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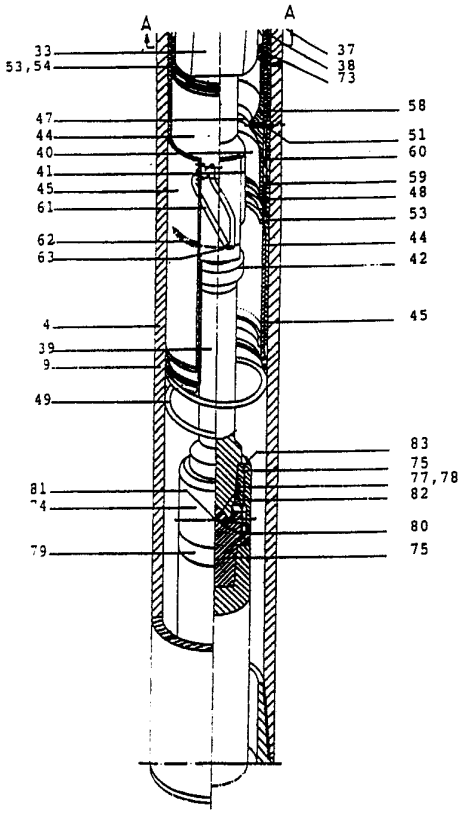
(57) Abstract

Apparatus for directing and steering the foremost part of a drillstring at earth drillings, which apparatus is provided with a piston (43) contained in a housing, and which piston under steering of the mass flow of the drilling fluid is displaceable between two or more end positions, and wherein the piston is coupled to at least one set member, which cooperates with means for steering the end of the drillstring.



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DEVICE FOR STEERING THE FOREMOST PART OF A DRILL PIPE

The invention relates to an apparatus to direct and steer the foremost part of a drillstring by earth drillings.

Such an apparatus is known.

When by an embodiment of the known apparatus, one has to drill further according to a side branch starting from a vertical bore, the drillstring is retrieved from the borehole, and a wedge shaped guiding piece is let down into the borehole, and subsequently the drillstring again lowered in the borehole, and by which the wedge shaped guiding piece deviates the foremost part of the drillstring side wards, so that then is drilled in more horizontal direction, to form the required side track.

With an other embodiment of the known apparatus for the forming of a side branch starting from the vertical bore, at the bottom end of the drillstring a bend piece is incorporated, which then carries the bit and a drilling motor. To form the side branch, the bit then is driven by the drilling motor and by non rotating drillstring, and consequently is drilled ahead sidewards to form the required side track.

With again an other embodiment of the known apparatus, for yielding of a sideward deviation starting from the vertical borehole one or more stabilizers are applied, and by which again the foremost part of the drillstring can be deviated.

By all these embodiments of the known apparatus, it is every time again required, for the incorporation of the wedge shape quiding piece, or of the bend piece at the bottom and of the drill string, or of the stabilizers, to retrieve the whole drillstring from the borehole, to subsequently lower down the tapered shaped guiding piece in the bore hole, or to incorporate the bend piece, or the stabilizers at, or nearby the bottom end of the drillstring.

This again and again retrieving of the drillstring out of the borehole, to take the necessary arrangements, for further sidewards drilling starting from the vertical borehole, is very time consuming and costly.

The invention intends to take away these disadvantages of the known apparatus or apparatuses.

The apparatus, according to the invention, is characterized for that purpose, by an in a housing incorporated piston, which is displacable under steering of the mass flow of the drilling fluid through the drillstring between two or more positions, and whereby the piston is connected with at least one adjusting organ, which co-operates with devices for directing and guiding of the end of the drillstring.

By the steering of the piston with the massflow of the drilling fluid through the drillstring , the guiding devices at the end of the drillstring can be steered from the earth surface, and conforming apparatus according to the invention it is not anymore required, for drilling of the side branch starting form the vertical first bore, to retrieve the total drillstring again and again from the borehole. The housing in which the piston is incorporated can, in an adequate way, be part of the drillstring.

By an embodiment of the apparatus in accordance, with the invention, the devices for the directing and guiding of the bottom end of the drillstring are made-up by one or more stabilizer blades. These stabilizer blades then can be steered by the piston by means of the mass flow of the drilling fluid.

By an other embodiment of the apparatus, in accordance with the invention, the devices are made-up by two, hinged interconnecting housing parts, whereby the piston is incorporated in one housing part and the adjusting organ connected to the piston is co-operating with an adjusting organ, solidly connected to the other housing part, such that, by displacing of one adjusting organ with respect to the other adjusting organ, the position of the housing parts with respect to the other is changed.
In a favorable way in one of the housing parts the bearing of the bit and in the other housing part a drive motor for the bit thereby can be accommodated.

By again an other embodiment of the invented apparatus,

the devices are made-up by at least one bearing of a bit, and which bearing is displacable transverse to the housing under steering of the adjusting organ, and the there to connected piston, such that, by the displacement of the bearing out of the centerline of the housing, the shaft of the bit is directed under an angle with the center line. In a favorable way by an embodiment, the piston is displacable against spring force in the housing part from a repose position to an adjusted position.

By a further embodiment of the invented apparatus, the devices are made-up by two in and out telescoping housing parts. In favorable way there by, at least one of the housing parts can be provided with one or more from the housing part expandable jam organs, by means of which the housing part can be fixed in the borehole.
By this execution form, the foremost part of the drillstring can be moved forward in the borehole with a caterpillar movement under steering of the mass flow of the drilling fluid.

Further characteristics and special features of the invention will appear from the here after following description on basis of the drawing of some embodiment examples.

Fig. 1 gives a schematic picture of an embodiment of a drilling motor, as being connected to the end of the drillstring (1). At the drill string side a stabilizer (2) is accommodated in front of the downhole motor. The downhole motor itself can be divided in; the housing in which the drive motor (3) is situated, the drive housing

with a fixed bend (4), between which the interconnecting shaft is situated, which interconnects the shaft of the drive motor with the shaft of the bearing housing (5). At the end of the bearing housing the bit is located (6). In the schematic example a stabilizer (7) is also incorporated at the bearing housing.

Fig. 2 shows a partly exploded perspectively longitudinal view of the drive housing (4), in which the components of the adjusting system, and the other the components of the drive housing are given, partly in view, and partly in longitudinal section.

The drive housing (4) is divided in two parts namely: the upper part (8) and the lower part (9), which are hinging interconnected. In this embodiment of the invention the connection consists of a connecting- and hinging coupling, where by the housing part (8) is provided with a inserting part (10), which penetrates trough the hinge joint into the housing part (9).

The axial pressure forces are transferred from the upper housing part (8) to the lower housing part (9) by a ring with a spherically shaped surface (11), which is arranged to the housing part (8), and a ring- and bowl shaped surface (12), which is provided to the lower housing part (9).

The axial pulling forces are transferred from the lower housing part (9) by a ring and spherically shaped surface (13), and are supported against an in the lower housing part (9) installed ring shaped shoulder (14) and ring

with bowl shaped surface (15) which is accommodated tightly on the inserting part (10). The ring (15) leans against a locking ring (16), which leans against a ring shaped shoulder (17) provided on the inserting part (10). If necessary the rings (13,15 and 16) can be locked against rotation, and for assembly reasons divided in two parts, while the ringparts of (15) and (16) are gripping in each other by locking edges (18) and are bolted together, by which the dividing surfaces of the rings (15 and 16) are rotated 90°, with respect to each other, around the axial centerline of the inserting part (10), which is not indicated on the drawing.

The lower housing part (9) is arranged at the upper end with a ring-and spherically shaped surface (19), which leans against a ring with bowl surface (20), located on a cylindrical sealing ring (21), which is arranged around a contracted part (22) of the upper housing part (8).

The spherical- and bowl shaped surfaces (11, 12, 13, 15, 19, and 20) all have a common spherical rotation center (23) and are provided with grooves (24, 25 and 26), in which sealing rings are located, such that drilling grit of the drilling fluid can not penetrate in the hinge joint.

In the grooves at the fluid side (6) scraper seals can also be installed, to protect the sealing rings and the against each other leaning surfaces against the penetration of drilling grit.

In the inserting part (10) channels (27) are provided,

which are in connection with the drilling fluid, and the interior of the hinge joint, which at the inner side are plugged off by a lost sealing nut (28), provided with an opening. In the channels slidable plugs are installed, which take care of equalizing of differential pressure between the interior of the hinge joint and the drilling fluid in the drive housing part (9).

The number of channels is adapted to their dimensioning, so that these contain a sufficient amount of lubricant, for compensation of lubricant losses, and for compensation of compression of unexpectedly retained air bubbles during the assembly.
The hinge joint is provided with a greasing nipple and lockable de-aerating opening, not shown in the drawing.

At the inner side of a cylindrical ring (21) a ring shaped saving (29) is provided, in which in axial direction, with respect of the centerline of the upper housing part (8), a movable ring (30) is located. The saving is in connection via narrow channels with the outside of the housing part (8), and the space (31) between the cylindrical ring (21) and the hollow- and bowl shaped hinging surfaces (11 and 12), to compensate for pressure differential across the seal. The saving (29) is dimensioned such, that this contains sufficient spare lubricant, for compensation of lubricant leak losses and for compensation of the compression of air bubbles, which unexpectedly are present after assembly: The ring is provided with a lubrication nipple and a lockable de-aerating opening, which are not given on the drawing.

The inserting part (10) extends itself through the rings (13 and 16) in the lower housing part (9), as an inserting set organ (32). This inserting set organ (32) is provided with two parallel surfaces (33) at opposing sides at the outer circumference, see fig. 3, which are closely fitting against two parallel surfaces (34), provided to segments (35) at the inner side of the lower housing part (9). These segments can also be accommodated as fixed parts of the lower housing part (9).

In fig. 3 a cross section is given at the level of the end of the inserting setting organ (32), as well as a part of the longitudinal view of this part. The segment shaped parts (35) are provided in the shown embodiment as loose components, which in rotational direction are secured against rotation to the centerline of this housing part by circular wedges (36), which rest in half circular shaped grooves, arranged in the segments (35) and the inner side of the housing part (9), parallel to the center line of the lower housing part. The parallel surfaces (33) and (34) serve for the transfer of a heavy torque moment from one housing part to the other, while they take care of that both housing parts can only hinge in one plain with respect to each other.

Perpendicular to the parallel surfaces (33) and (34), see fig. 2, opposite to each other adjusting surfaces (37) are provided at the outer circumference of the inserting setting organ (32), which run under an angle with respect to the centerline of the setting organ (32).
Against these surfaces adjusting organs or rules (38) are resting, which are supported at the opposing sides on the

inner surface of the housing part (9), or inserted part of the cylinder (45). In cross section, see fig. 3, the adjusting surfaces (37) and the surfaces of the housing part (9) of cylinder (45), to which the adjusting organs support, are of segment-circular shaping.

By displacement of the adjusting organ (38), with respect to the inserting setting organ (32), the housing part (8) is displaced hinging around the center point of rotation (23) with respect to the other housing part (9).

In the, on fig. 2 given, embodiment, according to the invention, a solution is created by means of the divided accommodation of the transmitting zones for large axial pressure forces, axial pulling forces and torque moments from one housing part to the other, by which it is possible to convey a heavy connecting shaft through the hinging bend piece, while in addition a sufficiently large annular flow area (40) can be realized for the drilling fluid.

By application of a helicoil motor, according to the invention, the misaligned eccentrically wobbling rotation of the connecting shaft, with respect to the concerning housing part, can also be accommodated in case the adjustable bend piece is located in the drive housing or between two drive motor sections.

According to the, in fig. 2 shown, embodiment of the invention, in the lower housing part (9) an adjusting system according the invention is shown, which consists of the following main components which co-operates with

each other: - The connecting shaft (39) on which thickening (41 and 42) are located, - a thrust body in the shape of a piston (43) which envelopes the connecting shaft (39), - a cylindrical body (44), which envelopes the piston (43), and to which the adjusting organs (38) are connected, which co-operates with the inclining surfaces (37) on the inserting set organ (32), - a second cylindrical body (45) which envelopes the cylindrical body (44).

The piston (43) is provided with an annular flow opening, through which the connecting shaft (39) is passed and which allows for a sufficiently large flow channel (46) between the connecting shaft (39) and the enveloping piston (43). The inner surface of the piston is profiled, such that, a contraction (47) is present of the flow channel, which functions as a hydraulic resistance. The piston (43) is provided with a soft spring (48) working against the direction of flow, which is supported in the enclosing cylinder (44).

The enveloping cylinder (44) is provided with a strong spring (49) working against the direction of flow, which is supported in the lower part of the housing part (9). The second enveloping cylinder (45) is fixed, see fig. 3, in the housing part (9), and serves for ease of manufacturing and assembling, as well as for locking of the segments (35) in axial direction. Fixation in axial direction, see fig. 2, is realized in the shown arrangement, by the inserting of balls (53) in tangential grooves (54), in the inner circumference of the housing part (9) and the outer circumference of the enveloping

cylinder (45).

In the cylinder (45) a fixed pawl (58) is accommodated, which inserts into a groove (59), accommodated in the other cylinder (44), as well as a spring loaded pawl (60) which fits in the groove (56).

In fig. 4 can be seen, that according to the invention, in the piston (43) a number by spring (52) loaded ratchets (51) are installed, which can displace in the grooves (55 and 56) and over the herein between situated surface of the cylinder (44). The piston (43) is secured against rotation with respect to the cylinder (44) by a pin groove connection, which is not shown in the drawing.

To the cylinder (44) adjusting organs (38) are connected, which are leaning at the outside, against between the segments (35) installed inserting parts (60) of this cylinder, by which the cylinder (44) is secured in rotary direction, which can be seen in fig. 3. At the outer circumference of the cylinder (44) a number of closed loop grooves (61) are made with a deformed heart shaped patron. At the inner circumference of the cylinder (45) tangential grooves (62) are made.

The two cylinders (44 and 45) are interconnected with each other with the help of balls (63), of which one part is located in groove (61) and the other part in groove (62). The balls (63) are loaded by springs (64 and 65) at both sides, which are accommodated in the tangential grooves. The neutral load lines (66) are situated between the points a and d, as shown in fig. 4a.

In fig. 4 a schematic overview is given of different important positions of components of the adjusting system with respect to the housing part (9), and the cylinder (45). The functioning of the system will be explained with the help of positions, which demarcate different working phases.

First activation phase before adjusting

In starting position the system is in position 1. The piston (43) bears against the stop (67) of the cylinder (44). The ratchet (51) is situated in extended position at the beginning of the groove (54) in up flow direction, while the contraction (47) is situated in a position, at some distance from the first thickening (41) of the connecting shaft. The soft spring (48) is sized and dimensioned such, and assembled with pre-tension, that by a small change in mass flow with respect to the required maximum operating mass flow, the piston is going to displace in the direction of the flow, from position 1 to position 2.

Adjusting phase

In position 2 the ratchet (51) bears against the stop edge (68) in the groove (55), so that in the direction of the flow, the piston (43) is locked with respect to the piston (44). The restriction-opening of the piston is then situated at the level near the beginning of the first thickening (41) of the connecting shaft, so that as a consequence of the contraction of the flow channel, the thrust-force on the piston is increased. The piston and the cylinder are displacing as a consequence of this together in the direction of the flow to position 3,

against the working mechanism of the strong spring (49).

The ball (63) has been displacing hereby in the closed groove, from position a to position b. The adjusting organs (38) connected to the cylinder (44), are displacing by the thrust-force induced on the cylinder (44), with respect to the inserting set organ (32), see fig. 2, under intensification depending on the angle of the slope of the adjusting surfaces (37), from adjusting-force to setting-force, which is exercised perpendicular to the axial shaft of the housing part (9) on the setting organ (32). The housing part (8) and the housing part (9) are hinging thereby, with respect to each other, over the hereby belonging setting angle.

Locking phase

By the combined forwarding displacement of the piston (43) and the cylinder (44), the ratchet (51) is lifted in position 3 by the pawl (58) and the piston delocked from the cylinder. As on the cylinder the force of the strong backing spring (49) is working, but almost no hydraulic force, this is moving against the direction of the flow to position 4, whereby the ball (63) is displacing in the groove (61) from position b to position c, and the cylinder (44) is locked in flow up direction with respect to the housing (9) and the cylinder (45).

Locking position - signaling phase

At the moment of disconnecting of the piston (43) and the cylinder (44), a large hydraulic force and a small contracting force of the spring (48) is working due to the position of the contraction, with respect to the end

of the first thickening (41) on the shaft. As a consequence of this the piston will displace fast down flow to a balanced position 5, wherein the hydraulic force is in balance with the force of the spring (48). The ratchet (51) is let down, during this phase, in the groove (56). By the relative fast displacement of the contraction (47) from a position with small flow channel to a much larger flow channel, a good detectible negative pressure drop in the drilling fluid occurs.

Massflow - restoring phase

After detection of the negative pressure drop, the massflow of drilling fluid can be adjusted back to the original operating massflow. The piston (43) then diplaces to position b, until the ratchet arrives at the stop edge (69).

Second activation phase for delocking

For delocking of the adjusting mechanism the massflow is changed in a positive way with a relative small value, by which the thrust force on the piston (43) increases again, until this force is becoming larger than the force of the spring (48). The piston then moves to position 7, by which the ratchet arrives at the stop edge (70) of the groove (56).

Delocking phase

As the contraction (47) then is situated near the second thickening (42) of the connecting shaft, then, on the piston (43) again, a much higher thrust force is exercised, through which the piston (43) and the cylinder (44) are displacing together to position (8), whereby the

ball is displacing from position c to position d, and blocks the piston and the cylinder further in down flow direction. The mechanism is then in delocked position in flow up direction.

Restoring phase

By decreasing of the mass flow to zero or a lower value, the piston (43) and the cylinder (44) will displace in up flow direction, while the co-operating adjusting organs restore the position of both housing parts to the original position, under influence of the strong spring (49).

During this phase two cases may occur:

A. One, by which the backward movement of the piston (43) overrules that of the cylinder (44) and the piston is moving faster backward then the cylinder. In position 9 the ratchet is lifted and falls back in the groove (55).

B. One, by which the contrary is the case, the ratchet remains in groove (56) and the ratchet is only lifted in position (10), when the cylinder (44) is again in the starting position, and the spring loaded pawl (60) then only can be in the pushed out position 10. The ball (63) in this phase displaces from position d to position e and following back to position a.

In the, on the drawing shown embodiment of the invention, in fig. 4, also the sub figures 4a and 4b are given. In fig. 4a the movement of the ratchet (51) is given with respect to the grooves in the cylinder, in following order of the above phases. In fig. 4b the movement of the spring loaded pawl (60), with respect to the cylinder (44), is given in following order of the discussed

phases.

Groove (55) is smaller in width than groove (56), and groove (59) is smaller in width than groove (55). The spring loaded pawl (60), which has the width of groove (56), can only be in the starting positions of the piston (44) in the groove (56) in forced out position, by which the pawl can not influence the remaining operation of the adjusting system. Groove (55) and groove (56) may also have the same width. The spring loaded pawl or pawls fit or fits in different embodiments, at both ends in savings which are incorporated in the cylinder (44).

The inserting setting organ (32) and the adjusting organs (38) are provided, where they reach their set position, with end surfaces (72) and (73) of a certain length, which are parallel to each other. As shown in fig. 3, it can be seen, that the rules in cross section have a segmented circular surface, as to have a significant surface available, to solidly fix the set organs that means the housing parts (8) and (9), with respect to each other, in the set positions. As upon locking the adjusting organs move backward over a short distance, the end surfaces (73) on the set organ (32) are made elongated. The ratchet mechanism in the piston (43), with co-operating grooves and pawls, and the locking mechanism of grooves and the balls are situated, in cross sectional view, over an angle with respect to each other. The number of these mechanism can be one or more, depending on the execution.

In the in fig. 2 drawn embodiment of the invention, the

adjustable bent piece is accommodated in the housing parts (8) and (9), and as a matter of fact, at the motor side. This has the consequence, that in case the drive motor is existing of a helicoil motor, one has not only have to take care off the misalignment and the centrical rotating connecting shaft, but also with the wobbling movement, which the rotor makes during rotation. In case the adjustable piece is accommodated between two segments of the drive motor housing, the connecting shaft also rotates wobbling and eccentric.

As in the adjustable bent piece, in comparison with fixed bent pieces, components are accommodated, which further limit the rotating space of the connecting shaft, the presently commonly used flexible couplings of the tulip type can not be applied for this invention, as they have play and are strongly subjected to wear, by which these as consequence of hitting of the shaft against the internal components of the housing part can be destroyed soon, and one of the idea's which the invention aims to improve can not be satisfied.
The invention aims further to solve also this problem effectively, by application of a total new type of flexible coupling (74). In fig. 2 these are shown. They consist of a part with outer teeth (75) and a part with inner teeth (76).

A pivot surface (77) in part (75), which in the shown embodiment, is part of the shaft which is connected here to with a screwed connection, and a pivot surface (78) in part (76) are bearing against each other, for the transfer of the high axial trust force, which the rotor

imposes on the connecting shaft in case a helicoil motor is applied. To seal against drilling grit, between the two parts (75) and (76) at the outer side a ring, which is attached to part (75) and a ring (80) around a contracted part of part (76) are accommodated, which are provided with grooves with elastic distorsionable sealing rings and or scraper springs. The against each other bearing surfaces of the teethes, pivot surfaces and the surfaces of the rings which are bearing against each other are made such, that they all have the same spherical center point of rotation. In part (75) channels (82) are provided, which contain movable plugs, which are connected with the drilling fluid side and with the internal space of the coupling. At the fluid side the opening is provided with a saved closing nut (83) with interconnecting opening.

In the figure is not indicated a lubrication nipple, as well as a closable de-aerating opening. The channels with the movable plugs serve for: compensation of differential pressure over the sealing rings, compensation for compression of air bubbles, in the case these are unexpectedly present after filling during assembling, and for compensation off leakage.

In fig. 5 an other embodiment, according to the invention, is shown, by which the angle of the bend piece can be set in two steps.

For this the surfaces (37), see also fig. 2, on the inserting part (32) of the housing part (8) are made in two steps (85, 86), against which the adjusting organ (38) are bearing. Aside of the pawls (58) and (60), and

the ratchets (51), as given in fig. 2 and fig. 5, additional fixed pawls (88) and spring loaded pawls (87) are installed. The spring loaded pawl (87) can only be in pushed out position, when the interconnecting ball (63) is located in 9 and the adjusting organs in the second set position 14.

On the outside of the cylinder (44), as given in fig. 2, the grooves (61) are extended with such like grooves (89), see fig. 5, and the tangential grooves (62) at the inner side of the second surrounding cylinder (45) are maintained, between which interconnecting balls are situated, at both groove sides spring loaded in the tangential.

With this adjusting system, depending on the wish, one can shift over the first step as given before the embodiment of fig. 2, described in fig. 4, or in analogy of this shifted on to the second step, so that the hinging angle of the both housing parts (8 and 9) of fig. 2 can be adjusted in two steps.

In fig. 5 only 3 main positions are given, namely: the situation, position, which equals with position 1 of fig. 5, the situation, position 6, which equals the set situation, position 7, of fig. 5, the situation, position 14, by which the adjusting system has adjusted both housing parts (8) and (9) over the second angle and the operating condition is restored.
The way of operation will be explained for the second step, by which adjustment over the first step has been carried out as described for fig. 5 till position 6.

Activation phase for adjustment of the second stroke

The operating mass flow is increased by a relatively small value, such that the thrust pressure on the piston (43) becomes larger than the reacting force of the soft spring (48). The piston (43) displaces as a consequence down flow with respect to the cylinder (44), such that the inserted ratchet (51) arrives at the stop edge (70) of the groove (56), in accordance to position 7 of fig. 4.

Adjusting phase for the second stroke

As at the end of the foregoing phase, position 7, the piston (43) is locked down flow with respect to the cylinder (44), by the ratchet (51) and the contraction (47) then is situated near the beginning of the second thickening (42) on the shaft, the thrust pressure on the piston (44) is increased and the piston (43) and cylinder (44) move together down flow till position 11. The interconnecting ball (63) displace hereby from c to f.

The adjusting organs (38), connected to the cylinder (44), hereby are displacing with respect to the second inclined surface (85), on the set organ (32) under intensification from adjusting force, to set force. Both housing parts (8) and (9) are hinging hereby over the second adjusting angle.

Locking phase second stroke

By the combined forward displacement of the piston (43) and the cylinder (44), the ratchet (51) is lifted out of the groove (56) by pawl (87) and the piston is delocked from the cylinder, position 11. By the strong backing

spring (49) the cylinder moves backwards to position (12) (not shown in the figure), whereby the inter connecting ball displaces from f to g, and the cylinder (44) is being locked in flow-up direction with respect to the second cylinder (44) and housing part (9).

Locking position signaling phase second stroke

At the moment of delocking of the piston (43) with respect to the cylinder (44), position 11, a large thrust pressure is still exercised on the piston, as the contraction is situated at the end of the second thickening (42) on the shaft. The piston displaces fast flow down to position 13 to an equilibrium position between thrust pressure and counter pressure of the spring (48) or limiting position 13, by which a fast negative pressure drop occurs in the drilling fluid.

Mass flow restore phase after second stroke

After detection of the negative pressure dip the mass flow is considerably reduced, through which the piston displaces flow up with respect to the cylinder (44). The ratchet (51) falls back in the groove (56) and is lifted in position 14 by the strip loaded pawl (87), which then can only be in pushed out position, if the inter-connecting ball (63) is located in position g. The piston then moves flow up, by which the ratchet (51) falls back in groove (55) and arrives at the stop (50) in position 14, and blocks further displacement of the piston. The massflow then is set to the original operating massflow.

Activation phase for the second delocking

The mass flow is increased with a relative small amount

with respect to the operating massflow. The piston (43) moves until the extended ratchet (51) in the groove (55) arrives at the stop (68). The contraction (47) then is located in position (16) near the level of the beginning of the second thickening.

Delocking phase of the second stroke

As the contraction (47) is situated at the level of the beginning of the second thickening (42), the thrust pressure is increased, and the piston (43) and the cylinder (44) displace together flow down, until the inter connecting ball (63) has moved from position g to h. The adjusting mechanism then is in delocked condition, position 17, and the inter connecting ball in h.

Restore phase after second stroke

By a considerable decrement of the mass flow the piston (43) and cylinder (44) move together to the starting situation, position 1, under influence of the adjusting force of the spring (48). In fig. 6 a simplified embodiment of the invention is given. This characterizes one groove (89) with a ratchet lifting edge (43) and no pawls. In the starting position the piston (43) is accommodated one stroke further up flow then as given by the embodiment in fig. 2.

At the outside of the cylinder (44) and the second cylinder (45), or on the inside of the housing part (9), two similar grooves are incorporated, with a two side spring loaded inter connecting ball, as in fig. 2.

By activation the contraction (47) of the piston (43)

displaces first till the stop edge (91), after which the piston (43), as well as the cylinder (44), displace further down flow, until the interconnecting ball (63) is arrived in b, by which further displacement is limited.

By decreasing of the mass flow the cylinder moves backwards till the ball (63) is arrived in c, and the piston (43) is moving further backwards, till the stop edge is reached, prior to lifting of the ratchet (51) by the edge (90). The adjusting organ then is situated in the dotted position 2. The path of movement of the ratchet is given in fig. 6.

For the delocking, the piston (43) is activated again; this displaces flow down till the ratchet (51), after first having been let down in the groove (89), arrives at the stop edge (91), after which the piston (43) as well as the cylinder (44) move together down flow, until the ball (63) is arrived in d, see fig. 4. By decreasing of the mass flow the piston (43) and cylinder (44) move up flow. The cylinder (44) moves hereby, until the ball (63) reaches e and the piston (43) moves further backwards till the stop edge (67) prior to lifting of the ratchet (51) by the inclined edge (90). The path of movement of the ratchet is shown in fig. 6.

In fig. 7 a further embodiment of the invention is given. Hereby in the piston (43) a ball or barrel shaped ratchet (92) is accommodated in a saving (98) in the piston (43), in stead of a spring loaded ratchet, which in the starting position is situated at the up-stream side (93) of a groove (94) in the cylinder (44), while downstream

of this in the second cylinder (45) or in the housing part a saving (95) is situated. In contradiction to the previous embodiment, on the outer circumference of the piston (43) a closed groove (96) is located, in analogy previous embodiment, and in the inner side of the cylinder (44) an interconnecting ball or pin (63) is situated, which partly also inserts in groove (96), however not indicated in the figure. The groove (96) can also be executed zigzagging over the total circumference with at the level of the locking position the in-and out hook shape.

By the activation of the piston (43) this displaces down stream, until the ratchet (92) arrives at the stop edge (97) of the groove (94), whereafter the piston (43) and the cylinder (44) move together downstream, whereby the housing parts (8) and (9) are hinging, with respect to each other. When the ratchet (92) reaches the saving (95), the ratchet (92) then moves in this saving (95), whereby the cylinder (44) is locked with respect the cylinder (45) and or the housing part (9).

As the contraction (47) is still situated at the level of the end of thickening (41), this will move under influence of the trust pressure, in first instant fast, and afterward slower to it's end position. The ball (63) then has displaced from a to b in the groove. By decreasing of the mass flow to the operating mass flow the piston (43) moves upstream until the ball (63) is situated in c and the piston (43) then is locked with respect to the cylinder (44) in this position, as well as the position of both housing parts (8 and 9) with respect

to each other.

For the restoring of the position of both housing parts (8 and 9), with respect to each other, the piston (43) is activated again, by which this displaces down stream until the ball (63) is situated in d. After decreasing of the mass flow the piston (43) moves up stream. At the moment that the saving (98) in the piston is situated above the saving (95) in the cylinder (44), the ratchet (92) displaces out of the saving (95) into the saving (98), by which the cylinder (44) is unlocked and the piston (43), as well as the cylinder (44), move backwards to the starting position under influence of the spring forces and both housing parts (8 and 9) are adjusted, with respect to each other, to the starting position.

By the up and down movement the piston (43) rotates up and down around the axial centerline depending upon the width of the patron of the groove (96). By the end positions a, b, c and d the groove (96) is executed with short extendings, such that by the backward movement the piston is forced to rotate a little, so that the ball (63), as consequence of the friction working against the direction of rotation, is forced to take the right way.

Concerning the various embodiments, depending on the wish and situation of the adjustable bent piece, the adjusting system can also be located up stream, with respect to the adjustable bent piece. The location of the components of the adjusting system, with respect to each other, then is adapted accordingly, and the axial pressing springs can be substituted by two or more pulling springs. The

embodiment, by which one adjusting system is co-operating with two bent pieces, can also be of advantage.

In case an adjustable bent piece with adjusting system is situated above the drive motor, the motor shaft can be elongated at the top side or a fixed shaft can be applied in this part.

In a further embodiment conforming the invention in the adjusting system a pressure sensor, a decoding unit, a current source, as well as a circuit which can energize a locking mechanism are incorporated. Herewith the activation system can be blocked, so that this can not go into action if not wished. The advantage of this is, that the activation system is not anymore dependable for its action of a value above the operating mass flow, and no margin have to be reserved herefor. A further advantage of this embodiment is, that in case more then one adjustable bend pieces are, provided, the adjusting systems of each bend piece can be activated independently from each other. The current sources for example can be incorporated in the thickening of the pistons, at the contraction, or in axial thickened shoulders in the piston.

Fig. 8 and 9 give an illustration of an embodiment as an example of a partly exploded perspectively longitudinal view and a cross section view, of a stabilizer, which is incorporated in a drill string, in which the components of the set and adjusting system, and other components of this stabilizer can be seen partly in longitudinal section and in view.

The stabilizer housing (100) is provided with radial in two positions adjustable stabilizer blades (101) to which set organs (102) are connected, which leans against an adjusting organ (103) (38) (44) which in axial direction is provided with stepped wise executed adjusting surfaces (104). Adjustability in more positions can be easily realized. By displacement of the adjusting organ (103) (44) in the direction of the stream, the set organs (102) and the stabilizer blades (101) are displaced radially to the outside, by the inclined part of the adjusting surfaces (104), against the force of the spring (105), until they are situated in the second set position. By displacement of the adjusting organ in up stream direction, the stabilizer blades (101) and set organs (102) move back under influence of the spring (105) to the original first set position. Displacement limiting plates (107) and the stop edges (108) prevent that the blades can get out of the housing.

In the example it can be seen that the adjusting organ is incorporated in an elongated housing part (109). The shaft (110) (39) with thickening is loosely incorporated from the stabilizer housing, and is supported by rings provided with arms (111), radially in the second surrounding cylinder of, and radially axial gliding in the adjusting organ (103) (44). The downstream supporting ring (111) is axially supported in the elongated housing part (115). The strong spring (106) (49) is locked between a locking edge (113) of the cylinder (103) (44) and the arms of the upstream located supporting ring (111).

Embodiments, by which the stabilizer blades extend asymmetrically can be realized on a simple way, by adapting the adjusting surfaces (104) to this, while stabilizer blades also can be incorporated at one side.

Stabilizers with at one side executed stabilizer blades can also be applied to steer the bit by force, for example in hard geological formations, by-passing of a fish, or to drill short radius boreholes. Here by the apparatus is accommodated between the bend and the bit, and serves as push off pad (shoe), and the adjusting system can, if desired, be integrated in the adjusting of the adjustable bent housing.

In fig. 10, as example, schematically an alternative embodiment of a stabilizer blade, push off pad, and its housing and the remaining components can be seen.
The push off pad hinges hereby around a downstream located pawl (117). A tumbler (118) hinges the push off pad to the outside by means of a tumbler (119), when this rotates clock wise. By counter rotation the push off pad hinges back under influence of the spring (119) in its housing (120). The rotation of the tumbler is effectuated by the adjusting organ (121) (44), on which at the outside a groove is located with a therein fixed shoulder or pawl (122). By the downflow displacement of the adjusting organ the pawls (112) engages in a saving (123) of the tumbler (118) and the tumbler is rotated. By the upstream movement of the adjusting organ a reverse rotation takes place through the mechanism.

In fig. 11 schematically a half longitudinal section can

be seen of an embodiment with two in and out telescoping housing parts conforming the invention, with two set lengths.

As illustration hereby is started from the principal of an adjusting system as can be seen in fig.6, under the understanding that spring loaded pawls (126) are incorporated to lift the ratchet (127) nearby the elongated position, while the locking mechanism between both pipe parts is not shown. In the adjusting system no strong spring (44) is incorporated as the inward telescoping of the string parts can take place, simply by putting the bit on bottom and the application of some pressure.

In fig. 12 schematically a half longitudinal section can be seen of an embodiment in which a wedge (128) and a wedge groove (129) can be seen to transfer the torque moment from one to the other main string part. In figures 11 and 12 can be seen, that the shaft with thickening is supported in the string parts, by rings provided with arms (130), which support the shaft radially in the string parts, by which the down stream one is made gliding in the string part (124), and the upstream one is axially retained with respect to string part (125), by means of two spring mounted retaining rings (126) and (127).

In fig. 13 schematically as example, a half longitudinal section can be seen of an embodiment of a jam (131) (claw), its own housing, and remaining components. In case the adjusting organ (124), from fig. 11 and 12, string part (124), moves with respect to string part

(125) stream wards, the adjusting organ (133) is displaced inward against the stepped wise executed adjusting surface (134) and the claw (131) hinges out off its housing (135) under influence of the force of the spring (136). By the inward telescoping of both string parts the displacements takes place in reverse direction.

The telescopic embodiment can be applied for the following applications:

The elongation of the drill string between the bit and the at a certain distance stream up located stabilizer, for changing of this length to tune steering of the direction of drilling, by which the system is provided with a locking mechanism with one or more positions.

The increase of the bit pressure, nearby the end of the drill string, by very long bore holes and lateral drilling, by which depending on the still available push-off pressure against the drillstring, a claw mechanism can be applied, which can secure the up flow part steps wise to the wall off the borehole under steering of the mass flow.

Providing of an apparatus, where by the drillstring can move forwards independently. Hereby a strong spring is incorporated in the apparatus and to each string part a claw system, such that the drilling system moves forward independently, under steering of the mass flow.

Claims:

1 Apparatus for directing and steering of the foremost part of a drillstring by earth drillings, characterized by; a piston enclosed by a housing, which piston under steering of the mass flow of the drilling fluid is displacable between two or more end positions, and wherein the piston is connected with at least one set organ, which co-operates with a device for the steering or the end of the drill string.

2 Apparatus as claimed in claim 1, characterized, in that the device is formed by one or more stabilizer blades.

3 Apparatus as claimed in claim 1, characterized, in that the device is formed by two housing parts, hinged to each other, wherein the piston is enclosed by the one housing part, and the set organ connected to the piston co-operates with a set organ fixed to the other housing part, such that, by the displacement of the one set organ with respect to the other co-operating set organ, the position of both housing parts with respect to each other is changed.

4 Apparatus as claimed in claim 3, characterized, in that the one housing part encloses the bearing of the bit and the other housing part encloses a drive motor, and the shaft starting from the drive motor is passing through a central opening in the hinge joint to the bearing of the bit.

5 Apparatus as claimed in claim 1, characterized; in that

the devices are made up by at least one bearing of the bit, and which bearing is displacable transverse to the housing under steering of the set organ, such that, by the displacement out of the center line of the housing of the bearing, the shaft of the bit is directed under an angle with the center line.

6 Apparatus as claimed in claim 1, characterized, in that the piston is displacable against spring force in the housing part from a rest position to an adjusted position.

7 Apparatus as claimed in claim 3 or 4, characterized, in that the piston is provided with a central opening for passing of the drilling fluid and the shaft of the motor, of the bit, or motor rotor.

8 Apparatus as claimed in one of the preceeding claims, characterized, in that the piston is build up by a sleeve, which is displacable between two end positions in a housing part provided with a spring, which at the one side bears against the sleeve, and at the other side against the housing part, while within this sleeve a piston part guided by the sleeve is slidable up and down, and co-operates with a weaker spring, which at the one side bears against the sleeve and at the other side against the piston part, and in which the piston part is provided with an inwardly directed collar or vaulting, which co-operates with at least one local thickening arranged on the shaft, such that by the increasing of the mass flow of the drilling fluid above the operating value, the piston part with the collar is moved towards

the thickening, and there diminishes the flow opening of the drilling fluid, by which the thrust pressure on the piston is increased, and after abutting of the piston part with the limitation of the path of movement of the piston part within the sleeve, the whole of the piston part and sleeve are moved forward in the housing part against spring force to the adjusting position, for the displacement of the adjusting organ connected with the sleeve.

9 Apparatus as claimed in claim 8, characterized; in that the piston part is provided with a ratchet, which can insert into a first groove present in the sleeve, and being provided with end stops, which limit the path of movement of the piston part with respect to the sleeve.

10 Apparatus as claimed in claim 8, characterized in; that the piston part is provided with a ratchet, which can insert into a groove present in the sleeve with at the one side, as seen in the direction of the flow of the drilling fluid, an end stop and at the other side an inclined end part, over which the ratchet can be lifted.

11 Apparatus as claimed in claim 9, characterized; in that, as seen in the direction of the flow of the drilling fluid, the groove is connected via an intermediale or contracted part to a further second groove, while the ratchet may be moved backwards out of the first groove against a spring force, under the action of a pawl accommodated in the housing part, and by means of which the ratchet by passing of the intermediate or contracted part can be lifted out off the first groove,

and afterwards can fall into the second groove.

12 Apparatus as claimed in claim 10, characterized; in that, as seen in the direction of the flow of the drilling fluid, in front of the first pawl a second pawl is accommodated, which under spring force can be moved from one housing part till into the path of movement of the sleeve, and which co-operates with the ratchet to move same backwards against spring force out of a groove in the sleeve.

13 Apparatus as claimed in claim 12, characterized; in that, as seen in the direction of the flow of the drilling fluid, behind the pair of pawls one or more identical and/or functional equivalent pairs of pawls are accommodated.

14 Apparatus as claimed in one of the preceeding claims; characterized; in that a locking mechanism is present, which is operated by the up and down movement of the piston, with at least two end positions, which correspond to the end positions of the piston.

15 Apparatus as claimed in claim 14, characterized; in that the locking mechanism is made-up of at least one pair bowl shaped channels, of which one channel is accommodated in the outer covering of the sleeve, and the other channel is accommodated in the surrounding surface of the housing part, or of a further there in fixed accommodated sleeve, wherein both channels surround an interconnecting element as a ball, which in one tangential channel is pressed by spring force to a middle

position, while the other channel has the shape of a closed loop, with at least one situation place for the ball, which corresponds with the rest position of the piston, and with at least on rest position for the ball, which corresponds with an adjusted position of the piston, and in which the ball by a forward movement and a following backward movement of the piston performed hook in and hook out movement can be brought in, respectively can be brought out.

16 Apparatus as claimed in claim 14, characterized, in that the closed loop nearby the adjusted position corresponding to a rest position of the ball has a zigzag shaped course.

17 Apparatus as claimed in one of the preceeding claims, characterized; in that the hinge joint of the both housing parts is carried out with spherical and bowl shaped sliding surfaces, while further these sliding surfaces are limited by segment shaped elements, whereby the connection can only hinge in one plane.

18 Apparatus as claimed in one of the preceeding claims, characterized, in that the shaft at both side is connected via flexible couplings to respectively the drive motor and the bit.

19 Apparatus as claimed in claim 17, characterized in, that the coupling is carried out with a part with internal teeth, and with a part with external teeth, wherein the teeth co-operate with each other, while the coupling further is carried out with bowl- and

spherical shaped pivot surfaces.

20 Apparatus as claimed in one of the preceeding claims; characterized; in that in one or more constructional parts of the apparatus, and over which pressure differences can appear, differential pressure compensating devices are present in the form of bottomless borings, in which plugs are movable up and down.

21 Apparatus as claimed in one of the preceeding claims, characterized; in that in the adjusting system a pressure pulls sensor, a decoding unit, a current source, and a circuit which can energize a locking mechanism, is incorporated.

22 Apparatus as claimed in one of the preceeding claims, characterized, in that the device are made-up of two, telescoping housing parts.

23 Apparatus as claimed in claim 22, characterized; in that at least one housing part is provided with one or more jamming organs, by means of which the housing part can be fixed in the borehole.

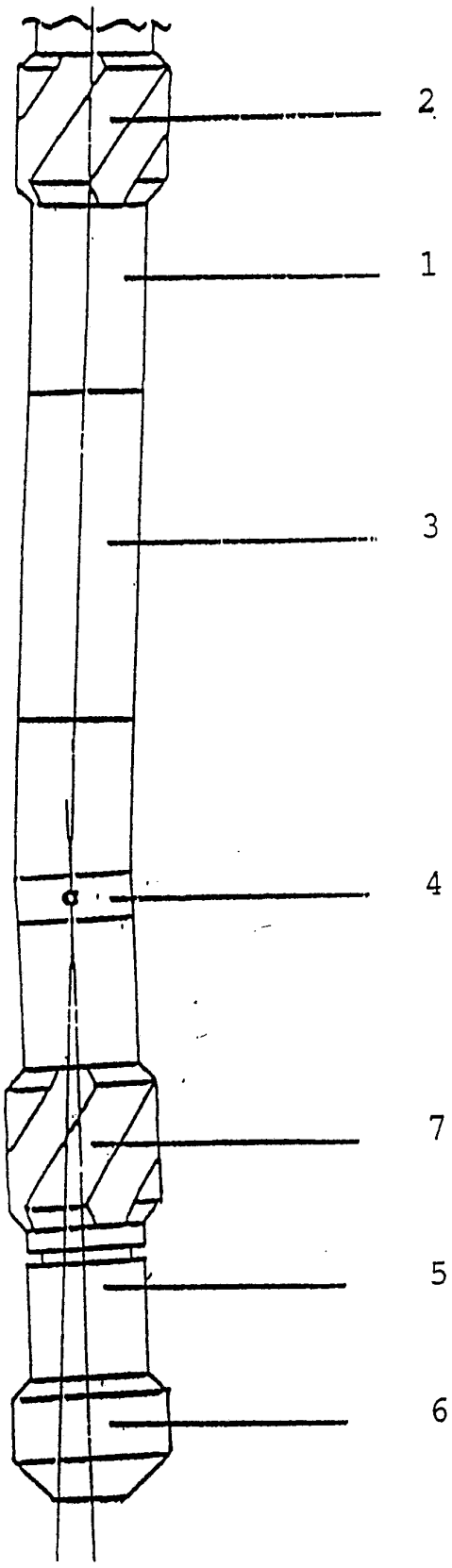

FIG.1

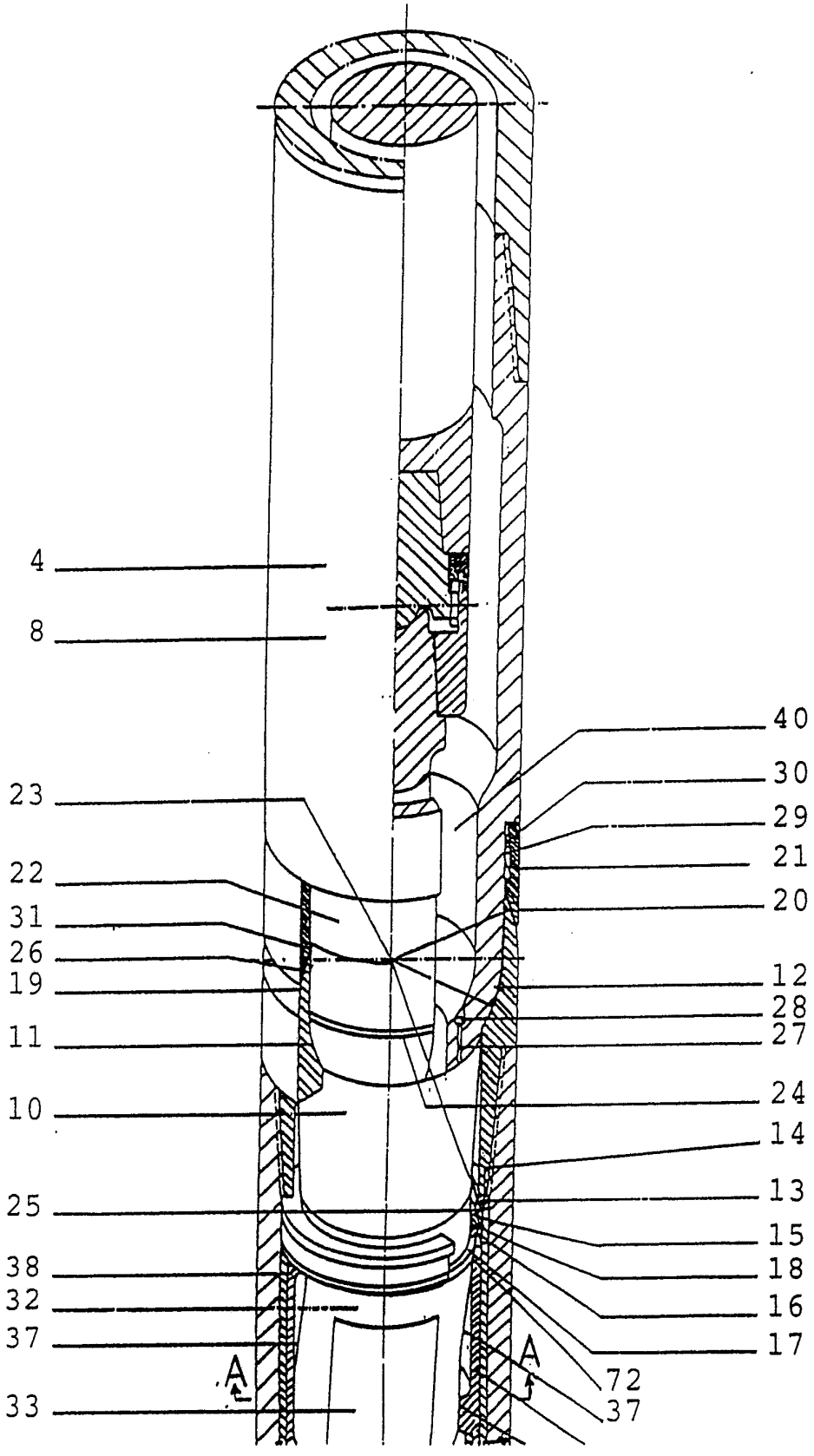
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FIG.2'

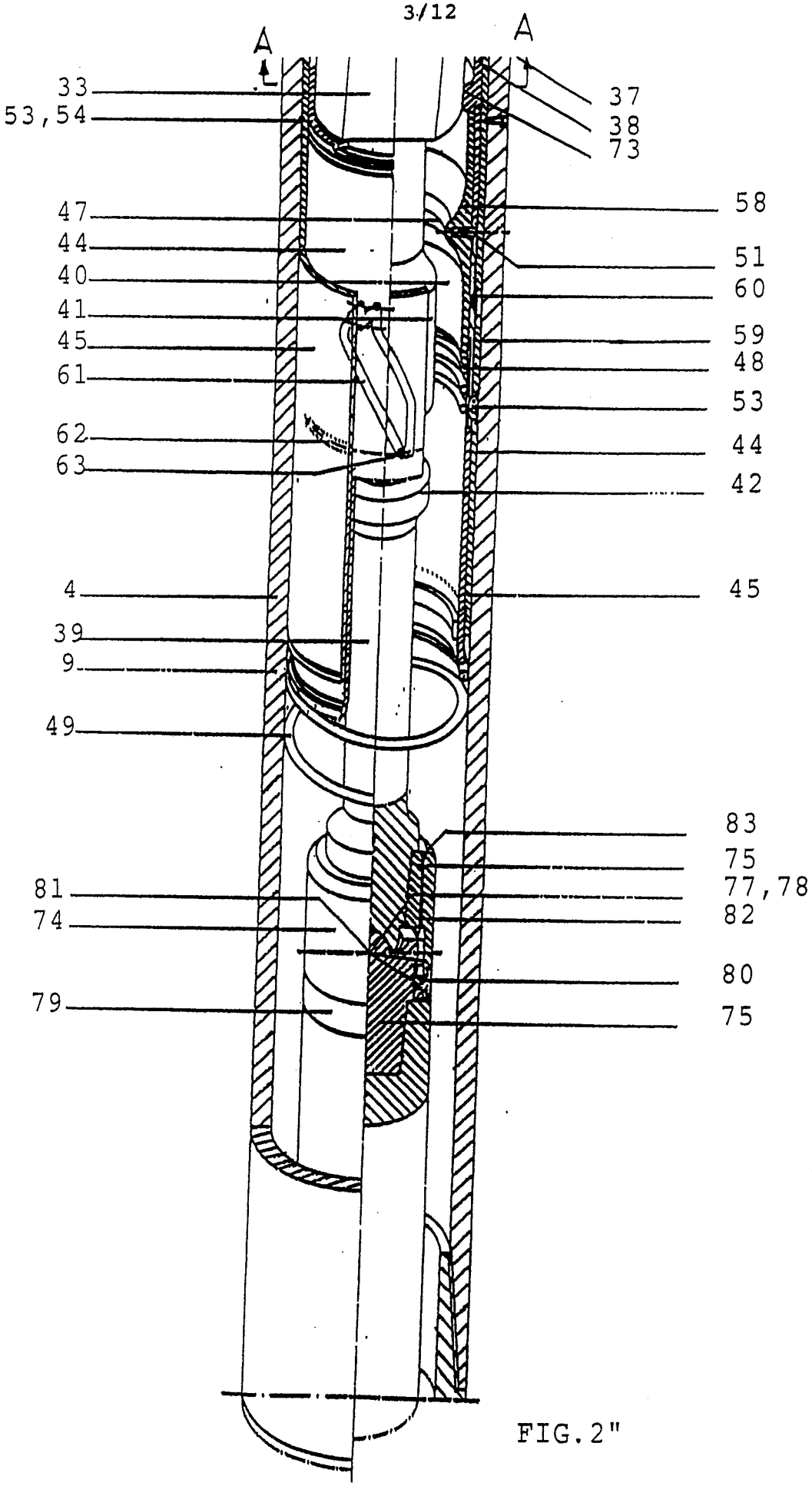
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FIG.2"

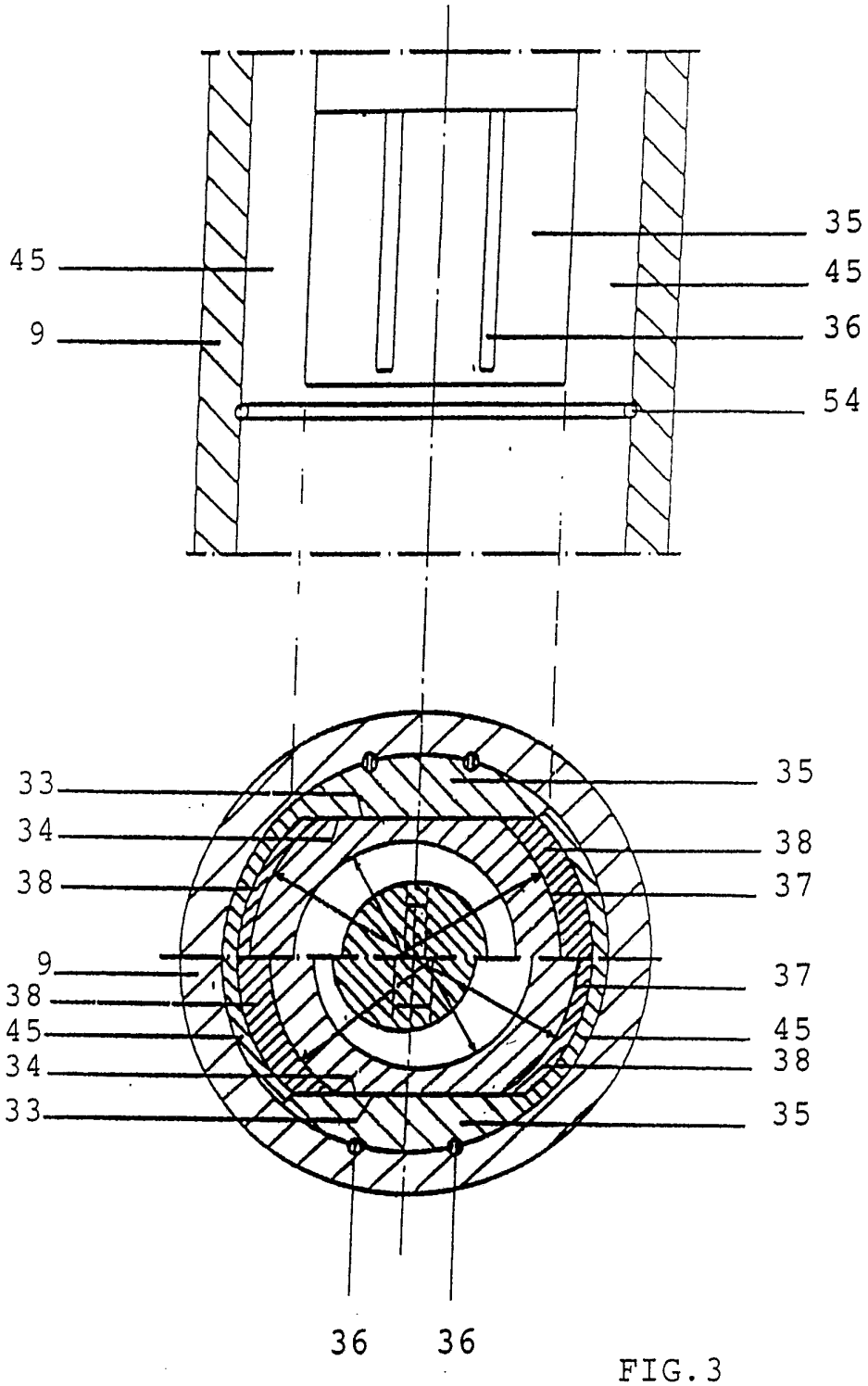
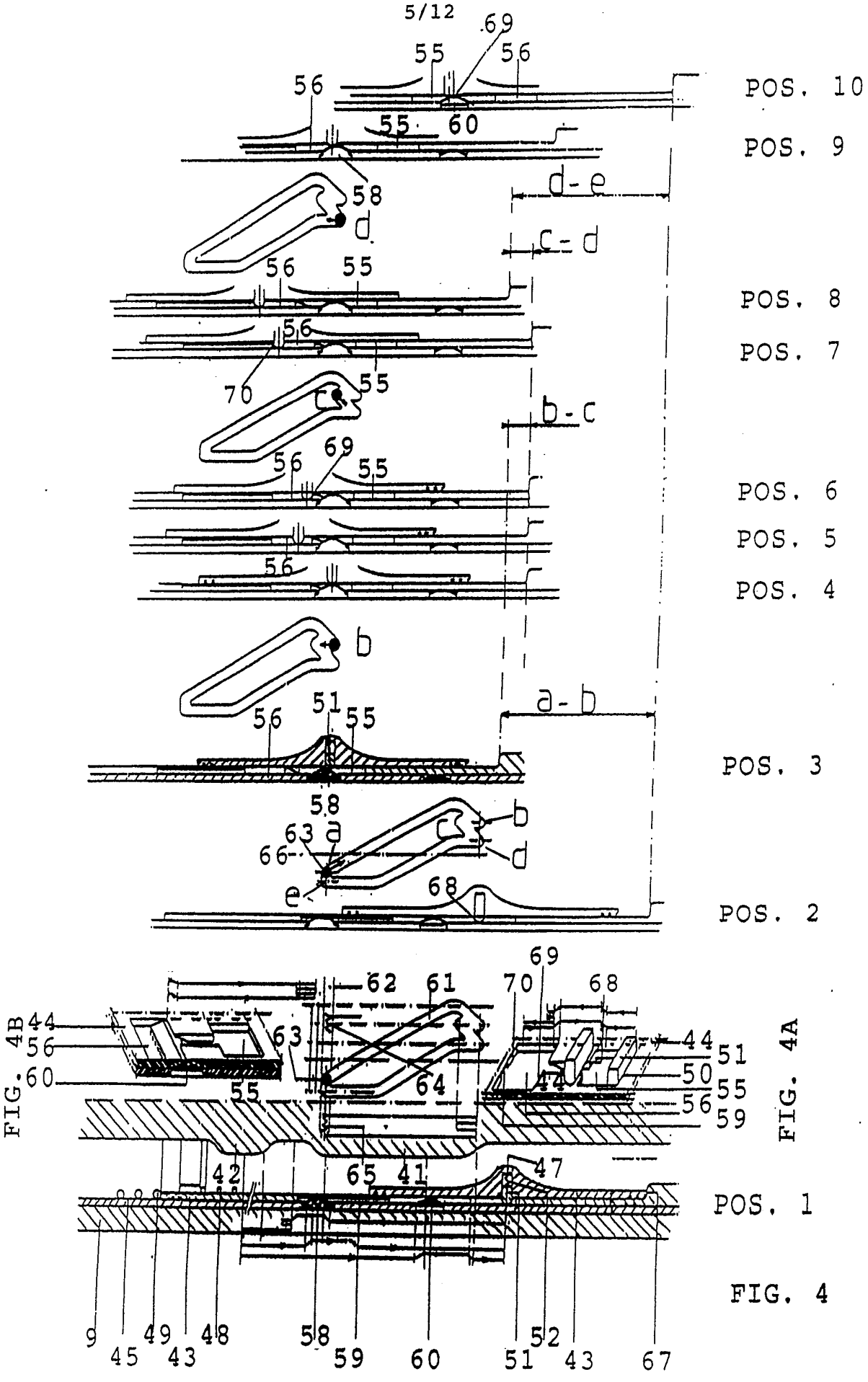


FIG.3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60
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c-d
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70
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b-c
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POS. 10
POS. 9
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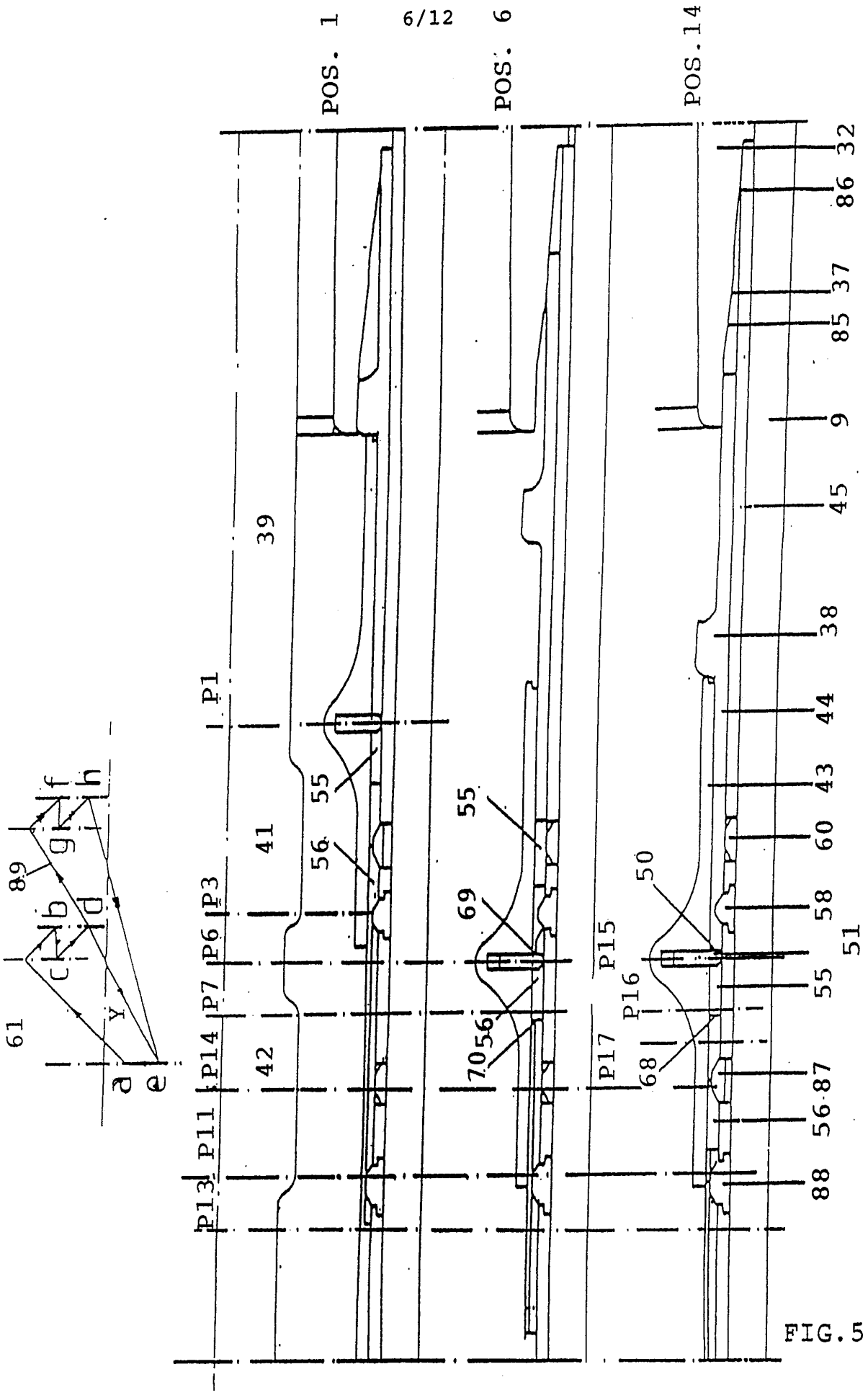
POS. 4
POS. 3
POS. 2
POS. 1
FIG. 4A
FIG. 4B
FIG. 4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POS. 6
POS. 14
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b
c
d
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FIG.5

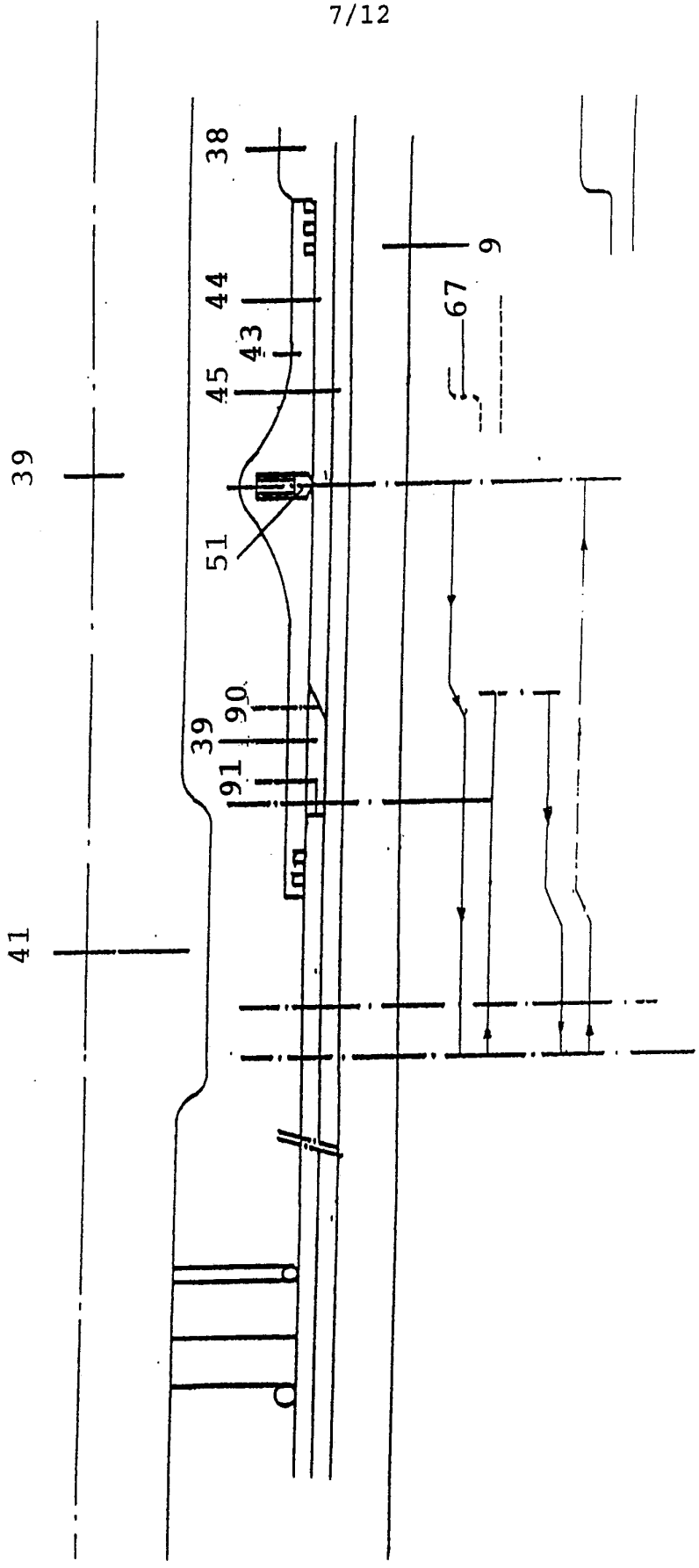

FIG.6

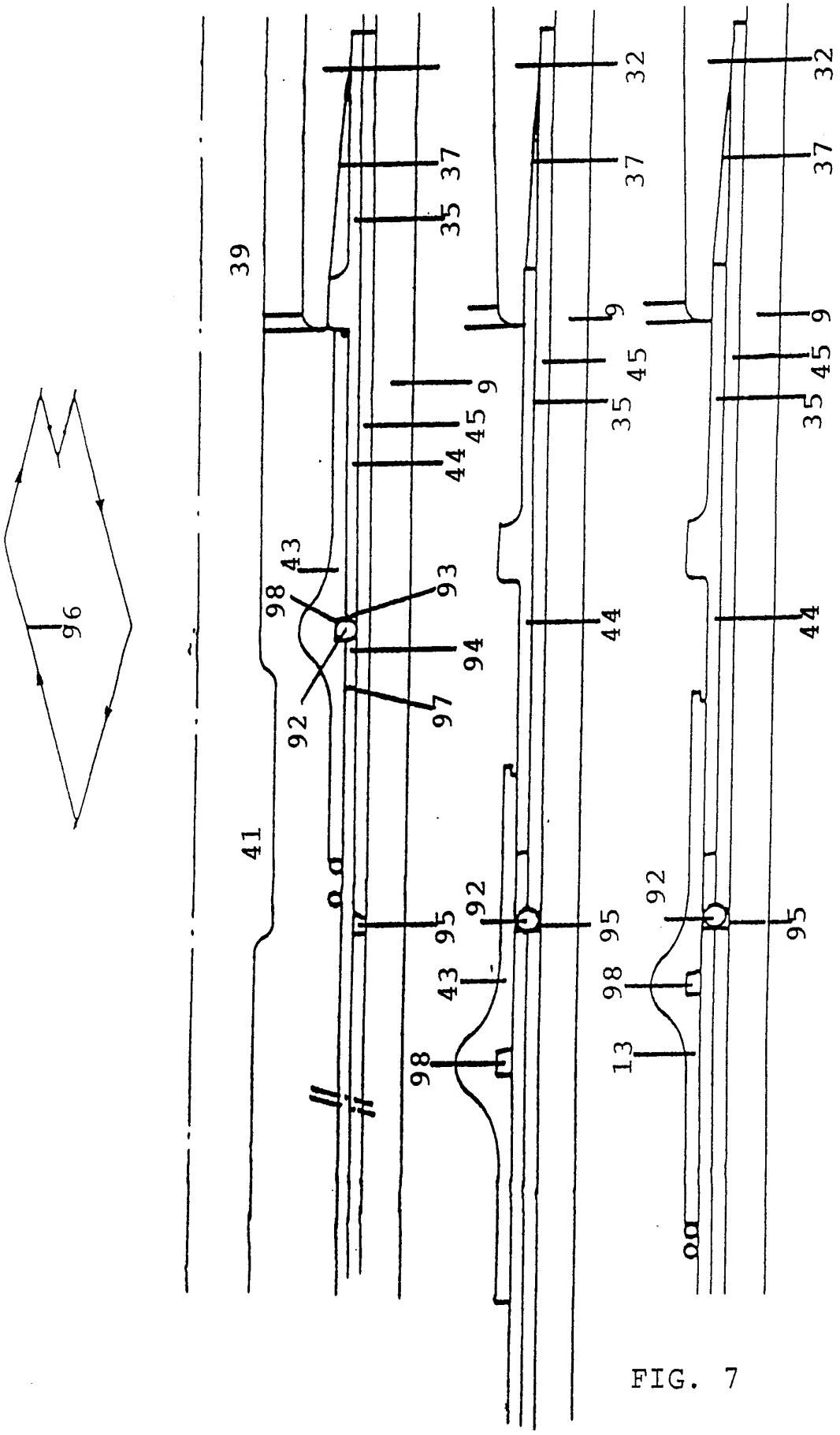

FIG. 7

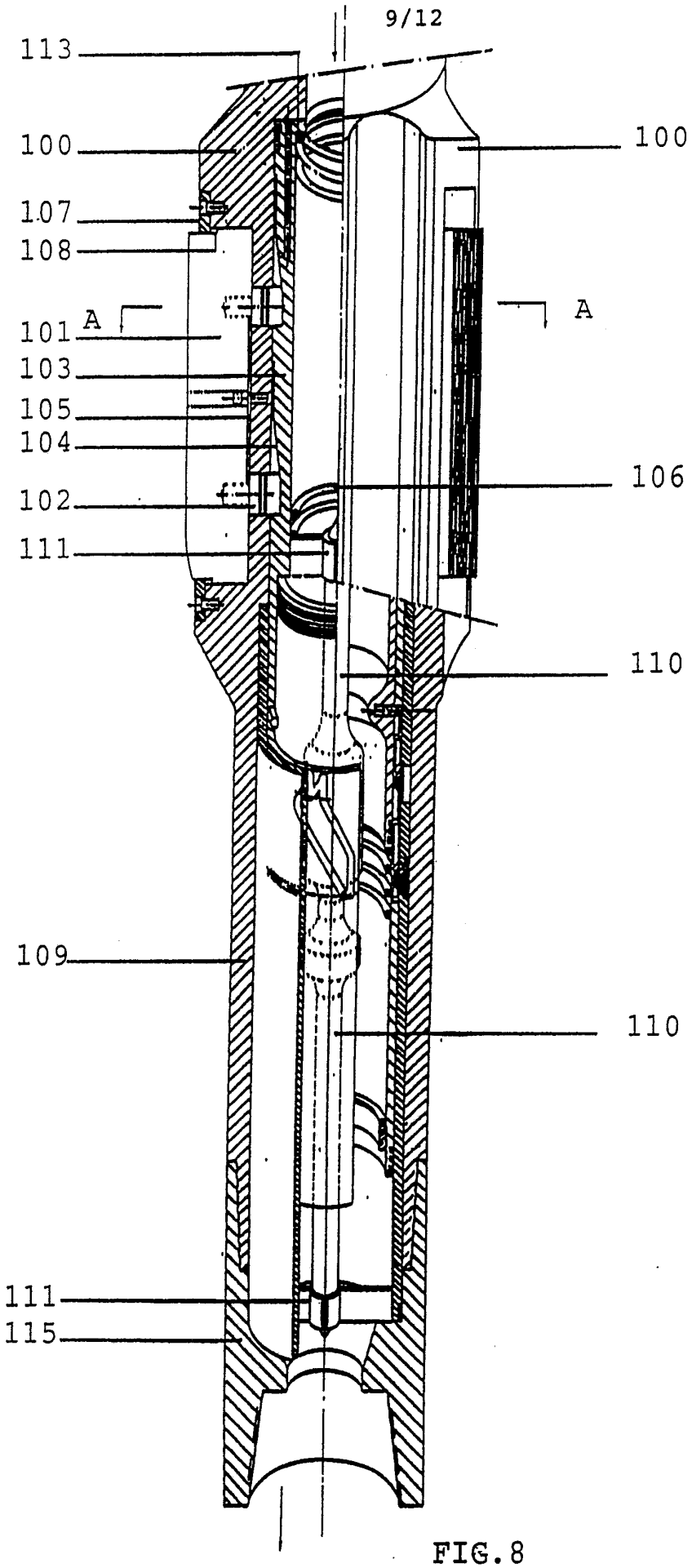
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FIG.8

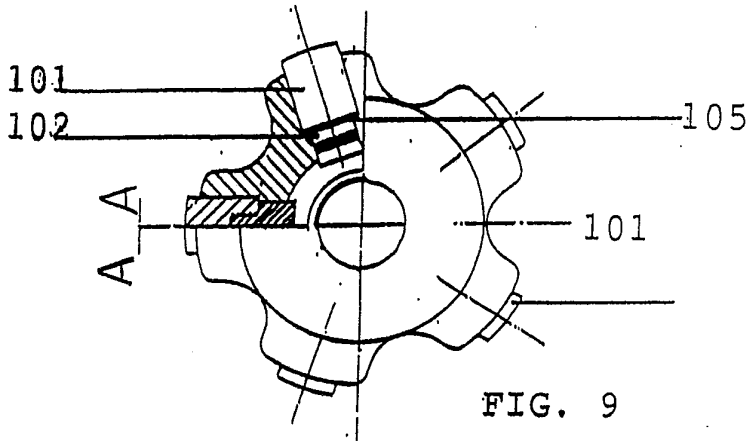

FIG. 9

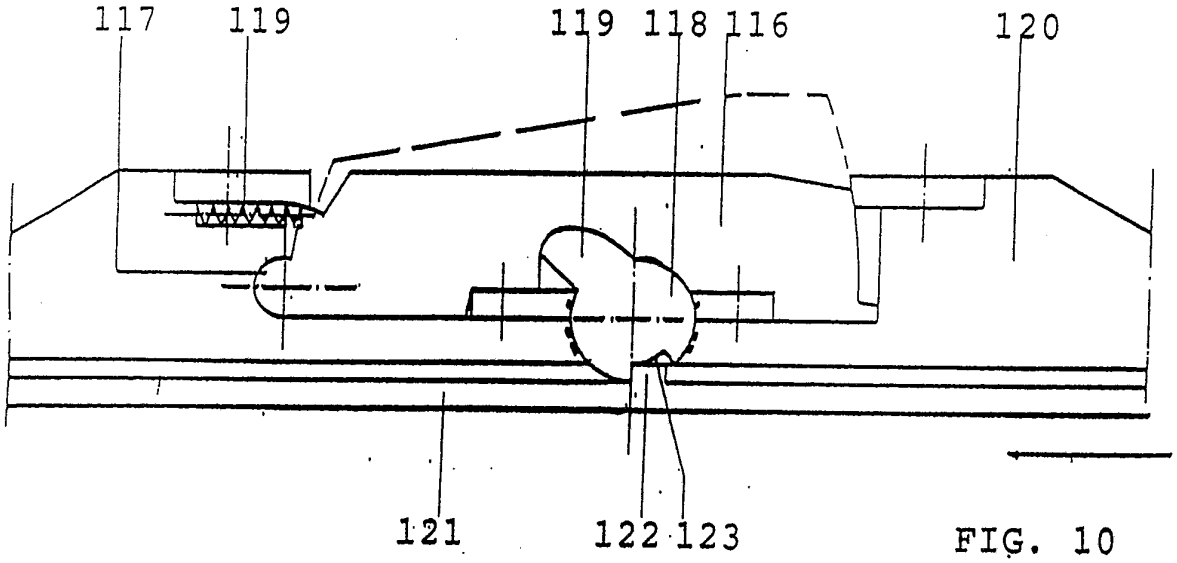

FIG. 10

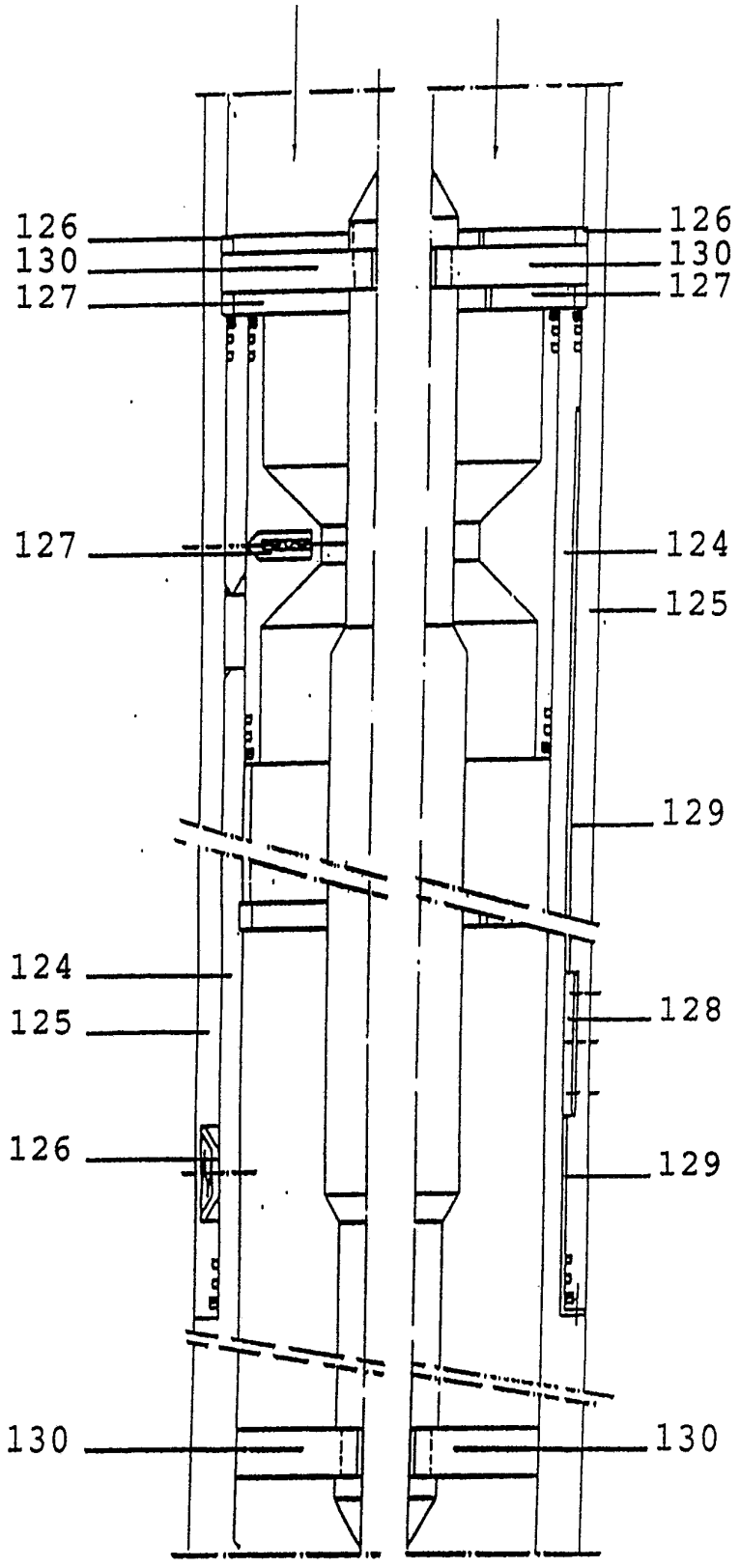
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FIG.11 FIG.12

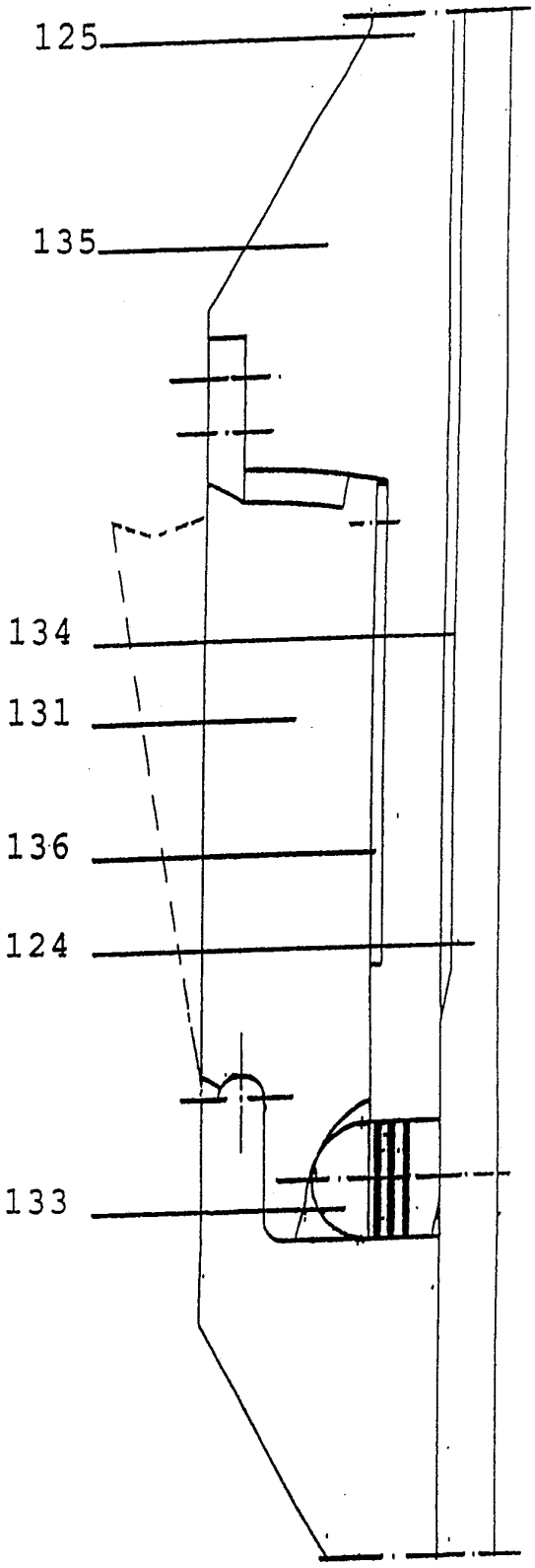

FIG. 13