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(12) (19) (CA) **Demande-Application**

(21) (A1) **2,304,732**
(86) 1999/03/23
(87) 1999/09/30

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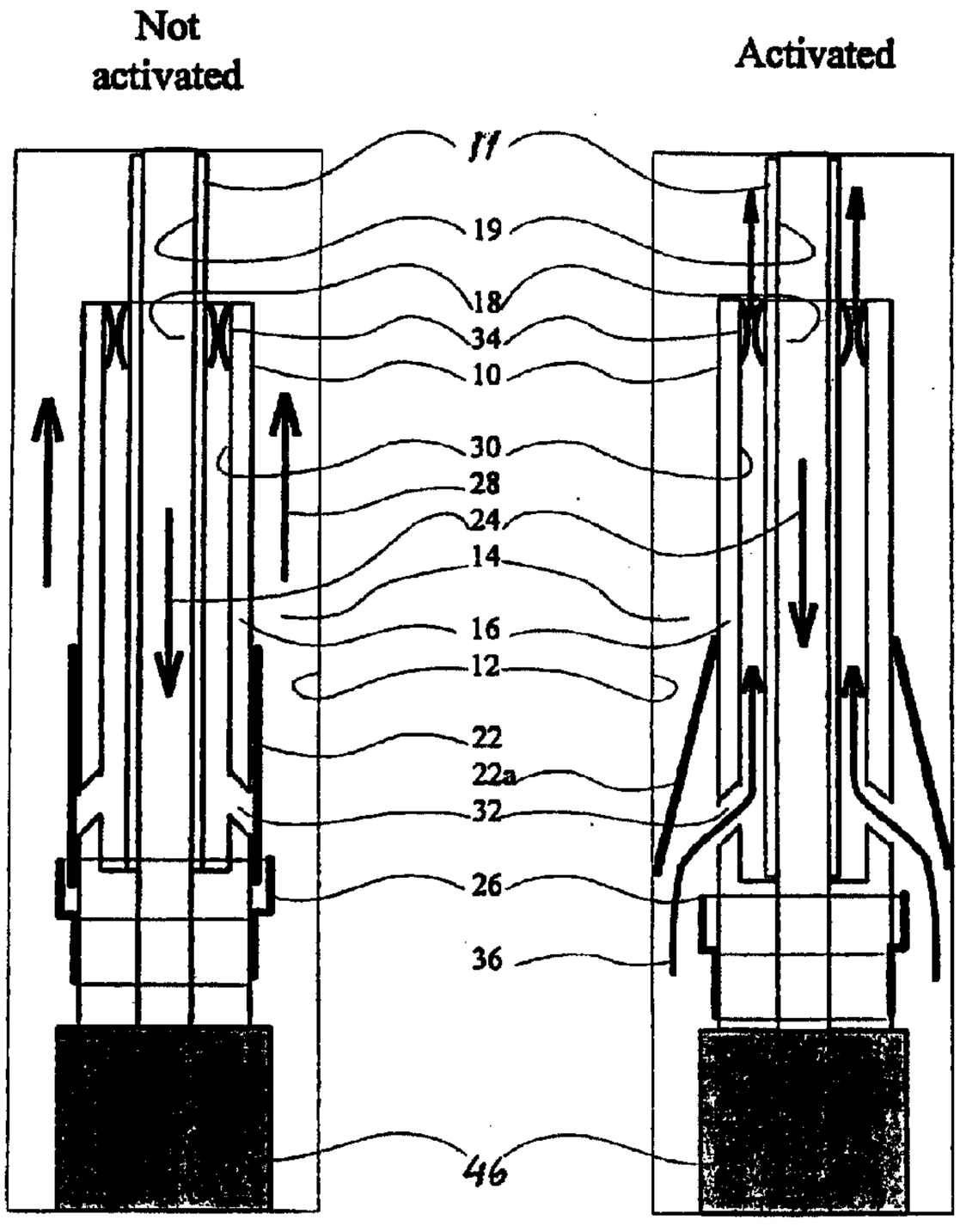
(51) Int.Cl.[6] E21B 33/10, E21B 34/00
(30) 1998/03/23 (19981305) NO

(54) **BLOC OBTURATEUR DE PUITS**

(54) **BLOWOUT PREVENTER**



(57) L'invention concerne un bloc obturateur de puits (10; 110), conçu pour être inclus à une garniture de forage (11; 111) de manière à isoler la partie de fond de l'annulaire (14; 114) située entre ladite garniture et la paroi (12; 112) du trou de sonde. Ce bloc obturateur de puits est constitué d'un corps tubulaire (16; 116) et d'un

(57) A blowout preventer (10; 110) adapted to be included in a drill string (11; 111) to isolate a downhole portion of the annulus (14; 114) between the drill string and borehole wall (12; 112). The blowout preventer comprises a tubular body (16; 116) and an expandable packer means (22; 122) having an inactive or unset

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dispositif d'étanchéité extensible (22; 122), lequel peut adopter une position inactive ou non fixe permettant à un fluide de s'écouler à travers l'annulaire (14; 114), ou une position active de déclenchement permettant d'obturer cet annulaire (14; 114). Le corps tubulaire (16; 116) de ce bloc obturateur présente un alésage traversant (18; 118) aligné par rapport à l'alésage de la garniture de forage, ainsi que des passages (30; 130) parallèles audit alésage (18; 118), des orifices d'admission de fluide (32; 132) étant ménagés de manière à être recouverts de manière hermétique par le dispositif d'étanchéité (22; 122) une fois celui-ci dans sa position inactive, et découverts lors du déclenchement de ce dispositif d'étanchéité (22; 122), ce qui permet à ce dernier de s'étendre dans sa position d'obturation afin de fermer ledit annulaire (14; 114).

position permitting fluid flow through annulus (14; 114), and a released, active or set position closing the annulus (14; 114). The tubular body (16; 116) has a through-bore (18; 118) aligned with the bore of the drill string and passageways (30; 130) parallel to the bore (18; 118) with fluid inlet ports (32; 132) arranged in a manner to be sealingly covered by the packer means (22; 122) in its unset position, and uncovered upon release of the packer means (22; 122) to permit it to expand into its sealing position closing the annulus (14; 114).

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : E21B 33/10, 34/00

A1

(11) International Publication Number: **WO 99/49180**

(43) International Publication Date: 30 September 1999 (30.09.99)

(21) International Application Number: PCT/NO99/00097

(22) International Filing Date: 23 March 1999 (23.03.99)

(30) Priority Data:
19981305 23 March 1998 (23.03.98) NO

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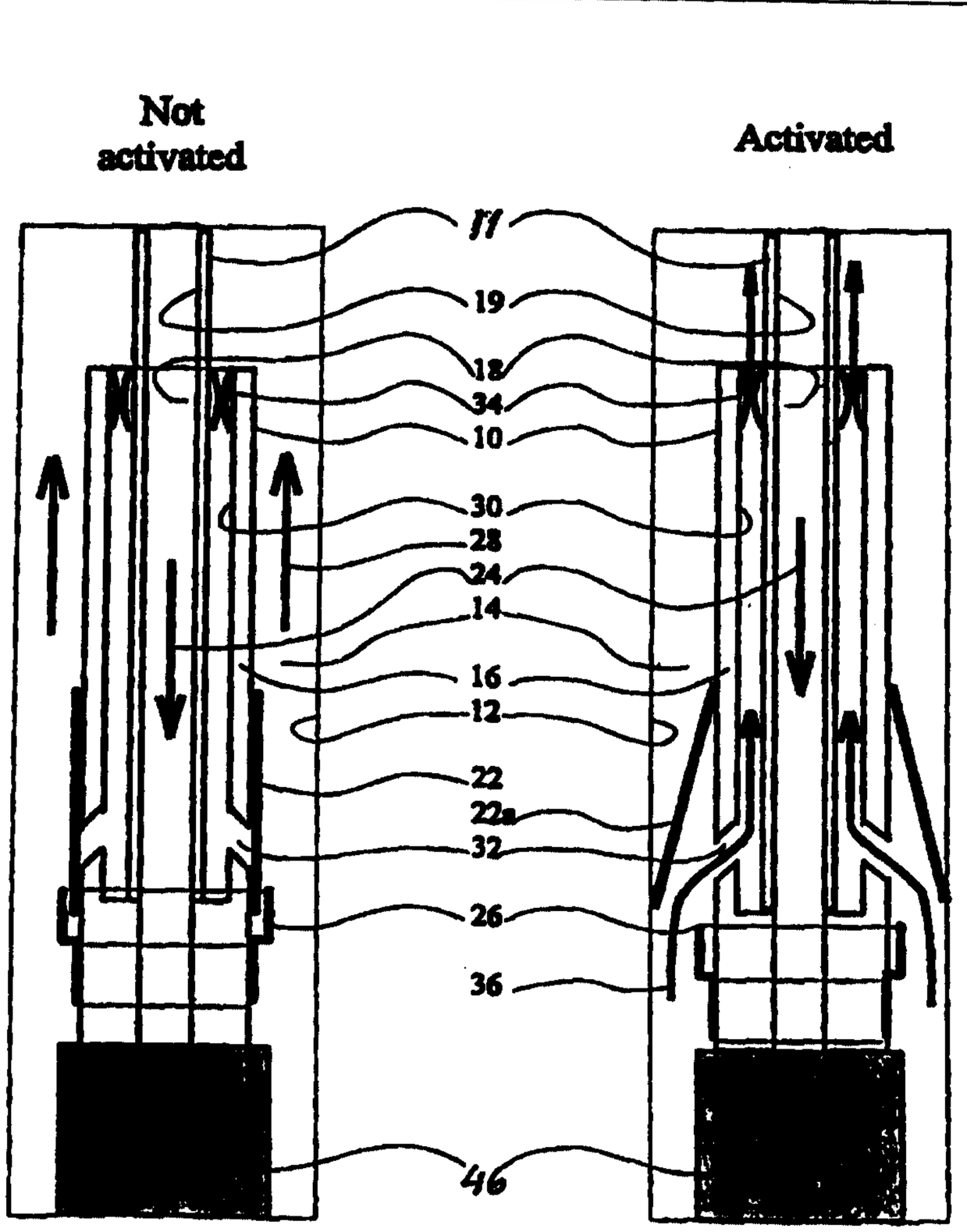
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: BLOWOUT PREVENTER

(57) Abstract

A blowout preventer (10; 110) adapted to be included in a drill string (11; 111) to isolate a downhole portion of the annulus (14; 114) between the drill string and borehole wall (12; 112). The blowout preventer comprises a tubular body (16; 116) and an expandable packer means (22; 122) having an inactive or unset position permitting fluid flow through annulus (14; 114), and a released, active or set position closing the annulus (14; 114). The tubular body (16; 116) has a through–bore (18; 118) aligned with the bore of the drill string and passageways (30; 130) parallel to the bore (18; 118) with fluid inlet ports (32; 132) arranged in a manner to be sealingly covered by the packer means (22; 122) in its unset position, and uncovered upon release of the packer means (22; 122) to permit it to expand into its sealing position closing the annulus (14; 114).



BLOWOUT PREVENTER

The present invention relates to a blowout preventer adapted to be included in a drill string wherein, upon the occurence of an uncontrolled blowout of fluid (liquid and/or gas) in a subsea well, the blowout preventer is released in a manner to adopt an activated or set position stopping the blowout. More specifically, the invention relates to a blowout preventer as defined in the ingress of the appending claim 1.

Blowout preventers based on expandable packer elements are often used when drilling top hole sections, i.e. borehole sections near the seabed where high pressure shallow gas pockets may be encountered, to prevent uncontrolled blow-out if the pressure downhole of the blowout preventer is higher that provided by the hydrostatic pressure caused by the drilling mud above the packer.

Packer elements of prior art blowout preventers of the above type, such as that disclosed in published PCT application WO 88/08917, are generally designed to be capable of completely isolating the borehole below the packer. In contrast to this the present invention relates to a blowout preventer permitting a certain de-gree of controlled fluid leakage to the annulus above the packer, whereby drilling mud may be caused to fill up the entire borehole in an emergency situation asso-ciated with a dangerous blowout from the subsea well.

In order to detect any so-called "shallow gas" in top-hole sections in the up-per seabed stratum, one or more "pilot holes" are often drilled. The pilot hole is drilled with a smaller diameter than full bore diameter, in order to permit an in-crease of the downhole pressure by increasing the pumping rate of the drilling mud. Drilling pilot holes means added costs. Using a blowout preventer accord-ing to the invention eliminates the need of initially drilling a such pilot hole, while it also provides the necessary safety with regard to any high pressure zones that may be encountered. The blowout preventer according to the invention which is based on a packer means with a leak feature, is primarily intended for use in the above mentioned top-hole sections, where the borehole is not provided with cas-ing.

When, during prior art drilling, the bit at the end of the drill string encounters a zone of the formation having a higher pressure than that produced by the hydro-static fluid column in the subsea well, any fluid (liquid and/or gas) present will be

able to flow into the well and out of it, if no particular measure has been taken to prevent it.

Often, when drilling the upper section of a subsea well, no blowout preventer is used, and normally seawater is used as a drilling fluid when drilling the well. Therefore, when using this prior and conventional drilling technique, it is particularly important to ascertain that there are no high pressure zones to be encountered along the intended drilling path.

When drilling at greater sea depth, however, the formations in the upper strata of the subsea well are less consolidated than those at shallow waters.

The radial expansion capability of the type of packer that is used in prior blowout preventers is limited, and therefore such prior blowout preventers may not be capable of providing a satisfactory sealing around the wall of the wellbore annulus if the formation is unconsolidated or washed out to have a diameter larger than normal. Such insufficient sealing capacity of prior packer elements is uncontrollable and not to be compared with the intended and controllable leaking capability of the blowout preventer of the present invention, the latter permitting a fluid circulation that may be brought to cause the wellbore to be completely filled with drilling mud in an emergency situation such as a blowout.

Prior blowout preventers of the type having inflatable packer elements which are deflated when lowered into the well in their inactive ready position, requires a higher internal pressure in inflated, set position than the pressure prevailing below the packer element in the subsea well. This is due to the fact that the unset packer element itself resists being inflated.

As explained above such inflatable packing elements suffers from insufficient expandability upon inflation. On very deep waters formations might be encountered which are unconsolidated or weak, resulting in a non-uniform borehole wall having varying cross-section along a length thereof, which would necessitate an expansion of the inflatable packing element beyond that for which it is designed. Thus, prior packing elements are not capable of being sufficiently expanded.

The primary object of the present invention is to eliminate or substantially alleviate drawbacks, deficiencies and restrains on the range of applications of prior art technology associated with the drilling for oil and gas, and thus to provide a simple, effective and safe blowout preventer capable of protecting subsea wells

against a blowout from an unexpected pressure zone in the formation that is drilled.

This is achieved through the invention, by a type of blowout preventer as introductorily described, incorporating the new and specific features recited in the characterising portion of the appending patent claim 1. Advantageous embodiments of the invention are defined in the remaining appending claims.

In order to be capable of preventing inflow into the subsea well caused by a blowout from an unexpected pressure zone, the pressure in the lowest part of the well has to be increased until it exceeds the pressure prevailing in the formation. According to the invention this is achieved by activating the blowout preventer packer means which comprises a plurality of individual packer elements which, in their activated set position, closes or isolates the annulus between the blowout preventer and borehole wall.

The blowout preventer comprises a tubular body including a packer means adapted to adopt a deactivated or unset and an activated or set position, a latching and releasing means for retaining and releasing the packer means, and an activating means for activating the latching and releasing means.

The tubular body of the blowout preventer is provided with passageways through which the fluidflow is directed from downstream inlet ports to upstream outlet ports.

The upstream end of each passageway can be provided with one or more nozzles while their opposite closed or downstream end communicates with the annulus through a port.

The radially outer end openings of the ports are normally covered by the individual elements of the packer means when these elements are in their non-activated position. The packer elements are in the form of relatively wide, self-contained slats one end (the upstream end) of which is attached at the exterior of the tubular body of the blowout preventer while the free ends of the slats engage the exterior of the tubular body in the inactive position of the packer means.

The packer slats are made from steel or another appropriate metal or metal alloy subjected to a heat treatment imparting a springy property to the slats that tends to urge them radially outwards. The free end portions of the packer slats are kept in their inactive retracted position with the slat bodies biased radially inwards by means of the movable latching and releasing means. Owing to their springy

nature the slat elements tend to swing or spring radially outwards with their free outer end portions sealingly engaging the opposite borehole wall upon release of the latching and releasing means.

The blowout preventer also comprises an activator means for activating the packer slat latching and releasing means, the latter advantageously being in the form of an annular latching or retaining part carried by a sleeve-like part sliding on the packer tubular body between a latching and a releasing position.

When the latching and releasing means slides along the tubular body to release the slat ends, the radially outer openings of the inlet ports that were covered by a portion of the slats are uncovered to permit fluidflow into the passageways in the tubular body of the blowout preventer, and out therefrom through the nozzles in the outer ends of the passageways.

By adjusting the pump flow rate the downhole pressure can be adjusted to a safe level avoiding fracturing of the formation while preventing inflow into the well. Relatively high flow rates (1000-2000 litre/minute) must be used to achieve this. In this manner fluidflow into the subsea well can be stopped at a minimum of time and heavier drilling mud inflowed into the well, re-establishing the pressure balance of the well even without circulation.

Non-limiting embodiments of the invention is described below with reference to the appending drawings, in which:

Fig. 1 is a schematic sectional view of a blowout preventer according to the invention, with the slats of its packer means in an inactive or unset position, showing the directions of the corresponding fluidflows through the blowout preventer and externally of the blowout preventer tubular body as indicated by arrows;

Fig. 2 is similar to fig. 1, but with the slats of the packer means in their released or set position expanded radially outwards into sealing engagement with the borehole wall, and showing the corresponding fluidflows through the blowout preventer;

Fig. 3 is an elevational, partial sectional view, to a smaller scale than figs. 1

and 2, showing the blowout preventer in its inactive condition with retracted packer slats;

Fig. 3A illustrates, to a considerably larger scale, an encircled portion of fig. 3;

Fig. 4 is a cross-sectional view taken along lines IV-IV in fig. 3;

Fig. 5 is a schematic longitudinal cross-sectional view of the blowout preventer showing packer slats in their active, set position;

Fig. 5a is an enlarged partial view of a portion of the packer slat structure encircled in fig. 5;

Fig. 6 is a partial lateral cross-sectional view to a larger scale, showing the packer slats in their active position sealingly engaging the wall of the well and illustrating outer and inner slats and elastomer diaphragms incorporated in the packer means;

Fig. 7 is a partial view showing the elastomer diaphragms of the packer means vulcanized to an edge of the inner packer slats;

Fig. 8A – 8C are schematic side views of a packer means positioned in a well with its packer slats in set position, in unset position in a normal well (a well having standard cross-section) and in set position in a washed out well (a well having an unusually large diameter), respectively;

Fig. 9 is an elevational cross-sectional view of the activator of the blowout preventer which operates to actuate the latching and releasing means to release the packer slat ends permitting the slats to spring outward into a sealing position, and showing the slats in their inactive position, retained at their lower end portions by the latching and releasing means;

Fig. 10 is a cross-sectional view taken along the line X-X in fig. 9;

Fig. 11 is a cross-sectional view taken along line XI-XI in fig. 9;

Fig. 12 is similar to fig.9, but here the actuator has been operated to actuate the latching and releasing means to displace the latter for releasing the retained portions of the packer slats which, owing to their springy nature, have expanded radially outward into set position;

Fig. 13 and 14 are longitudinal cross-sectional views of a particularly preferred embodiment of a blowout preventer according to the invention, incorporating a deactivateable packer means, shown in activated (expanded) and deactivated (retracted) position, respectively;

Fig. 15 is an elevational view of the blowout preventer of fig.13 and 14 shown in activated or set position;

Fig. 16 is a plan view of a slat to be used in the blowout preventer according to figs. 13 -15;

Fig. 17 includes three cross-sectional views of the slat of fig. 16, taken along the lines A-A, B-B and C-C respectively in the latter figure, and

Fig. 18 schematically shows a sector of a cross-section through slats according to figs. 16 and 17 of the packer means in activated and deactivated position respectively in the area corresponding to the cross-sectional lines C-C in fig. 16.

It is referred to the drawings, firstly to the schematic illustrations shown in fig. 1 and 2, where reference numeral 10 denotes a blowout preventer according to the invention, while 12 denotes the borehole wall and 14 the annulus defined between the exterior of blowout preventer 10 and the borehole wall 12. Blowout preventer 10 is contemplated as being threaded to a drill string 11 in a manner to be aligned with the latter, such that blowout preventer 10 thereby defining with the

borehole wall 12 a longitudinal portion of annulus 14, while the drill string and borehole wall 12 define the remaining portion of annulus 14.

The blowout preventer 10 comprises a longitudinal tubular housing 16 having an axial through-bore 18 aligned with bore 19 of the drill string 11 and of a succeding tool, such as a drill bit 20 (see fig. 3).

A packer means, generally denoted by reference numeral 22, comprises springy metal slats or ribs 22a to be described more in detail later on, in connection with figs. 5 through 10. The metal slats are secured at their upstream ends (referred to the downward flow direction which is substantially vertical as indicated by arrow 24) and retained in their retracted positions, fig. 1, in which the slats down stream end portions are surrounded and retained in this inactive position by means of a movable latching and releasing means 26 as described below in connection with figs. 10 - 13, the slats of the packer means, upon release thereof, expanding laterally to have their outer ends sealingly engage the walls 12 of the wellbore as shown in fig. 2.

Figs. 1 and 2 specifically illustrate the fluidflow pattern such as for drilling fluid pumped downhole from the surface to a blowout preventer, shown in activated and non-activated position in fig. 1 and 2 respectively.

During normal drilling, with the blowout preventer in inactive position as shown in fig. 1, back flow of pumped down drilling fluid indicated by arrow 24 takes place in the usual manner, upwards through the annulus 14 as indicated by arrows 28.

When the blowout preventer according to the present invention is released, allowing the packer means thereof to expand into its active sealing position for closing annulus 14, the situation is as schematically illustrated in fig. 2.

The tubular body 16 of the blowout preventer 10 is formed with a plurality (e.g. eight) fluid passageways 30 extending parallel to the central bore 18 from end openingsor ports 32 to upstream end openings 34 preferably provided with nozzles 34' or similar throttle means opening into annulus 14.

Fluid flowing through passageways 30 of tubular body 16 in the activated position of the blowout preventer 10 is indicated with arrows 36. 46 refers to the cylindrical housing of the latching and releasing means 26 as described in more detail below.

With reference to fig. 3, 3A and 4, the tubular body 16 of the blowout preventer 10 is formed with a central through-bore 18 and eight passageways 30. As detailed in fig. 3A the passageways 30 have radially outward and upward diverging discharge portions terminating in removable throttle means 34'.

The slat latching and releasing means 26 is controlled by an actuator generally shown at 44 in fig. 3. The ports 32 of the internal passageways 30 are here formed longer and narrower than those shown in the schematic illustrations of figs. 1 and 2. Below actuator 44 is an optional downhole motor 47 above drill bit 20.

The packer slats 22a are formed from concentrical outer and inner layers of metal slats with an intermediate elastomer.

According to fig. 3A outer slat layer 22a' is attached, such as by threads, at the level of the outlet ends 34 of the internal passageways 30.

Fig. 5a shows in greater detail a portion encircled in fig. 5, consisting of concentric slat layers with elastomer 22a''' between outer slat layer 22a' and inner slat layer 22a''. The configuration of the packer slats 22a according to this embodiment is shown in more detail in figs 6 and 7.

The plan partial views 6 and 7 illustrate the position and peripheral distribution of the outer layer of slats 22a', the inner slats 22a'' and elastomer diaphragm 22a''' (broken thick lines). According to fig. 7 the elastomeric diaphragm is secured to the edge of each inner slat 22a'' such as by vulcanization.

Figs. 8A – 8C schematically illustrate the positions of the packer slats 22a, with non-activated blowout preventer, fig. 8A, with activated blowout preventer in a normal well (normal diameter), fig. 8B, and with activated blowout preventer in a washed out and thus considerably widened well 12', respectively. The inherent springy properties of the suspended slats 22a, as a consequence of their design, figs. 5A, 6 and 7, provide for a considerable transversal expansion potential of the blowout preventer 10.

Fig. 9 – 12 particularly illustrate the construction and function of the actuator 44 associated with the latching and releasing means 26 for the slats 22a of the packer means 22. Said means 26 comprises an annular rim section 26' surrounding the lower ends of slats 22a retaining them in their inactive position. Annular section 26' is coaxially connected to a sleeve-like section 26'' slideably disposed along a portion of the blowout preventer 10 tubular body 16.

A lower portion of the tubular body 16 is surrounded by a tubular housing 46 the inner surface of which defines an annular space 48 with the outer surface of tubular body 16 along a central longitudinal portion thereof. Sleeve portion 26'' slidably extends into this annular space 48 with a flanged end section 26A forming an annular piston in the annulus space 48.

In the inactive position of the blowout preventer 10, the latching and releasing means 26 is held in an upper position as shown in fig. 9, leaving a small annular space portion 48' above annular piston 26A. By applying pressurized fluid into this annulus space portion 48', piston 26A and consequently annular rim section 26' will be urged downwards, thus releasing packer slats 22a when the upper edge of rim section 26' passes below the lower ends of the slats when moving downward to its bottom end position shown in fig. 12.

To this effect, annular space portion 48' communicates with an internal oil channel 50 including an electro-hydraulic pilot valve 52 and leading to a longitudinal oil reservoir 54 parallel to the central through-bore 18, the upper portion of which is filled with pressurized gas acting as an accumulator 62. The gas-oil interface is denoted by reference numeral 55. Two electrical batteries 56 are disposed parallel to oil reservoir 54, see also fig.11. The batteries are connected to an underlieing microprocessor 58 and pressure sensor 60.

The latching and releasing means 26 is held in its upper latching position shown in fig. 9 by any suitable means, such as a shear pin (not shown). The annular space 48 below piston 26A is vented by an aperture 64 through the wall of housing 46.

When the blowout preventer 10 is to be activated, such us from the position shown in fig. 9 to that shown in fig. 12, a pressure pulse code is transmitted through the fluid column in the central bore 18 of the drill string central bore 18. Pressure sensor 60 is adapted to react on the pressure pulses in a manner to transmit signals that are received and compared with a pre-programmed code in microprocessor 58. Once agreement is determined upon such comparison, the microprocessor 58 transmits a signal to pilot valve 58, causing the latter to permit supply of oil from reservoir 54 pressurized by accumulator 62 into annular space portion 48' via internal oil channel 50, forcing down the latching and releasing means 26 to release packer slats 22a, as described above.

In the embodiment shown in the drawings so far, the packer means 22 of the blowout preventer 10 according to the invention could consist of two concentric cylinders split along part of their lengths to define individual slats which, together with the elastomeric diaphragm, form the sealing provided by the blowout preventer according to the invention in its activated, i.e. expanded position. The slats are made of a springy metal material and shaped in such a manner that when released from their inactive position they serve to expand the diameter of the packer means until their outer free end portions engage the walls of the borehole 12 along the periphery of the blowout preventer.

Annular space 14 is now closed off and well fluid downhole of the packer means 22 will flow up through passageways 30 via ports 32 and into annulus 14 uphole of packer means 22 through nozzles 34' at the upper ends of passageways 30. In a critical blowout this would happen within a few seconds, i.e. at the same rate as that of the downhole pressure increase. Formation fluids will now circulate through the passageways 30 and nozzles 34' of the blowout preventer, up through annulus 14 above the packer means 22 to discharge into the sea above the well-bore, to permit heavier drilling mud to circulate down into the well until pressure balance is re-established, such as previously described.

The invention is not limited to the disclosed embodiments. Thus, the configuration of the packer means 22 could be modified based on the embodiment consisting of outer slats 22a', inner slats 22a'' and intermediate elastomer diaphragm 22a''', in which the slats are made from two concentric cylindrically bent thin metal plates that are split along a certain length to form individual slats 22a', 22a'' biased towards expanded sealing position, such as shown in figs. 8B and 8C, the elastomeric diaphragm 22a''' providing the sealing effect. Any other suitably expandable packer element of a similar configuration could be used within the scope of the invention as defined in the appending patent claims.

Important features of packer means 22 are its configuration and position relative to ports 32 of passages 30. Thus, the function of packer means 22 is two-fold, at least in activated position, where it closes annulus 14 between blowout preventer 10 and wellbore 12, while at the same time uncovering ports 32 of passages 30 to permit fluidflow through the blowout preventer 10 and annulus 14 uphole, such as previously described.

However, in an embodiment, not shown, the latching and releasing means 26 itself, instead of the end portionsof the packer slats 22a could be formed, dimensioned and positioned, in the non-activated mode of the blowout preventer 10, in a manner to close ports 32 of passageways 30 and, upon release, uncovering passageway ports 32 and simultaneously unlatching the packer slats 22a permitting the latter to spring radially outward.

The inherent transvers springiness of the slat packer means, which is caused by a combination of the selected spring steel, pre-treatment of the steel sheet material, intermediate elastomer, configuration of the slats, etc, assists in urging the packer slats 22a into sealing engagement with the wellbore wall 12 in addition to the force provided by the pressure differential across packer means 22.

The blowout preventer 10 according to the invention, as disclosed above, is capable of being activated very rapidly, which is of utmost importance upon the occurrence of a critical blowout, thus permitting rapid rebalance of the well owing to the high fluid circulation rate that can be achieved.

As an alternative, the slideable latching and releasing means 26 in form of a sleeve with annular piston 26A could, rather than being positioned as described above and shown in the drawings, be positioned uphole of packer means 22 and adapted to be pulled upwards upon activation. In a such alternative embodiment sleeve 26 would have to travel a longer distance than that of the embodiment described above. On the other hand, a such alternative embodiment would permit deactivation of the packer means in situ without having to retrieve the blowout preventer to the surface in order to deactivate it.

However, in figs. 13 - 18 there is shown a particularly advantageous embodiment of a blowout preventer according to the invention, featuring a deactivateable packer means. The same reference numerals, with the addition of the number 100, as in the previous embodiment according to fig. 1 – 12, are used for like or similar parts. Fig. 13 is a longitudinal sectional view of blowout preventer 110, where packer means 122 is shown in activated or set, i.e. fully expanded position, while in fig. 15 it is shown in deactivated, i.e. fully retracted position.

As in the previous embodiment 10, the blowout preventer 110 comprises a tubular body 116 having an axial through-bore 118, packer means 122 including springy metal packer slats 122a,passageways 130, longitudinal fluid inlet ports 132, outlet ports or nozzles 134, upper slat attachment e.g. in form of a threaded

latching ring 116', latching and releasing means 126, actuator 144, hydraulic accumulator 162, oil reservoir 154, interface 155, pilot valve 154, battery 156, microprocessor 158, and pressure sensor 160.

The preferred embodiment of blowout preventer 110 according to the invention differs from the previously shown and described blowout preventer 10, essentially in that the lower end portions 122b of packer slats 122a which, in the activated or set position of the packer means are adapted to sealingly engage wellbore wall 112, each are connected to the latching and releasing means 126 by a narrow longitudinal connecting element 123. Thus, in the shown embodiment elements 123 are connected to a rim portion 126' at the lower end of the sleeve 126" latching and releasing means 126, the sleeve 126" with annular piston 126A being slideably resiprocatably disposed in annular space 148 between cylindrical housing 146 and tubular body 116. Oil channels 150,150' respectively, extend from oil reservoir 154 via valve 152 to open into upper and lower end of annular space 148, respectively. Thus, in blowout preventer 110, housing 146 constitutes, together with internal annular piston 126A, a double acting hydraulic cylinder, as opposed to the single acting cylinder 46, 26A of the previous embodiment 10.

Otherwise the components of blowout preventer 110 and its mode of operation upon being activated, is essentially the same as those of the previously described blowout preventer 10.

During running and normal operation of drill string 111 including blowout preventer 110 in deactivated position in wellbore 112 as shown in fig. 15, the latching and releasing means 126 is retained in its lower end position by means of pressurized fluid applied through channel 150 to annular space 148 above piston 126A. In this manner the connecting elements 123 keep the slats 122a stretched to closely engage the exterior surface of tubular body 116, in which the slat lower portions sealingly cover body inlet ports 132.

Upon a signal from the surface via pressure sensor 160 and microprocessor 158, pilot valve 152 opens to permit fluidflow through channel 150' into annular space 148 below piston 126A to force the latching and releasing means 126 up to its upper end position, slackening connecting elements 123 to release the packer slat lower end portions 122b such that these, by their inherent springiness assisted by the pressure of the up-flowing fluid in well-annulus 114 are urged radially out-

ward to sealingly engage the wellbore wall 112 in the activated mode of blowout preventer 110, as illustrated in fig. 14 and in fig. 16.

Connection elements 123 are narrow enough to permit well fluids to flow freely in between them and in under the packer slats 122a. Moreover, connecting elements 123 possess a certain degree of rigidity, such that initially at the moment of release during the upward travel of sleeve 126, they transmit thrust to the slat end portions 122b to rapidly urge the latter radially outward and permitting the well fluid in below the slats expanding them further toward the wellbore wall.

The slats 122a of blowout preventer 110 could be of a design substantially similar to that of slats 22a of the previously described embodiment 10, having the lower end portions of the slats suitably connected to connecting elements 123. The latter could be formed of any suitable material.

However, packer slats 122a of a somewhat modified form as appearing from the plan view of fig. 16 and sections according to fig. 17, are preferred for embodiment 110. They generally consist of a long relatively thick bracing element 100a supporting a long, substantially triangularly tapering, outer packer sheet 100b extending in one lateral direction from bracing element 100a and an inner packer sheet 100b' extending from the bracing element in a lateral direction opposite from that of outer sealing sheet 100b and separated therefrom by the thickness bracing element 100a, as appearing from the cross-sections according to fig. 17. The connection elements 123 are here depicted simply as suitably configured extensions of the bracing elements 100a. Fig. 18 schematically illustrates a sector of a cross-section through packer means 122 in the area along section line C-C in fig. 16, showing how the slats 122 packer sheets 100b, 100b' overlappingly cover each other in their deactivated positions retracted toward the tubular body 116, and in their activated positions expanded into engagement with the borehole wall 112. Along an end portion of the slat attachment 122a' the thickness of each slat bracing element 100a is preferably split longitudinally a certain distance by a cut 166, such as shown in figs. 13 and 17.

The extension elements 123 also act as a screen to prevent solid particles in the well fluid in annulus 114 from entering the interior of the packer. Preferably there is also a screen means 170, such as a metal mesh, around tubular body 116 in the area at the longitudinal ports 132.

Although not shown in figs. 13 -18 the slats of the packer means 122 could be provided with intermediate elastomer sealing diaphragm as in the previous packer means 22.

Patent Claims:

1. Blowout preventer (10; 110), adapted to be incorporated in a drill string (11; 111), comprising a radially and peripherically expandable packer means (22; 122) which is shiftable between a retracted inactive position permitting fluidflow (28, 28') passed the blowout preventer in the annulus (14; 114) defined between the drill string (11; 111) and the wall (12; 112) of a wellbore, and a released, expanded position in which it seals with the borehole wall (12;112), said packer means (22; 122) being associated with a latching and releasing means (26; 126) movable between a latching position preventing said packer means (22; 122) from expanding and an unlatching position releasing said packer means (22; 122) permitting the latter to expand into its active sealing position, characterized in that the blowout preventer (10; 110) comprises a tubular body (16; 116) formed with a central through-bore (18; 118) aligned with the bore (19) of the drill string, at least one passageway (30; 130) extending substantially parallel with the central bore (18; 118) and having a fluid inlet (32; 132) and a fluid outlet (34; 134), and that the packer means (22; 122) and/or the movable latching and releasing means (26; 126) is configured and positioned relative to the outlet (32; 132) of the passageway (30; 130) in such a manner that the packer means (22; 122) in its inactive position or the latching and releasing means (26; 126) in its active retaining position covers and closes said inlet (32; 132) or uncovers said inlet (32; 132) when the packer means (22; 122) is in its expanded active sealing position.

2. Blowout preventer according to claim 1, characterized in that the packer means (22; 122) is attached at a circumferential fastening portion thereof to the tubular body (16; 116) of the blowout preventer (10; 110) and split or otherwise configured along a certain length thereof as seen in the longitudinal direction of the tubular body (16; 116) from a free edge portion opposite said fastening portion, to form springy slats (22a; 122a), and that the movable latching and releasing means (26; 126), in its active latching position, is adapted to engage the free end portion of the packer means releasing same upon being moved towards its inactive releasing position, in a manner to permit said plurality of slats to perform a radial and peripherical expansion into sealing position, the latching and releasing means (26; 126) having an annular retainer section (26'; 126') connected with a sleeve section

(26"; 126") slideably disposed along a portion of the tubular housing (16; 116) or a guiding portion coaxially connected therewith.

3. Blowout preventer according to claim 2, characterized in that the packer means (22; 122) is formed from two concentrical, cylindrically configured, springy metal thin sheets that are split from a circumferential edge thereof along a certain axial length thereof to form a plurality of outer and inner slats (22a'; 122a', 22a"; 122a") having a longitudinal, triangular or trapezoidal circumferential shape, and an intermediate elastomer diaphragm (22a"'; 122"'), said outer and inner slats and elastomer diaphragm forming a three-layer slat assembly (22a'; 122a', 22a"; 122a", 22a"'; 122a"') which, at the circumferential edge opposite the split circumferential edge comprises said attachment portion which is secured to the tubular body (16; 116) of the blowout preventer (10; 110).

4. Blowout preventer according to claim 1, characterized in that the outlet (34; 134) of said at least one passageway (30; 130) is provided with a nozzle (34'; 134').

5. Blowout preventer according to claim 2, characterized in that the sleeve section (26"; 126") of the latching and releasing means (26; 126) is provided with an annular piston (26A; 126A) reciprocating disposed in an annular space (48; 148) defined between the blowout preventer (10; 110) tubular body (16;116) and a surrounding tubular housing (47; 147), said piston (26A; 126A) acted upon by pressurized fluid supplied to the annular space (48; 148).

6. Blowout preventer according to claim 5, characterized in that it comprises a battery-driven microprocessor (58; 158) which is connected to a pilot valve (52; 152) and a pressure sensor (60; 160) adapted to respond to a pressure code transmitted from a surface position through a fluid column in the bore of the drill string (11; 111) and blowout preventer (10; 110), and which upon response thereto, transmits signals that are received by the microprocessor (58; 158) which is adapted to compare these sensor signals with a pre-programmed code and, upon agreement, transmit signals to pilot valve (52; 152) through an internal pressure fluid channel (50; 150) leading from a pressure fluid reservoir (54; 154) in the

blowout preventer (10; 110) to one side of the annular piston (26a, 126a) in annular space (48; 148).

7. Blowout preventer according to claim 6, characterized in that the pressure fluid reservoir (54; 154) is filled with oil below a volume of pressurized gas.

8. Blowout preventer according to any one preceding claim, characterized in that the internal passageways (30; 130) are equidistantly disposed circumferentially about the central bore (18; 118).

9. Blowout preventer according to claim 8, characterized in that the outlets (34, 134) of the internal passageways (30, 130) divert radially outwards.

10. Blowout preventer according to any one preceding claim, characterized in that the downstream end portions of the packer slats (122) are connected to the movable latching and releasing means (126) via longitudinal connection elements (123) permitting deactivation of the blowout preventer by movement of the latching and releasing means (126) in a direction opposite that of its releasing movement.

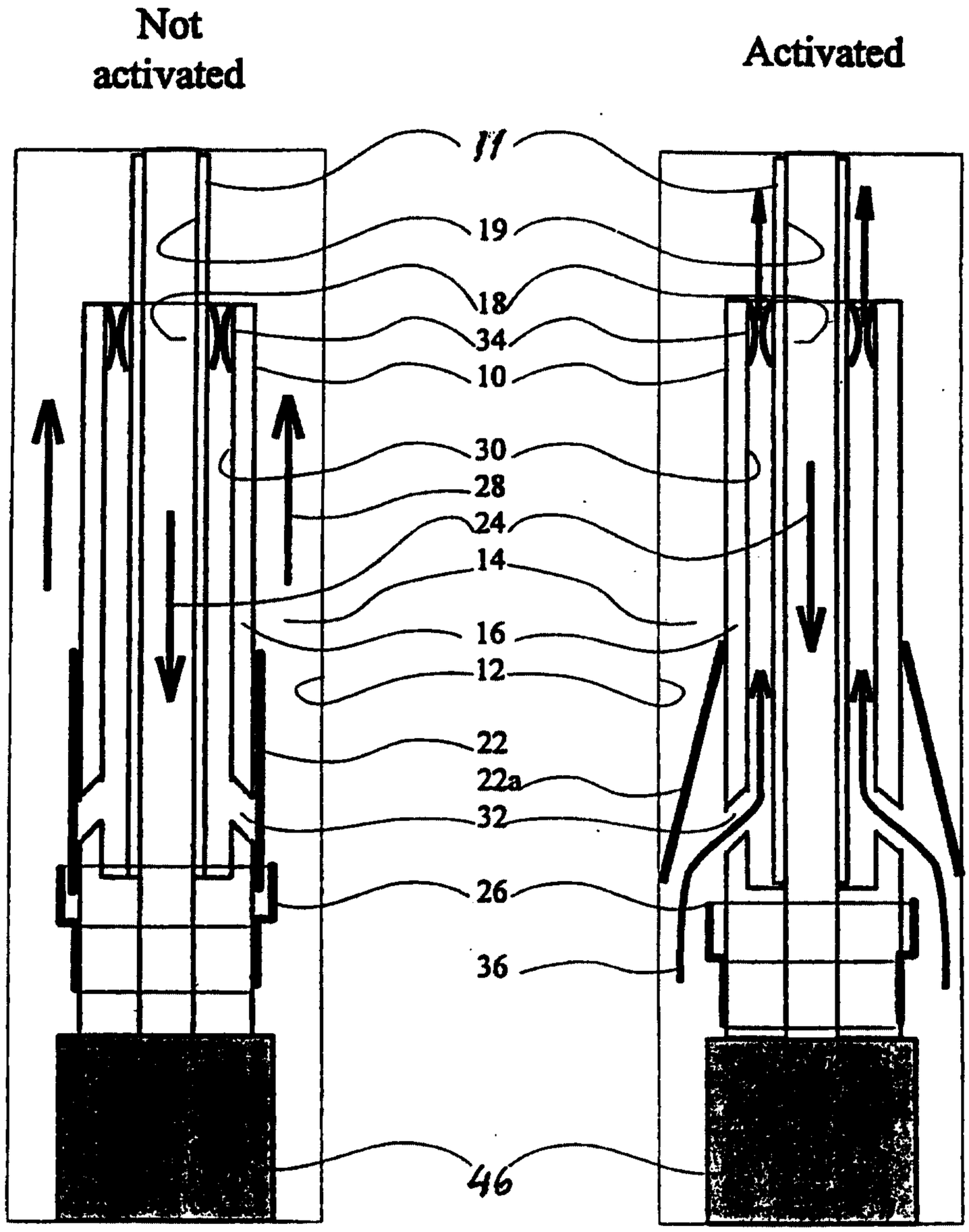

Not activated
Activated
11
19
18
34
10
30
28
24
14
16
12
22
22a
32
26
36
46

Fig.1 Fig.2

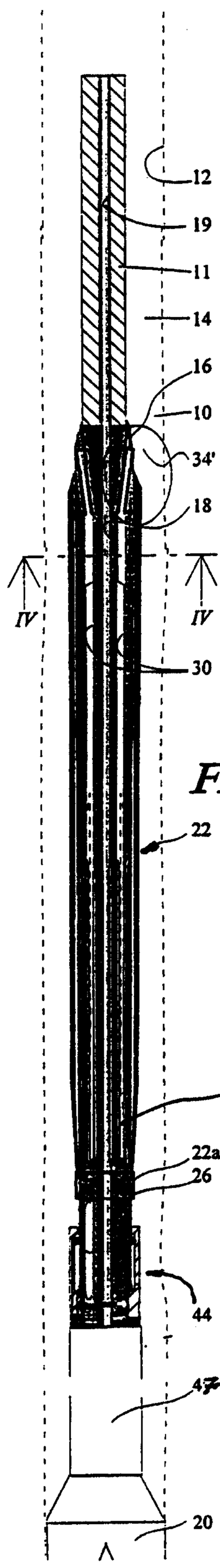
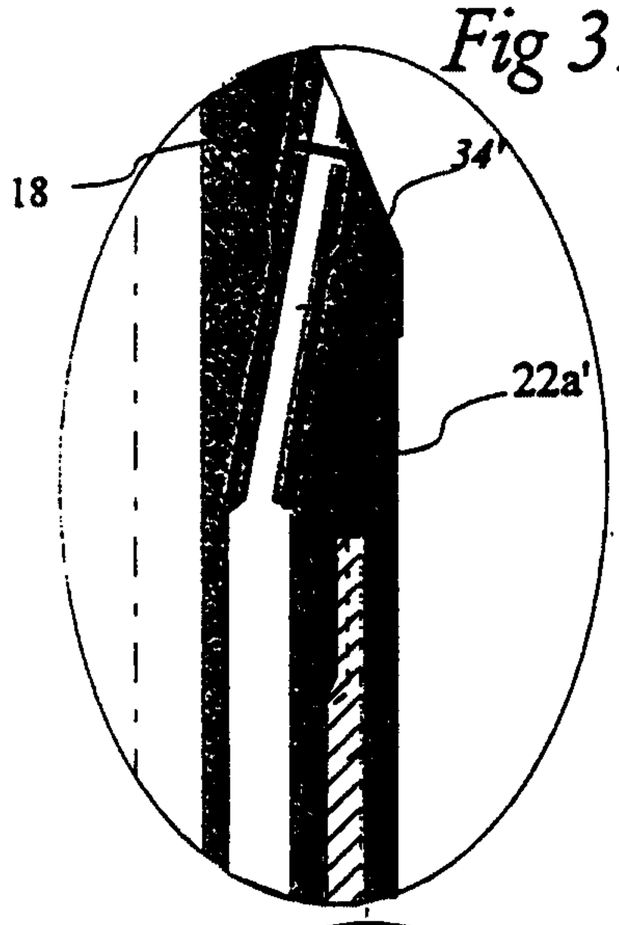


Fig 3

Fig 3A



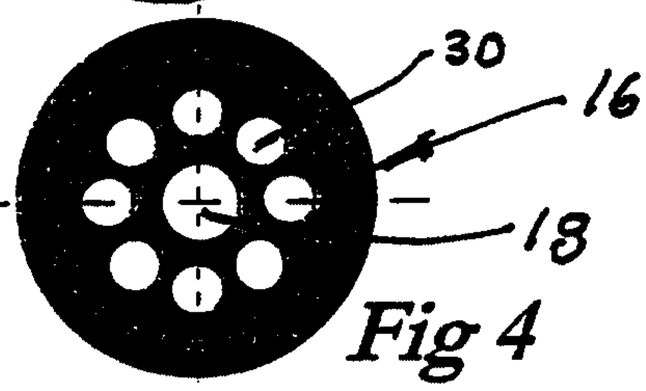


Fig 4

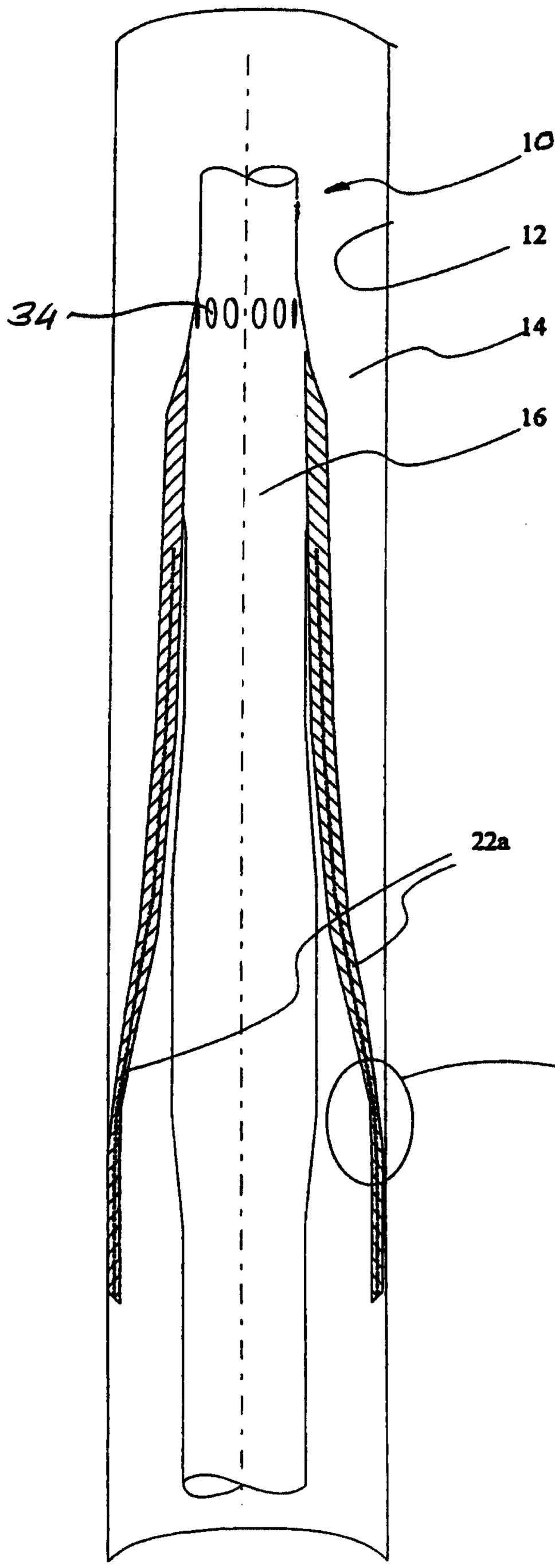


Fig. 5 *Fig. 5 a*

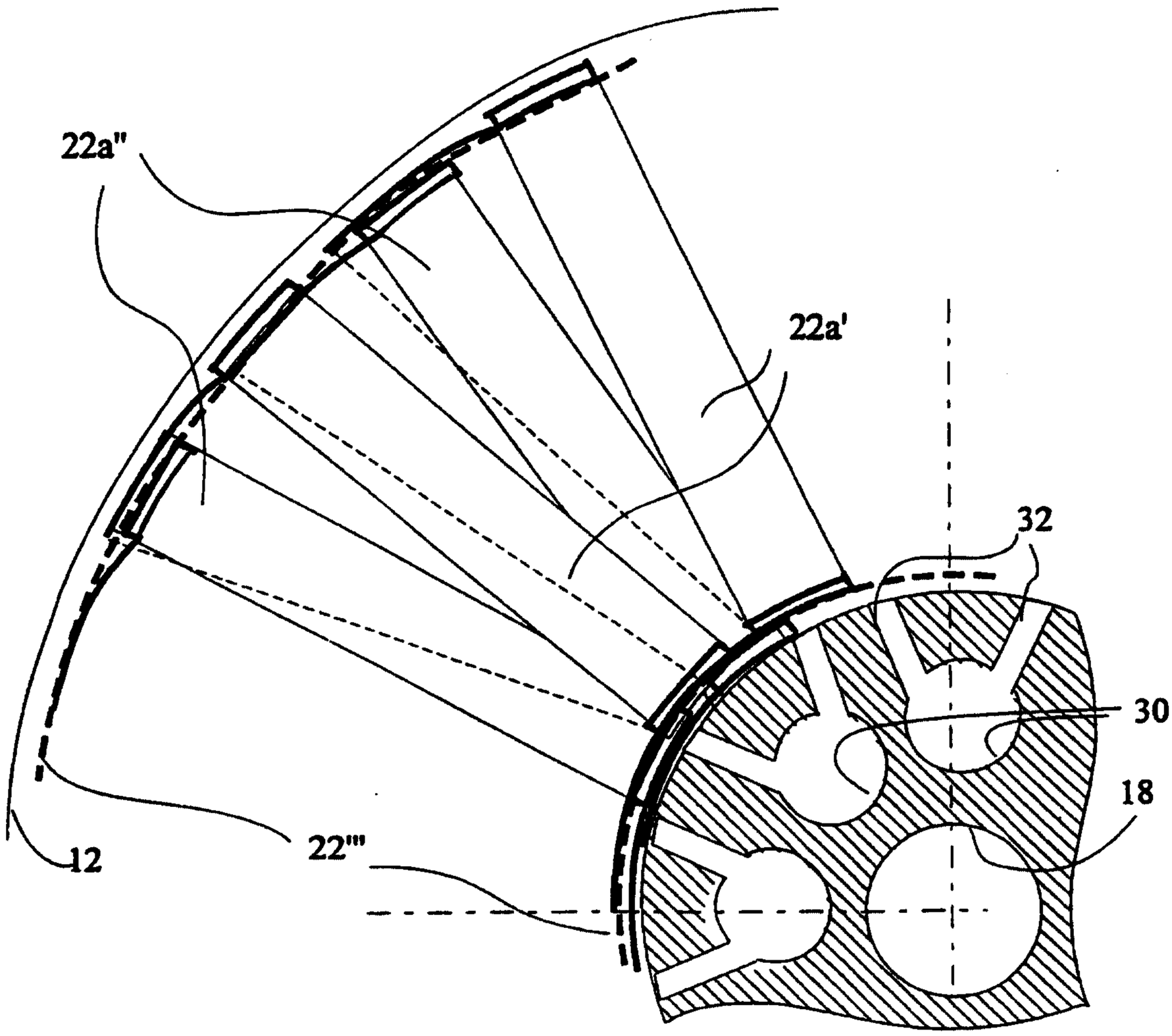


Fig. 6

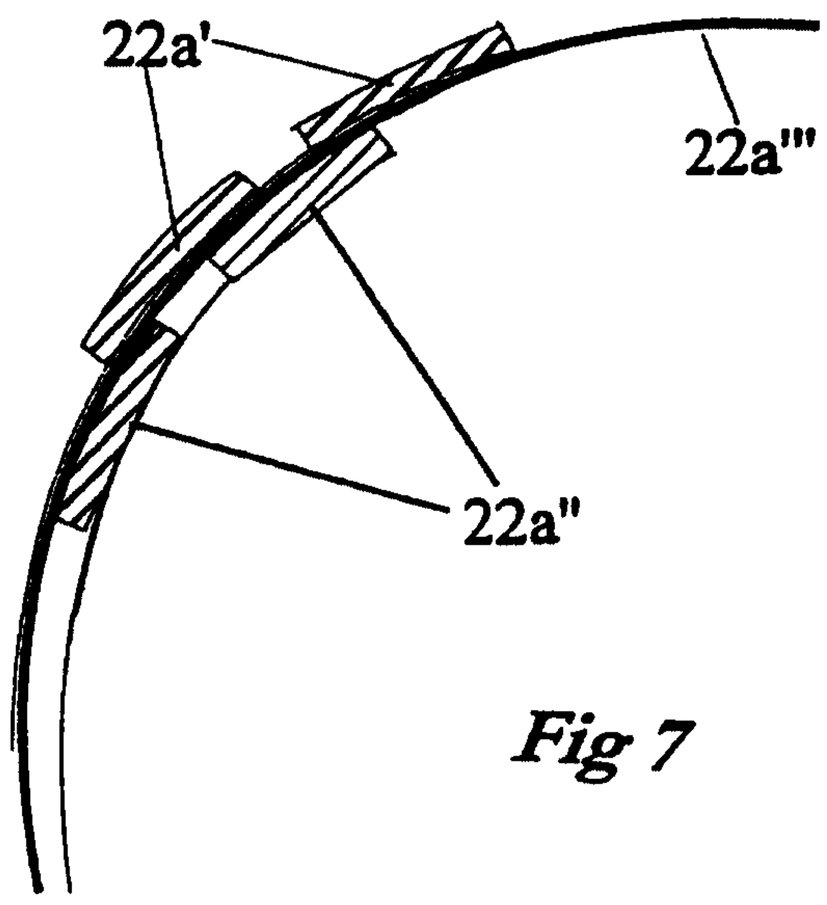


Fig 7

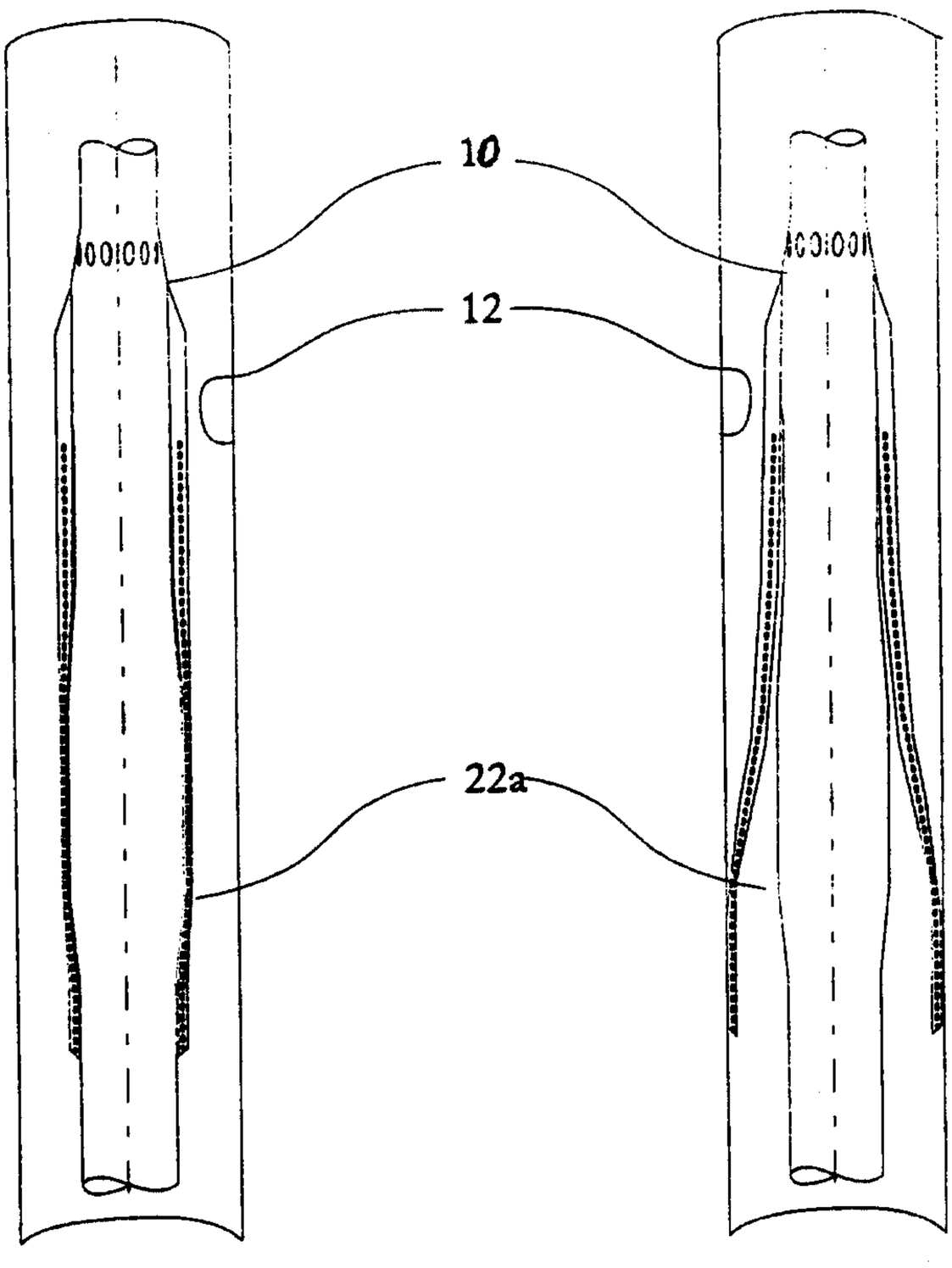


Fig 8 A

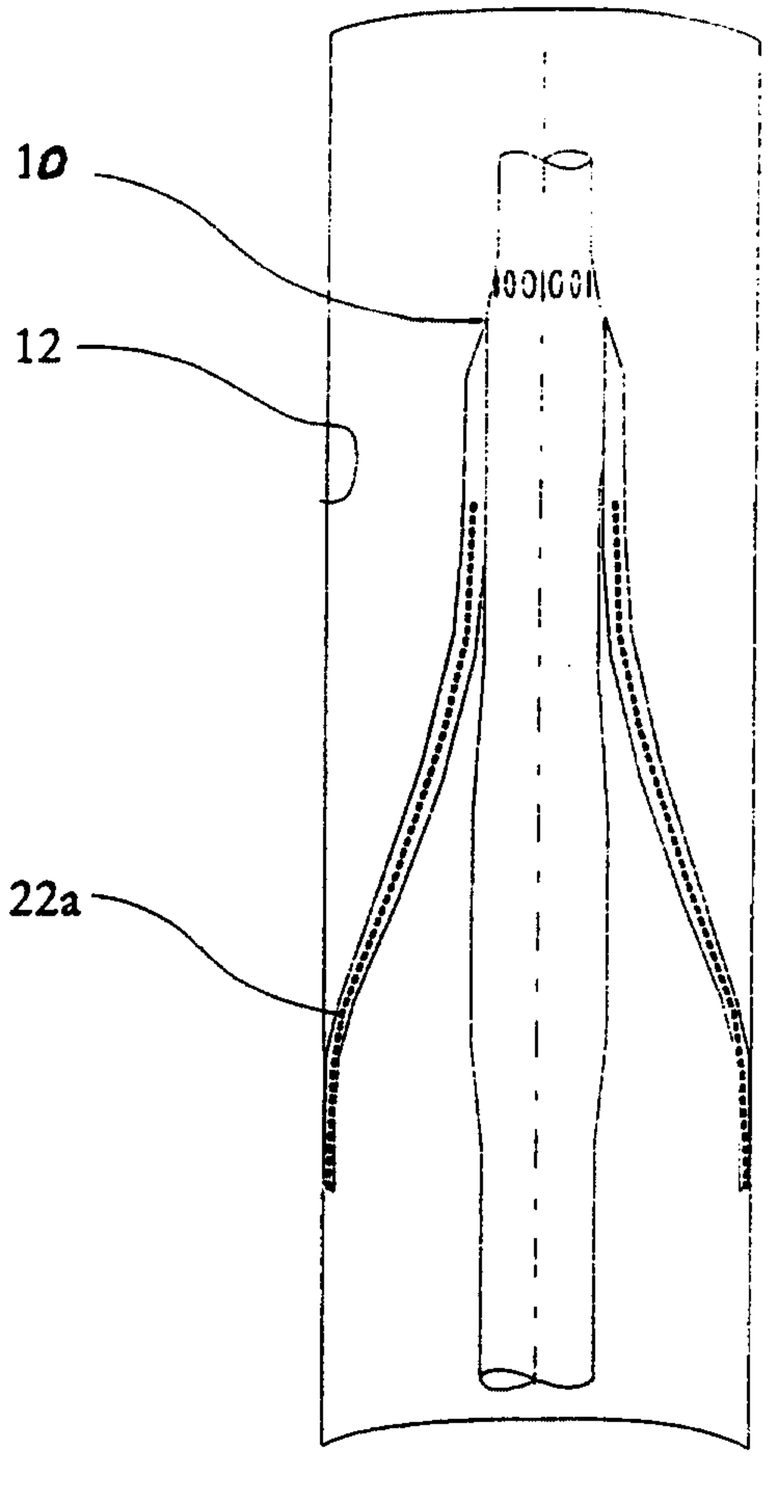


Fig 8B

Fig 8 C

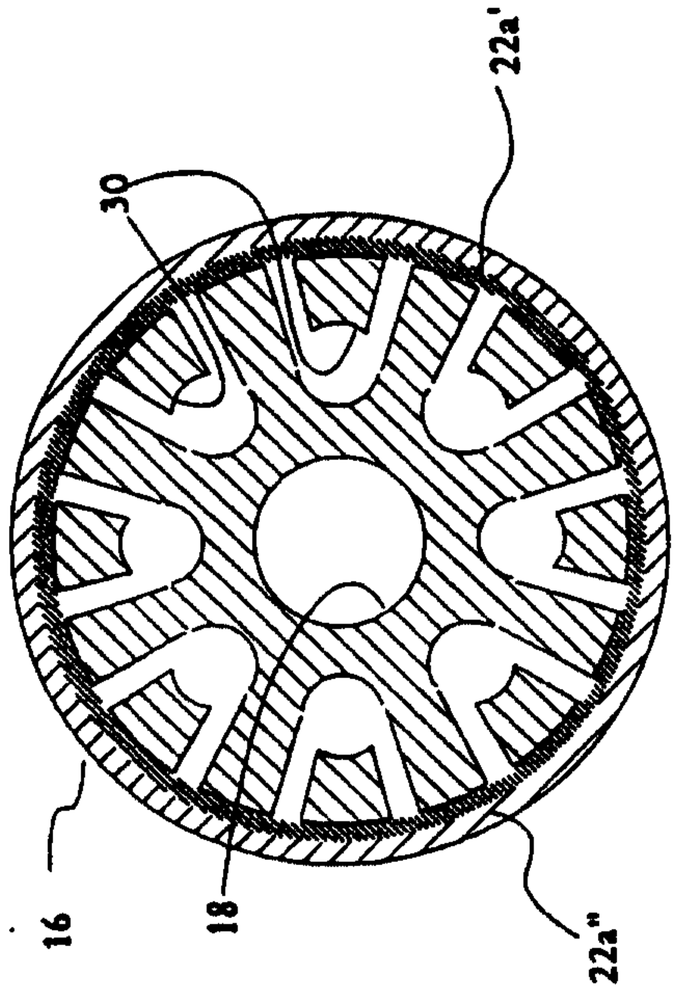


Fig. 10

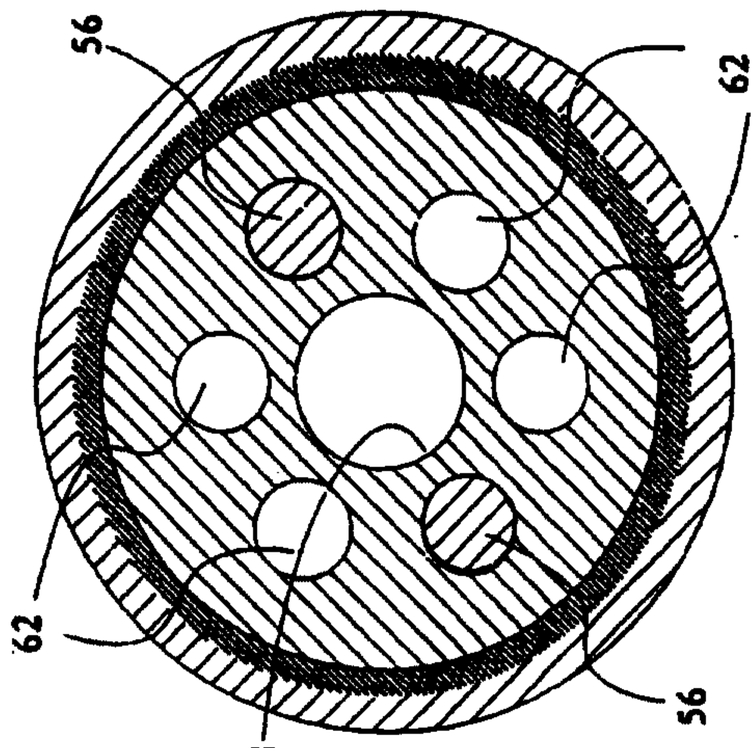


Fig. 11

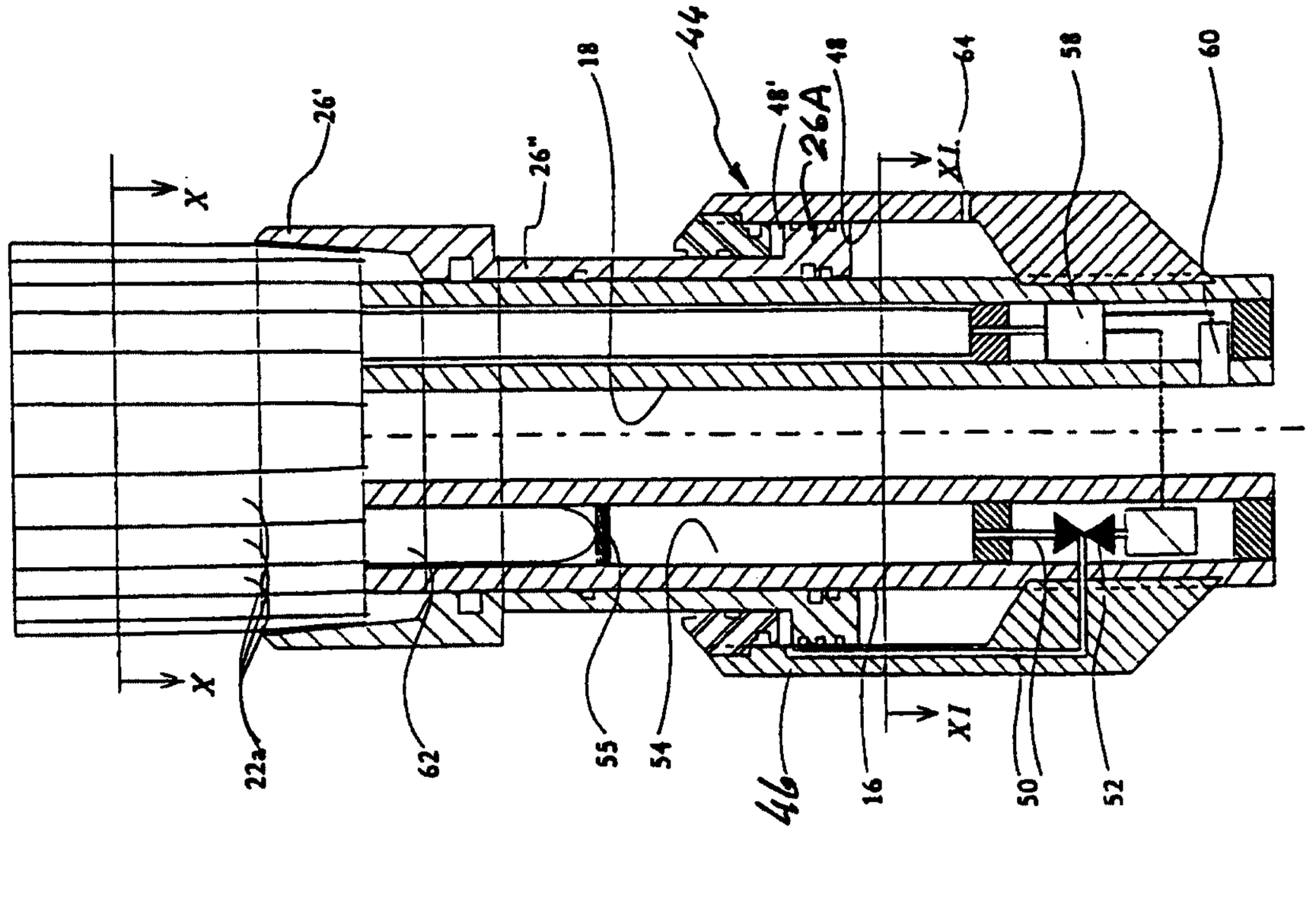


Fig. 9

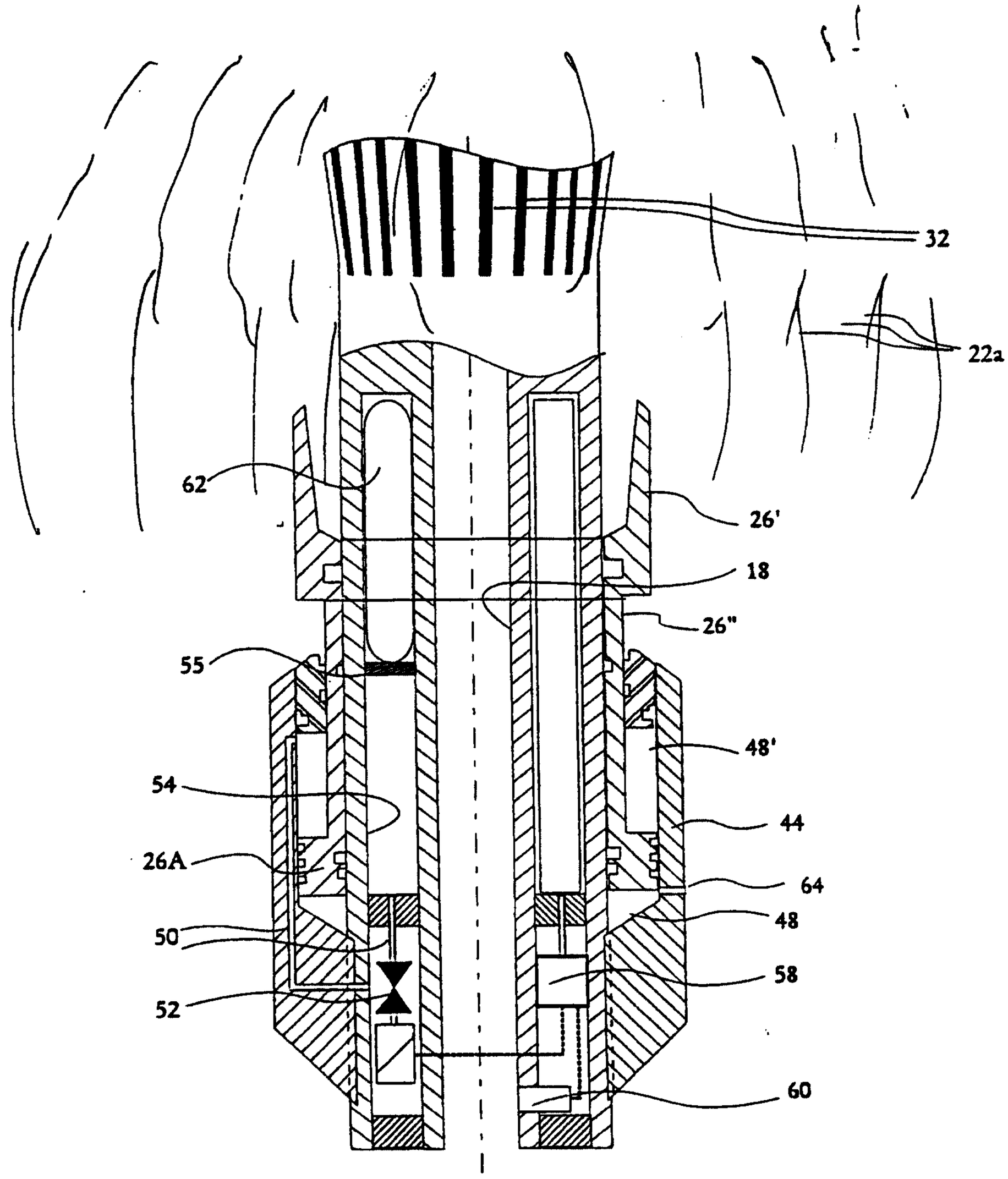


Fig. 12

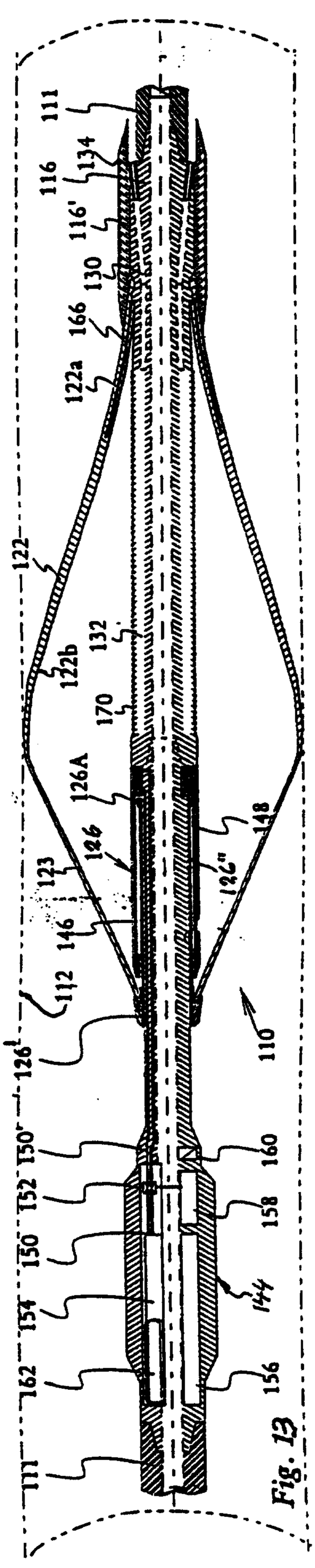


Fig. 13

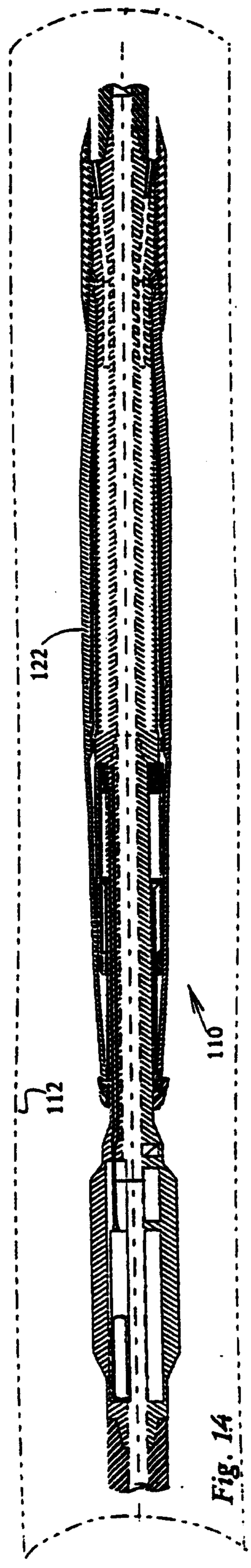


Fig. 14

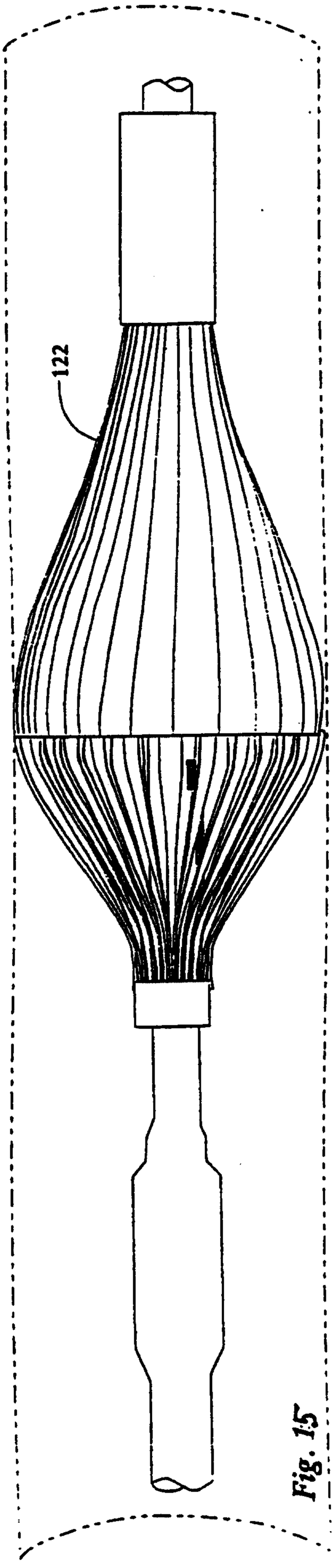


Fig. 15

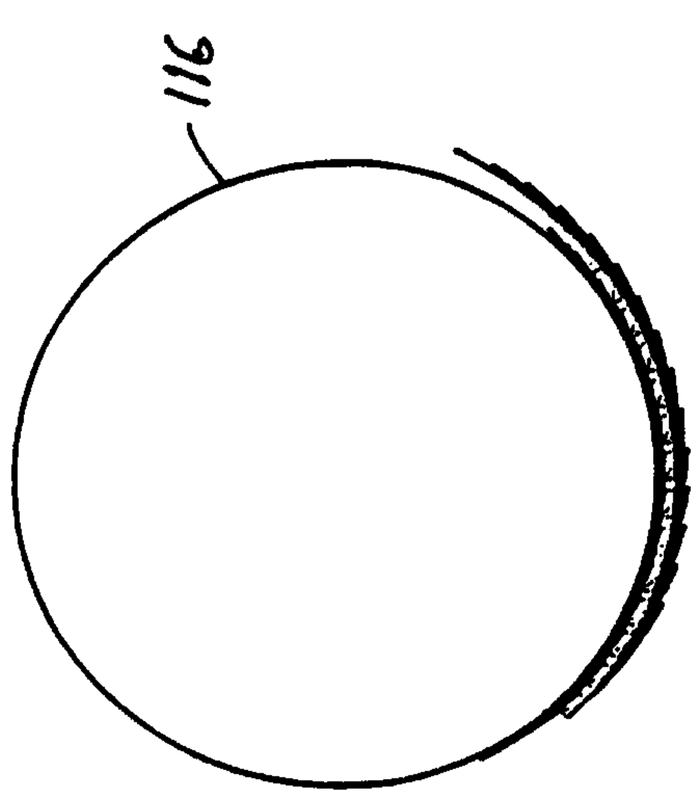


Fig. 16

Fig. 17

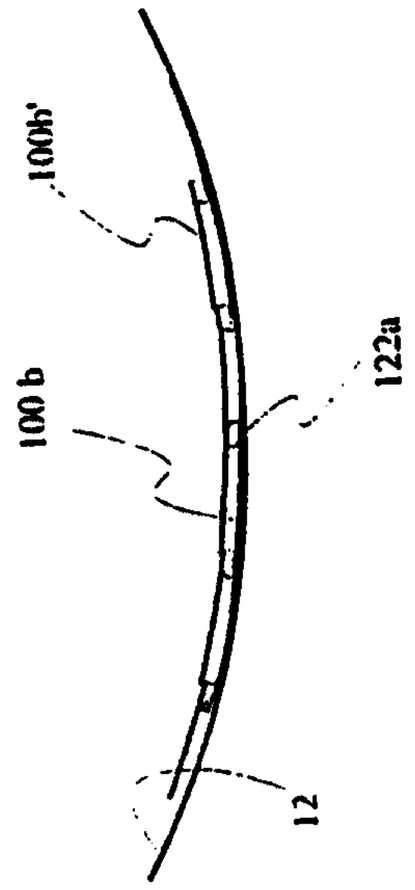


Fig. 18