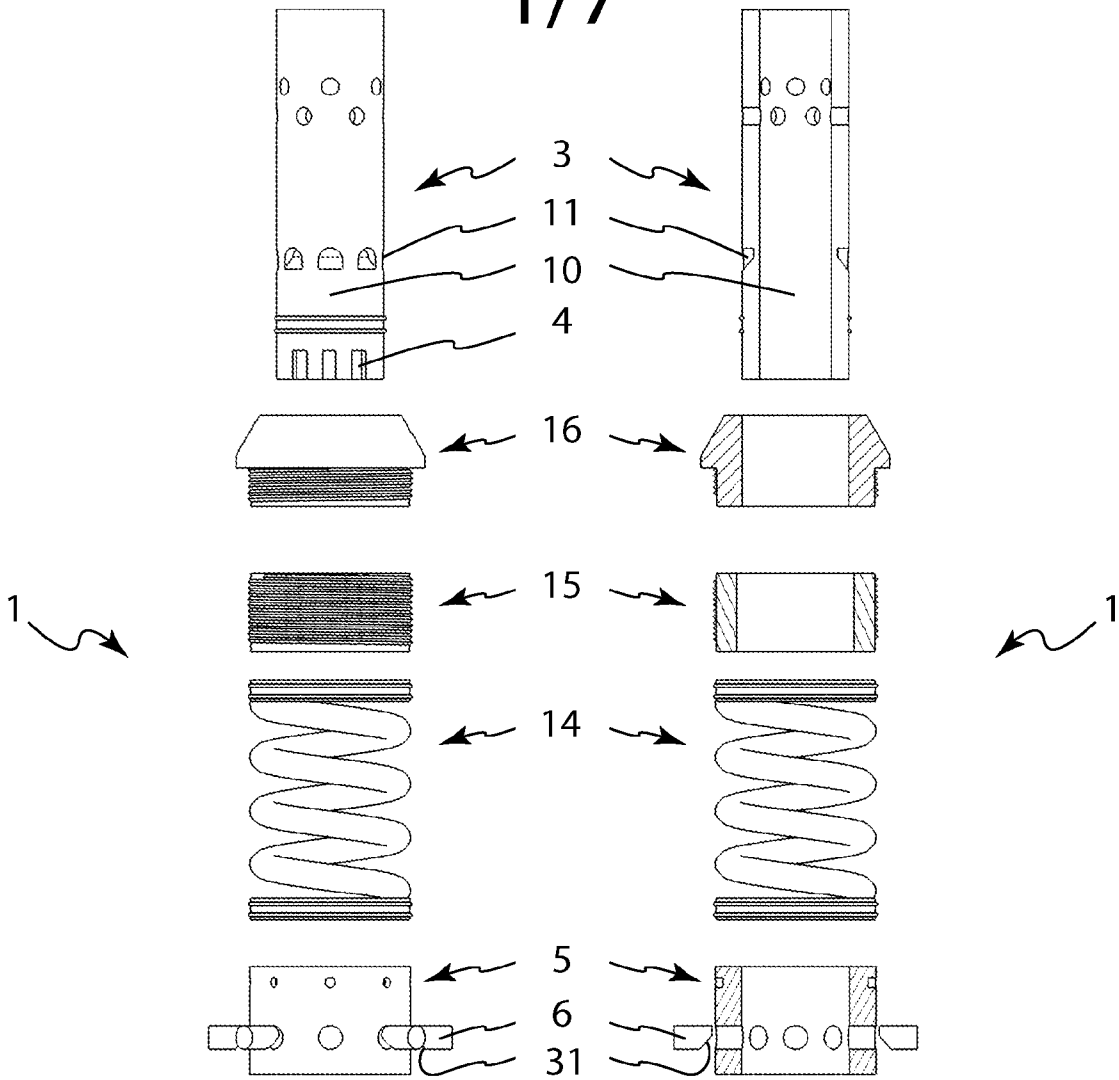


Fig. 1

Fig. 2

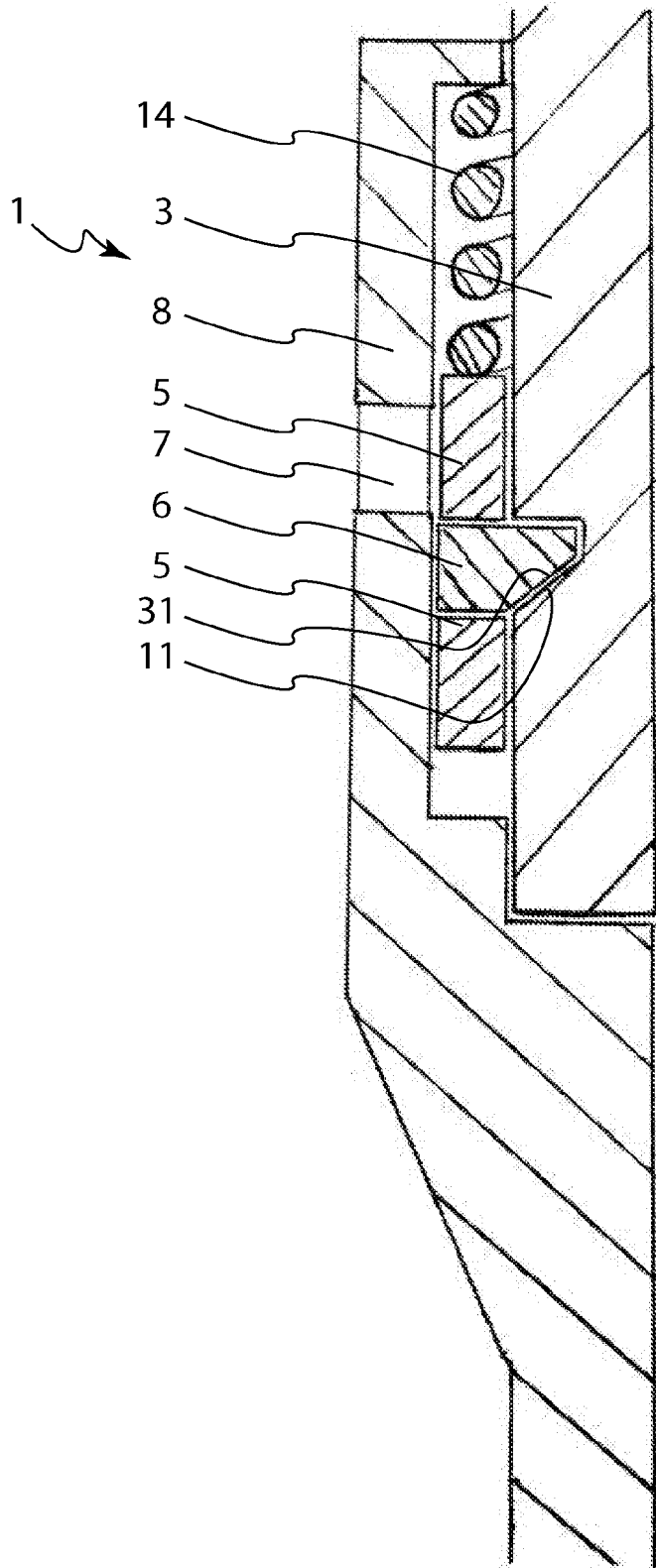


Fig. 3

Fig. 3 is a cross-sectional view of a mechanical assembly. The assembly includes a central shaft with several components. At the top, there are four circular elements, possibly rollers or bearings, labeled 14. Below them is a component labeled 3. Further down is a component labeled 8. Below that is a component labeled 5. Below that is a component labeled 7. Below that is a component labeled 6. Below that is a component labeled 5. Below that is a component labeled 31. Below that is a component labeled 11. A curved arrow labeled 1 points to the left side of the assembly. The drawing uses hatching to indicate different materials and cross-sections.

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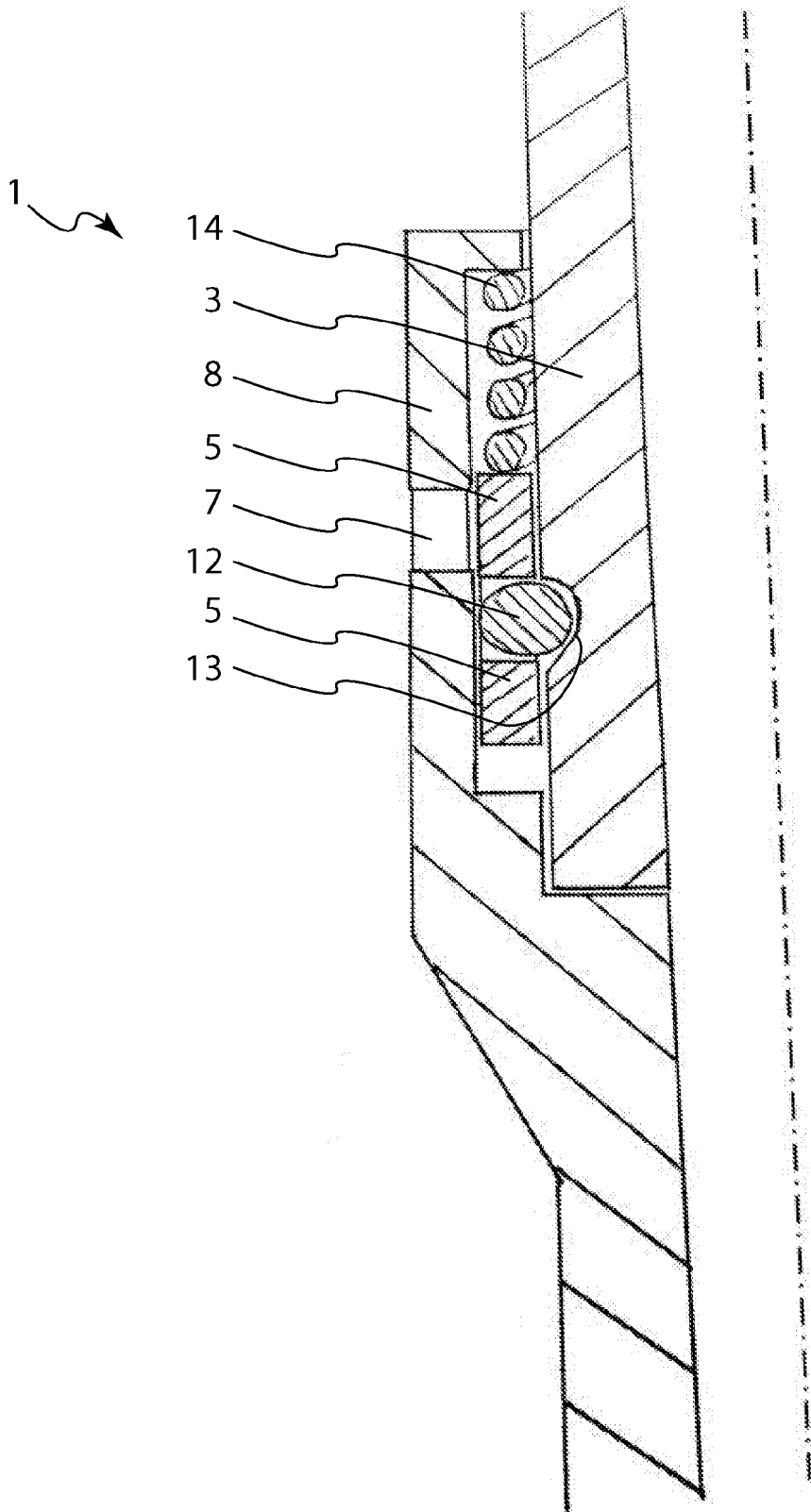


Fig. 4

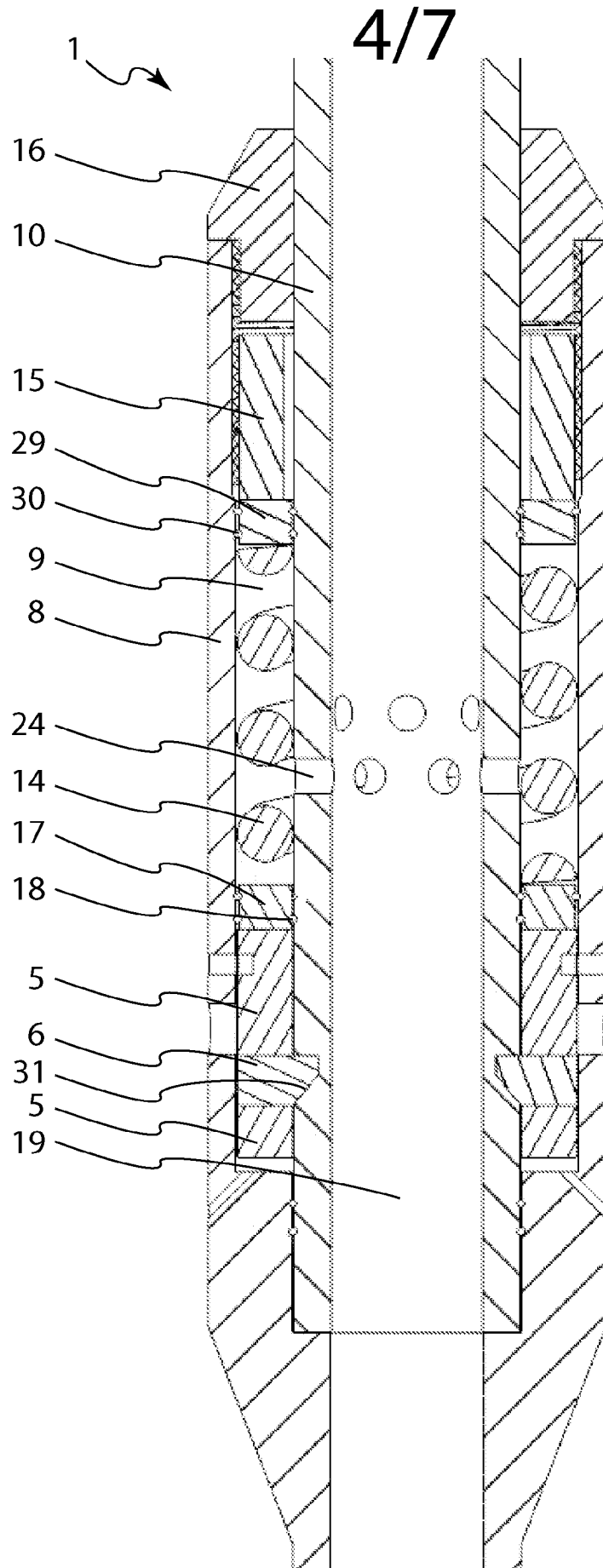


Fig. 5

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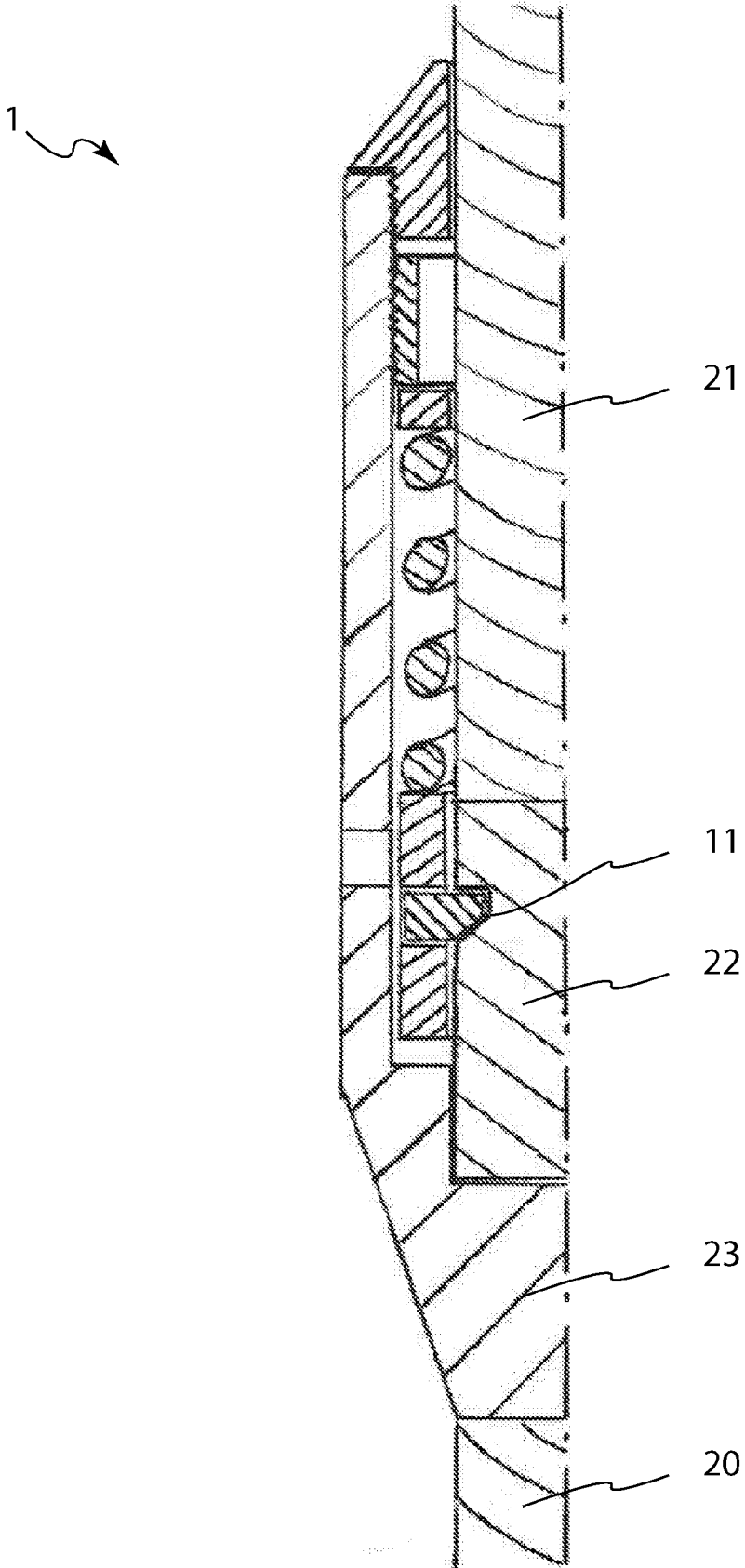


Fig. 6

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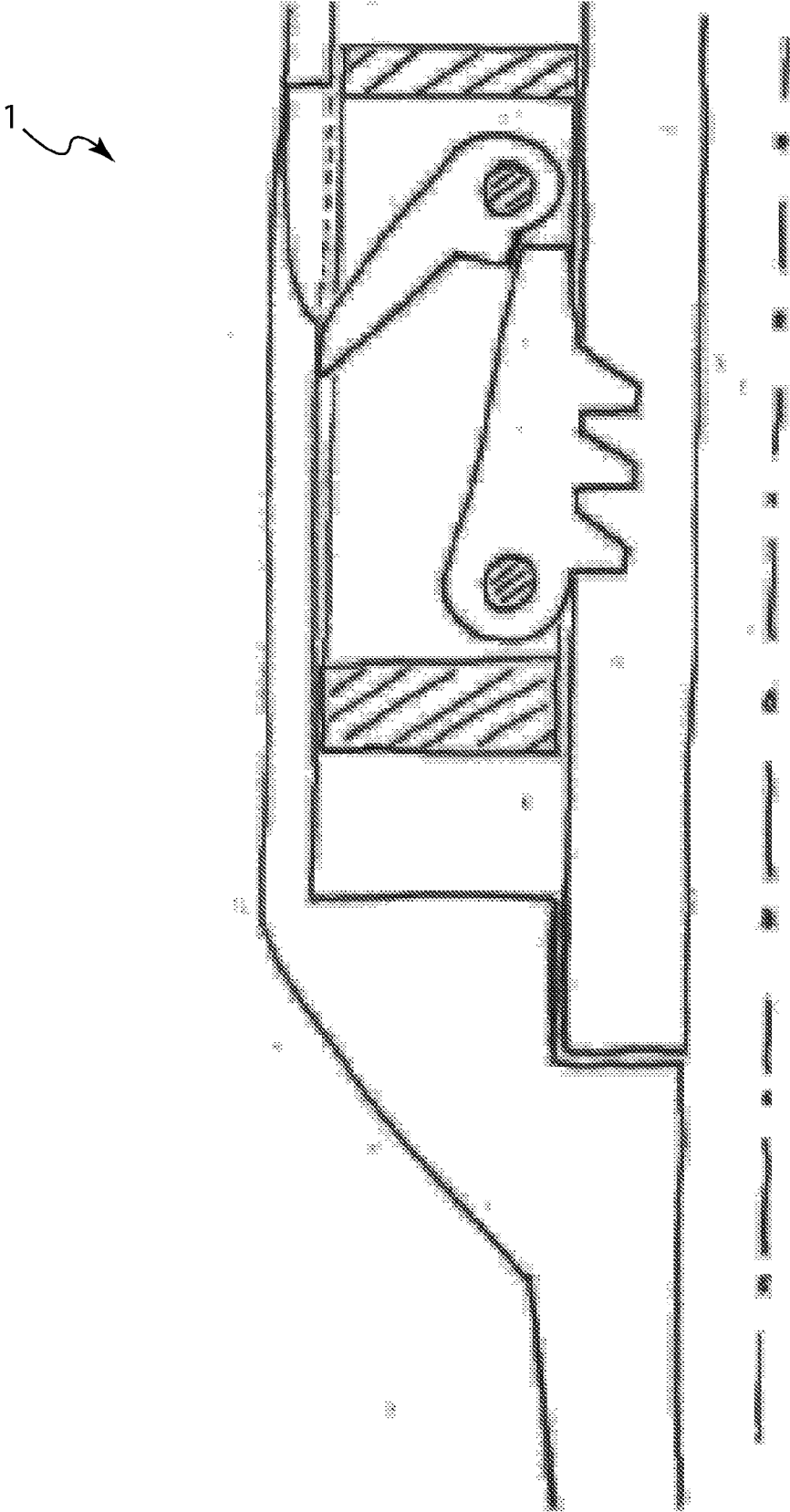


Fig. 7

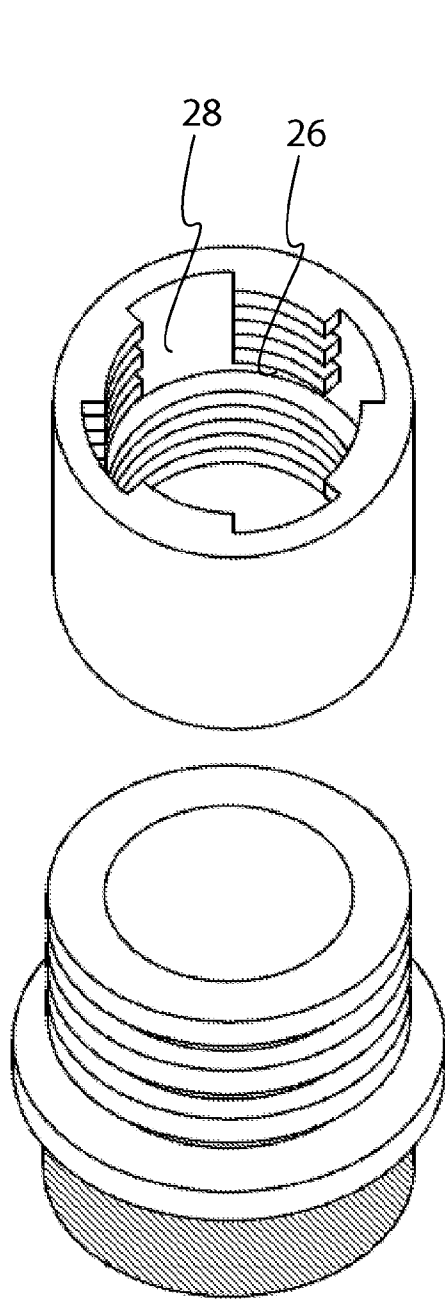


Fig. 8

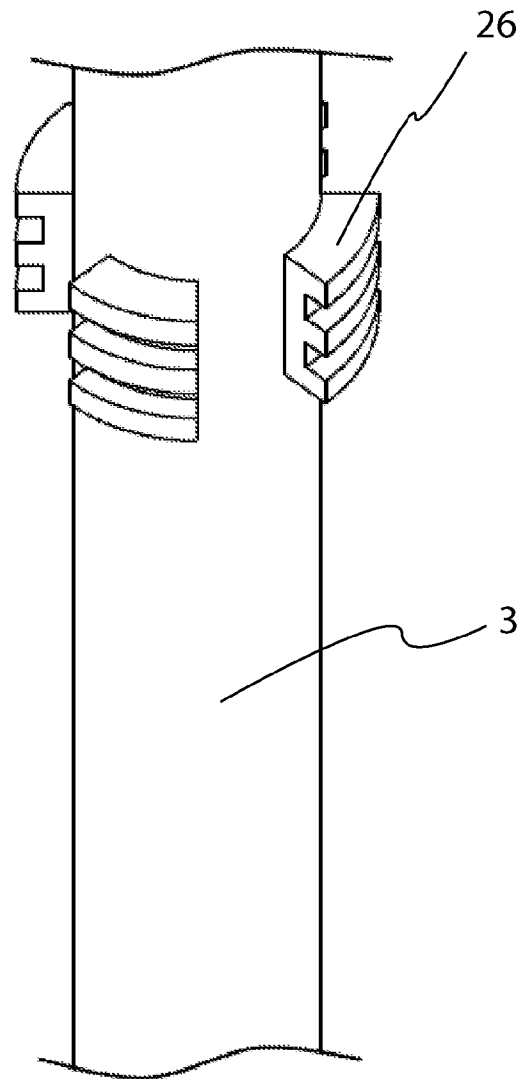


Fig. 9