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(54) **ACTUATING MECHANISM**

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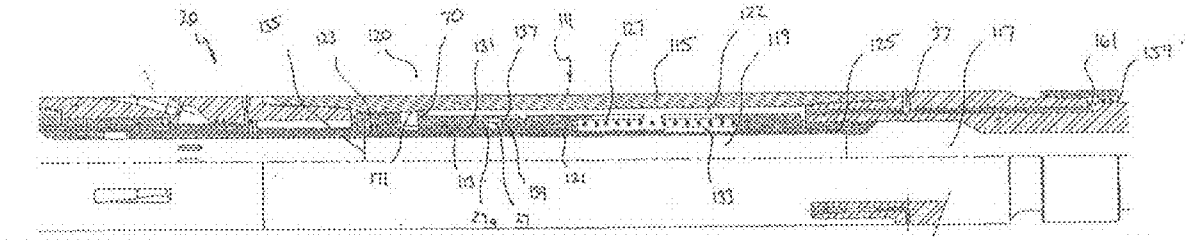
(57) **ABSTRACT**

An actuating mechanism (**111**) comprising an inner member (**113**) and an outer member (**115**) axially slidable relative to each other, the inner and outer members (**113**, **115**) cooperating to define an internal passage (**117**) for the flow of a fluid therethrough. The inner member (**113**) being configured such that upon a predetermined change in pressure between a first region (**119**) and a second region (**120**) the actuating mechanism (**111**) is caused to move between a first condition and a second condition.



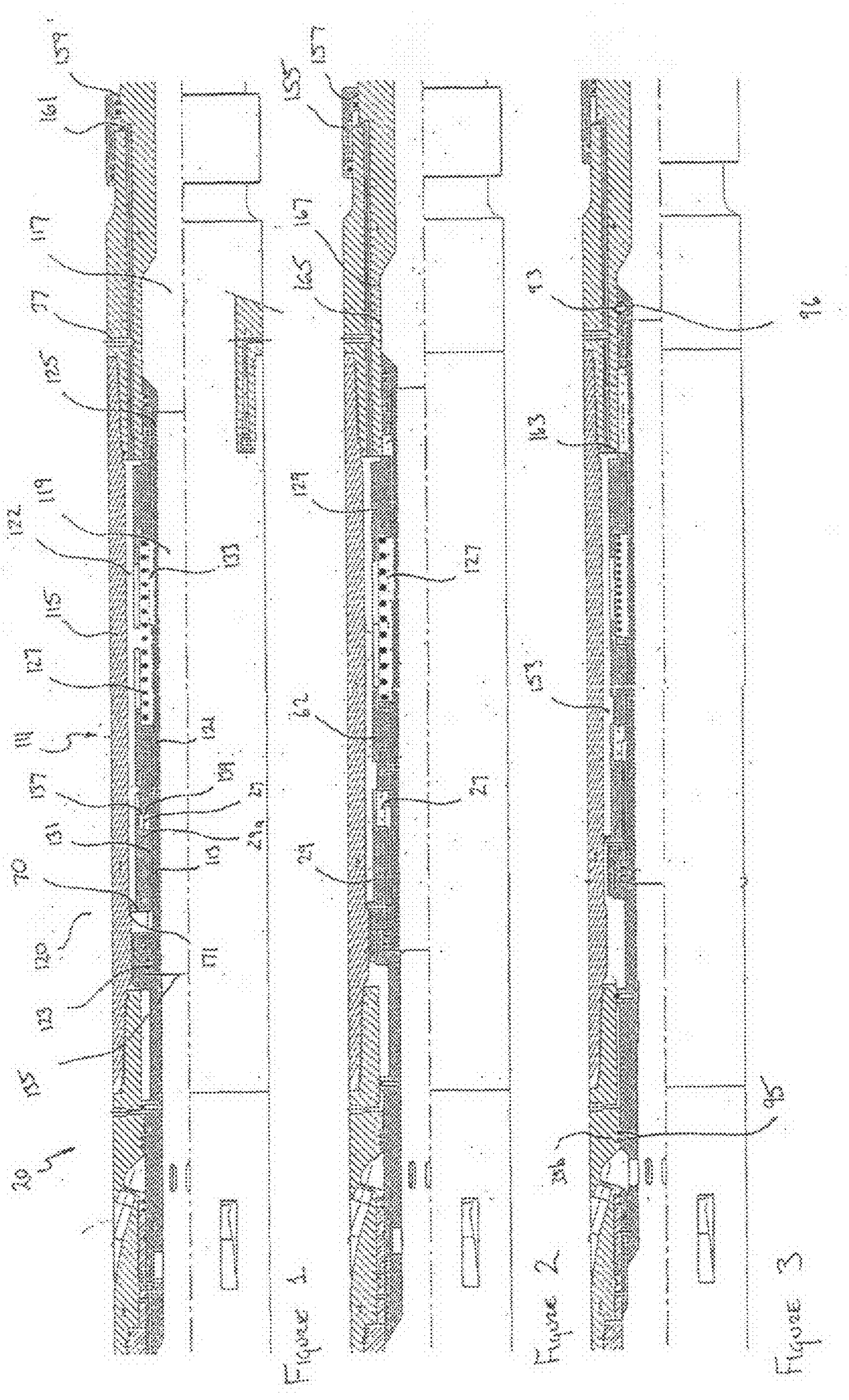


Figure 1

Figure 2

Figure 3

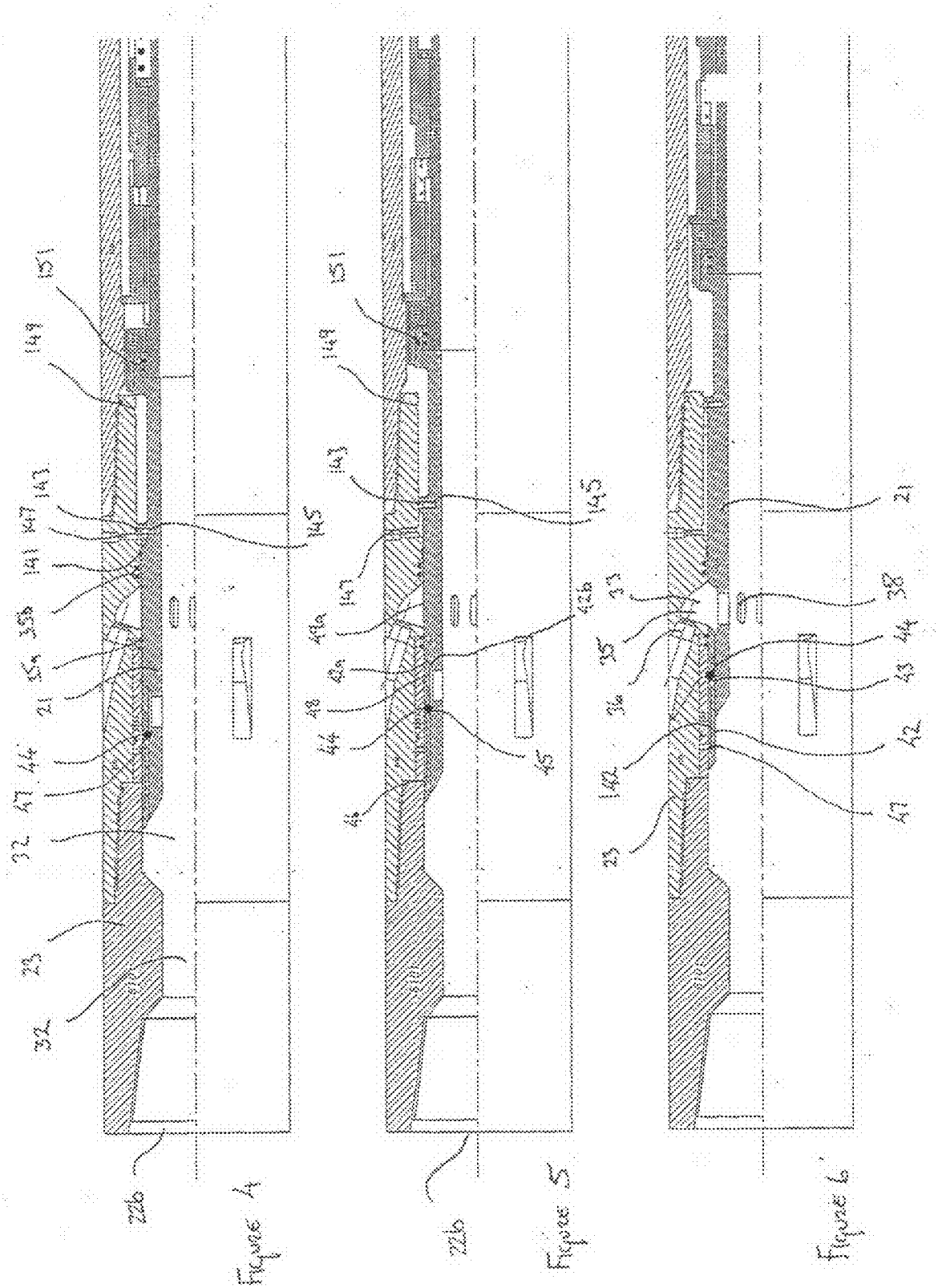

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Figure 4
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Figure 6

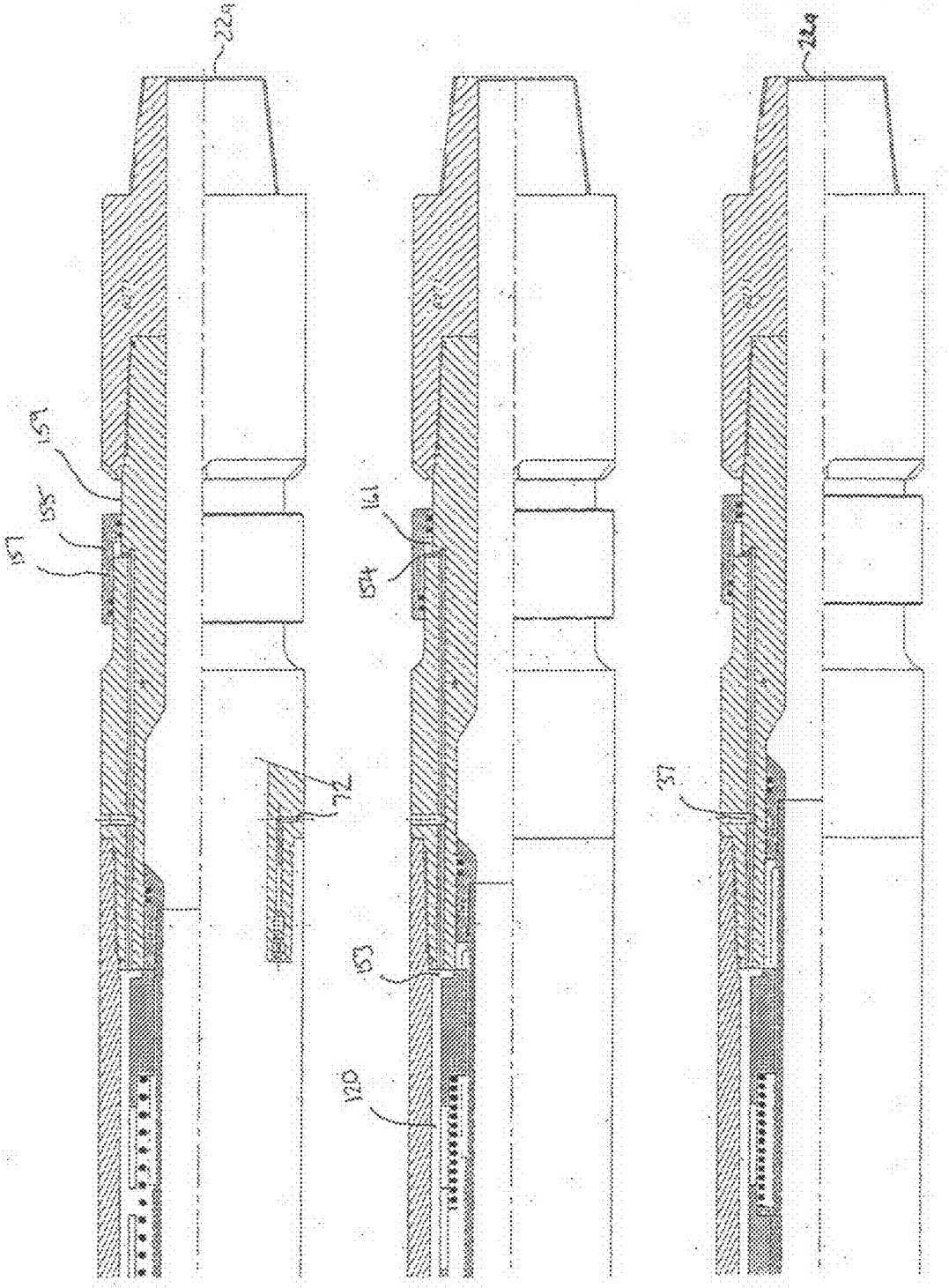

Figure 7

Figure 8

Figure 9

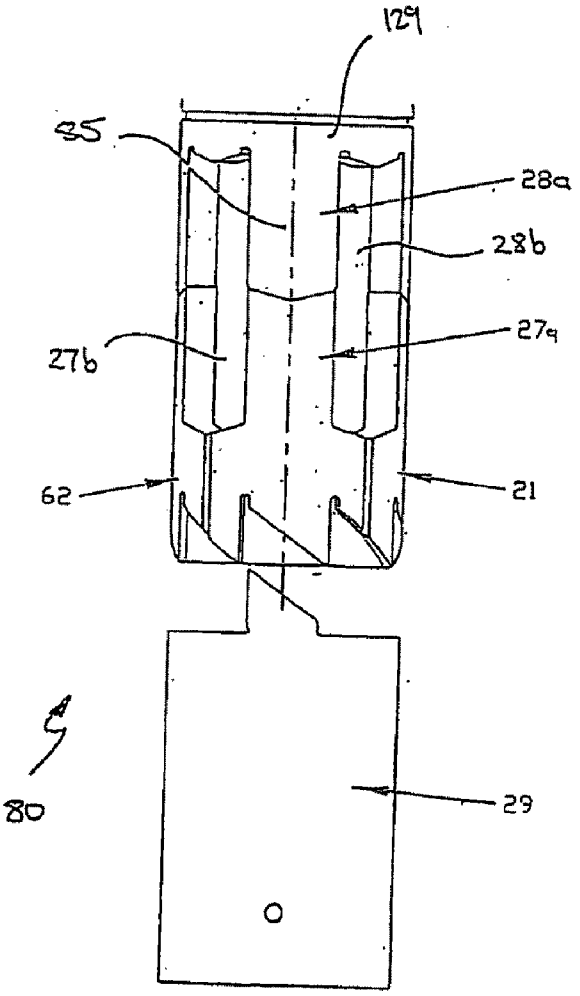

Figure 10

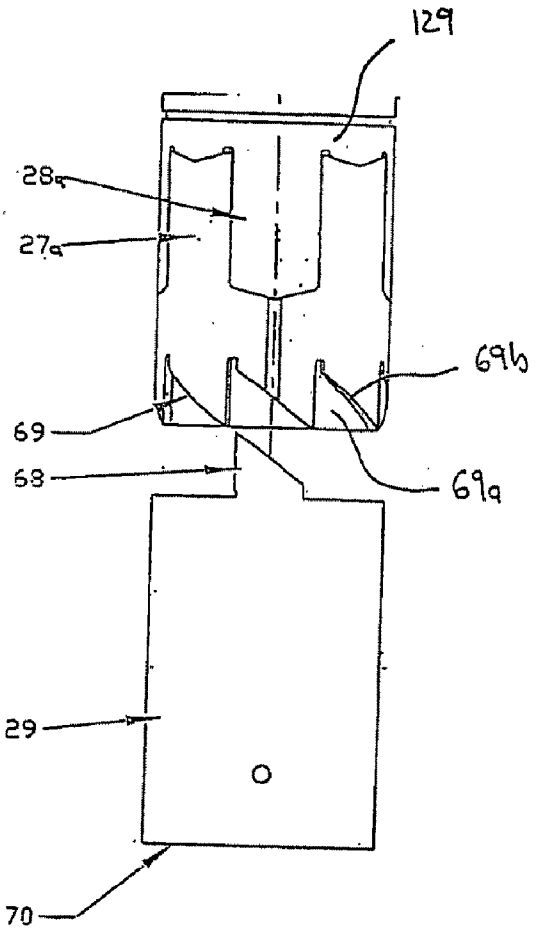

Figure 11

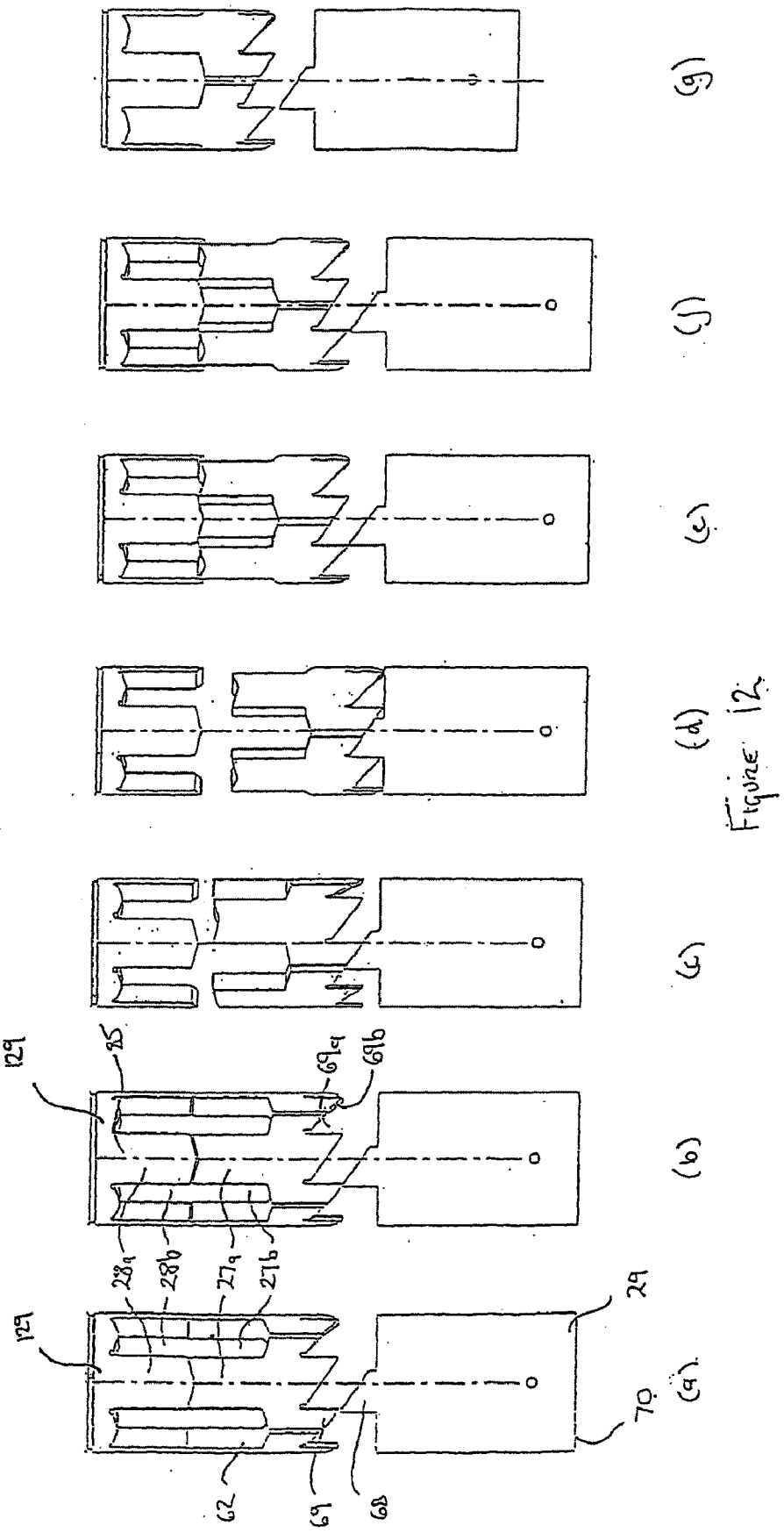

Figure 12

ACTUATING MECHANISM

FIELD OF THE INVENTION

[0001] The present invention generally relates to an actuating mechanism for use in an apparatus to effect movement of the apparatus between two or more modes of operation. For instance, the actuating mechanism can be used in a flushing device incorporated in a drilling stem used in mining to open and shut the device.

BACKGROUND ART

[0002] The current invention can be applied in many different types of tools and devices. For instance it may be incorporated in under reamers, casing cutters, ball valves and other type of valves, packers and tools for deep mineral air drilling.

[0003] The invention would also be useful in flushing devices used in drilling strings in oil and gas explorations and extraction. As well paths in exploration and extraction activities in mining industries become increasingly longer and the network more complicated, new challenges are constantly being faced in the area of well boring. One of these challenges is in respect of maintaining suitable conditions for the operation of the drill head or bit to cut through the medium.

[0004] When drilling well bores, slurry, used to operate the drill head, is pumped from the surface through a drill stem assembly to the drill head. This slurry, upon reaching the end of the bore is caused to return to the surface, passing through the annular space between the sidewalls of the bore and the drill stem assembly before reaching the surface, whereby the returning slurry suspends the cuttings, made during the drilling process, transporting them back to the surface. The removal of the cuttings ensures the bore remains relatively clean, providing optimal conditions for drilling. Failure to remove the cuttings, or a suitable percent of the cuttings can create blockages and jamming, resulting in costly down time and may even result in the equipment being irretrievable.

[0005] A build up of cuttings may result in a reduction in the flow of slurry to and from the drill head, it may place unnecessary loads on the drill head and stem assembly and may also cause the drill head to be wedged or jammed in the bore. Furthermore, with the increase in use of horizontal bores in well networks, a build up of cuttings on the lowermost or bottom surface of the bore may cause side displacement of the drill head which will result in the bore taking on a new and incorrect direction.

[0006] Several areas of the drilling process have been investigated and improvements have been made which enhance the process of returning the cuttings to the surface. These solutions have included improvements to the slurry composition used to drive the drill head, as well as improvements to the actual drill head and the speed in which it may operate. However, improvements are still required in order to increase and improve the removal of cuttings from the bore.

[0007] Increasing the flow rate of the slurry and hence the return rate of the slurry to the surface does not sufficiently solve the problem. Owing to the narrow gap of the annular space, cuttings still tend to collect in this area. This not only inhibits the drilling process but is also problematic when introducing pipe linings. Also during subsequent cementing, additional problems are experienced if the hole is not clean.

[0008] Several mechanical flushing devices have been developed to assist in the clearing of the cuttings. These devices are incorporated with the drill stem assembly and, when in a closed condition allow the passage of the slurry to pass therethrough before proceeding to the drill head. When required the flushing device is caused to move to an open condition. In this condition a percentage of the slurry is diverted from the main flow passage, through ports located on the outside of the flushing device and into the annular space between the flushing device and the bore wall. The flushing device is remotely operated from the surface and typically requires the pumps to be switched off before the state of the flushing device may be changed.

[0009] As the annular space between the drill stem assembly and the bore wall is particularly narrow, it is often the cause of packing or wedging of cuttings in this region. It is therefore highly desirable to keep this region clear. Hence, diverting a portion of the fluid as it passes through the flushing member to the annular space assists in flushing this area and maintaining a clear passage for the flow of return fluid and cuttings to the surface.

[0010] Several of these flushing devices are referred to in U.S. Pat. No. 6,161,632. The invention disclosed in U.S. Pat. No. 6,161,632 provides a flushing device which remains in a closed state by the weight of the drill stem which acts downwardly. Relieving this weight by applying a relative pull upon the drill stem results in the flushing device moving to an open state, causing a predetermined percentage of the slurry to be diverted from the main passage into the annular space for as long as the weight of the drill stem assembly has been relieved.

[0011] Subsequent, to the return of the weight loading, the ports close and the full flow of the slurry is again delivered to the drill head allowing the drilling process to continue.

[0012] Hence, in order to maintain the flushing device in a closed state a compressive force must be maintained upon the flushing device. Similarly, in order to maintain the flushing device in an open state a tractive force must be maintained upon the flushing device. If the compressive or tractive force is not constantly applied to the flushing device during the required condition, the flushing device may automatically and uncontrollably move to the alternate condition.

[0013] The outer valve part and inner valve part of the flushing device disclosed in U.S. Pat. No. 6,161,632 are connected in permanent rotation via key and keyway slots between the valve parts. The manner in which these parts are coupled together result in high concentrations in forces at this junction, leading to failures at this interface, requiring costly repairs to be made.

[0014] A further deficiency in this device is in relation to the bleed holes located on the outer wall of the tool. These bleed holes allow cuttings to get into the flushing device, contaminating the various parts within the flushing device and resulting in tool failure.

[0015] Another type of flushing device currently available overcomes some of the deficiencies of the device disclosed in U.S. Pat. No. 6,161,632 in that a tractive force does not need to be maintained upon the device in order for it to remain open. However, a compressive force must be maintained in order to keep the device in a closed state. Loss of compression will automatically result in the tool moving to an open state, regardless of whether the surface pump(s) are in operation or not. This is undesirable during a drilling operation. Furthermore, this particular device is constructed such that the major moving components operate in the slurry, leading to reliability problems with the parts. Similarly to U.S. Pat. No. 6,161,

632, breather ports also allow cuttings to enter the device, causing additional problems in relation to the reliability of the device.

[0016] This device relies on hydraulic pressure to achieve the required tensile loading. Owing to the configuration of the device, hydraulic lock can occur resulting in a build up of pressure. When the pressure builds beyond a predetermined value, a relieve disc bursts causing the device to default to an open state, requiring the drill stem assembly to be brought back to the surface so that the flushing device can be repaired or replaced.

[0017] Further variations of these type of tools have also been developed. However, they often comprise many moving parts, which reduce the reliability of the tool, particularly in the operational conditions experienced, and/or require components to mechanically lock with other components, which under sufficient pressure result in the failing or deformation of these components, rendering the tool useless.

[0018] The preceding discussion of the background to the invention is intended only to facilitate an understanding of the present invention. It should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was part of the common general knowledge in Australia as at the priority date of the application.

[0019] It is against this background, and the problems and disadvantages associated therewith, that the present invention has been developed.

SUMMARY OF INVENTION

[0020] The present invention provides an actuating mechanism comprising:

[0021] an inner member and an outer member axially slidable relative to each other, the inner and outer members cooperating to define an internal passage for the flow of a fluid therethrough;

[0022] the inner member being configured such that upon a predetermined change in pressure between a first region and a second region the actuating mechanism is caused to move between a first condition and a second condition.

[0023] Preferably the first region is in the internal passage of the actuating mechanism.

[0024] Preferably the second region is external of the actuating mechanism. The pressure in the second region may be transmitted to a third region located within the actuating mechanism. Preferably the third region is located substantially between the inner and outer members. In this arrangement a change in pressure in the second region affects the pressure in the third region.

[0025] Preferably at least a section of the inner member is exposed to both the first and third regions. Preferably an inner surface of the inner member is exposed to the first region and an outer surface of the inner member is exposed to the third region. When there is a pressure difference between these regions unequal forces are exerted across the inner member. Preferably when this inequality reaches the predetermined value the actuating mechanism is caused to move between its first and second conditions.

[0026] Preferably the inner member and outer members are in the form of pipes.

[0027] The inner member may comprise a wash pipe which is configured to have a first end with an outer diameter larger than the outer diameter at the second end. Preferably the wash pipe has a portion having a tapered outer diameter. The portion may have a constant inner diameter.

[0028] Preferably the wash pipe has a first seal assembly located along the outer diameter adjacent the first end and a second seal assembly located along the outer diameter adjacent the second end. Preferably the first seal assembly and the second seal assembly each have at least one seal. Preferably the at least one seal of the second seal assembly has a smaller cross section than the at least one seal of the first seal assembly.

[0029] The degree of change in pressure required between the first region and the second region to operate the actuating mechanism may be varied by changing the cross sectional diameter of the at least one seal of the second seal assembly. Preferably an internal portion of the outer member against which the second seal assembly slidingly engages can be varied according to changes in cross sectional diameter of the at least one seal in the second seal assembly.

[0030] Preferably a cavity is defined between the inner member and outer member. Preferably the cavity is filled with a lubricant such as oil. The cavity may have an opening which opens into a chamber of an equalising device. The equalising device may be in the form of a floating sleeve which is slidingly retained on an outer portion of the outer member and which surrounds the chamber. Preferably, volumetric changes in the cavity result in the floating sleeve moving with respect to the opening. Preferably the floating sleeve is in communication with the second region such that pressure in the second region is transmitted to the cavity. Preferably the cavity provides the third region.

[0031] Preferably the cavity is sealed from the internal passage such that the cavity may not be contaminated. Preferably the cavity is also sealed from the area external the actuating mechanism to again ensure the cavity remains free from contamination. This ensures that the moving parts of the actuating mechanism are retained in an environment where contaminants cannot affect the operation of the actuating mechanism, increasing its reliability.

[0032] The equalising device may also balance and cushion the movement between the inner and outer sleeve.

[0033] Preferably the actuating mechanism comprises an indexing mechanism which indexes between a first position, wherein the actuating mechanism is in the first condition and a second position wherein the actuating mechanism is in the second condition.

[0034] Preferably the indexing mechanism is located between the first and second members. Preferably the indexing mechanism operates within the cavity. Preferably the indexing mechanism engages the inner member. The indexing mechanism may comprise an indexing sleeve, a travel stop and a positioning sleeve.

[0035] The indexing sleeve may be fixed rotationally to the inner member, this may be by way of a key way arrangement. Preferably the indexing sleeve is axially movable relative to the inner member.

[0036] The travel stop may be mounted on the inner member such that it may rotate about the longitudinal axis thereof. Preferably the travel stop is substantially constrained against axial movement relative to the inner member.

[0037] The positioning sleeve may be fixed rotationally to the inner member, this may be by way of a key way arrangement. Preferably the positioning sleeve is axially movable relative to the inner member.

[0038] The indexing sleeve and travel stop may be biased away from each other. The biasing force may be provided by a first spring. The travel stop and positioning sleeve may also be biased away from each other. The biasing force may be provided by a second spring.

[0039] Preferably the travel stop is adapted to co-operate with the indexing sleeve during the indexing sequence.

[0040] The indexing sleeve may have a first end which provides a bottom face and a second end having a projection, defining a pawl, extending in an axial direction from the periphery of said second end.

[0041] The travel stop may have a first end adapted to engage and mesh with the projection on the indexing sleeve and a second end adapted to engage and mesh with the positioning sleeve. Preferably a first end of the positioning sleeve is shaped to engage and mesh with the second end of the travel stop.

[0042] Preferably the second end of the travel stop is configured to provide a plurality of fingers and corresponding slots, which co-act with corresponding fingers and slots integral with the positioning sleeve. Each finger and slot of the travel stop may terminate in at least one depression or trough. Each finger and slot of the positioning sleeve may terminate in at least one peak. Each peak may be complimentary in shape to each trough so that upon engagement each finger on the travel stop aligns with a finger and/or slot on the positioning sleeve depending on whether the indexing mechanism is in its first position or second position.

[0043] Preferably when the indexing mechanism is in its first position the fingers on the travel stop align and mate with the fingers on the positioning sleeve. In this condition the fingers are opposed.

[0044] Preferably when the indexing mechanism is in its second position the slots on the travel stop align and mate with the fingers on the positioning sleeve, whilst the fingers on the travel stop align and mate with the slots on the positioning sleeve. In this condition the fingers are interlaced.

[0045] In one configuration of the indexing mechanism each finger and each slot on the travel stop each have one trough, and each finger and each slot on the positioning sleeve each have one peak.

[0046] In this configuration the actuating mechanism actuates, or cycles, between the first and second conditions in alternating fashion.

[0047] In another configuration of the indexing mechanism each finger and each slot on the travel stop each have one trough, and each finger on the positioning sleeve has one peak, whilst each slot on the positioning sleeve has two peaks.

[0048] In this configuration the actuating mechanism actuates, or cycles, from first condition to second condition to second condition before returning to the first condition.

[0049] Other configurations of the indexing mechanism will obviously allow for a variety of different cycles depending on the number of troughs each finger and/or slot on the travel stop has, and/or the number of peaks each finger and/or slot on the positioning sleeve has.

[0050] Obviously, the peaks may be on the fingers and slots of the travel stop whilst the troughs may be on the fingers and slots on the positioning sleeve.

[0051] The actuating mechanism may comprise at least one retention mechanism to releasably retain the actuating mechanism in one condition until the predetermined pressure differential between the first and third regions is reached whereupon the actuating mechanism is able to move from one condition to the other.

[0052] The retention mechanism may be a detent.

[0053] The retention mechanism may comprise a ball fixed relative to the inner member but biased radially outward from the inner member. The outer member may have a first groove and a second groove on its inner surface spaced a distance from each other. Preferably this distance is substantially equal in length to the axial distance the inner member moves relative to the outer member as the actuating mechanism moves between its first and second conditions. Each groove may be annular with a cross section complimentary to the ball so that the ball can be received therein and hold the inner member relative to the outer member.

[0054] Alternatively, the ball may be fixed relative to the outer member and biased radially inward from the outer member, the inner member may have the first groove and the second groove on its outer surface spaced a distance from each other substantially equal in length to the axial distance the inner member moves relative to the outer member as the actuating mechanism moves between its first and second conditions.

[0055] Preferably the actuating mechanism is capable of flexing whilst still capable of effective operation. The actuating mechanism may incorporate a joint capable of allowing pivotal movement relative to the longitudinal axis. Preferably the joint is in the form of a knuckle joint and allows the inner member to pivot. The joint allows the actuating mechanism to operate effectively even when loads applied to the outer member cause it to deflect between its ends.

[0056] Preferably the actuating mechanism is incorporated in an apparatus, such as a tool, for actuating the apparatus between first and second operational condition.

[0057] In one aspect of the invention the apparatus is a flushing device, whereby the actuating mechanism causes the flushing device to move between the first operable condition, wherein the flushing device is closed and the second operable condition wherein the flushing device is open.

[0058] Preferably an inner sleeve of the flushing device comprises the inner member of the actuating mechanism, whilst an outer sleeve of the flushing device comprises the outer member of the actuating mechanism. The flushing device also has an internal passage which incorporates the internal passage of the actuating mechanism.

[0059] The outer sleeve may incorporate openings. These openings may be blocked from the internal passage when the flushing device is in the closed operable condition, and register with the internal passage when the flushing device is in the open operable condition.

[0060] Preferably the flushing device is configured such that the flushing device remains in the selected open or closed operable condition regardless of any expansive or compressive force.

[0061] When in use the inner sleeve and outer sleeve are in mutual support.

[0062] Preferably the openings provide a flushing outlet, whereby when the flushing device is in an open operable condition a predetermined percentage of the fluid is diverted from the passage.

[0063] The flushing outlet preferably comprises a plurality of apertures in the inner sleeve, an annular chamber in the outer sleeve and a plurality of nozzles. The flushing outlet may form a passage between the annular chamber and the

outside of the flushing device when the flushing device is in its open operable condition. Each nozzle may be shaped so as to direct diverted fluid backwards, away from the drill head.

[0064] Preferably a fluid tight seal is provided between the inner and outer sleeve as the flushing device moves from a closed operable condition to an open operable condition. The flushing device may comprise an intermediate sleeve located between the inner and outer sleeve and located between the flushing outlet and the inlet of the flushing device to provide the fluid tight seal.

[0065] In another aspect of the invention the apparatus is an under reamer or casing cutter whereby the actuating mechanism causes the under reamer or casing cutter to move between a first operable condition, wherein a cutting device is contained within the under reamer or casing cutter, and a second operable condition wherein the cutting device protrudes from the under reamer or casing cutter to cut as required. Alternatively the actuating mechanism may cause the cutting device to move between a first operable condition, wherein the cutting device is off, and a second operable condition wherein the cutting device is on. An under reamer is a tool used to smooth the wall of a well, enlarge the hole, help stabilize the bit, straighten the well bore and/or to drill directionally.

[0066] In another aspect of the invention the apparatus is a valve, such as a ball valve, whereby the actuating mechanism causes the valve to move between a first operable condition, wherein the valve is closed and a second operable condition wherein the valve is open.

[0067] Other applications of the actuating mechanism also include the operation or activity of a packer, use in deep mineral ore drilling, use with single shot operation for permanent installations.

[0068] The present invention also provides a flushing device comprising:

[0069] an inner sleeve and an outer sleeve, moveable relative to each other between an open operable condition, wherein a percentage of the fluid passing through a central passage of the flushing device can be diverted through a plurality of flushing outlets, and a closed operable condition, wherein the fluid outlets are blocked from the passage,

[0070] an actuating mechanism operable between the inner and outer sleeves, and having first and second conditions which correspond to the open and closed operable conditions, the actuating mechanism being responsive to a fluid pressure differential between a cavity defined between the inner and outer sleeves, and the pressure in the internal passage, for movement between its first and second conditions, whereby the actuating mechanism, when in the first or second condition couples the inner sleeve to the outer sleeve to prevent movement of the inner sleeve relative to the outer sleeve until predetermined value of pressure differential is reached.

[0071] The invention also provides a flushing device for flushing diverted fluid upwards into an annular space between a drill stem and a hole, where a slurry passes through a central passage of the flushing device to a drill head, whereupon it reverses direction, passing through the annular space before returning to the surface with cuttings from the drilling process suspended in the return slurry, the flushing device is adapted to change between an open operable condition, whereby a predetermined percentage of fluid is diverted from the passage to the annular space to assist in maintaining a clean bore, and a closed operable condition, whereby the full flow of the slurry is delivered to the drill head, and is configured such that the increase or reduction of pressure in the internal passage relative to the pressure external the flushing device causes an actuating mechanism located in the device to cycle between a first and second condition whereby the flushing device correspondingly cycles through open and closed operable conditions.

[0072] The present invention also provides a flushing device comprising:

[0073] an inner sleeve, slidingly received in an outer sleeve, the inner and outer sleeves cooperating to define an internal passage for the flow of a fluid, and are permanently coupled such that there is no rotational movement between the two sleeves;

[0074] the outer sleeve having a plurality of flushing outlets

[0075] an actuating mechanism comprising an inner and outer member, incorporated within the inner and outer sleeves, an internal passage which is common with the internal passage of the flushing device, the actuating mechanism being caused to cycle between open and closed conditions with change in the pressure differential acting upon the inner member;

[0076] an indexing mechanism which indexes as a result of the operation of the actuating mechanism, the indexing mechanism indexes between first and second positions such that the flushing device moves between an open operable condition, whereby the plurality of flushing outlets are open for discharging a quantity of the fluid from the internal passage, and a closed operable condition, whereby the plurality of flushing outlets are closed, the operable condition depending on the position of the indexing mechanism.

DESCRIPTION OF THE DRAWINGS

[0077] The invention will be better understood by reference to the following description of a specific embodiment thereof as shown in the accompanying drawings in which:

[0078] FIG. **1** is a sectional view of the invention used in a flushing device;

[0079] FIG. **2** is a sectional view of the invention in a closed condition during operation;

[0080] FIG. **3** is a view similar to FIG. **2** but in an open condition;

[0081] FIG. **4** is a sectional view of the inlet end of the flushing device depicted in FIG. **1**;

[0082] FIG. **5** is a sectional view of the inlet end of the flushing device depicted in FIG. **2**

[0083] FIG. **6** is a sectional view of the inlet end of the flushing device depicted in FIG. **3**

[0084] FIG. **7** is a sectional view of the outlet end of the flushing device depicted in FIG. **1**;

[0085] FIG. **8** is a sectional view of the outlet end of the flushing device depicted in FIG. **2**

[0086] FIG. **9** is a sectional view of the outlet end of the flushing device depicted in FIG. **3**

[0087] FIG. **10** is a view of an indexing mechanism in an opposed relation;

[0088] FIG. **11** is a view similar to FIG. **4** but in an interlaced relation;

[0089] FIG. **12** is a view of the indexing mechanism according to the sequence of positions as it moves between an opposed to interlaced relation.

BEST MODE(S) FOR CARRYING OUT THE INVENTION

[0090] The invention according to an embodiment is in the form of an actuating mechanism **111** comprising an indexing mechanism **80**, an inner member **113** and an outer member **115**, which cooperates with the inner member **113** to provide an internal passage **117** through which fluid passes. The internal passage **117** also provides a first region **119**, whilst a second region **120** is defined by an area external to the outer member **115**.

[0091] Referring to FIGS. **1** to **9** the actuating mechanism **111** is incorporated in a flushing device **20**.

Flushing Device

[0092] The flushing device **20**, comprises an inner sleeve **21** and an outer sleeve **23**, which cooperate to provide a fluid passage **32** having an inlet **22***b* and an outlet **22***a*. The fluid passage **32** incorporates the internal passage **117** of the actuating mechanism **111**.

[0093] The inner sleeve **21** comprises the inner member **113** of the actuating mechanism **111** and provides a plurality of apertures **38** spaced annually therearound, as shown in FIGS. **1** to **6**.

[0094] The outer sleeve **23** of the flushing device **20**, comprises the outer member **115** of the actuating mechanism **111** and defines the inlet **22***b* and the outlet **22***a* of the flushing device **20**.

[0095] The outer sleeve **23** is adapted to be releasably incorporated in the drill stem assembly and provides a plurality of flushing outlets **33**. The flushing outlets **33** allow fluid to pass from passage **32** to the annular space between the flushing device **20** and the bore wall (not shown) when the flushing device **20** is in an open condition, as represented in FIG. **6**.

[0096] Each flushing outlet **33** comprises an annular chamber **35** located on the inner face of the outer sleeve **23**, and a plurality of nozzle assemblies **36** in communication with the annular chamber **35** and spaced around the perimeter of the flushing device **20**. Each flushing outlet **33** extends obliquely outwards and backwards.

Wash Pipe

[0097] As best shown in FIG. **1**, the inner member **113** of the actuating mechanism **111** incorporates a portion called a wash pipe **121**. The wash pipe **121** has a constant internal diameter whilst a portion of the outer diameter tapers inwardly from a first end to a second end, the first end being closer to the inlet **22***b* of the flushing device **20**.

[0098] The inner member **113** has a second seal assembly **93** comprising a pair of seals **96** located along an outer diameter and adjacent its second end. The inner member **113** also incorporates a further set of seals **35***b* comprising a pair of seals **95** adjacent the annular chamber **35**. The seals **96** of the second seal assembly **93** have a smaller cross section than the seals **95** of the set of seals **35***b*.

[0099] The actuating mechanism **111** also comprises a cavity **153** located between the inner member **113** and the outer member **115**. The cavity **153** defines a third region **122**.

[0100] An internal portion **165** of the outer member **115** provides a surface **167** against which the second seal assembly **93** of the inner member slidingly engages.

[0101] The pressure differential required between the first region **119** and the third region **122** in order for the actuating mechanism **111** to alternate between first and second conditions can be varied by changing the cross sectional diameter of the seals **96** in the second seal assembly **93**. Changes in cross sectional diameter of the seals **96** are accommodated by changes in the diameter of the internal portion **167** of the outer member **115**, against which the second seal assembly **93** slidably engages varies according to

Indexing Mechanism

[0102] The indexing mechanism **80** is best shown in FIGS. **10**, **11** and **12**. The indexing mechanism **80** comprises an indexing sleeve **29**, rotating travel stop **62**, and a positioning sleeve **129**.

[0103] The inner sleeve **29** provides a pawl **68** projecting from an end thereof. Referring to FIG. **1**, the indexing sleeve **29** is rotationally fixed relative to the inner member **113** by a key way arrangement **131**. The indexing sleeve **29** also comprises a projection **29***a* extending inwardly from a first end of the indexing sleeve **29**, as best shown in FIG. **10**. The portion **29***a* of the indexing sleeve **29** provides a face upon which first spring **67** acts to bias the indexing sleeve **29** towards a shoulder **171** on the internal surface of the outer member **115**.

[0104] As shown in FIG. **10** to **12**, the positioning sleeve **129** comprises a plurality of fingers **28***a* and slots **28***b* which are configured to provide a peak at their periphery. The positioning sleeve **129** is rotationally fixed relative to the inner member **113** by a key way arrangement **133**, as shown in FIG. **1**. The outer member **115** provides a shoulder **163** against which the positioning sleeve **129** abuts.

[0105] As shown in FIG. **10** to **12**, the rotating travel stop **62** provides a ratchet **69** comprising a plurality of indents **69***a* which are adapted to receive pawl **68**. In particular, each indent **69***a* comprise a ramp **69***b* which slidingly engages pawl **68**. Travel stop **62** also provides a plurality of fingers **27***a* and slots **27***b* which are configured to provide a trough at their periphery. These troughs mate with corresponding peaks of the positioning sleeve **129** when the travel stop **62** engages therewith.

Operation of the Indexing Mechanism

[0106] The operation of the indexing mechanism **80** is best described with reference to FIG. **12**. Movement of the inner member **113** towards an inlet of the internal passage **117** with respect to the outer member **115** will result in a bottom face **70** of the indexing sleeve **29** abutting shoulder **171** of the outer member **115**, preventing further downward movement of the indexing sleeve **29**.

[0107] Continued downward movement of the inner member **113** will result in travel stop **62** moving towards indexing sleeve **29** causing the fingers **27***a* to disengage from the fingers **28***a*, as shown in FIG. **12***b*. The travel stop **62** is biased towards the indexing sleeve **29** by second spring **127** acting between the travel stop **62** and the positioning sleeve **129**, as shown in FIG. **1**.

[0108] Continued downward movement will result in the ratchet **69** engaging the pawl **68** which is offset sufficiently from the plurality of indents **69***a* so that the front region of the

ramp **69***b* of an indent **69***a* sufficiently engages the top portion of the pawl **68** as best shown in FIG. **12***b*.

[0109] Continued downward movement will result in travel stop **62** rotating as the ramp **69***b* slides down the face of the pawl **68**. This will continue until the indent **69***a* completely receives the pawl **68**, as shown in FIG. **12***d*.

[0110] Referring to FIG. **1**, when the inner member **113** is caused to move upwardly as a result of the change in pressure differential acting across the wash pipe **121**, a bottom surface **137** of the travel stop **62** is caused to abut a shoulder **139** located on the outer surface of the wash pipe **121**. Continued movement of the inner member **113**, in addition to the biasing force exerted by first spring **27** between the indexing sleeve **29** and the travel stop **62**, results in disengagement therebetween as the travel stop **62** moves towards the positioning sleeve **129**.

[0111] As indicated in FIG. **12***e*, the fingers **27***a* do not entirely align with slots **28***a*. However, due to the configuration of the peaks **82**, continued upward movement of the inner member **113** results in the fingers **27***a* sliding over the fingers **28***a* causing further rotation of the travel stop **62** until the fingers **27***a* align with slots **28***a* of the positioning sleeve **129**, such that the fingers are interlaced. Continued upward movement of the inner member **113** will result in the engagement of the fingers **27***a* with the slots **28***b*. When the fingers **27***a* and **28***a* are interlaced the actuating mechanism **111** is in its second condition, and the flushing device **20** is in its open operable condition, as shown in FIG. **1**.

[0112] A similar process will in turn cause the rotating travel stop **62** to be indexed to a second position whereby the fingers **27***a* align with fingers **28***a* such that they are in an opposed relation. When the fingers **27***a* and **28***a* are opposed the actuating mechanism **11** is in its first position, and the axial movement of the inner member **113** is sufficient only for the pawl **68** to disengage the ratchet **69**.

[0113] The axial movement of the rotating travel stop **62** is restricted to the movements of the inner member **113**. Downward movement of the travel stop **62** relative to inner member **113** is prevented by shoulder **139**. The biasing force exerted by second spring **127** prevents upward movement of the travel stop **62** relative to the inner member **113**. The rotational movement of the travel stop **62** is governed by the flushing device **20** and the travel stops **62** position with respect to indexing sleeve **29**, and fingers **28***a* and slots **28***b*.

[0114] The operation of the indexing mechanism **80** with respect to the operation of the flushing device **20** is further discussed below.

Retention Mechanism

[0115] As best shown in FIGS. **4** to **6**, the actuating mechanism **111** also comprises a retention mechanism **141** to releasably retain the actuating mechanism **111** in one condition until the predetermined pressure differential between the first region **119** and third region **122** is reached, whereupon the actuating mechanism **111** is permitted to move from one condition to the other.

[0116] The retention mechanism **141** is provided by a plurality of detents comprising a ball **143** fixed axially relative to the inner member **113** but biased radially outwardly from the inner member by detent spring **145**. The outer member **115** has a first groove **147** and a second groove **149** on the inner surface, each being spaced a distance from each other substantially equal in length to the axial distance the inner member **113** moves relative to the outer member **115** when the actuating mechanism **111** moves between its first and second conditions.

[0117] Each groove **147**, **149** is annular and has a cross section complimentary to that of the ball **143** such that the ball **143** is snugly received therein so as to hold the inner member **113** relative to the outer member **115**.

Operation of the Retention Mechanism

[0118] In operation, when the actuating mechanism **111** is in its first condition the ball **143** is received in the first groove **147**, as shown in FIG. **1**. As the pressure difference between the first region **119** and third region increases to a predetermined value, the ball **143** is forced inwardly by the action of the axial force on the inner member **113** caused by the pressure of the fluid flowing through the passage. When the ball **143** is caused to disengage from the first groove **147**, the inner member **113** moves rapidly to either an intermediate position between the first groove **147** and second groove **149**, as shown in FIG. **2**, or until the actuating mechanism **111** is in its second condition, as shown in FIG. **3**, wherein the ball **143** aligns and engages with the second groove **149**, whereby the actuating mechanism **111** is held in its second condition.

[0119] When the actuating mechanism **111** is in its second condition, a drop in the pressure differential between the first region **119** and third region **122** to a predetermined value, will result in the ball **143** moving inwardly due to the axial force acting on the inner member **113**, and disengaging the second groove **149**, allowing the inner member **113** to move rapidly with respect to the outer member **115**, and the actuating mechanism **111** moves back to its first condition.

[0120] Upon disengagement of the ball **143** from the first groove **147**, the extent to which the inner member **113** moves with respect to the outer member **115** is dependant on the position of the indexing mechanism **80**. If the indexing mechanism **80** is in its first position the fingers of the travel stop **62** are in opposed relation to the fingers on the positioning sleeve **129**. This restricts the axial movement of the inner member **113** with respect to the outer member **115** so that the inner member **113** is only able to move to an intermediate position between the first and second grooves as best shown in FIG. **2**.

[0121] If the indexing mechanism **80** is in its second position the fingers of the travel stop **62** are interlaced with the fingers on the positioning sleeve **129**. This allows for greater axial movement of the inner member **113** with respect to the outer member **115** so that the actuating mechanism **111** is able to move to its second condition, as shown in FIG. **3**.

Knuckle

[0122] The actuating mechanism **111** incorporates a knuckle joint **151** capable of allowing pivotal movement of the inner member **113** relative to its longitudinal axis. The knuckle joint **151** allows the actuating mechanism **111** to operate effectively even when loads applied to the outer member **115** cause it to deflect between its ends.

Cavity

[0123] Referring now to FIGS. **1** to **3**, the cavity **153**, defined between the inner member **113** and the outer member **115**, filled with a lubricant such as oil. The cavity **153**, which is sealed to prevent the ingress of any contaminants, houses

the indexing mechanism **80** and the retention mechanism **141**, and ensures reliable conditions for the functioning of these components.

[0124] In use, the volume of the cavity **153** changes as the inner member **113** moves relative to the outer member **115**. To ensure the volume of the cavity is free to fluctuate according to movement of the inner member **113**, the actuating mechanism **111** incorporates an equalising device **155**. The equalising device comprises a floating sleeve **157** which is slidingly retained on an outer portion **159** of the outer member **115**, and provides a chamber **161** which is in fluid communication with the cavity **153** through an opening **154**. As the inner member **113** moves, the volume of the cavity **153** changes accordingly. When the volume is reduced, the lubricant exits the cavity **153** through opening **154** and into the chamber **161**, causing the floating sleeve **157** to move accordingly to allow for the increase in volume in the chamber **161**. Similarly, when the volume of the cavity **153** increases, lubricant is caused to move from the chamber **161** into the cavity **153**, and the floating sleeve **157** is caused to move accordingly. Hence, the floating sleeve **157** moves relative to the opening **154** to accommodate volumetric changes within the cavity **153**.

[0125] The floating sleeve **157** is in communication with the second region **120**. As a result the pressure in the second region **120** is transmitted to the chamber **161** and the cavity **153**. Hence, the pressure, and volume, of the third region **122** provided by the cavity **153**, is representative of the pressure in the second region **120**. As outer surfaces of the wash pipe **121** are exposed to the cavity **153**, the pressure in the second region **120** affects the operation of the actuating mechanism **111**.

[0126] The equalising device **155** balances and cushions the movement between the inner and outer members.

[0127] The outer member **115** also provides a port **37** which is in communication with the cavity **153** allowing it to be filled with lubricant if so required.

[0128] The equalising device **155** is provided with seals to seal the interface between the floating sleeve **157** and the outer member **115**.

Intermediate Sleeve

[0129] The flushing device **20** also comprises an intermediate sleeve **42** located between the inner sleeve **21** and the outer sleeve **23**.

[0130] Referring to FIGS. **4** to **6** the intermediate sleeve **42** comprises a outwardly extending shoulder **46** at its first end, and terminates at its other end with a sloping face **42***a*. The sloping face **42***a* mates with upwardly sloping face **42***b* located on the inner sleeve **21** to provide a seat.

[0131] The intermediate sleeve **42** also contains a plurality of holes **43** which receives a plurality of balls **44**. Each ball **44** has a diameter greater than the radial thickness of the intermediate sleeve **42** such that when the intermediate sleeve **42** is at its lower most position each ball **44** protrudes beyond the interface between the intermediate sleeve and the inner sleeve **21** and rests against the downwardly sloping face **45** of the inner sleeve **21**. The mating of seat portion **42***a* of the intermediate sleeve **42** with the upwardly sloping face **42***b* of the inner sleeve **21** is at a predetermined distance from the plurality of holes **43** such that the balls **44** are not permitted to enter aperture **38**.

[0132] The intermediate sleeve **42** is rotationally fixed to the outer sleeve **23** by key way arrangement **142**. This arrangement assists in ensuring the interface between the intermediate sleeve **42** and outer sleeve **23** does not become clogged with fluid (slurry) passing through the flushing device **20**.

Operation of Flushing Outlet

[0133] In operation, movement of the inner sleeve **21** in an upward direction causes the downwardly sloping face **45** to abut against the ball **44**, as shown in FIG. **7**, causing the intermediate sleeve **42** to move upwardly with the inner sleeve **21**. Continued upward movement will be restricted by the intermediate sleeve **42** abutting against projection **47**. This abutment occurs as the ball **44** aligns with annular groove **48** allowing ball **44** to be received therein, as shown in FIG. **6**.

[0134] This enables the inner sleeve **21** to continue to move upwardly whilst intermediate sleeve **42** remains locked in position. Continued upward movement of inner sleeve **21** will result in the plurality of apertures **38** being open to the flushing outlet **33**, as shown in FIG. **6**.

[0135] The operation of the intermediate sleeve **42** ensures the apertures **38** remain closed until the aperture **38** begins to align with annular chamber **35** of the flushing outlet **33**. When a gap is introduced between the sloping face **42***b* and conical face **42***a*, the passage which allows the fluid to pass from the passage **32**, through the slots **38** and through the flushing outlet **33** opens.

[0136] The annular chamber **35** has a set of seals **35***a*, **35***b* adjacent each side thereof. These seals render the interface between the inner sleeve **21** and outer sleeve **23** fluid tight, preventing slurry passing from the passage **32** and into the interface and the cavity **153** when the flushing device **20** is in an open operable condition. When the flushing device is in a closed operable condition a first section **49***a* of the inner sleeve **21** co-acts with seals **35***a* to provide a seal. As the inner member **113** moves upwardly relative to the outer member **115**, the intermediate sleeve **42** moves upwardly to co-act with the seals **35***a* and provide a seal below the annular chamber **35**, preventing fluid passing through the apertures **38** and ingressing between the inner sleeve **21** and outer sleeve **23**.

[0137] When the flushing device **20** moves to a closed operable position as shown in FIGS. **4** and **5**, the inner member **113** moves downwardly relative to the outer member **115**, providing a barrier between the inner passage **32** and the annular chamber **35** of the flushing outlet **33**. Continued movement of the inner member **113** will result in the sloping face **42***b* abutting mating conical face **42***a* of the intermediate sleeve **42** whilst simultaneously the downwardly facing slope **45** passes groove **48**. The plurality of balls **44** will then be forced to move in an inward direction resulting in the intermediate sleeve engaging the inner sleeve **21** to move downwardly with further downward movement of the inner sleeve **21**.

[0138] Sloping face **42***b* and conical face **42***a* remain in intimate contact until they have passed seals **35***a*.

Operation of the Flushing Device

[0139] The operation of the flushing device **20** between an open operable condition and a closed operable condition, and vice versa, is extremely simple and reliable, and allows the flushing device **20** to remain in the required condition by maintaining a predetermined pressure differential between the first region **119** and third region **122**.

[0140] Referring to FIGS. **1** to **6**, the passage **32** through which fluid passes is partly defined by the inner wall of the inner sleeve **21**. This inner Wall substantially provides a barrier, preventing the ingress of slurry in to the cavities between the inner sleeve **21** and outer sleeve **23**. Where apertures **38** are provided, seals are provided to prevent leakage of the slurry.

[0141] In the closed operable condition the indexing mechanism **80** is arranged such that the fingers **27***a* are in opposed relation with fingers **28***a*, as shown in FIGS. **2**, **5**, **8** and **12***a*. In this mode the flushing outlet **33** is closed.

[0142] In order for the flushing device **20** to move from the closed operable condition, shown in FIG. **2**, to the open condition, shown in FIG. **3**, the surface pumps are momentarily switched off such that no slurry is passing through the flushing device **20**. This results in a change in pressure differential between the first region **119** and third region **122**, causing the inner member **113**, and hence the inner sleeve **21**, to move relative to the outer sleeve **23** in a direction towards the inlet **22***b*.

[0143] As a result of this movement the travel stop **62** is free to move in the same axial direction, being biased to do so as the second spring **127** forces the travel stop **62** to disengage from the positioning sleeve **129**.

[0144] Continued movement of the inner member **113** results in compression of first spring **67** as the travel stop **62** moves towards the indexing sleeve **29**, which is prevented from downward movement by shoulder **171** against which it abuts. As previously discussed the travel stop **62** engages the pawl **68** on the indexing sleeve **29**. Further movement of inner sleeve **21** towards inlet **22***b* results in the ramp **69***b* of the indent **69***a* to slidingly abut the pawl **68**, causing the travel stop **62** to rotate until the indent **69***a* fits over pawl **68** (FIG. **12***d*). At this point the travel stop **62** has rotated so that the fingers **27***a* are nearly aligned with corresponding slots **28***b* of the end portion **85**.

[0145] At this point the ball **143** aligns with first groove **147**, and due to detent spring **145**, engages the first groove **147** to hold the inner member **113** axially fixed relative to the outer member **115**, as shown in FIG. **4**.

[0146] The pumps are then started and the pressure in the first region **119** increases. When the pressure differential between the first region **119** and third region **122** is large enough to overcome the force of the ball **145** acting in the first groove **147**, the ball **147** disengages the first groove **147** and the inner member **113** is caused to move rapidly with respect to the outer member **115**.

[0147] This causes shoulder **139** to move the travel stop **62** away from the indexing sleeve **29** (FIG. **12***e*). As the force acting on the inner member **113** due to the pressure differential is greater than the force of the second spring **127**, the inner member **113** moves towards the positioning sleeve **129**. As the travel stop **62** approaches positioning sleeve **129**, the end of fingers **27** contact the end of fingers **28***a*. Owing to the peak configuration **82** of fingers **28***a* the travel stop **62** is caused to further rotate such that the fingers **27***a* now align with slots **28***b* (FIG. **12***f*).

[0148] Continued movement of the inner member **113** towards the outlet **22***a* will result in the end of fingers **27***a* abutting the bottom surface of the slots **28***a* such that the fingers **27***a* and **28***a* are in an interlaced configuration.

[0149] At this point the ball **143** of the retention mechanism **141** is aligned with the second groove **149**, whereupon the ball **143** engages the second groove **149** holding the inner member **113** relative to the outer member **115**, as shown in FIG. **2**.

[0150] As the fingers **27***a* and **28***b* become interlaced the upward movement of the inner member **113** has caused the inner sleeve **21** to disengage intermediate sleeve **42** and allow the apertures **38** to align with flushing outlets **33**. This condition is depicted in FIGS. **3** and **6**.

[0151] The retention mechanism **141** prevents the closure of the flushing outlet **33** until the force exerted by spring **127** is able to overcome both the force of the retention mechanism **141** holding the inner member **113** relative to the outer member **115**, and the pressure differential between the first region **119** and the third region **122**.

[0152] When the flushing device **20** is in an open condition, a percentage of fluid is diverted from passage **32** through flushing outlet **33**, exiting from the flushing device **20** into the annular space between flushing device **20** and the wall of the bore. The percentage of fluid diverted is largely dependant on the size of the orifice of nozzle assembly **36**, and may be adjusted accordingly. The diverted fluid is used to assist in cleaning the bore of cuttings.

[0153] To close the flushing outlet **33** and cause the flushing device **20** to move to a closed condition, the pressure differential between the first region **119** and third region **122** is reduced so that the force of spring **127** is greater than the force exerted by the retention mechanism **141**, at which point the ball **143** disengages the second groove **149**, allowing the inner member **113** to rapidly move with respect to the outer member **115** towards the inlet **22***b*. Simultaneously the travel stop **62** disengages from the positioning sleeve **129** and moves towards the indexing sleeve **29**, ready to cycle to a new position.

[0154] Continued downward movement will result in the indexing sleeve **29** abutting the shoulder **171** and the ball **143** of the retention mechanism **141** will once again aligning with and engaging first groove **147**. Simultaneously, the ratchet **69** on the travel stop **62** engages pawl **68** causing the travel stop **62** to rotate. Upon an increase in pressure differential sufficient to overcome the force exerted by the retention mechanism **141**, the inner member **113** is again caused to move relative to the outer member **115** towards the outlet **22***a*. As the travel stop has indexed to a new position, the troughs **81** of fingers **27***a* engage the peaks **82** of fingers **28***a* of the positioning sleeve **129** so that the fingers are in opposed configuration, as best shown in FIG. **12***a*. In this position the inner member **113** is prevented from full axial movement relative to the outer member **115** due to fingers **28***a* and **27***a* being in opposed relation. The flushing device **20** is in a closed operable condition, as shown in FIG. **2**.

[0155] During the indexing process, the downward movement of inner member **113** has resulted in the inner sleeve **21** re-engaging intermediate sleeve **42**, and blocking the path between the inner passage **32**, closing the flushing outlets **33**.

[0156] The switching between the two conditions of the flushing device **20** may be controlled remotely by the operator on the surface. The operator will know to activate and deactivate the flushing device **20** according to the behaviour of the drilling stem assembly, the drilling head, and the slurry which is being returned to the surface.

[0157] The operational condition of the flushing device **20** can only be changed by deliberate actions on the part of the operator.

[0158] The flushing device **20** may be placed anywhere along the drilling stem assembly, its position depending on the application. Indeed the drilling of a well may require the inclusion of one or more flushing devices **20** to be used to maintain the required conditions in the bore.

[0159] Where required the surface of the components are coated with a hard, wear resistant coating and ground to a fine finish in order to prevent scouring of the surface by the action of the drilling fluid. This also assists in prolonging the life of the seals.

[0160] The required pressure differential between the first region **119** and third region **122** can be varied by varying the force exerted by detent spring **145** on ball **143**.

[0161] The retaining mechanism **141** provides a retaining force equal to or slightly greater than the load differential of the spring **127** as it is compressed from its original length (flushing device **20** in its closed operable condition) to its compressed length (flushing device **20** in its open operable condition). Hence the wash pipe **121** (and therefore inner member **113** and inner sleeve **23**) will not move until the pressure differential is sufficient to fully compress spring **127**. At this point the ball **143** is forced to retract and the wash pipe **121** will snap to the fully open condition (when fingers of indexing mechanism **80** are interlaced), where the ball **143** will engage the second groove **149**, such that the flushing device **20** is in its open operable condition.

[0162] Upon falling pressure, the retention mechanism **141** holds the flushing device **20** open until the pressure differential falls below the force generated by the spring **127**, at which point the ball **143** will retract from the second groove **149** and the wash pipe **121** will snap back, moving the flushing device **20** to its closed operable condition.

[0163] The retention mechanism **141** also prevents partial opening and closing of the actuating mechanism **111**. At the point were the pressure differential is sufficient to move the actuating mechanism **111** to its next condition, the ball **143** retracts from the appropriate groove (depending upon position) and the actuating mechanism snaps into its next condition—there being no gradual movement between the first and second conditions of the actuating mechanism **111**.

[0164] Furthermore the pressure differential required to operate the actuating mechanism may be varied by varying the diameter of the seals **96** of the second seal assembly **93**, as previously discussed. This does not however affect the ratio between opening and closing pressures.

[0165] In another embodiment of the invention, the flushing device **20** does not include the intermediate sleeve **42**. In such an embodiment the inner sleeve **21** is configured to ensure a fluid tight seal exists between the inner sleeve and the outer sleeve.

[0166] Whilst only one application of the invention has been described it is to be appreciated that the invention can be used in relation to many other applications. For instance, it may be used in operating or actuating a ball valve or any type of valve, an under reamer or casing cutter, it can be easily converted to a single shot operation for a permanent installation, and it may be used for deep mineral air drilling.

[0167] Modifications and variations such as would be apparent to the skilled addressee are considered to fall within the scope of the present invention.

[0168] Throughout the specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

1-84. (canceled)

85. An actuating mechanism comprising:

an inner member and an outer member axially slidable relative to each other, the inner and outer members cooperating to define an internal passage for the flow of a fluid therethrough;

the inner member being configured such that upon a predetermined change in pressure between a first region and a second region the actuating mechanism is caused to move between a first condition and a second condition.

86. The actuating mechanism according to claim **85** wherein the first region is in the internal passage of the actuating mechanism.

87. The actuating mechanism according to claim **85** wherein the second region is external of the actuating mechanism.

88. The actuating mechanism according to claim **85** wherein the pressure in the second region is transmitted to a third region located within the actuating mechanism, such that a change in pressure in the second region affects the pressure in the third region.

89. The actuating mechanism according to claim **88** wherein the third region is located substantially between the inner and outer members.

90. The actuating mechanism according to claim **88** wherein at least a section of the inner member is exposed to both the first and third regions.

91. The actuating mechanism according to claim **88** wherein an inner surface of the inner member is exposed to the first region and an outer surface of the inner member is exposed to the third region.

92. The actuating mechanism according to claim **88** wherein the actuating mechanism is caused to move between its first and second conditions when the pressure difference between the first region and third region reaches a predetermined value, due to the unequal forces being exerted across the inner member.

93. The actuating mechanism according to claim **85** wherein the inner member and outer members are in the form of pipes.

94. The actuating mechanism according to claim **85** wherein the inner member comprises a wash pipe having a first end with an outer diameter larger than an outer diameter at a second end, the wash pipe has a portion having a tapered outer diameter.

95. The actuating mechanism according to claim **94** wherein the wash pipe has a first seal assembly located along the outer diameter adjacent the first end and a second seal assembly located along the outer diameter adjacent the second end.

96. The actuating mechanism according to claim **95** whereby varying the cross sectional diameter of an at leak one seal of the second seal assembly varies pressure differential required between the first region and the second region to operate the actuating mechanism.

97. The actuating mechanism according to claim **95** whereby an internal portion of the outer member against which the second seal assembly slidingly engages can be varied according to changes in cross sectional diameter of the at least one seal in the second seal assembly.

98. The actuating mechanism according to claim **85** wherein a cavity is defined between the inner member and outer member, the cavity being filled with a lubricant such as oil.

99. The actuating mechanism according to claim **98** wherein the cavity has an opening which opens into a chamber of an equalising device.

100. The actuating mechanism according to claim **99** wherein the equalising device is in the form of a floating sleeve which is slidingly retained on an outer portion of the outer member and which surrounds the chamber, whereby volumetric changes in the cavity result in the floating sleeve moving with respect to the opening.

101. The actuating mechanism according to claim **100** wherein the floating sleeve is in communication with the second region such that pressure in the second region is transmitted to the cavity.

102. The actuating mechanism according to claim **96** wherein the cavity provides the third region.

103. The actuating mechanism according to claim **96** wherein the cavity is sealed from the internal passage such that the cavity may not be contaminated.

104. The actuating mechanism according to claim **85** wherein the actuating mechanism comprises an indexing mechanism which indexes between a first position, wherein the actuating mechanism is in the first condition and a second position wherein the actuating mechanism is in the second condition.

105. The actuating mechanism according to claim **104** wherein the indexing mechanism is located between the first and second members.

106. The actuating mechanism according to claim **104** wherein the indexing mechanism operates within the cavity.

107. The actuating mechanism according to claim **104** wherein the indexing mechanism comprises an indexing sleeve, a travel stop and a positioning sleeve.

108. The actuating mechanism according to claim **107** wherein the indexing sleeve is fixed rotationally to the inner member.

109. The actuating mechanism according to claim **107** wherein the indexing sleeve is axially movable relative to the inner member.

110. The actuating mechanism according to claim **107** wherein the travel stop is mounted on the inner member such that it may rotate about the longitudinal axis thereof, and wherein the travel stop is substantially constrained against axial movement relative to the inner member.

111. The actuating mechanism according to claim **107** wherein the positioning sleeve is fixed rotationally to the inner member.

112. The actuating mechanism according to claim **107** wherein the positioning sleeve is axially movable relative to the inner member.

113. The actuating mechanism according to claim **107** wherein the indexing sleeve and travel stop are biased away from each other.

114. The actuating mechanism according to claim **107** wherein the travel stop and positioning sleeve are biased away from each other.

115. The actuating mechanism according to claim **107** wherein the travel stop is adapted to co-operate with the indexing sleeve during the indexing sequence.

116. The actuating mechanism according to claim **107** wherein the indexing sleeve has a first end which provides a bottom face and a second end having a projection, defining a pawl, extending in an axial direction from the periphery of the second end.

117. The actuating mechanism according to claim **116** wherein the travel stop has a first end adapted to engage and mesh with the projection on the indexing sleeve and a second end adapted to engage and mesh with the positioning sleeve.

118. The actuating mechanism according to claim **117** wherein a first end of the positioning sleeve is shaped to engage and mesh with the second end of the travel stop.

119. The actuating mechanism according to claim **117** wherein the second end of the travel stop is configured to provide a plurality of fingers and corresponding slots, which co-act with corresponding fingers and slots integral with the positioning sleeve, wherein each finger and slot of the travel stop terminates in at least one depression or trough, whilst each finger and slot of the positioning sleeve terminates in at least one peak complimentary in shape to the depression/trough so that upon engagement each finger on the travel top aligns with a finger and/or slot on the positioning sleeve depending on whether the indexing mechanism is in its first position or second position.

120. The actuating mechanism according to claim **119** whereby when the indexing mechanism is in its first position the fingers on the travel stop align and mate with the fingers on the positioning sleeve, such that the fingers are opposed and when the indexing mechanism is in its second position the slots on the travel stop align and mate with the fingers on the positioning sleeve, whilst the fingers on the travel stop align and mate with the slots on the positioning sleeve, such that the fingers are interlaced.

121. The actuating mechanism according to claim **119** wherein the number of peaks/troughs on each finger/slot determines whether the actuating mechanisms cycles between the first condition and second condition.

122. The actuating mechanism according to claim **85** wherein the actuating mechanism comprises at least one retention mechanism to releasably retain the actuating mechanism in one condition until the predetermined pressure differential between the first and third regions is reached whereupon the actuating mechanism is able to move from one condition to the other.

123. The actuating mechanism according to claim **122** wherein the retention mechanism is a detent, comprising a ball fixed relative to the inner member but biased radially outward from the inner member.

124. The actuating mechanism according to claim **85** wherein the outer member may have a first groove and a second groove on its inner surface spaced a distance from each other, whereby the distance there between is substantially equal in length to the axial distance the inner member moves relative to the outer member as the actuating mechanism moves between its first and second conditions.

125. The actuating mechanism according to claim **124** wherein each groove is annular with a cross section complimentary to the ball so that the ball can be received therein and hold the inner member relative to the outer member.

126. The actuating mechanism according to claim **122** wherein the retention mechanism comprises a ball fixed relative to the outer member and biased radially inward from the outer member, the inner member having a first groove and a second groove on its outer surface spaced a distance from each other substantially equal in length to the axial distance

the inner member moves relative to the outer member as the actuating mechanism moves between its first and second conditions.

127. The actuating mechanism according to claim **85** wherein the actuating mechanism is incorporated in an apparatus, such as a tool, for actuating the apparatus between first and second operational condition.

128. The actuating mechanism according to claim **127** wherein the apparatus is a flushing device, whereby the actuating mechanism causes the flushing device to move between the first operable condition, wherein the flushing device is closed and the second operable condition wherein the flushing device is open.

129. The actuating mechanism according to claim **128** wherein an inner sleeve of the flushing device comprises the inner member of the actuating mechanism, an outer sleeve of the flushing device comprises the outer member of the actuating mechanism, and an internal passage of the flushing device incorporates the internal passage of the actuating mechanism.

130. The actuating mechanism according to claim **129** wherein the outer sleeve incorporate openings, the openings being blocked from the internal passage when the flushing device is in the closed operable condition, and register with the internal passage when the flushing device is in the open operable condition.

131. The actuating mechanism according to claim **128** wherein the flushing device is configured such that the flushing device remains in the selected open or dosed operable condition regardless of any expansive or compressive force.

132. The actuating mechanism according to claim **130** wherein the openings provide a flushing outlet, whereby when the flushing device is in an open operable condition a predetermined percentage of the fluid is diverted from the passage to the outside of the flushing device.

133. The actuating mechanism according to claim **132** wherein the flushing outlet comprises a plurality of apertures in the inner sleeve, an annular chamber in the outer sleeve and a plurality of nozzles.

134. The actuating mechanism according to claim **129** wherein a fluid tight seal is provided between the inner and outer sleeve when the flushing device moves from a closed operable condition to an open operable condition.

135. The actuating mechanism according to claim **134** wherein the flushing device comprises an intermediate sleeve located between the inner and outer sleeve between the flushing outlet and the inlet of the flushing device, the intermediate sleeve being adapted to provide the fluid tight seal.

136. The actuating mechanism according to claim **127** wherein the apparatus is an under reamer or casing cutter whereby the actuating mechanism causes the under reamer or casing cutter to move between a first operable condition, wherein a cutting device is contained within the under reamer or casing cutter, and a second operable condition wherein the cutting device protrudes from the under reamer or casing cutter to cut as required.

137. The actuating mechanism according to claim **127** wherein the apparatus is an under reamer or casing cutter whereby the actuating mechanism causes the cutting device to move between a first operable condition, wherein the cutting device is off, and a second operable condition wherein the cutting device is on.

138. The actuating mechanism according to claim **127** wherein the apparatus is an under reamer or casing cutter whereby the apparatus is a valve, such as a ball valve, whereby the actuating mechanism causes the valve to move between a first operable condition, wherein the valve is closed and a second operable condition wherein the valve is open.

139. A flushing device comprising

an inner sleeve and an outer sleeve, moveable relative to each other between an open operable condition, wherein a percentage of the fluid passing through a central passage of the flushing device can be diverted through a plurality of flushing outlets, and a closed operable condition, wherein the fluid outlets are blocked from the passage,

an actuating mechanism operable between the inner and outer sleeves, and having first and second conditions which correspond to the open and closed operable conditions, the actuating mechanism being responsive to a fluid pressure differential between a cavity defined between the inner and outer sleeves, and the pressure in the internal passage, for movement between its first and second conditions, whereby the actuating mechanism, when in the first or second condition couples the inner sleeve to the outer sleeve to prevent movement of the inner sleeve relative to the outer sleeve until predetermined value of pressure differential is reached.

140. A flushing device for flushing diverted fluid upwards into an annular space between a drill stem and a hole, where a slurry passes through a central passage of the flushing device to a drill head, whereupon it reverses direction, passing through the annular space before returning to the surface with cuttings from the drilling process suspended in the return slurry, the flushing device is adapted to change between an open operable condition, whereby a predetermined percentage of fluid is diverted from the passage to the annular space to assist in maintaining a clean bore, and a closed operable condition, whereby the full flow of the slurry is delivered to the drill head, and is configured such that the increase or reduction of pressure in the internal passage relative to the pressure external the flushing device causes an actuating mechanism located in the device to cycle between a first and second condition whereby the flushing device correspondingly cycles through open and closed operable conditions.

141. A flushing device comprising:

an inner sleeve, slidingly received in an outer sleeve, the inner and outer sleeves cooperating to define an internal passage for the flow of a fluid, and are permanently coupled such that there is no rotational movement between the two sleeves;

the outer sleeve having a plurality of flushing outlets

an actuating mechanism comprising an inner and outer member, incorporated within the inner and outer sleeves, an internal passage which is common with the internal passage of the flushing device, the actuating mechanism being caused to cycle between open and closed conditions with change in the pressure differential acting upon the inner member;

an indexing mechanism which indexes as a result of the operation of the actuating mechanism, the indexing mechanism indexes between first and second positions such that the flushing device moves between an open operable condition, whereby the plurality of flushing outlets are open for discharging a quantity of the fluid from the internal passage, and a closed operable condition, whereby the plurality of flushing outlets are closed, the operable condition depending on the position of the indexing mechanism.

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