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(54) DEVICE AND METHOD FOR PRESSURE REGULATION OF A WELL

VORRICHTUNG UND VERFAHREN ZUR DRUCKREGELUNG EINES BOHRLOCHS

DISPOSITIF ET PROCÉDÉ D'AJUSTEMENT DE PRESSION D'UN PUITS

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Description

[0001] This invention relates to a device for pressure regulation of a well. More particularly, it relates to a device for pressure regulation of a well which is provided with a return pump for drilling fluid, wherein the operating level of drilling fluid in an annulus formed between an outer pipe and an inner pipe is at a height level between the upper end portion of the outer pipe and the bottom portion of the well. The invention includes a method of using the device as well.

[0002] In some wells, for example petroleum wells, the geological conditions are such that the pressure difference between a pressure by which well fluid is entering the well formation and a pressure by which drilling fluid is exiting the well formation is relatively low.

[0003] A disadvantage when drilling and maintaining such wells is that pressure differences in the drilling fluid owing to, for example, flow resistance in the return path for drilling fluid or displacement of the drill pipe may cause unintended events.

[0004] The physical properties of the drilling fluid are adjusted to a number of conditions. For example, its specific gravity is chosen to be such that the static pressure from the drilling fluid will resist the fluid pressure in the well formation, whereas the viscosity of the drilling fluid is chosen to be such that cuttings are transported away from the well in a best possible way.

[0005] These conditions necessary *per se* may have the effect of the pressure in the well becoming so large that drilling fluid will enter the formation as drilling fluid is being circulated.

[0006] There are two methods of avoiding this that have become relatively widely used. In so-called underbalanced drilling, a drilling fluid which has an insufficient specific gravity to resist the pressure from the formation fluid only by static pressure is used. It is therefore necessary to pressunze the return path from the well. This is often done by arranging a choke valve on the outlet of the return path. In addition, an extra auxiliary pump is often placed near the outlet to pump drilling fluid into the return path.

[0007] The main drawback of this method is the safety conditions, as a failure in the choking of the return valve or the auxiliary pump could result in an uncontrolled inflow of formation fluid from the well formation into the return path.

[0008] The second method includes it having become common in wells that are drilled from the seabed, in which the return flow of drilling fluid takes place through a riser, to arrange an outlet from the riser in a position between the drilling device and the seabed. The outlet is connected to the drilling device via a return pump.

[0009] Patent Application WO 00/50731 discloses the features of the preamble of claim 1.

[0010] By regulating the flow rate through the return pump, the drilling fluid level in the annulus between the riser and, for example, a drill pipe may be regulated. This enables the use of a drilling fluid having a sufficient specific gravity to drill at overbalance, meaning that if the equipment stops, the static pressure from the drilling fluid will be sufficient for formation fluid to be prevented from entering the well. However, the fluid level in the annulus must be lowered when the pressure in the well rises owing to drilling fluid circulation, for example. This is done by increasing the flow through the return pump. However, it is a drawback that because of limited return-pump capacity and relatively large annulus volumes, among other things, the regulation could take several minutes.

[0011] In this period, inflow of drilling fluid into the formation may occur.

[0012] The invention has for its object to remedy or reduce at least one of the drawbacks of the prior art.

[0013] The object is achieved according to the invention through the features which are specified in the description below and in the claims that follow.

[0014] A device is provided for pressure regulation of a well which is provided with a return pump for drilling fluid, the operating level of drilling fluid in an annulus formed between an outer pipe and an inner pipe being at a height level between the upper portion of the outer pipe and the bottom portion of the well, the device being characterized by the return pump being in the annulus.

[0015] By the upper portion of the outer pipe is meant, here, the portion of the outer pipe that extends highest, whether casing or riser.

[0016] Thus, the device is well suited for use both in sea-based wells and in land-based wells in which, down in the ground, there is not normally access to the annulus, for example through a casing.

[0017] The return pump may be placed at a height level lower than the lowest expected operating level of the drilling fluid to ensure that the return pump has fluid contact with the drilling fluid.

[0018] At least in an area of the annulus within which the expected operating level of returning drilling fluid will be, the annulus may be provided with a restriction lining elongated in the longitudinal direction of the annulus, which may also include instrumentation.

[0019] The restriction lining, which may occupy a substantial part of the volume of the annulus, has the effect of a particular change in the operating level of drilling fluid in the annulus requiring a substantially smaller amount of drilling fluid to be pumped out or in, compared with an annulus without a restriction lining.

[0020] The restriction lining may, in the main, surround the inner pipe, the restriction lining, in its operating position, being axially fixed relative to the outer pipe.

[0021] The restriction lining may include several lining portions. For example, the restriction lining may be composed of several lining portions interconnectable in the longitudinal direction. Further, the lining portions may consist of cross-sectionally bowl-shaped portions. It may be necessary to use several lining portions in order to install the restriction lining on a drilling floor, for example, while it is gradually being lowered into the outer pipe.

[0022] The return pump may be in the restriction lining, a return pipe extending via the restriction lining. The restriction lining may also be provided with sensors of different kinds, for example for measuring the operating level of the returning drilling fluid, and electrical, optical and hydraulic lines.

[0023] The restriction lining may also be provided with a fill pipe for drilling fluid to be filled relatively quickly into the annulus.

[0024] The device may be used by means of a method for the pressure regulation of a well which is provided with a return pump for drilling fluid, and in which the operating level of drilling fluid in an annulus formed between an outer pipe and an inner pipe is at a height level between the upper end portion of the outer pipe and the bottom portion of the well, the method being characterized by including the positioning of a return pump in the annulus.

[0025] The method may further include placing the return pump at a height level lower than the lowest expected operating level of the drilling fluid.

[0026] The method may further include placing an elongated restriction lining at least in an area of the annulus within which the expected operating level of returning drilling fluid is.

[0027] The method may further include controlling the pumping rate of the return pump to regulate the operating level to the desired height level in the restriction lining.

[0028] The device and method according to the invention enable a relatively quick adjustment of the pressure in the well in that the height level of the returning drilling fluid can be regulated relatively quickly by adjusting the pumping rate of the return pump or by pumping drilling fluid from a drilling device into the annulus.

[0029] In what follows, an example of a preferred embodiment and method is described, which is visualized in the accompanying drawings, in which:

Figure 1 shows schematically a device according to the invention;

Figure 2 shows schematically the device of figure 1 adapted to a fixed installation;

Figure 3 shows schematically the device of figure 1 adapted to a vessel;

Figure 4 shows schematically the device of figure 1 adapted to a vessel in relatively shallow water;

Figure 5 shows schematically and on a larger scale a pump arrangement for the device of figure 1 by means of a section VI-VI of figure 6; and

Figure 6 shows a section V-V of figure 5.

[0030] In the drawings, the reference numeral 1 indicates a well in the ground 2. The well 1 is provided with an outer pipe 4 in the form of a casing, an inner pipe 6 in the form of a drill pipe 6 extending down into the well 1. An annulus 8 is formed between the outer pipe 4 and the inner pipe 6.

[0031] For well engineering reasons that are indicated in the introductory part of the description, the operating level 10 of the returning drilling fluid must be at a lower height level in the annulus than the upper portion 12 of the outer pipe 4.

[0032] A return pump 14 has an inlet 15 which is arranged in the annulus 8 at a height level lower than the lowest expected operating level 10. From the return pump 14, drilling fluid is flowing out of the well via return pipes 16.

[0033] Necessary lines 18 for power supply to the return pump 14 are shown in the figures 5 and 6.

[0034] A restriction lining 20 surrounds the inner pipe 6 over a length extending over the expected variation height of the operating level 10. The restriction lining is fixed relative to the outer pipe 4, at least in the longitudinal direction of the outer pipe 4. The length of the restriction lining 20 will normally extend over a number of pipe lengths, not just one pipe length as indicated in figure 1 which shows the device schematically.

[0035] In this preferred embodiment, the pump 14 is arranged in the lower portion of the restriction lining 20 while the return pipe 16 and lines 18 extend through the restriction lining 20. The restriction lining 20 is also provided with instruments, not shown, for measurement and regulation of different kinds not specified.

[0036] A filling pump 22 is connected to the well 1 via a fill pipe 24. The fill pipe 24 is provided with a number of openings, not shown, towards the annulus 8 to enable quick filling of the annulus 8 whenever needed.

[0037] During a stop in the circulation of drilling fluid via the inner pipe 6 and back via the annulus 8, the operating level 10 is regulated to a particular height level.

[0038] When the inner pipe 6 is being moved into the well, or when circulation is resumed, the pressure increases in the well 1, whereby the operating level has to be lowered to avoid inflow of drilling fluid into the formation.

[0039] The return pump 14 is therefore regulated for a relatively short time to pump at a rate greater than the rate of the drilling fluid supply, whereby the operating level 10 is lowered in the annulus. The restriction lining 20 occupies a considerable part of the volume of the annulus 8, whereby the operating level drops relatively rapidly to a new, desired height level.

[0040] Whenever it is relevant to raise the operating level, the capacity of the return pump 14 may be reduced to less than the amount of drilling fluid supplied. If necessary, the filling pump 22 may be started.

[0041] In an alternative embodiment, see figure 2, the restriction lining 20 is hung off in a restriction lining hanger 26 on the well head 28. A high-pressure riser 30 extends up to a blowout preventer 32 located below a drilling floor

34.

[0042] The return pipe 16 is extended out from the restriction lining 20 via the restriction lining hanger 26.

[0043] In a further embodiment, see figure 3, the outer pipe 4 is constituted by a marine riser which is connected to a drilling device 36 by means of a telescopic pipe 38.

[0044] Here, the restriction lining hanger 26 is arranged at the upper end portion of the outer pipe 4.

[0045] In still another embodiment, see figure 4, the restriction lining hanger 26 is located, in a manner corresponding to that in figure 2, on the well head 28. A telescopic marine riser 40 extends from the blowout preventer 32 to the drilling device 36.

[0046] The operation of the exemplary embodiments of figures 2-4 corresponds to that explained with reference to figure 1.

[0047] In figure 5, part of the restriction lining 20 is shown in a vertical section. The return pump 14 includes a pumping part 42 and a motor part 44. In the figure, the return pipe is shown in broken lines, but is not in the correct position. Lines 18, here in the form of hydraulic lines for the operation of the motor part 44, extend to the surface.

[0048] The pump part 42 may be constituted by any kind of suitable pumps. Because of its relatively large capacity in relation to its external dimensions, a screw pump, also termed a Moineau pump, has proved suitable for the purpose.

[0049] The motor part 44 may be constituted by a corresponding machine, but driven as a hydraulic motor. Alternatively, the motor part 44 may be constituted by an electric motor.

[0050] As shown in figure 6, a number of return pumps 14 may surround the inner pipe 6. The return pumps 14 may also be arranged one behind the other in the longitudinal direction of the inner pipe 6. In figure 6, it is also shown that the restriction lining 20 may include several bowl-shaped lining portions 46.

Claims

1. A device for the pressure regulation of a well (1) which is provided with a return pump (14) for drilling fluid, and in which the operating level (10) of drilling fluid in an annulus (8) which is formed between an outer pipe (4) and an inner pipe (6) is at a height level between the upper portion (12) of the outer pipe (4) and the bottom portion of the well (1), **characterized in** that the return pump (14) is positioned in the annulus (8) and where a return pipe (16) extends through the annulus (8) from the return pump (16) and out of the well (1), and where the annulus (8) is open in the area in which the return pump (14) is placed.

2. The device in accordance with claim 1, **characterized in that** the inlet (15) of the return pump (14) is placed at a lower level than the lowest expected operating level (10) of the drilling fluid.

3. The device in accordance with claim 1, **characterized in that** at least in an area of the annulus (8) within which the expected operating level (10) of returning drilling fluid is, the annulus (8) is provided with a restriction lining (20) elongated in the longitudinal direction of the outer pipe (4).

4. The device in accordance with claim 3, **characterized in that**, in the main, the restriction lining (20) surrounds the inner pipe (6).

5. The device in accordance with claim 3, **characterized in that** in its operating position, the restriction lining (20) is axially fixed relative to the outer pipe (4).

6. The device in accordance with claim 3, **characterized in that** the restriction lining (20) includes several lining portions (46).

7. The device in accordance with claim 3, **characterized in that** the return pump (14) is in the restriction lining (20).

8. The device in accordance with claim 3, **characterized in that** the restriction lining (20) is provided with a fill pipe (24).

9. A method of pressure-regulating a well (1) which is provided with a return pump (14) for drilling fluid and in which the operating level (10) of drilling fluid in an annulus (8) which is formed between an outer pipe (4) and an inner pipe (6) is at a height level between the upper end portion (12) of the outer pipe (4) and the bottom portion of the well (1), **characterized in that** the method includes:

   - placing the return pump (14) in the annulus (8);
   - connecting a return pipe (16) to the return pump (16) where the return pipe (16) extends through the annulus (8) and out of the well (1); and
   - letting the annulus (8) be open in the area in which the return pump (14) is placed.

10. The method in accordance with claim 9, **characterized in that** the method further includes placing the inlet (15) of the return pump (14) at a height level lower than the lowest expected operating level (10) of the drilling fluid.

11. The method in accordance with claim 9, **characterized in that** the method further includes placing an elongated restriction lining (20) at least in an area of the annulus (8) within which the expected operating level (10) of returning drilling fluid is.

12. The method in accordance with claim 11, **characterized in that** the method further includes regulating the capacity of the return pump (14) to regulate the operating level (10) to the desired height level along the restriction lining (20).

Patentansprüche

1. Vorrichtung zur Druckregelung eines Bohrlochs (1), welches mit einer Rückförderpumpe (14) zur Bohrspühlung versehen ist, und in welchem die Betriebsebene (10) der Bohrspühlung in einem Ringraum (8), welcher zwischen einem Aussenrohr (4) und einem Innenrohr (6) gebildet ist, auf einer Höhenebene zwischen dem oberen Abschnitt (12) des Aussenrohres (4) und dem unteren Abschnitt des Bohrlochs (1) ist, **dadurch gekennzeichnet, dass** die Rückförderpumpe (14) im Ringraum (8) positioniert ist und wobei sich ein Rücklaufrohr (16) durch den Ringraum (8) von der Rückförderpumpe (14) und aus dem Bohrloch (1) heraus erstreckt, und wobei der Ringraum (8) in einem Bereich, in welchem die Rückförderpumpe (14) platziert ist, offen ist.

2. Vorrichtung gemäss Anspruch 1, **dadurch gekennzeichnet, dass** der Einlass (15) der Rückförderpumpe (14) auf einer niedrigeren Ebene als die niedrigste zu erwartende Betriebsebene (10) der Bohrspühlung platziert ist.

3. Vorrichtung gemäss Anspruch 1, **dadurch gekennzeichnet, dass** zumindest in einem Bereich des Ringraumes (8), innerhalb welchem die zu erwartende Betriebsebene (10) der rückkehrenden Bohrspühlung ist, der Ringraum (8) mit einer Beschränkungsauskleidung (20) versehen ist, welche in Längsrichtung des Aussenrohrs (4) verlängert ist.

4. Vorrichtung gemäss Anspruch 3, **dadurch gekennzeichnet, dass** hauptsächlich die Beschränkungsauskleidung (20) das Innenrohr (6) umgibt.

5. Vorrichtung gemäss Anspruch 3, **dadurch gekennzeichnet, dass**, in ihrer Betriebsstellung, die Beschränkungsauskleidung (20) bezüglich dem Aussenrohr (4) axial fixiert ist.

6. Vorrichtung gemäss Anspruch 3, **dadurch gekennzeichnet, dass** die Beschränkungsauskleidung (20) mehrere Auskleidungsabschnitte (46) beinhaltet.

7. Vorrichtung gemäss Anspruch 3, **dadurch gekennzeichnet, dass** die Rückförderpumpe (14) in der Beschränkungsauskleidung (20) ist.

8. Vorrichtung gemäss Anspruch 3, **dadurch gekennzeichnet, dass** die Beschränkungsauskleidung (20) mit einem Füllrohr (24) versehen ist.

9. Verfahren zur Druckregelung eines Bohrloches (1), welches mit einer Rückförderpumpe (14) zur Bohrspühlung versehen ist, und in welchem die Betriebsebene (10) der Bohrspühlung in einem Ringraum (8), welcher zwischen einem Aussenrohr (4) und einem Innenrohr (6) gebildet ist, auf einer Höhenebene zwischen dem oberen Abschnitt (12) des Aussenrohres (4) und dem unteren Abschnitt des Bohrlochs (1) ist, **dadurch gekennzeichnet, dass** das Verfahren beinhaltet:

   - Platzieren der Rückförderpumpe (14) im Ringraum (8);
   - Verbinden eines Rücklaufrohres (16) mit der Rückförderpumpe (14), wobei sich das Rücklaufrohr (16) durch den Ringraum (8) und aus dem Bohrloch (1) heraus erstreckt; und
   - Zulassen, dass der Ringraum (8) in dem Bereich, in welchem die Rückförderpumpe (14) platziert ist, offen ist.

10. Verfahren gemäss Anspruch 9, **dadurch gekennzeichnet, dass** das Verfahren weiter das Platzieren des Einlasses (15) der Rückförderpumpe (14) auf einer niedrigeren Höhenebene als die niedrigste zu erwartende Betriebsebene (10) der Bohrspühlung beinhaltet.

11. Verfahren gemäss Anspruch 9, **dadurch gekennzeichnet, dass** das Verfahren weiter das Platzieren einer verlängerten Beschränkungsauskleidung (20) zumindest in einem Bereich des Ringraumes (8), innerhalb welchem die zu erwartende Betriebsebene (10) der rückkehrenden Bohrspühlung ist, beinhaltet.

12. Verfahren gemäss Anspruch 11, **dadurch gekennzeichnet, dass** das Verfahren weiter das Regulieren der Leistung der Rückförderpumpe (14) beinhaltet, um die Betriebsebene (10) auf die gewünschte Höhenebene entlang der Beschränkungsauskleidung (20) zu regulieren.

Revendications

1. Un dispositif d'ajustement de pression d'un puits (1) pourvu d'une pompe de refoulement (14) pour le fluide de forage, et dans lequel le niveau opérationnel (10) du fluide de forage dans un espace annulaire (8) formé entre un tube externe (4) et un tube interne (6) se situe à un niveau de hauteur entre la partie supérieure (12) du tube externe (4) et la partie inférieure du puits (1), **caractérisé en ce que** la pompe de refoulement (14) se trouve dans l'espace annulaire (8) et où un tube de refoulement (16) s'étend à

travers l'espace annulaire (8) depuis la pompe de refoulement (14) et hors du puits (1), et où l'espace annulaire (8) est ouvert dans le domaine dans lequel la pompe de refoulement (14) est située.

2. Le dispositif selon la revendication 1, **caractérisé en ce que** l'entrée (15) de la pompe de refoulement (14) est située à un niveau inférieur au niveau opérationnel attendu le plus bas (10) du fluide de forage.

3. Le dispositif selon la revendication 1, **caractérisé en ce que** au moins dans un domaine de l'espace annulaire (8) dans lequel le niveau opérationnel attendu (10) du fluide de forage refoulé existe, l'espace annulaire (8) est pourvu d'un chemisage de restriction (20) élongé dans la direction longitudinale du tube externe (4).

4. Le dispositif selon la revendication 3, **caractérisé en ce qu'**en général, le chemisage de restriction (20) entoure le tuyau interne (6).

5. Le dispositif selon la revendication 3, **caractérisé en ce que** dans sa position opérationnelle, le chemisage de restriction (20) est axialement fixé par rapport au tuyau externe (4).

6. Le dispositif selon la revendication 3, **caractérisé en ce que** le chemisage de restriction (2) inclut plusieurs portions de chemisage (46).

7. Le dispositif selon la revendication (3) **caractérisé en ce que** la pompe de refoulement (14) est dans le chemisage de restriction (20).

8. Le dispositif selon la revendication 3, **caractérisé en ce que** le chemisage de restriction (20) est pourvu d'un tuyau de remplissage (24).

9. Un procédé d'ajustement de pression d'un puit (1) qui est pourvu d'une pompe de refoulement (14) pour le fluide de forage et dans lequel le niveau opérationnel (10) du fluide de forage dans un espace annulaire (8) formé entre un tube externe (4) et un tube interne (6) se situe à un niveau de hauteur entre la partie supérieure du tube externe (4) et la partie inférieure du puit (1), **caractérisé en ce que** la procédé inclut :

- placer la pompe de refoulement (14) dans l'espace annulaire (8) ;
- connecter un tube de refoulement (16) à la pompe de refoulement (14) où la pompe de refoulement (16) s'étend à travers l'espace annulaire (8) et hors du puit (11); et
- permettre à l'espace annulaire (8) d'être ouvert dans le domaine dans lequel la pompe à refoulement (4) est située.

10. Le procédé selon la revendication 9, **caractérisé en ce que** le procédé inclut d'avantage placer une entrée (15) de la pompe de refoulement (14) à un niveau de hauteur inférieur au niveau opérationnel attendu le plus bas (10) du fluide de forage.

11. Le procédé selon la revendication 9, **caractérisée en ce que** le procédé inclut d'avantage placer un chemisage de restriction (20) élongé au moins dans un domaine de l'espace annulaire (8) dans lequel le niveau opérationnel attendu (10) du fluide de forage refoulé existe.

12. Le procédé selon la revendication 11, **caractérisé en ce que** le procédé inclut d'avantage réguler la capacité de la pompe de refoulement (14) pour ajuster le niveau opérationnel (10) au niveau de hauteur désiré le long du chemisage de restriction (20).

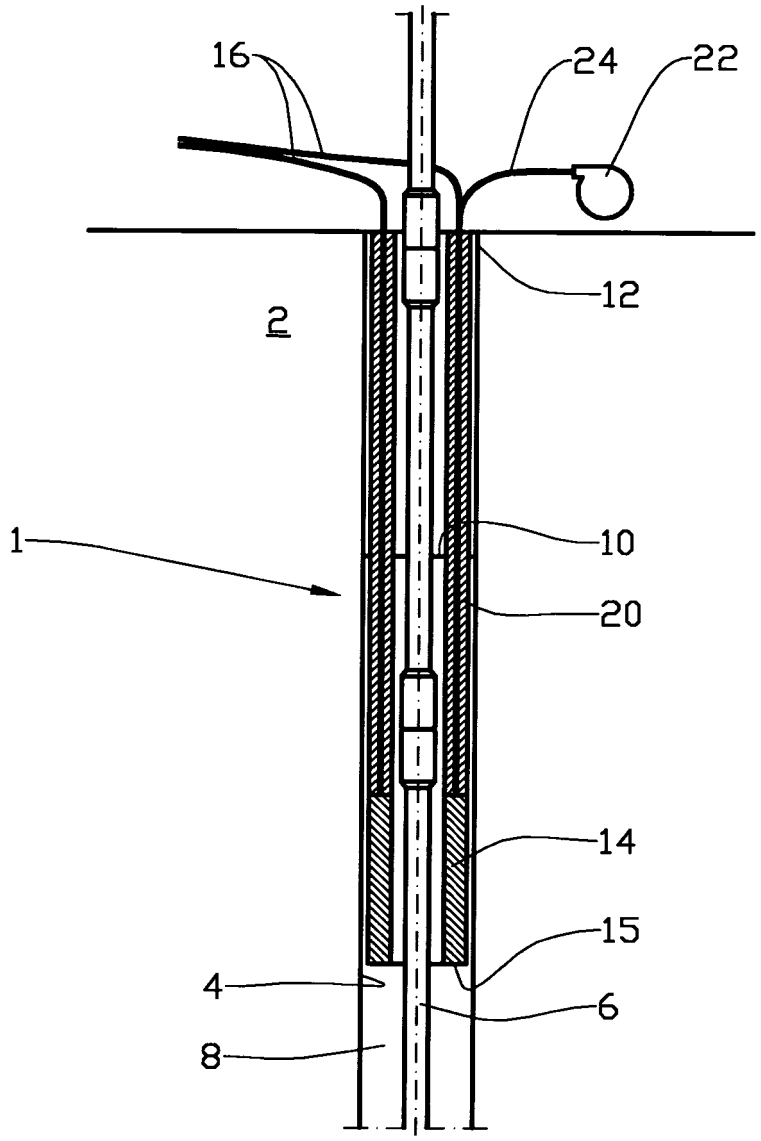


Fig. 1

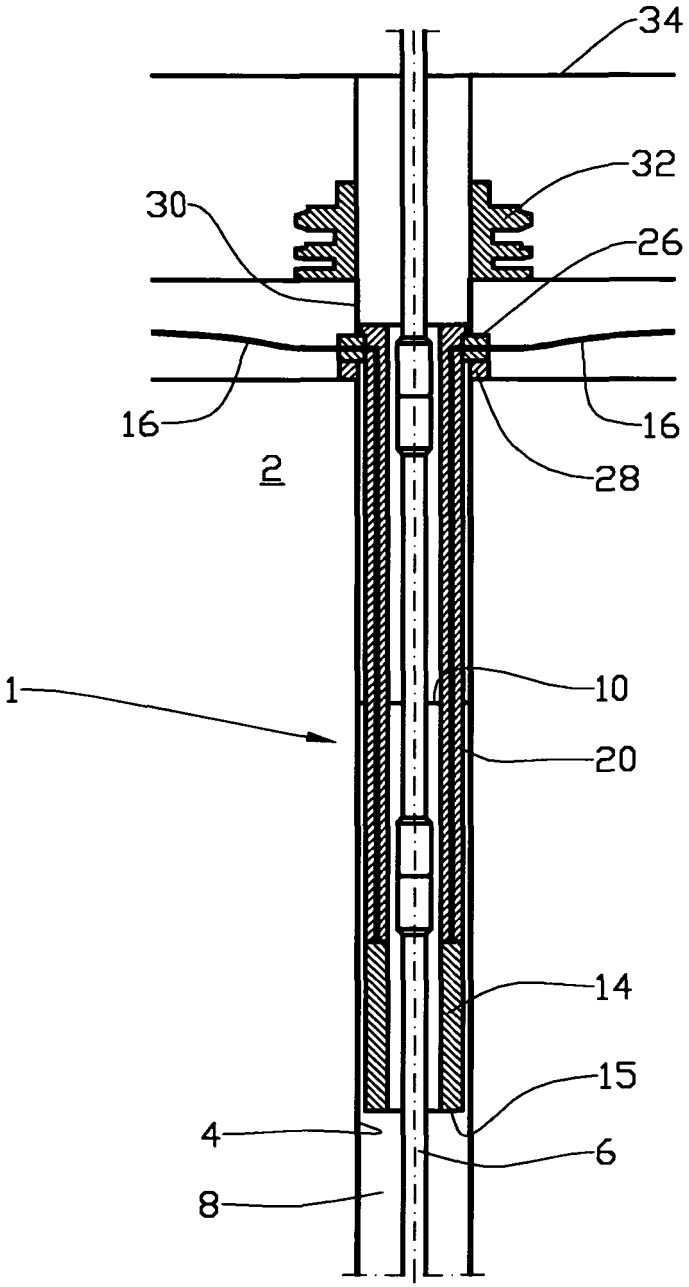


Fig. 2

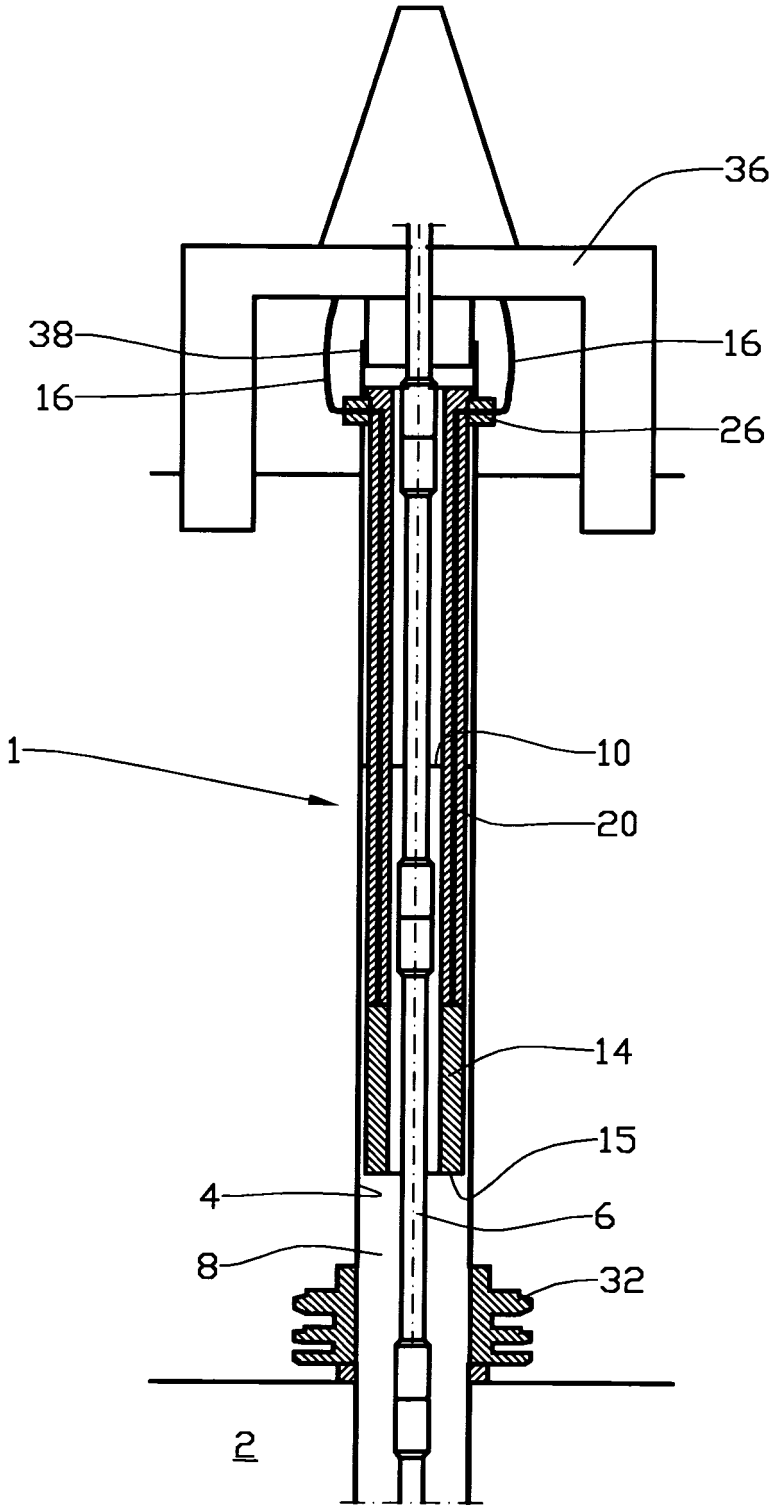


Fig. 3

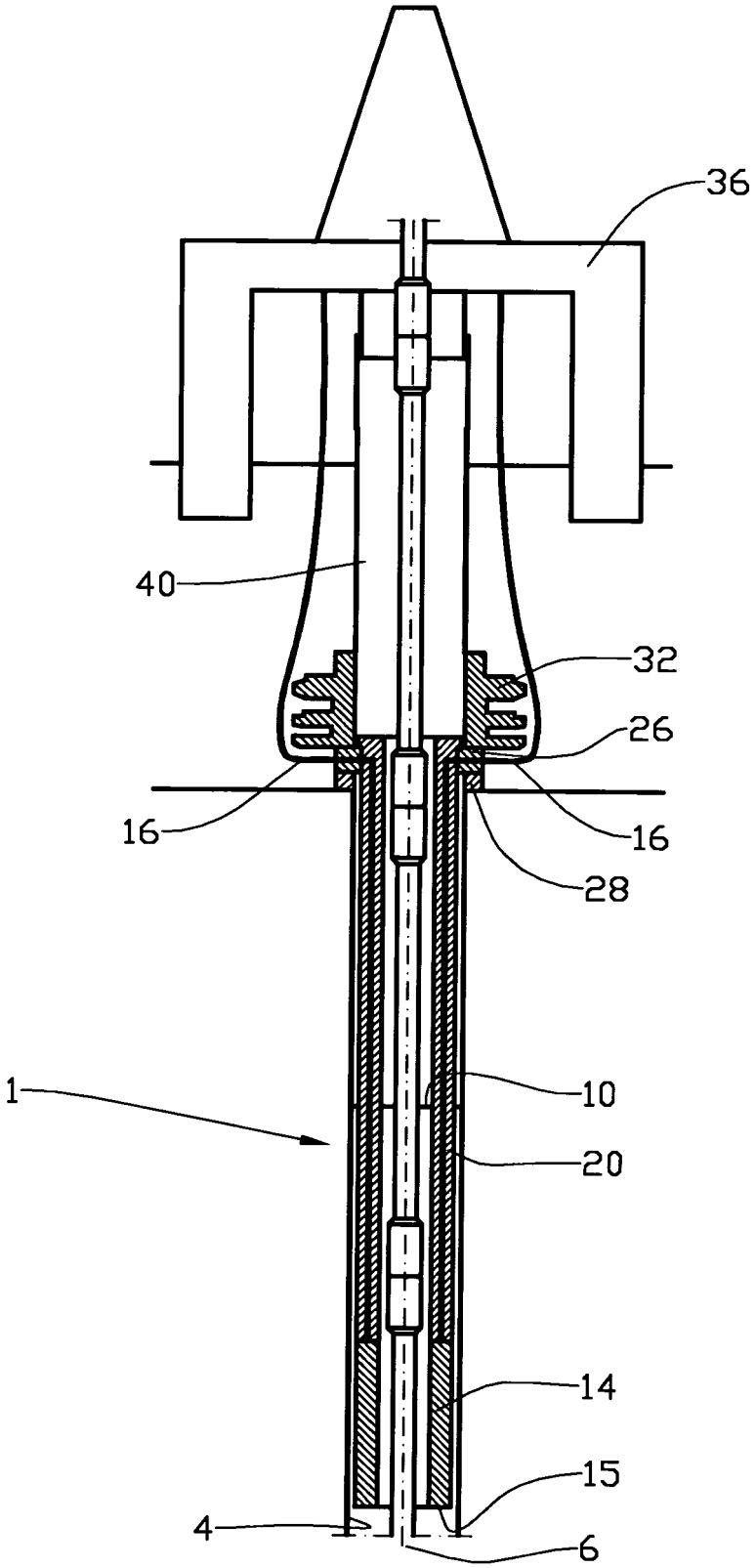
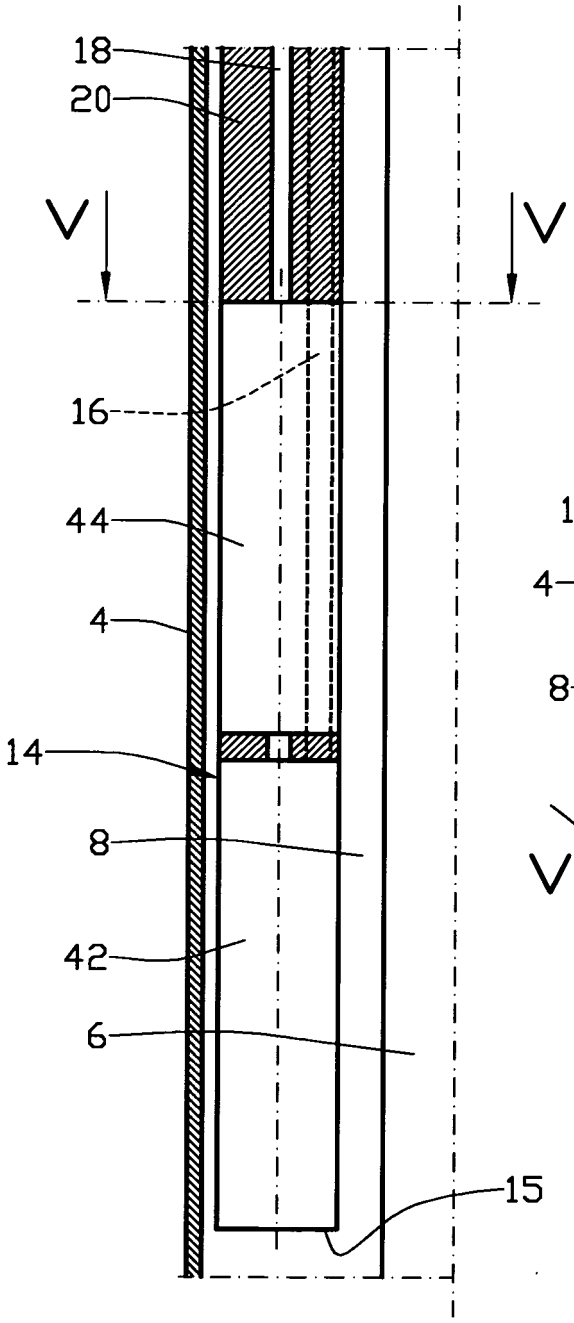
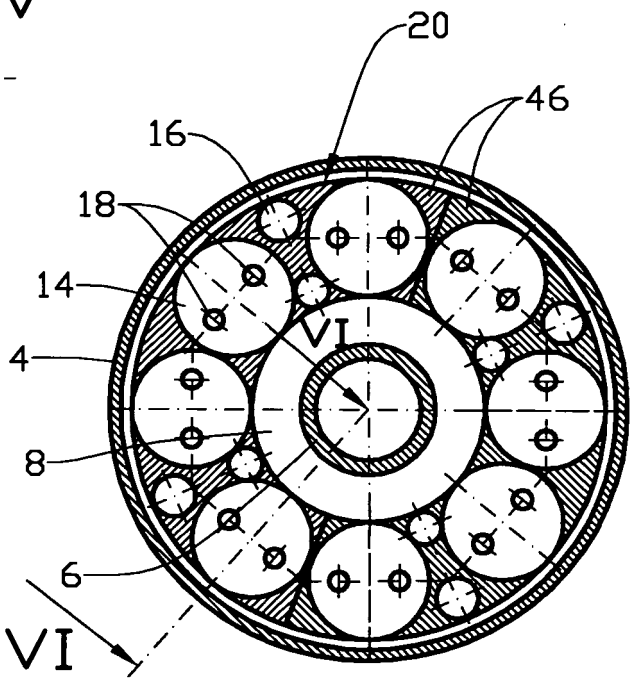


Fig. 4



VI-VI

Fig. 5



V-V

Fig. 6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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