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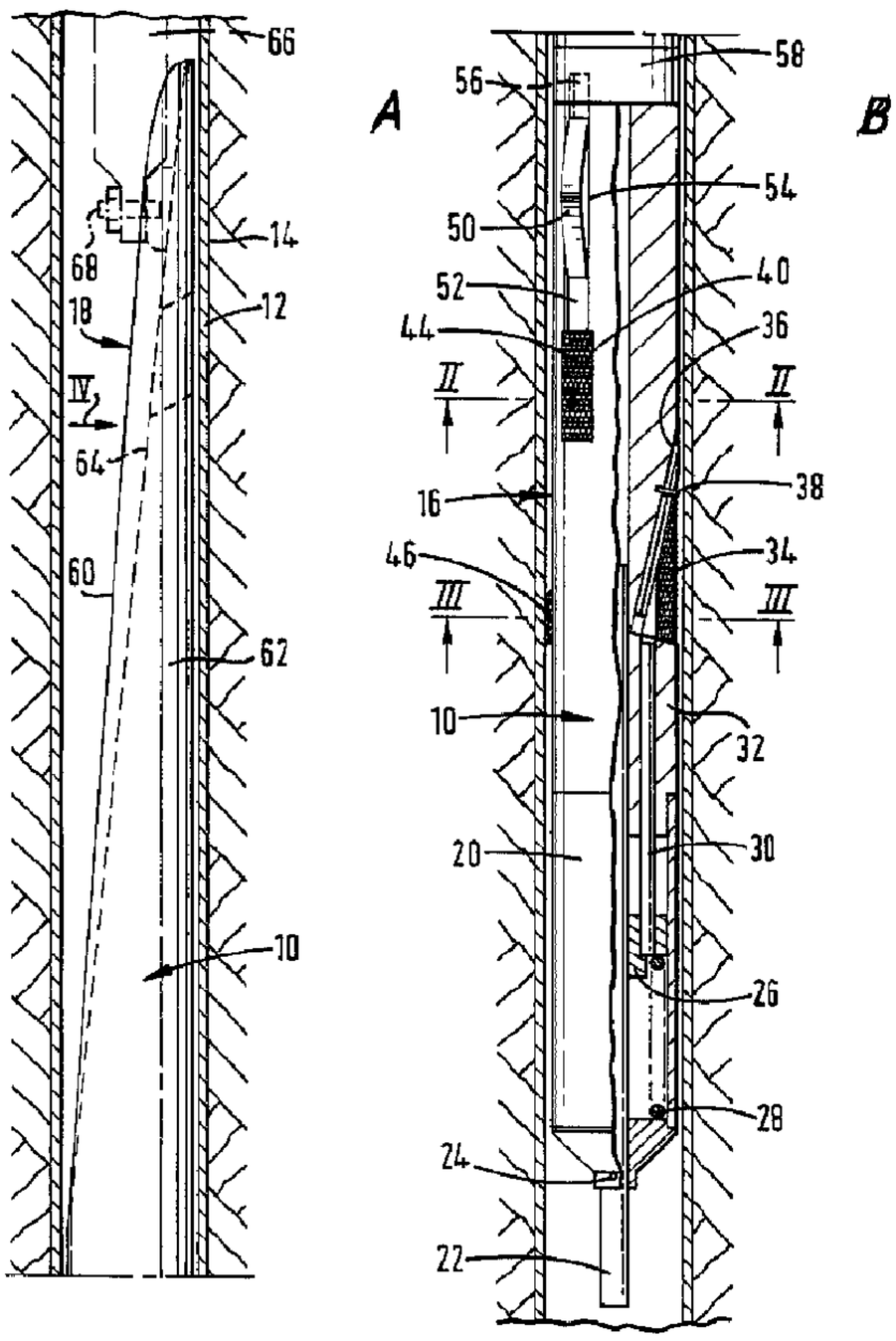

(57) Abrégé/Abstract:
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(54) Title: WHIPSTOCK ASSEMBLY

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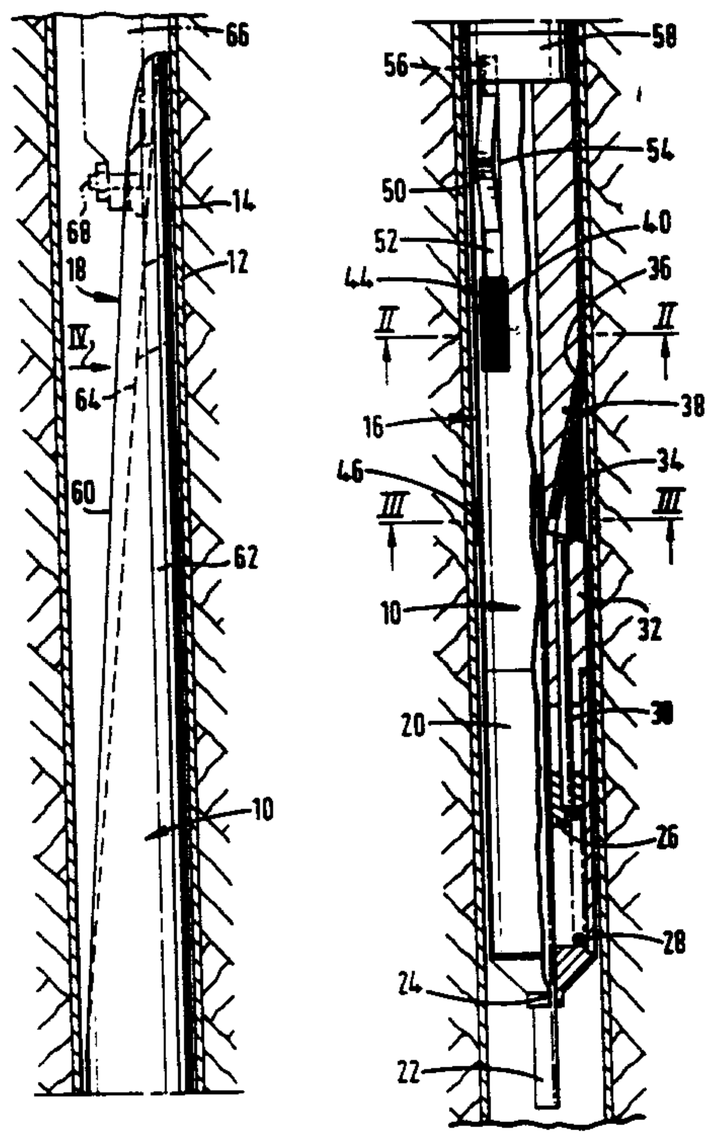
A whipstock assembly (10) comprises a setting section (16) and a guide section (18) which are substantially rigidly connected together. In preferred embodiments, a fulcrum member (40) is provided which projects outwardly from the housing (20). When the whipstock assembly (10) is landed a coil spring (28) biases a wedge (34) upwardly and outwardly into contact with the casing (12). This pivots the setting section (16) and the guide section (18) about the fulcrum member (40) and biases the guide section (18) against the casing (12).



WHIPSTOCK ASSEMBLY

This invention relates to whipstock assemblies.

Whipstock assemblies are used in deviated drilling. In particular, conventional wellbores extend generally vertically into the ground. Once a particular strata is reached it is sometimes desirable to drill horizontally into that strata. In order to achieve this a landing plug is lowered down the casing of the well and locked in position. A whipstock assembly comprising a setting section and a guide section is then lowered down the casing and, when it reaches the landing plug a mechanism is actuated which locks the setting section in place. The guide section essentially comprises an upwardly tapered concave wedge. When the whipstock assembly is in place a milling tool is lowered along the guide section and actuated to cut a hole in the casing. The milling tool is then replaced by a normal drill which, guided by the guide section, drills a bore at an angle to the initial wellbore.

In certain conventional whipstock assemblies the guide section is pivotally mounted to the setting section and reliance is placed on spring assemblies acting between the setting section and the guide section to maintain the guide section against the wall of the casing.

In other known whipstock assemblies, such as shown in GB-A-727 897, the guide section and the setting section are integrally formed and reliance is placed on a spring assembly acting between the setting section and a setting shoe to maintain the guide section against the wall of the casing.

It will be appreciated that if the top of the guide section is not restrained firmly against the casing there is a possibility that the milling tool and/or the drill string will land on the top of the guide section

or possibly even be guided to the wrong side of the casing.

This problem is particularly acute when the initial wellbore is not truly vertical but is itself curved and it is desired to drill a lateral wellbore from the lower side of the casing. In this case the springs acting between the setting section and the guide section not only have to hold the top of the guide section against the casing but also act against the turning movement of the entire guide section tending to urge the top of the guide section towards the lower side of the casing. Since guide sections are generally relatively long (typically 4 to 7 metres) it will be appreciated that the problem becomes progressively more serious as the main wellbore deviates from vertical.

The present invention provides a whipstock assembly comprising a setting section and a guide section, which are substantially rigidly attached to one another or are integral, and a member actuable, in use, to bias said setting section towards a wall of a casing; characterized in that said whipstock assembly includes a fulcrum member disposed so that, in use, when said member is actuated, said setting section and guide section pivot about said fulcrum member to bias said guide section against said casing.

More specifically, the present invention provides a whipstock assembly comprising a setting section having a housing and a guide section which are substantially rigidly attached to one another or are integral, and a first actuating member actuable, in use, to bias the setting section towards a wall of a casing, wherein the whipstock assembly includes a fulcrum member which, at least in use, projects beyond the extremity of the housing so that when the first actuating member is actuated, the setting section and the guide section pivot about the fulcrum member to bias the guide section against the casing.

In one embodiment, the guide section and the setting section can be substantially rigidly connected together by welding, riveting, bolting or combinations thereof. The guide section can be inclined outwardly at an angle (α) with respect to the setting section, and in one embodiment α is less than or equal to 2°.

In one embodiment, the assembly can include a spring acting against the member, holding means to restrain the member against movement, and an actuator rod (22; 22′; 22″; 22‴; 22^{IV}; 22^{V}; 22^{VI}) which, on actuation, release the holding means.

The fulcrum member can comprise a wedge. The fulcrum member (40″; 40‴) can be movable into its operative position when the whipstock assembly reaches its operative position in a wellbore.

The assembly can include a second member (90; 90′) actuable, in use, to bias the setting section (16^{IV}; 16^{V}) towards a casing in concert with the first member (34^{IV}; 34^{V}). The second member can comprise a wedge. The first member and the second member can both comprise wedges which, when actuated, move along ramps in the same direction so that said whipstock assembly can be withdrawn from a casing subsequent to use. Alternatively, the first member and the second member can comprise wedges which, when actuated, move along ramps in opposing directions to inhibit withdrawal of said whipstock assembly subsequent to use.

The assembly can include a pad (46; 46′; 46^{IV}; 46^{VI}) arranged to limit pivotal movement of said setting section and said guide section about said fulcrum member. The guide section can be provided with a retrieval slot to facilitate retrieval of the whipstock assembly.

For a better understanding of the invention, reference will now be made, by way of example, to the accompanying drawings, in which:-

Figs 1A and 1B show the upper and lower parts respectively of one embodiment of a whipstock assembly in accordance with the present invention;

Fig. 2 is a section on line II-II of Fig. 1B;

Fig. 3 is a section on line III-III of Fig. 1B;

Fig. 4 is a view taken in the direction of arrow IV in Fig. 1A;

Figs. 5 and 6 show sequential steps in the retrieval of a whipstock assembly in accordance with the present invention;

Figs. 7 to 10 are horizontal sections showing a retrieval tool in various positions relative to a retrieval slot in the whipstock assembly; and

Figs. 11 to 15 are side views, partly in elevation and partly in section, showing parts of five further embodiments of whipstock assemblies in accordance with the invention.

In the accompanying drawings the width of the whipstock assembly has been exaggerated relative to the length for the purposes of clarity.

Referring to Figures 1A and 1B there is shown a whipstock assembly which is generally identified by reference numeral 10.

The whipstock assembly 10 is shown being lowered down a casing 12 in a wellbore 14.

The whipstock assembly 10 comprises a setting section 16 and a guide section 18.

The setting section 16 comprises a housing 20. An actuator rod 22 projects downwardly from the housing 20 and is held fast relative to the housing 20 by a shear pin 24.

A piston 26 is mounted fast on the actuator rod 22

and maintains a coil spring 28 in compression against the bottom of the housing 20.

A setting rod 30 is located in a bore in the piston 26 and extends upwardly through a guide member 32. The setting rod 30 terminates just below a wedge 34 which is slidably attached (see Fig. 3) to a ramp 36 and retained in the position shown by a shear pin 38.

A pair of fulcrum members 40 are mounted on the housing 20 and, as shown in Figure 2 are secured thereto by set-screws 42. The surface 44 of the fulcrum members 40 is serrated and projects beyond the radial extremity of housing 20 by an amount which may be varied by inserting shims between the fulcrum members 40 and the housing 20.

A pad 46 is mounted on the housing 20 below the fulcrum members 40 as shown. The pad 46 projects outwardly beyond the radial extremity of the housing 20 and is held in place by a set screw 48.

A spring 50 is mounted on the housing 20 above each fulcrum member 40. One end 52 of each spring is welded in a channel 54 in the housing 20 whilst the other end 56 is slidably mounted in the channel 54 below an annular band 58. The springs 50 serve to inhibit the serrated surfaces of the fulcrum member 40 and the pad 46 damaging the side of the casing 12 as the whipstock apparatus 10 is lowered down the casing 12.

A guide section 18 is formed integrally with the housing 20 and comprises an elongate portion 60 with a generally cylindrical outer surface 62 and a guide surface 64 which is concave and which tapers upwardly as shown.

In use, an inflatable packer is first lowered down the casing 14 and locked in the desired position. The whipstock assembly 10 is then bolted to the bottom of a starting mill 66 by a shear bolt 68 and lowered down the

casing 14 on the end of a work string.

When the actuator rod 22 strikes the inflatable packer (not shown) the shear pin 24 shears, and coil spring 28 expands driving the piston 26 upwardly. This in turn drives setting rod 30 upwardly until it impacts against wedge 34. The impact shears shear pin 38 and the wedge 34 moves upwardly along ramp 36. As the serrated outer surface of the wedge 34 moves outwardly beyond the circumference of the housing 20 the whole whipstock assembly 10 is moved to the left as shown in Figures 1A and 1B, flattening the springs 50 until the fulcrum members 40 come to rest against the wall of the casing 120. Further upward movement of the wedge 34 causes the entire whipstock assembly 10 to pivot about the fulcrum members 40 urging the portion of the whipstock assembly 10 below the fulcrum to the left as shown in Figure 1B and, more importantly, the entire guide section 18 to the right hard against the wall of the casing 14.

After the whipstock assembly 10 has been rotated to the desired position by rotating the starting mill 66 the work string supporting the starting mill 66 is slackened off so that the shear bolt 68 breaks.

The starting mill 66 is then lowered further down the casing 12. As the starting mill 66 is lowered it engages the guide surface 64 of the guide section 18 and is guided to the outside of the casing 14 where it is rotated to cut a hole in the wall of the casing 12 in the usual manner.

In one embodiment of a whipstock assembly for using in a casing having a nominal inner diameter of 175mm, the housing 20 had a nominal outer diameter of 160mm and the fulcrum members extended approximately 9.5mm beyond the periphery of the housing 20. The pad extended approximately 8mm beyond the periphery of the housing 20.

The coil spring 28 was compressed to exert a force

of approximately 273kg on piston 26 prior to shearing of shear bolt 24 and maintained a force of approximately 182kg on wedge 34 after actuation.

After the lateral well has been completed the whipstock assembly 10 is removed.

In particular, as shown in Figure 4, the guide section 18 is provided with a retrieval slot 70 which is approximately 20cm long and has a retrieval surface 72 which is inclined at about 60° to the vertical. A retrieval tool 74 (Fig. 5,6) is lowered down the casing 12. The retrieval tool 74 comprises a rod 76 having a catch 78. The rod 76 is approximately 5cm in diameter and the catch 78 is approximately 10cm long and extends 5cm from the rod 76. The catch 78 has a bevelled lower surface 80 and an upper surface 82 which is inclined at about 60° to the vertical.

In use, the retrieval tool 74 is lowered down the casing 12, the catch 78 is engaged in the retrieval slot 70 and the retrieval tool 74 is raised. The upward motion releases the wedge 34 allowing the whipstock assembly 10 to be removed from the casing 12.

Figures 7 to 10 show how the catch 78, the guide surface 64 and the retrieval slot 70 cooperate to facilitate engagement of the catch 78 in the retrieval slot 70. As can be seen from Figures 9 and 10, the catch 78 will enter the retrieval slot 70 provided that the catch 78 and the retrieval slot 70 are within about 22.5° of exact alignment. Accordingly, if an initial attempt to engage the catch 78 in the retrieval slot fails 70 the retrieval tool 74 should be rotated in increments of 45° until engagement is achieved.

Figures 11 to 16 show parts of six further embodiments of whipstock apparatus in accordance with the invention. Since all the embodiments operate in a similar manner to the whipstock apparatus 10 already de-

scribed only the significant differences will be discussed.

In Figure 11, the two fulcrum members 40 are replaced by a single fulcrum member 40', and the single pad 46 is replaced by two pads 46'. Furthermore, the spring 50' are disposed between the fulcrum member 40' and the pads 46'. By carefully adjusting the radial projection of the pads 46' the travel of the wedge 34' necessary to apply the guide section to the wall of the casing can be minimised. This ensures that the maximum available force from coil spring 28' is applied to the wedge 34'.

The setting section 16" shown in Figure 12 is particularly suitable for use in casings where there is minimal clearance between the outside of the housing 20" and the inside of the casing. In this embodiment the fulcrum member 40" is formed by a wedge similar to wedge 34". In use, when the actuator rod 22" is impacted it releases both piston 26" and piston 84. Wedge 34" slides upwardly and outwardly on ramp 36" whilst the wedge forming fulcrum member 40" slides upwardly and outwardly on ramp 86.

The setting section 16"' shown in Figure 13 is generally similar to that shown in Figure 12 except that once the wedge 34"' and the wedge forming the fulcrum member 40"' have been set the whipstock assembly cannot be retrieved. In particular, the wedge 34"' resists downwards movement in the casing whilst the wedge forming fulcrum member 40"' resists upwards movement. In this embodiment piston 84' is released by the breaking of a shear pin 88 when actuator rod 22"' is impacted.

The setting section 16^{IV} shown in Figure 14 comprises a fulcrum member 40^{IV} which projects beyond the housing 20^{IV} and a pad 46^{IV}. The setting section is pivoted about fulcrum member 40^{IV} when wedge 34^{IV} is

actuated. This embodiment also includes a locking wedge 90 which is set when actuator rod 22^{IV} is impacted. The locking wedge 90 locks the setting section 16^{IV} in the casing so that the whipstock assembly cannot be retrieved.

Finally, in the embodiment shown in Figure 15, the fulcrum member 40^{V} is disposed on the guide section 18^{V} rather than the setting section 16^{V}.

It will be noted that in all the embodiments the guide section 18 is rigidly attached to the setting section 16. Such attachment is preferably made by welding but other means, such as bolting and riveting would be equally acceptable. Furthermore, the guide section 18 and the housing 20 of the setting section could conceivably be made integral.

* * *

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A whipstock assembly comprising a setting section having a housing and a guide section which are substantially rigidly attached to one another or are integral, and a first actuating member actuable, in use, to bias said setting section towards a wall of a casing;

wherein said whipstock assembly includes a fulcrum member which, at least in use, projects beyond the extremity of said housing so that when said first actuating member is actuated, said setting section and said guide section pivot about said fulcrum member to bias said guide section against said casing.

2. The whipstock assembly as claimed in claim 1, wherein said fulcrum member is mounted on said housing and secured thereto.

3. The whipstock assembly as claimed in claim 1, wherein said fulcrum member is mounted on said guide section and secured thereto.

4. The whipstock assembly as claimed in claim 1, wherein said fulcrum member is movable into its operative position when said whipstock assembly reaches its operative position in a wellbore.

5. The whipstock assembly as claimed in claim 4, wherein said fulcrum member comprises a wedge.

6. The whipstock assembly as claimed in any one of claims 1 to 5, wherein said guide section and said setting section

are substantially rigidly connected together by welding, riveting, bolting or combinations thereof.

7. The whipstock assembly as claimed in any one of claims 1 to 6, wherein said first actuating member comprises a wedge.

8. The whipstock assembly as claimed in any one of claims 1 to 7, wherein including a spring acting against said first actuating member, holding means to restrain said first actuating member against movement, and an actuator rod which, on actuation, release said holding means.

9. The whipstock assembly as claimed in any one of claims 1 to 8, wherein including a second actuating member actuable, in use, to bias said setting section towards the casing in concert with said first actuating member.

10. The whipstock assembly as claimed in claim 9, wherein said second actuating member comprises a wedge.

11. The whipstock assembly as claimed in claim 10, wherein said first actuating member and said second actuating member both comprise wedges which, when actuated, move along ramps in the same direction so that said whipstock assembly can be withdrawn from the casing subsequent to use.

12. The whipstock assembly as claimed in claim 10, wherein said first actuating member and said second actuating member comprise wedges which, when actuated, move along ramps in opposing directions to inhibit withdrawal of said whipstock assembly subsequent to use.

13. The whipstock assembly as claimed in any one of claims 1 to 12, wherein the assembly includes a pad arranged to limit pivotal movement of said setting section and said guide section about said fulcrum member.

14. The whipstock assembly as claimed in any one of claims 1 to 13, wherein said guide section is provided with a retrieval slot to facilitate retrieval of said whipstock assembly.

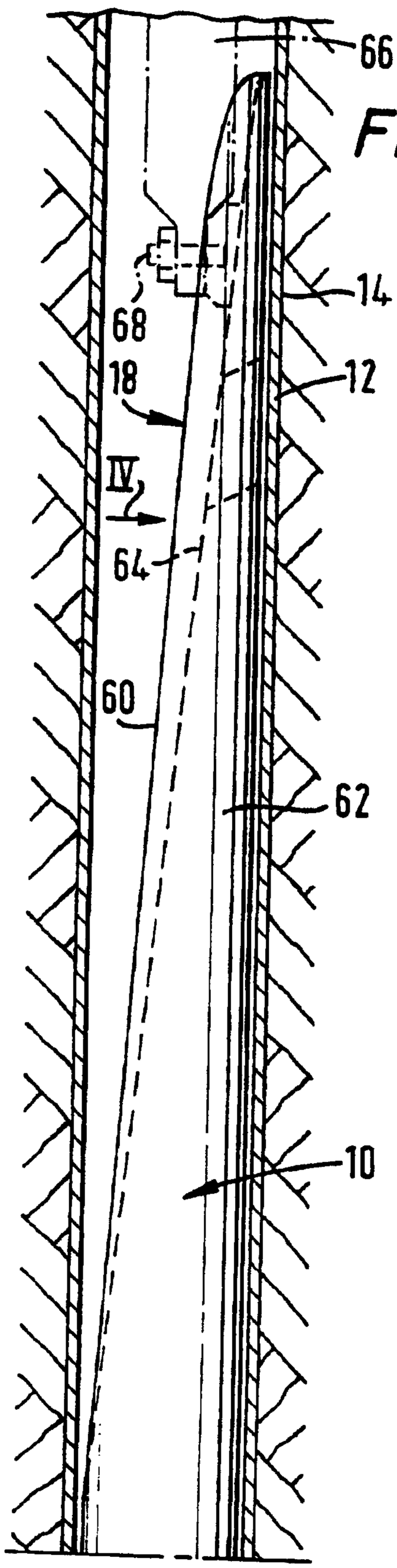

66
14
68
18
12
IV
64
60
62
10

FIG. 1A

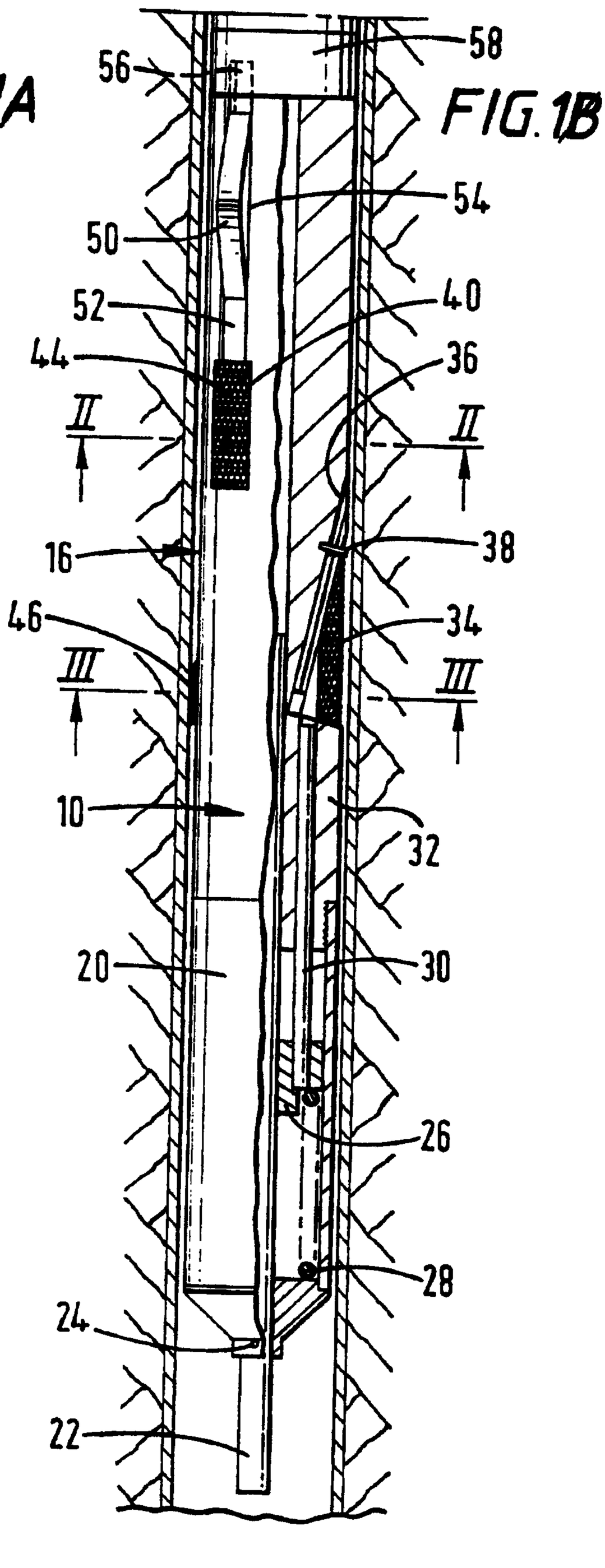

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FIG. 1B

FIG. 2

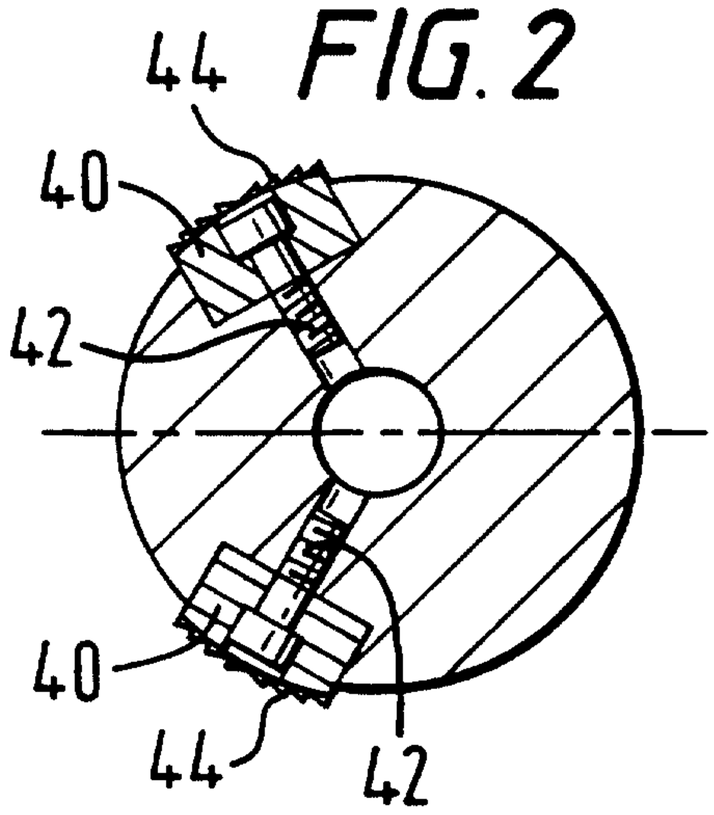
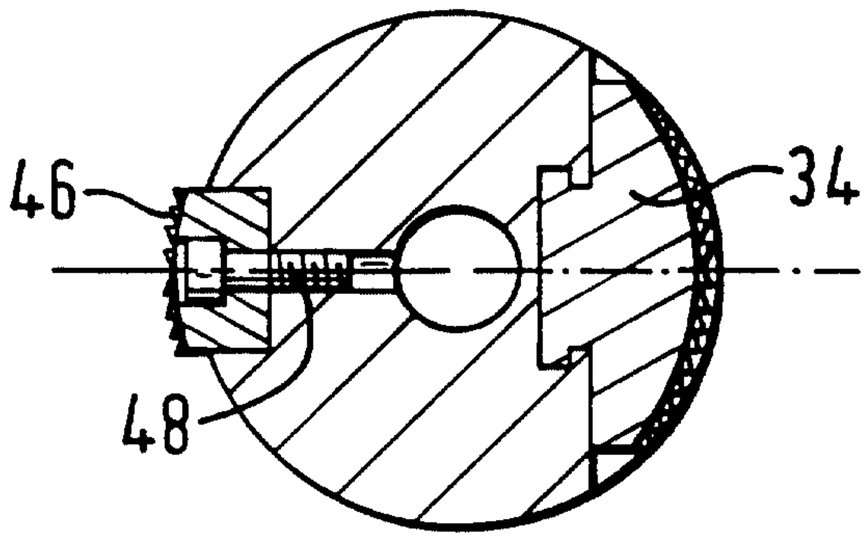


FIG. 3



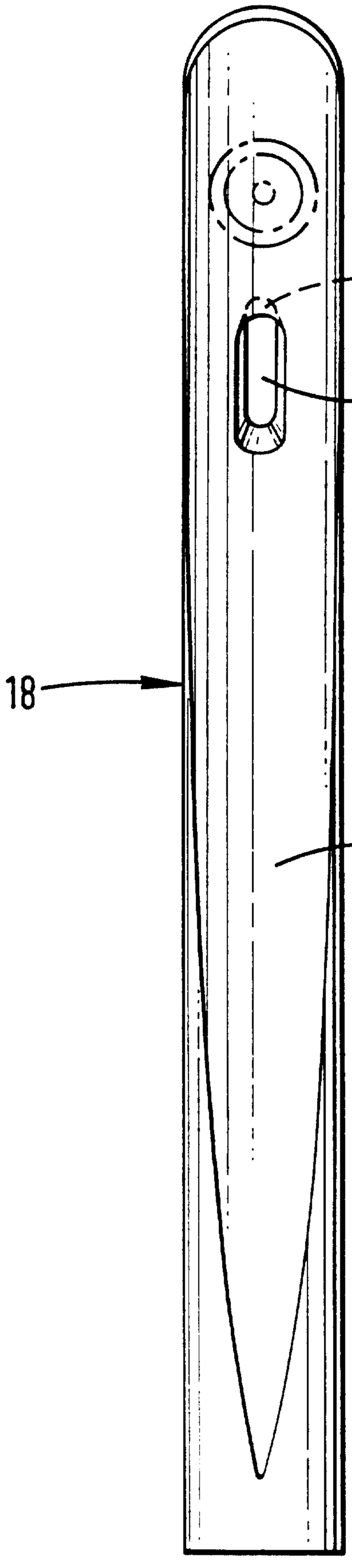


FIG. 4

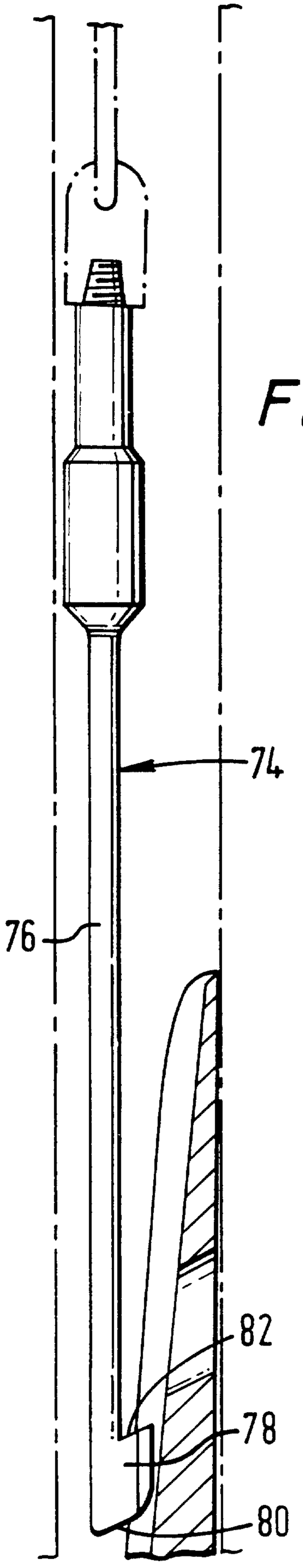


FIG. 5

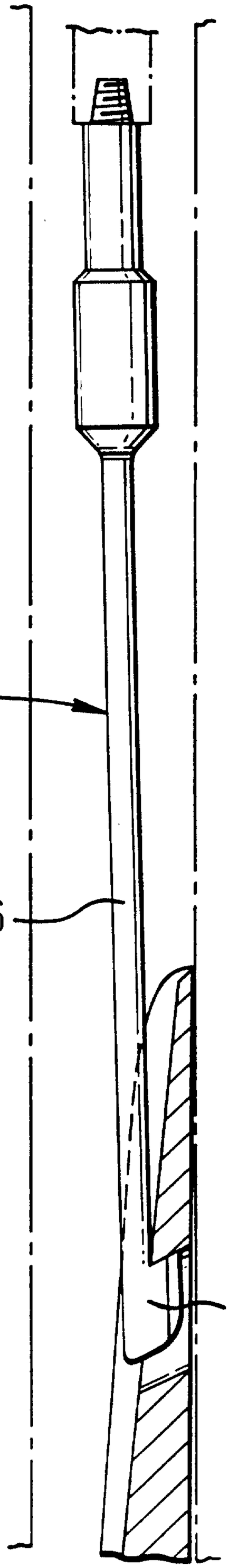


FIG. 6

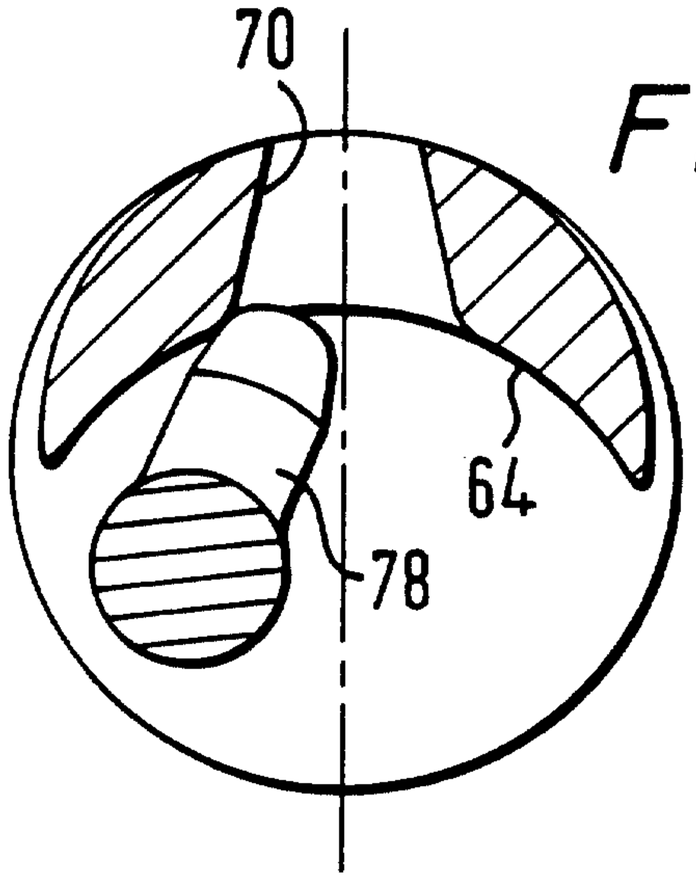


FIG.7

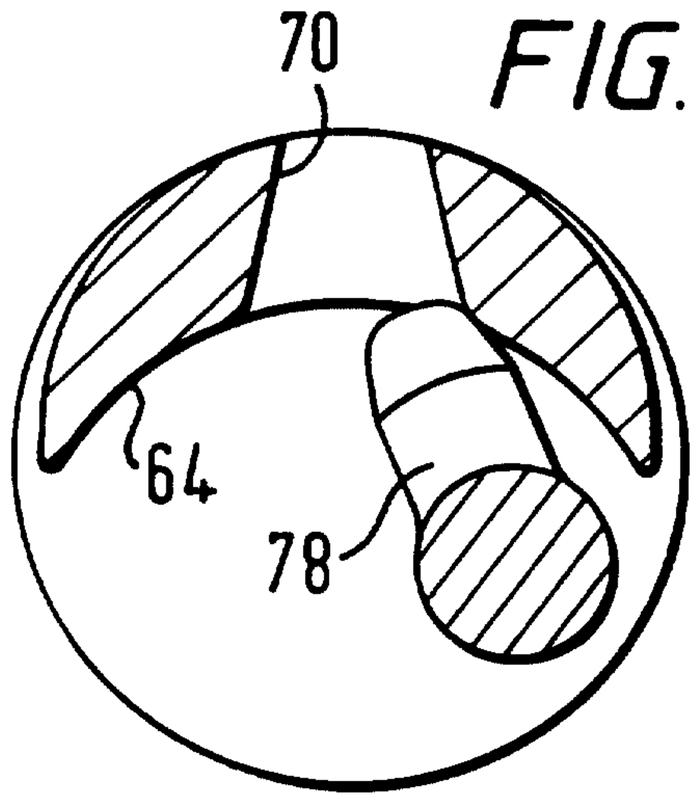


FIG.8

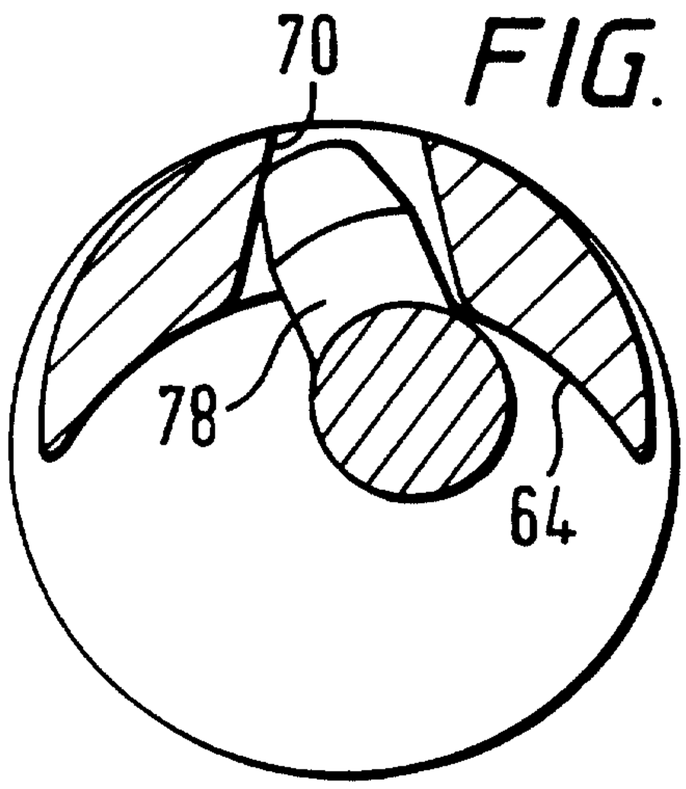


FIG.9

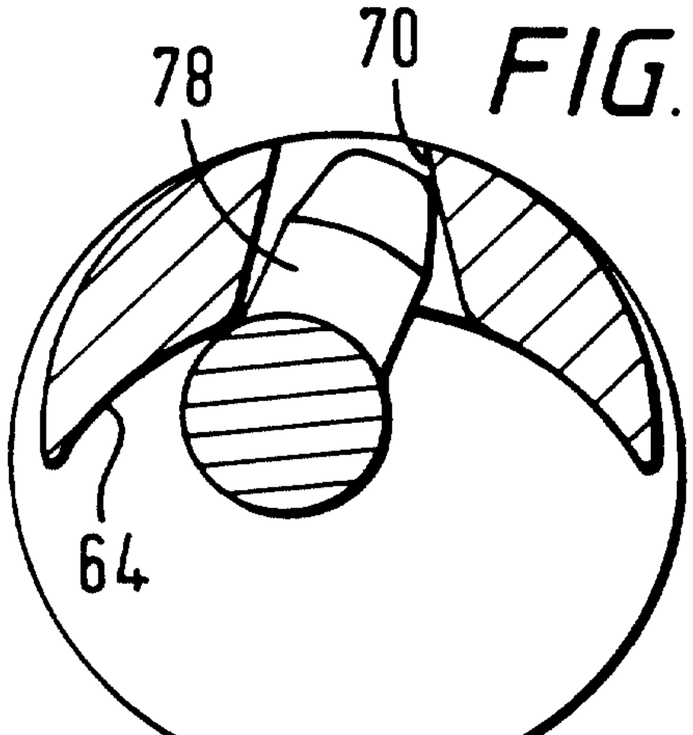


FIG.10

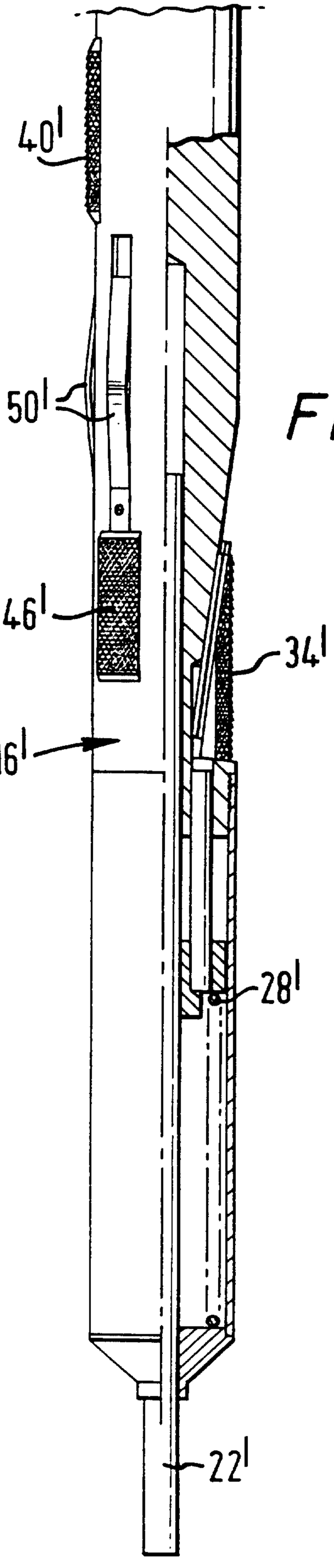
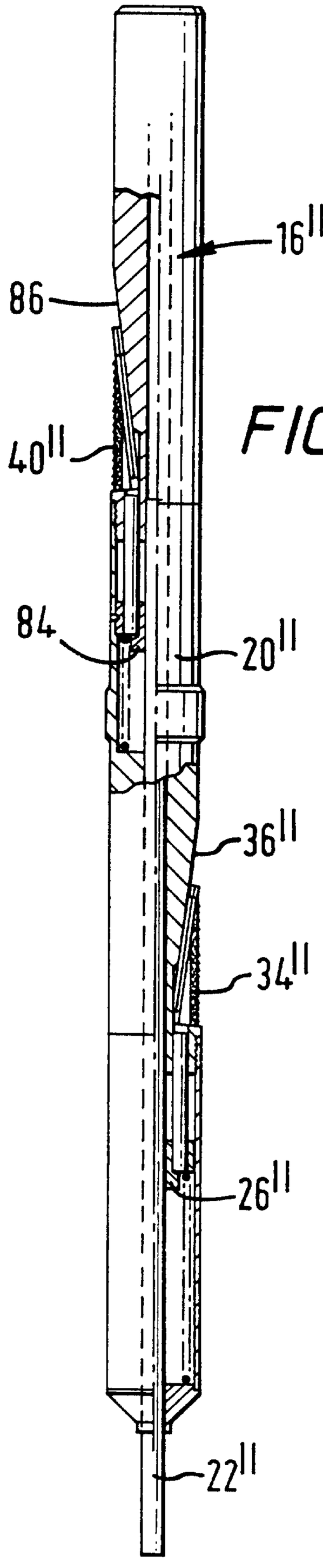

40I
50I
46I
34I
16I
28I
22I

FIG.11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40II
84
20II
36II
34II
26II
22II

FIG.12

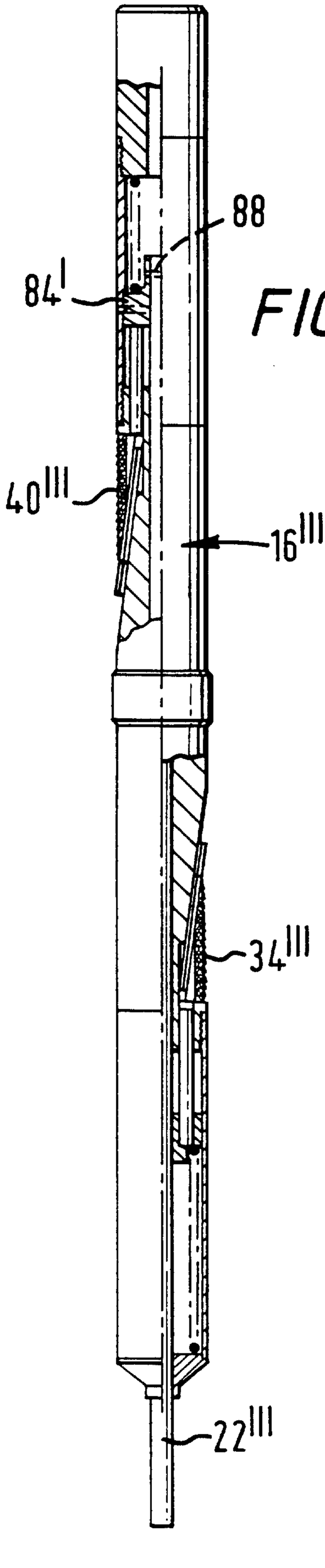
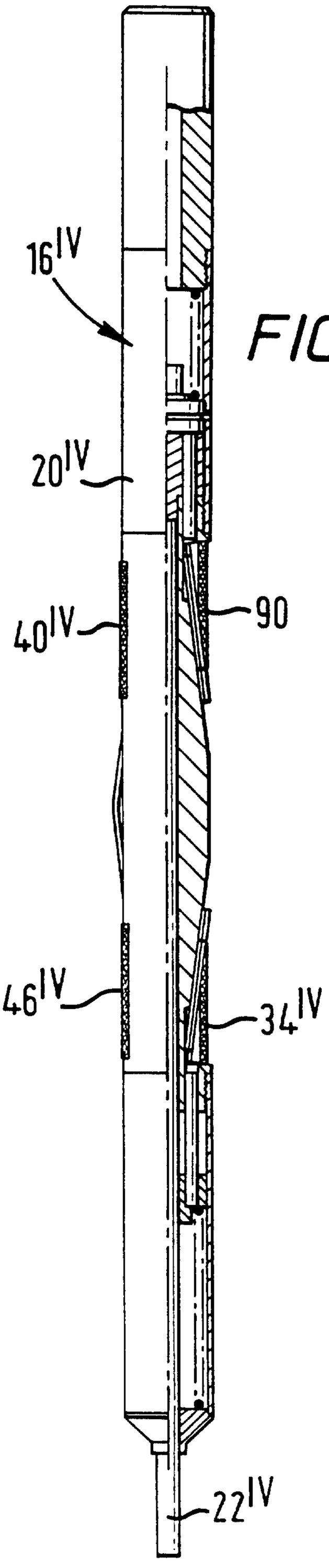

88
84I
40III
16III
34III
22III

FIG. 13


16IV
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90
46IV
34IV
22IV

FIG. 14

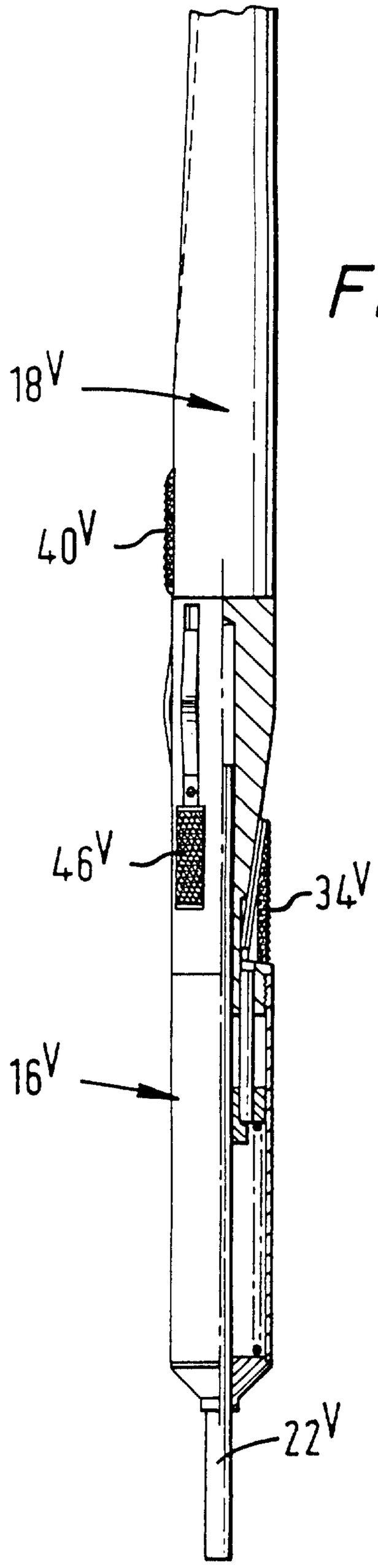
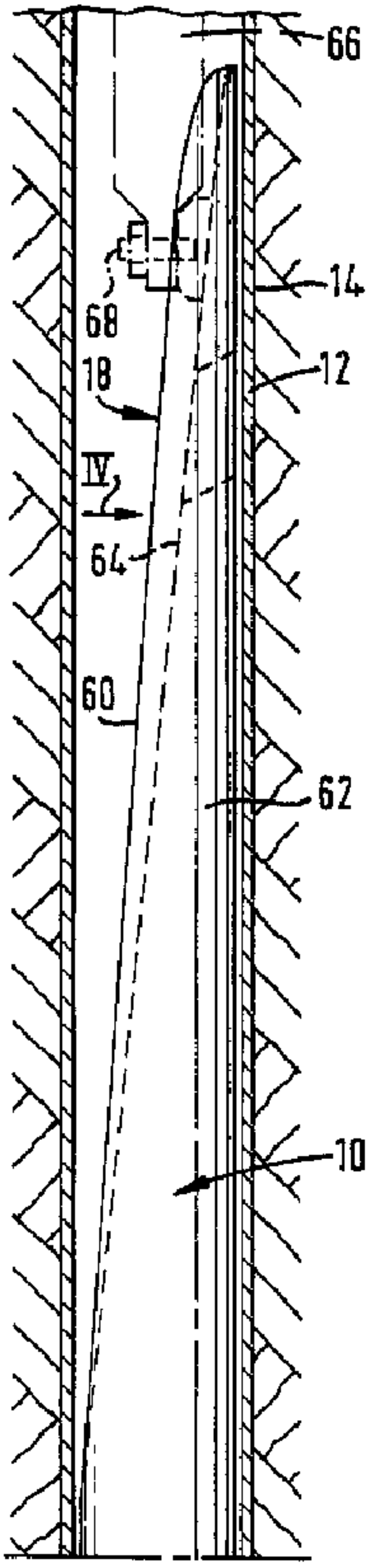


FIG. 15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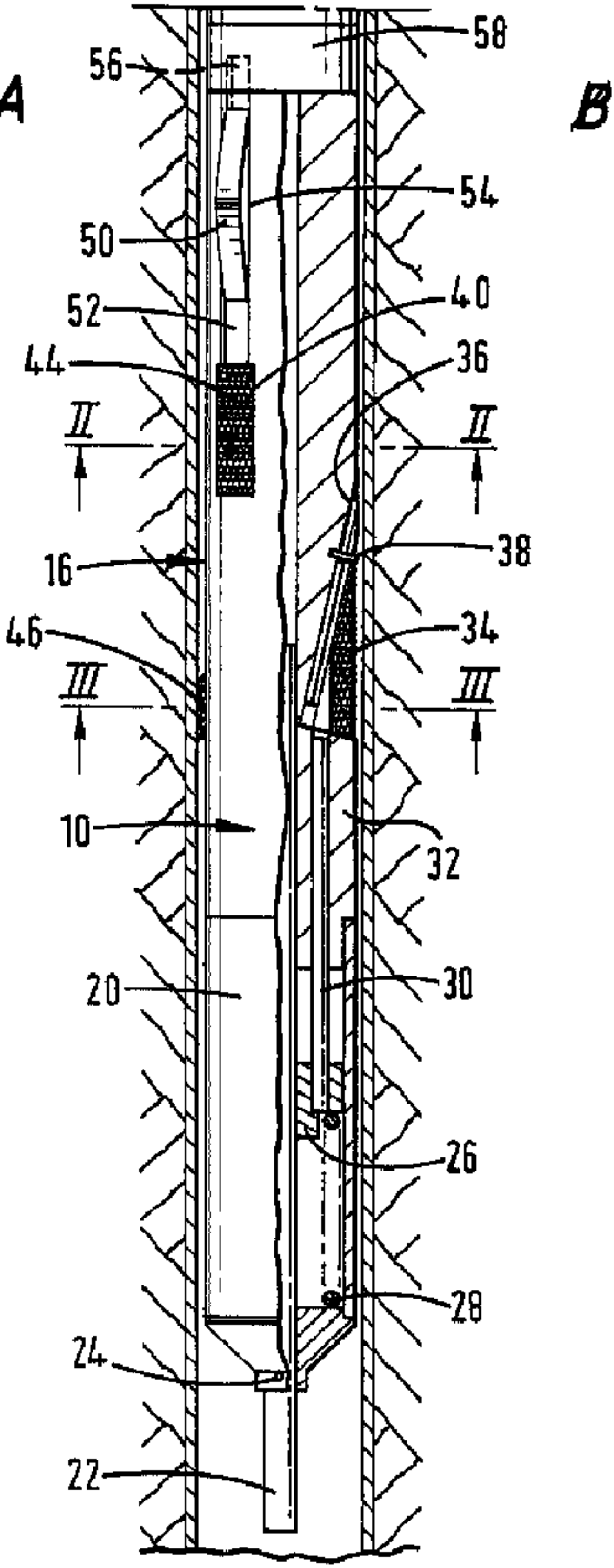
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