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(72) **Inventeur/Inventor:**
JANI, WILLIAM, CA

(73) **Propriétaire/Owner:**
JANI, WILLIAM, CA

(74) **Agent:** GOWLING LAFLEUR HENDERSON LLP

(54) **Titre :** OUTIL DE PERFORATION D'UN PUITS DE FORAGE
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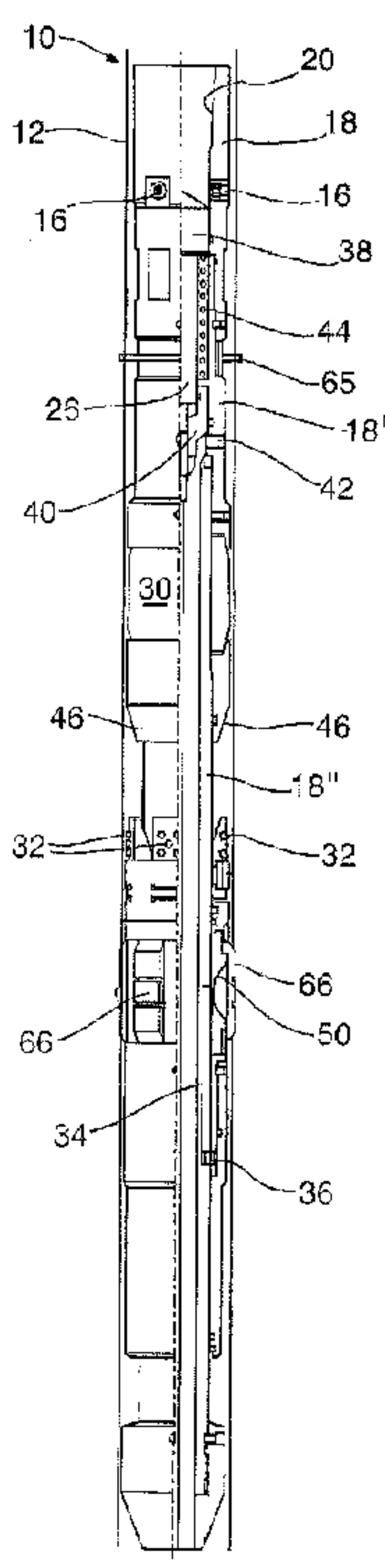

(57) **Abrégé/Abstract:**
A downhole tool for perforating a wellbore. A slidable plunger valve is provided, biased to cover jetting ports during run-in of the tool. A compressible packer may be provided below the jetting ports, and a jaw member provided below the packer . A "J" slot and pin arrangement may allow a three-position configuration, namely a run-in position where the packer is uncompressed and jetting ports closed, a set position where the packer is uncompressed ar d the jaw member forcibly frictionally engaged with the wellbore casing, and a jetting position where the packer is compressed, the tool is supplied with pressurized abrasive fluid, and the plunger valve has uncovered the jetting ports . The plunger valve may be made dual-acting, where during run-in the jetting ports are closed and a bypass port is uncovered , and in the jetting position the jetting ports are open and the bypass port is closed.

ABSTRACT

A downhole tool for perforating a wellbore. A slidable plunger valve is provided, biased to cover jetting ports during run-in of the tool. A compressible packer may be provided below the jetting ports, and a jaw member provided below the packer. A "J" slot and pin arrangement may allow a three-position configuration, namely a run-in position where the packer is uncompressed and jetting ports closed, a set position where the packer is uncompressed ar d the jaw member forcibly frictionally engaged with the wellbore casing, and a jetting position where the packer is compressed, the tool is supplied with pressurized abrasive fluid, and the plunger valve has uncovered the jetting ports. The plunger valve may be made dual-acting, where during run-in the jetting ports are closed and a bypass port is uncovered, and in the jetting position the jetting ports are open and the bypass port is closed.

WELLBORE PERFORATING TOOL

FIELD OF THE INVENTION

The present invention relates to a downhole tool for well completion, and more particularly to a downhole tool for perforating a wellbore in an underground hydrocarbon formation, prior to fracking and/or hydrocarbon recovery from such wellbore.

BACKGROUND OF THE INVENTION AND DESCRIPTION OF PRIOR ART

This background information is provided for the purpose of making known information believed by the applicant to be of possible relevance to the present invention.

No admission is necessarily intended, nor should be construed, that any of the preceding information, or the reference in the drawings to "prior art" constitutes prior art against the present invention.

When a well has been drilled in an underground hydrocarbon formation , the well is typically lined with cylindrical hollow casing (typically steel) to prevent collapse of the drilled well. Thus in order to "complete" a well in preparation for production of hydrocarbons from such cased well, the casing liner of the wellbore must first be perforated to allow hydrocarbons to be able to flow into the well.

Perforation of the wellbore casing must also precede the further "completion" step which is now typically carried out during most modern well completions, namely the further step of injecting a fracking fluid into the hydrocarbon formation via perforations in the wellbore casing, to thereby fracture the formation in the region of the well so as to create better recovery conditions and assist in flowing hydrocarbons out of the formation and into the wellbore.

Wellbore perforation has to date been conducted in three principle manners.

Firstly, wellbore perforations can be carried out by way of mechanical punch tools, which when inserted into a cased well and positioned at desired locations along a wellbore, punch a series of apertures in the steel casing at such locations where actuated to thereby perforate the casing .

Alternatively, casing perforation can be accomplished by way of detonation of explosive shaped charges at specific desired locations along a wellbore. In such method shaped explosive charges are inserted down a wellbore and electrically actuated to as to perforate the steel wellbore in the region of the placement of the shaped charges.

Alternatively, wellbore perforation can be accomplished by the use of a jetting tool which is inserted in the wellbore. An abrasive jetting fluid is supplied under high pressure to the jetting tool when positioned at a desired location along the wellbore. The jetting tool directs the jetting fluid outwardly in a pressure jet which impinges against the steel casing. Due to the continued abrasion of the directed high pressure jet against the side of the casing, the casing is perforated in the region of the jet(s).

US 3,175,613 entitled “Well perforating with abrasive fluids”, teaches one method of perforating a wellbore using an abrasive jet which contains sand, an liquid, and a gas such as carbon dioxide or nitrogen, which is used as the jetting fluid.

Jetting tools and techniques for perforating wellbores using pressurized abrasive fluids have generally been improved upon over the years.

For example, Canadian Patent Application 2,873,541 entitled “*Fracturing Valve and Fracturing String*” teaches a downhole tool 200 used for both perforating a wellbore and further fracking the formation via the perforations created in the wellbore. A sliding mandrel 15, a frac port 60 which may be opened and closed by mandrel 15 acting as a valve, a compressive packer 121 located on the tool downhole of frac port 60, a “j’ slot 123, and a plurality of jetting nozzles 12 located at an upper end of tool 200, all incorporated into tool 200. Figs. 7a, 8 & 9 show successive sequences in the positioning and operation of the tool 200 during “run-in” (Fig. 7a), “perforating” (Fig. 8), and “fracking” (Fig. 9). Specifically, the frac port 60 comprises a window on a tubular l, and an outer sleeve is disposed around the tubular which is slidable relative to the tubular, the outer sleeve having a port, wherein for (frac) fluid to exit the valve the window and port must each be aligned by relative movement to each other. Disadvantageously, however, the jetting nozzles 12 on such tool

200 have no means of being closed to prevent ingress of detritus and cuttings during "run-in" of tool 200 into the wellbore.

Canadian patent application CA 2,738,907 entitled "*Tools and Methods of Use in Completion of a Wellbore*" teaches a sand jetting tool 100 having an abrasive jet assembly 10, a 'j' slot, and a single compressible seal 11 (Fig. 1a) . The method disclosed therein is directed to an embodiment having a moveable slidable sleeve 41 secured by a shear pin, and using a locator to grip the sleeve 41 with slips to move sleeve 41 to open jetting ports 42, as shown in Fig. 4a, 4b thereof. Disadvantageously, therefore, the jetting ports 42 must be opened by inserting a special locator tool into the wellbore.

Canadian patent CA 2,693,676 teaches a sand jet tool 30 having a ball-actuated sandjet port, and an expandable packer 31 that is actuated by a "j" slot. The tool 30 has a debris relief passageway that is operatively associated with the 'j'slot and actuated (opened and closed) by movement of the 'J' slot.

Canadian patent 2,713,611 teaches a perforating and fracking tool having a sandjet perforating assembly 80, a "j"-slot for actuating resettable anchor device 41, and a bypass plug operating as a valve which allows equalization of pressure in a straddle zone 10 between cup seals 20, 30, to release pressure, when desired, between cup seals 20, 30, as shown in Fig. 1.

US 6,394,184 teaches a system and method for perforating and fracking a formation having a wellbore therein. Although perforating guns 136,146,156 are shown in some of the drawings, the disclosure teaches that the "perforating means" may also comprise an abrasive fluid-jet cutting device (ref. page 11, lines 13-15 and page 37, lines 5-6) and further in Fig. 10 thereof depicts such a device 310.

US publication 2014/0158361 relates to a multi-shift frac sleeve system 10 which uses a pressure actuated spring-biased sleeve 22 for opening and closing a frac port 18, which may be further actuated to move to a third position (Fig. 4) where frac port 18 is closed, as may be seen from Figs. 2-5 thereof. It teaches a pin 20 and 'j' slot 27 for controlling shifting of inner sleeve 14. Again, to open the frac ports 18, such patent application teaches an outer sleeve and an inner sleeve where the ports therein must be aligned in order for passage of fluid therethrough.

Canadian patent 2,611,928 teaches layers of staggered jet nozzles , wherein the jetting fluid is further used to frac the formation.

Canadian patent application CA 2,843,619 titled "*Downhole Tool Assembly with Debris Relief, and Method for using Same*" as per CA 2,693,676 (above) makes similar disclosure as CA 2,693,676, but requires that the debris relief valve be actuated by movement of the tool up or down, and not by a pressure differential.

CA 2,856,184, similar to CA 2,873,541 , relates to a downhole tool capable of performing both abrasive jet perforation as well as fracturing, with a valve portion made up of a tubular mandrel having a through bore continuous with a tubing string, and a frac window through the side of the tubular mandrel. Jet nozzle 98 is used for perforating (with the frac port closed and seal 121 deactivated) as shown in Fig. 11A thereof. Fig. 11 B shows the tool moved upwardly so that the frac window is open and positioned next to the created perforations 98 for fracking (seal 121 is activated). Again, the tubular and sleeve are each axially moveable relative to one another, and the valve is move to the closed position by applying a mechanical force to the tubular (i.e. raising it upwardly), as shown in Fig. 8, as opposed to the application of fluid pressure to the upper region of the tool

CA 2,224,571/ US 5,765,642 teaches a jetting tool having an expandable packer, having at least one fluid jet forming nozzle , wherein the jetting fluid is used to further frac the formation.

SUMMARY OF THE PRESENT INVENTION

Despite the above publications relating to jetting tools for wellbore completion, there is still a need in the industry for an effective jetting tool that is able to relatively quickly and reliably perforate a length of wellbore without having to do make in a number of successive trips down the wellbore.

It is thus an object of the present invention to provide an effective jetting tool for quickly and effectively perforating a wellbore during completion of such wellbore .

In some embodiments, it is an object to provide a tool which reduces and/or allows re-use of the jetting fluid being used, to thereby minimize the quantum of such fluid needed to perforate the wellbore.

In other embodiments, it is an object to provide a perforation tool that has a bypass port to assist in introducing the perforating tool into the wellbore and positioning it at the desired location along the wellbore.

It is a further object of the present invention to provide a jetting tool of a configuration which minimizes the prospect of such tool becoming sanded in within a wellbore during a sandjetting/perforation process and accordingly being incapable of being withdrawn from the wellbore.

It is still a further object of the present invention to provide a jetting tool which has biased means for maintaining the jetting ports in a closed position to thereby avoid inadvertent entry into the tool of fines, residual drill tailings or cuttings or other detritus, in the absence of a flushing fluid being present.

It is a still further object of the present invention to provide a tool in which the sand jetting ports used for perforating the casing may further subsequently immediately thereafter be used for injecting a fracking fluid into the formation via the created perforations in the casing.

It is still a further object of the present invention to provide a jetting tool which has internal pressure-actuated means for opening the jetting ports, and does not require mechanical up/down motion of the tool within the wellbore in order to open such jetting ports.

Accordingly, in order to provide *inter alia* the above objects, in a first broad embodiment the present invention provides a perforating tool for perforating a cased wellbore, comprising:

(i) a tubular mandrel;

(ii) a jetting port situated within a periphery of said tubular mandrel, which port when open allows a jetting fluid from an interior of said tubular mandrel to be radially directed outwardly in a jet; and

(iii) a spring-biased plunger valve, slidably moveable within said tubular mandrel, preventing fluid flow from uphole through said tubular mandrel in a downhole direction, biased to slidably cover said jetting port, which plunger valve when pressurized jetting fluid is supplied to an upper end of said tubular mandrel sufficient to overcome said spring-bias, slidably moves in said tubular mandrel so as to uncover said jetting port and allow said pressurized jetting fluid to flow radially outwardly from said jetting port and perforate said cased wellbore.

Advantageously with a jetting tool of the above configuration, the jetting ports remain closed (covered) during run-in of the tool into the wellbore, thereby allowing fluids containing detritus such as drilling fines to be flushed up the wellbore annulus which exists between the tool and the wellbore, thereby reducing the tendency of fines and sand which may otherwise remain to cause sanding-in of tool within the wellbore and such tool thereby being unable to be removed from the wellbore.

In a greatly preferred embodiment, the perforating tool is further provided with a packer member which when compressed expands so as to create a seal between the tool and the wellbore, to prevent abrasive jetting fluid from flowing downhole in the annulus between the tool and the casing, and allowing such sand to be forced uphole and thus recovered for re-use. An added benefit of recovering such abrasive fluid uphole is that such abrasive fluid, which typically contains sand as the abrasive component of the fluid, thus reduces the amount of sand downhole to allow better flow, and thus reducing the chance other tools which may be inserted downhole will become sanded in . Still further, the use of a perforating tool which further has a packer r may allow the sand jetting ports to be subsequently used for injecting a fracking fluid into the formation via the created perforations in the wellbore by likewise preventing such fracking fluid from escaping downhole .

Accordingly, in a broad aspect of such greatly preferred embodiment, the present invention comprises a perforating tool for perforating a cased wellbore, having:

(i) a tubular mandrel;

(ii) a jetting port situated at an upper end of said mandrel within a periphery of said tubular mandrel;

(iii) a compressible packer member positioned on said tubular mandrel below said jetting port;

(iv) a jaw member, fixedly secured to a pin member, slidably positioned on said tubular mandrel below said packer member and radially outwardly extendable when forced by a wedge-shaped member on said mandrel so as to frictionally engage said cased wellbore; and

(v) a 'j' slot for guiding and containing therewithin said pin member, said "j' slot located on said tubular mandrel below said packer member and adapted to guide said pin member therein to move from a "run-in " position, subsequently to a "set" position, and lastly to a "jetting" position;

wherein when said pin member in said 'j'-slot is in said "run-in " position said compressible packer member is uncompressed and said jaw member does not forceably frictionally engage said cased wellbore;

wherein when said pin member in said 'j'-slot is repositioned therein from said "run-in" position to said "set" position by pulling in an uphole direction on said tool said tubular mandrel slides upwardly relative to said jaw member; and

wherein when said pin member in said 'j'-slot is moved to said "jetting" position said tubular mandrel is allowed to slide relative to said jaw member so as to compress said compressible packer member and further cause said wedge-shaped member on said tubular mandrel to force said jaw member radially outwardly and in frictional engagement with said cased wellbore; and

(vi) a spring-biased plunger valve, slidably moveable within said tubular mandrel, preventing fluid flow from uphole through said tubular mandrel in a downhole direction, biased via a spring to slidably cover said jetting port , which plunger valve when pressurized jetting fluid is supplied to said upper end of said tubular mandrel at sufficient pressure to overcome said spring bias, slidably moves downward in said tubular mandrel so as to uncover said jetting port and allow said pressurized jetting fluid to flow radially outwardly therefrom and perforate said casing.

In a further refinement of the above embodiment, the perforating tool of such embodiment further comprises a bypass port situated in said tubular mandrel above said compressible packer, when open providing fluid communication between an exterior of said tool above said compressible packer and an interior of said tool below said compressible packer. The spring-biased plunger valve is a dual-acting plunger valve, biased via said spring to slidably cover said jetting port and to leave uncovered said bypass port, but when fluid pressure is supplied to said upper end of said tubular mandrel sufficient to overcome said spring bias, to slidably move within said tubular mandrel to uncover said jetting port and to simultaneously close said bypass port.

In a still further embodiment, an upper portion of said spring-based plunger is an upwardly-facing cone which directs said jetting fluid substantially uniformly to each of said circumferentially-spaced jetting ports.

In a still further embodiment of the present invention, such invention comprises a wellbore completion tool for perforating a casing of a cased wellbore, having :

(i) a tubular mandrel;

(ii) at least a pair of jetting ports situated at an upper end of said mandrel, positioned within a periphery of said tubular mandrel and in a plane substantially perpendicular to a longitudinal axis of said tubular mandrel;

(iii) a dual-acting spring-biased plunger valve, slidably moveable within said tubular mandrel, preventing fluid flow from uphole through said tubular mandrel in a downhole direction, biased to slidably cover said at least a pair of jetting ports when in a closed position, which when fluid pressure is supplied to said upper end of said tubular mandrel slidably moves to uncover said jetting ports;

(iv) a compressible packer member;

(v) a ‘j’ slot, located on said mandrel below said packer member, adapted to allow a pin member therein to move in a “run” position, a “set” position, and a “jetting” position;

(vi) a jaw member, positioned on said tubular member below said packer member, radially outwardly extendable when forced by a wedge-shaped element on said mandrel so as to frictionally engage said casing;

(vii) a bypass port situated in said tubular mandrel above said compressible packer;

(viii) a lower portion of said dual-acting plunger valve configured to uncover said bypass port and thereby allow fluid communication between an exterior of the tool uphole of the packer member and a hollow interior of said mandrel below said packer member when said dual-acting valve is in a position covering said jetting ports, and to close said bypass valve when said dual-acting valve is in a position uncovering said jetting ports;

wherein when said pin member in said ‘j’-slot is moved to said “run-in ” position said compressible packer member is uncompressed and said jaw member is not forceably frictionally engages said casing; and

wherein when said pin in said ‘j’-slot is moved to said “jetting” position said wedge shaped member compresses said compressible packer member and further forces said jaw member radially outwardly and in frictional engagement with said cased wellbore.

In preferred embodiments of the perforating tool, such tool comprises a plurality of jetting ports within a periphery of the tubular mandrel, all in a plane substantially perpendicular to a longitudinal axis of said tubular mandrel.

Where a plurality of jetting ports are used, such advantageously allows the creation of a series of perforations in the wellbore casing, for a single positioning of the tool at a longitudinal position within the wellbore.

Preferably, where a plurality of jetting ports are incorporated into the tool of the present invention, the jetting ports are uniformly and circumferentially spaced around said periphery.

The above summary of various aspects and embodiments of the invention does not necessarily describe the entire scope of the present invention. Other aspects, features and advantages of the invention will be apparent to those of ordinary skill in the art upon a proper review of the entire description of the invention as a whole, including the drawings and consideration of the specific embodiments of the invention described in the detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

For purposes of this disclosure and specification, including the claims, terms of direction and location used in this specification including the claims to specify location of components on the tool are with reference to the tools when placed in a vertical wellbore, although the tool is not restricted to being used in a vertical wellbore and may be placed in a deviated or horizontal wellbore.

For example, the terms “upper”, “upwardly”, “uphole”, “downhole”, “above”, “below”, and “lower” are with respect to the tool of the present invention, or relative positioning along the tool, when such tool is placed in a vertical wellbore.

The following drawings figures depict preferred and non-limiting embodiments of the invention, in which:

Fig. 1A is an exterior view of a preferred embodiment of the perforating tool of the present invention utilizing a plurality of jetting ports, a dual-acting plunger valve (not viewable from the exterior) a compressible/expandable packer member, a jaw member for temporarily anchoring the tool in the wellbore, and a bypass port, when such perforating tool is in the run-in position;

Fig. 1B is a partial sectional view of the perforating tool of **Fig. 1A**, showing the tool in the run-in position;

Fig. 2A, 2B, and 2C show sequential relative positions of the tool within a wellbore, namely for running-in the too within the wellbore, for setting the tool within the wellbore, and the position and configuration thereof for perforating the wellbore, respectively, wherein:

Fig. 2A is a partial sectional view of the perforating tool of **Fig. 1A** similar to that of Fig. 1B, showing the tool when in the "running in" position , further showing a view in the direction of arrow **"X"** on the 'j'-slot and the position of the pin member therein when in the "running-in" position;

Fig. 2B is a partial sectional view of the perforating tool of **Fig. 1A**, when the tool is in the jaw "set" position, further showing a view in the direction of arrow "**Y**" on the 'j'-slot and the position of the pin member therein when in the "set" position;

Fig. 2C is a partial sectional view of the perforating tool of Fig. 1A, when the tool is in the jetting /perforating position , further showing a view in the direction of arrow "**Z**" on the 'j'-slot and the position of the pin member therein when in the "set" position;

Fig. 3A, 3B, and 3C show enlargements of an upper portion of the tool as seen in each of respective Figs. 2A, 2B, and 2C, wherein:

Fig. 3A is an enlarged view of the upper portion of the tool , when in the "run-in" position as shown in Fig. 2A;

Fig. 3B is an enlarged view of the upper portion of the tool , when in the "set" position as shown in Fig. 2B:

Fig. 3C is an enlarged view of the upper portion of the tool , when in the "jetting" position as shown in Fig. 2C:

Figs. 4A, 4B, and 4C show enlargements of a lower portion of the tool as seen in each of respective Figs. 2A, 2B, and 2C, wherein:

Fig. 4A is an enlarged view of the lower portion of the tool when in the "run-in" position as shown in Fig. 2A, again further showing by way of an adjacent side elevation view, the 'j'-slot and the position of the pin member therein when in the "running-in" position;

Fig. 4B is an enlarged view of the lower portion of the tool , when in the "set " position as shown in Fig. 2B, again further showing by way of an adjacent side elevation view, the 'j'-slot and the position of the pin member therein when in the "set" position; and

Fig. 4C is an enlarged view of the lower portion of the tool , when in the "jetting" position as shown in Fig. 2C, again further showing by way of an adjacent side elevation view, the 'j'-slot and the position of the pin member therein when in the "jetting" position.

DETAILED DESCRIPTION OF SOME OF THE PREFERRED EMBODIMENTS OF THE PRESENT INVENTION

Fig.s 1A, 1B, 2A, 2B, 2C, 3A, 3B, 3C, and **4A, 4B, 4C** show a preferred embodiment of perforation tool **10** of the present invention, for perforating a casing **12** of a wellbore. Casing **12** is typically comprised of a plurality of hollow cylindrical segments (not shown) usually of high strength steel, which are threadably coupled together and line the wellbore.

Tool **10**, when supplied with pressurized abrasive jetting fluid **14,** exudes such high pressure abrasive fluid **14** radially outwardly in a jet **15** via one or more jetting ports **16** so as to thereby perforate the casing **12**. Preferentially, tool **10** comprises not just one but rather a plurality of jetting ports **16** uniformly and circumferentially spaced around a periphery of tubing mandrel **18,** in a plane **51** substantially perpendicular to a longitudinal axis **52** of tool **10** .

Tool **10** comprises a tubular mandrel **18**, which itself typically comprises a number of tubular segments **18', 18''** threadably connected together. Tool **10** is adapted to be threadably coupled via coupling threads **20** at an upper end **22** thereof to an end of coiled tubing or production tubing (not shown), and inserted downhole in casing **12**.

At least one jetting port **16**, and preferably a plurality of jetting ports **16**, are situated on a periphery **20** of tubular mandrel **18** of tool **10**. Jetting ports **16**, when uncovered (i.e. when jet ports **16** are thus open) allow jetting fluid **14** from an interior **24** of tubular mandrel **18** to be radially directed outwardly in a jet **15** (see **Fig. 3C**) to perforate casing **12.**

While tool **10** shown in the drawings is consistently shown as having a compressible packer member **30**, jaw members **32** for frictionally and forceably engaging the side of casing **12** , a 'j'-slot **34** (as further discussed below) , and a pin member **36** moveable in 'j'-slot **34** as further discussed below, these additional components are only present in preferred embodiments and only provide further capabilities and improve the operation of tool **10**. Tool **10**, however, in its broadest configuration does not possess nor need to possess these additional components and simply comprises jetting ports **16** which are adapted to be covered by a single acting spring-biased plunger valve **26**, which plunger valve **26** is adapted , when a pressurized fluid **14** is supplied to an upper end **22** of tool **10**, to move downwardly to thereby uncover jetting ports **16** and allow jetting fluid **14** to be forceably ejected from jetting ports **16** in a jet **15** (see **Fig. 3C**).

Likewise, in the embodiment of tool **10** shown in the drawings spring-biased plunger valve **26** is dual-acting. Specifically, spring biased plunger valve **26** is configured such that when an upper end **38** thereof is slidably positioned to cover jetting ports **16** simultaneously at a lower end **40** thereof such plunger valve uncovers and thus opens a bypass port **42**. Similarly when an upper end **38** of plunger valve **26** is slidably positioned to uncover jetting ports **16**, lower end **40** thereof covers bypass port **42** so as to thereby close bypass port **42**. Again, however, tool **10** in its broadest configuration may not possess a bypass port **42**, and/or the plunger valve **26** may not be dual-acting and only single acting to simply open and close jetting ports **16**.

Thus in its broadest embodiment, tool **10** comprises a spring-biased plunger valve **26** which is slidably moveable within tubular mandrel **18** from a first position in which a spring **44** biases such plunger valve **26** so as to cover jetting ports **16** (see **Figs. 2A, 2B** and **Figs. 3A,3B**) to a second position (ref. **Figs. 2C** and **3C**) in which pressurized fluid **14** provided to an upper end **22** of tool **10** via coil or production tubing overcomes a biasing force exerted by spring **44** and causes plunger valve **26** to move downwardly in tool **10** so as to uncover jetting ports **16**.

Advantageously, therefore, in its broadest embodiment tool **10** is able to maintain jetting ports **16** closed during run-in of tool **10** into casing **12** and thus prevent during such run-in any residual fines, sand, drill tailings, and/or other detritus within a wellbore from flowing into interior **24** of tool **10** via jetting ports **16** which detrimentally would otherwise cause plugging of jetting ports **16** and thereby prevent tool **10** from subsequently being able to perforate casing **12**.

Moreover, and also advantageously by virtue of such arrangement, jetting ports **16** may easily be subsequently opened without the need to use any other tool or need to withdraw tool **10** from casing **12**, merely by provision of an abrasive jetting fluid **14** from uphole to interior **24** of tool **10**, which then overcomes biasing force exerted on plunger valve **26** to cause plunger valve **26** to move slidably downwardly in tool **10** so as to uncover jetting ports **16** and allow perforation of casing **12** at the location of the tool **10** within casing **12.**

In a preferred embodiment, and with reference to the drawings figures, tool **10** as mentioned above advantageously is further provided with a compressible packer member **30**, jaw members **32** for frictionally and forceably engaging the side of casing **12** , a 'j'-slot **34** (as further discussed below) , and a pin member **36** moveable in 'j'-slot **34. A** radial **c**ompressible packer member **30,** typically of a compressible vulcanized rubber as may be commonly purchased, is positioned on tubular member **18** of tool **10,** below jetting ports **16.** At least one jaw member **32,** which is fixedly secured to a pin member **36,** is slidably positioned on tubular mandrel **18** below packer member **30.** Jaw member **32** is radially outwardly extendable when forced by a wedge-shaped member **46**, as shown in each of "jetting " positions illustrated in **Fig. 2C, 3C, and 4C,** to permit the tool **10** to be forceably and frictionally engaged with casing **12,** so as to secure longitudinally tool **10** within casing **12** when conducting the jetting (casing perforation step), as shown in **Fig.s 2C** and in greater detail in **Fig. 4C.**

A '**j**'-slot **34** is located on and within tubular mandrel **18** below packer member **30.** 'J'-slot **34** comprises a number of channels **34', 34"** and **34"** for guiding and containing therewithin pin member **36,** and in particular provides three (3) positions for such pin member **36** therein, namely in a first "run-in position **(see Fig. 2A** and in enlarged view in **Fig. 4A),** in a "setting" or "set" position **(Fig. 2B** and in enlarged view in **Fig. 4B),** and finally in a "jetting" position **(Fig. 2C** and in enlarged view in **Fig. 4C).**

Due to the slidable configuration of tubing mandrel **18** of tool **10** within jaw members **32**, when pin **36** in 'j'-slot **34** is in the "run-in " position within casing 12 compressible packer **30** is uncompressed and wedge-shaped member **46** immediately below packer **30** does not forceably engage jaw members **32.** Thus jaw members **46** do not forceably frictionally engage casing **12,** although light frictional engagement of jaw members **32** or other slidable "slips" **66** with casing **12** is typically always provided , such as by leaf springs **50** which cause for example slips **66** to be in constant frictional engagement with interior of casing **12** to thereby allow best operation of "j" slot **32** in the manner hereinafter described. Such light frictional engagement permits being able to reposition pin member **34** in 'j' slot **34** and thus reconfigure tool **10** from a "run -in" position(**Fig. 2A),** to a "set" position **(Fig. 2B),** and thereafter to a "jetting position" **(Fig.2C).**.

Specifically, during run-in, pin member **24** is typically within one channel **34'** of 'j' slot **34,** and further slidable movement of tubular **18** relative to jaw members **32** is prevented by pin member **36** contacting an extremity of channel **34',** as best shown in **Fig. 4A** .

Thereafter, by lifting up on tool **10,** namely by pulling in an uphole direction on tool **10** tubular mandrel **18** slides relative to jaw member **32** which remains frictionally located in casing 12, thereby causing pin member **36** to be repositioned within 'j' slot **34** and travel to second channel **34",** where further upward motion of tool **10** is then limited by pin member **36** reaching an opposite extremity in channel **34"** (see **Fig. 2B, 3B,** and as best shown in Fig. 4B).

Thereafter, by again then pushing down on upper end **22** of tool **10** pin member **36** in channel **34'''** of 'j'-slot **32** is moved to said "jetting" position (see **Fig. 2C, 3C** and **4C**), causing tubular mandrel **18** and wedge-shaped member **46** thereon to slide relative to said jaw member **32** and contact jaw member **32** so as to compress compressible packer **30** and further force said jaw member **46** radially outwardly and in frictional engagement with casing **12** to stabilize and secure tool **10** in casing **12** during supply of high pressure fluid to tool **10.** The pressurized fluid causes plunger valve 26 to move so as to uncover jetting ports **16,** thus allowing jet perforation of casing 12.

In a further preferred embodiment, shown in all drawings figures, a bypass port **42** is situated in tubular mandrel **18** above compressible packer **30.** When open, bypass port **42** provides fluid communication between an exterior of said tool **10** above compressible packer **30** and an interior **60** of tool **10** below compressible packer **30**, which bypass port **42**, during insertion (run-in) of the tool **10** into a fluid –filled casing **12**, when open allows fluid **62**, (i.e. liquid or gas) to bypass compressible packer **30** on tool **10** and travel uphole, thereby allowing tool **10** to move further downhole in casing **12**.

In such embodiment, spring-biased plunger valve **26** may further be a dual-acting plunger valve, biased via said spring to slidably cover jetting ports **16** at an upper end **38** thereof and to simultaneously leave uncovered bypass port **42** at a lower end **40** thereof when in the "run-in" position (**Figs. 2A, 3A, & 4A**). Then, when pressurized jetting fluid **14** is supplied to upper end **22** of tubular mandrel **18** under a pressure sufficient to overcome the biasing force being exerted on plunger valve **26** via spring **44**, plunger valve **26** is caused to slidably move within said tubular mandrel **18** so as to uncover at its upper end **38** jetting ports **16**, and, at its lower end **40**, to simultaneously close bypass port **42** (see **Fig 2C, 3C & 4C**).

Advantageously, in such preferred embodiment using compressible packer **30**, packer **30** when compressed in the tool jetting position as shown in **Figs. 2C, 3C, and 4C**) seals against casing **12** thereby forcing such pressurized fluid uphole where it can be recycled for re-use, thus preventing loss of abrasive jetting fluid **14** downhole.

Further advantageously, such preferred embodiment also allows use of a selectively actuated bypass port **42**, which when open (as normally the case, save during jetting/perforation step) better allows tool **10** to be more easily and quickly inserted into a wellbore by allowing gas and fluid therein to bypass packer **30**, which packer **30** even though not compressed during run-in typically effects some seal against casing **12** and thereby in absence of bypass port 42 would detrimentally substantially slow the insertion of tool **10** within a casing **12**. Likewise bypass port **42**, when open similarly allows, due to elimination of a suction effect by allowing fluid to bypass packer **30**, tool **10** to be moved uphole and be removed from within casing **12**.

Preferably, although not essential, a wiper plug **65** is positioned below jetting ports **16** and above bypass port **42** and packer **30**. Wiper plug **65** *inter alia* acts and functions as a cup seal, as shown in **Fig.'s 2C, 3C, and 4C,** to reduce or prevent amounts of pressurized abrasive fluid **15** (which typically contains sand) flowing into the region of the bypass port **42.** In particular, sand or abrasive fluid **15** if allowed to enter port **42** may otherwise inhibit or prevent movement of plunger valve **26** for purposes of opening and closing jetting ports **16** and bypass port **42,** which would thereby render tool **10** inoperative.

In a furher embodiment, immediately after perforating a casing **12**, the jetting fluid **14** may be ceased to be supplied and in its place a fracking fluid (which may have a formulation different than the pressurized abrasive jetting fluid **14**) supplied, so as to immediately allow fracturing of the formation at the location along the casing **12** of the created perforations. Such advantageously and conveniently allows the tool **10** of the present invention to both perforate and subsequently immediately frac the wellbore in the region of the perforations, thus eliminating the need to pull the perforation tool **10** from the well and subsequently insert a fracking tool into the wellbore, thus avoiding the consequent loss in time such step but in the further loss in time in having to align the fracking tool each time longitudinally within the wellbore with the created perforations in the casing **12** in order to effectively frac the wellbore at such locations.

Use of examples in the specification, including examples of terms, is for illustrative purposes only and is not intended to limit the scope and meaning of the embodiments of the invention set out and described in the disclosure. In the specification, the word "comprising" is used as an open-ended term, substantially equivalent to the phrase "including, but not limited to," and the word "comprises" has a corresponding meaning.

The scope of the claims should not be limited by the preferred embodiments set forth in the foregoing examples, but should be given the broadest interpretation consistent with the description as a whole, and the claims are not to be limited to the preferred or exemplified embodiments of the invention.

THE EMBODIMENTS IN WHICH AN EXCLUSIVE PROPERTY AND PRIVILEGE IS CLAIMED ARE SET OUT IN THE FOLLOWING CLAIMS:

1. A perforating tool for perforating a cased wellbore, comprising:

(i) a tubular mandrel;

(ii) a jetting port situated within said tubular mandrel, which port when open allows a jetting fluid from an interior of said tubular mandrel to be directed radially outwardly in a jet; and

(iii) a spring-biased plunger valve, slidably moveable within said tubular mandrel, preventing fluid flow from uphole through said tubular mandrel in a downhole direction, biased via said spring to slidably cover said jetting port, which plunger valve when pressurized jetting fluid is supplied to an upper end of said tubular mandrel sufficient to overcome said spring-bias, slidably moves in said tubular mandrel so as to uncover said jetting port and allow said pressurized jetting fluid to flow radially outwardly from said jetting port and perforate said cased wellbore.

2. A perforating tool for perforating a cased wellbore, comprising:

(i) a tubular mandrel;

(ii) a jetting port situated at an upper end of said mandrel within a periphery of said tubular mandrel which jetting port when open allows a jetting fluid from an interior of said tubular mandrel to be directed radially outwardly in a jet;

(iii) a compressible packer member positioned on said tubular mandrel below said jetting port;

(iv) a jaw member, fixedly secured to a pin member, slidably positioned on said tubular mandrel below said packer member and radially outwardly extendable when forced by a wedge-shaped member on said mandrel so as to frictionally engage said cased wellbore; and

(v) a 'j' slot for guiding and containing therewithin said pin member, said "j' slot located on said tubular mandrel below said packer member and adapted to guide said pin member therein to move from a "run-in " position, subsequently to a "set" position, and lastly to a "jetting" position;

wherein when said pin member in said 'j'-slot is in said "run-in " position said compressible packer member is uncompressed and said jaw member does not forceably frictionally engage said cased wellbore;

wherein when said pin member in said 'j'-slot is repositioned therein from said "run-in" position to said "set" position by pulling in an uphole direction on said tool said tubular mandrel slides upwardly relative to said jaw member; and

wherein when said pin member in said 'j'-slot is moved to said "jetting" position said tubular mandrel is allowed to slide relative to said jaw member so as to compress said compressible packer member and further cause said wedge-shaped member on said tubular mandrel to force said jaw member radially outwardly and in frictional engagement with said cased wellbore; and

(vi) a spring-biased plunger valve, slidably moveable within said tubular mandrel, preventing fluid flow from uphole through said tubular mandrel in a downhole direction, biased via a spring to slidably cover said jetting port, which plunger valve when pressurized jetting fluid is supplied to said upper end of said tubular mandrel at sufficient pressure to overcome said spring bias, slidably moves downward in said tubular mandrel so as to uncover said jetting port and allow said pressurized jetting fluid to flow radially outwardly therefrom and perforate said casing.

3. The perforating tool as claimed in claim 2, further comprising:

(vii) a bypass port situated in said tubular mandrel above said compressible packer, when open providing fluid communication between an exterior of said tool above said compressible packer and an interior of said tool below said compressible packer ; and

(viii) wherein said spring-biased plunger valve is a dual-acting plunger valve, biased via said spring to slidably cover said jetting port and to simultaneously leave uncovered said bypass port, but when fluid pressure is supplied to said upper end of said tubular mandrel sufficient to overcome said spring bias, to slidably move within said tubular mandrel to uncover said jetting port and to simultaneously close said bypass port.

4. A wellbore completion tool for perforating a casing of a cased wellbore, comprising:

(i) a tubular mandrel;

(ii) at least a pair of jetting ports situated at an upper end of said mandrel, positioned within a periphery of said tubular mandrel and in a plane substantially perpendicular to a longitudinal axis of said tubular mandrel, which jetting ports when open allow jetting fluid from an interior of said tubular mandrel to be directed radially outwardly in a corresponding plurality of jets;

(iii) a dual-acting spring-biased plunger valve, slidably moveable within said tubular mandrel, preventing fluid flow from uphole through said tubular mandrel in a downhole direction, biased to slidably cover said at least a pair of jetting ports when in a closed position, which when fluid pressure is supplied to said upper end of said tubular mandrel slidably moves to uncover said jetting ports;

(iv) a compressible packer member;

(v) a 'j' slot, located on said mandrel below said packer member, adapted to allow a pin member therein to move in a "run" position, a "set" position, and a "jetting" position;

(vi) a jaw member, positioned on said tubular member below said packer member, radially outwardly extendable when forced by a wedge-shaped element on said mandrel so as to frictionally engage said casing;

(vii) a bypass port situated in said tubular mandrel above said compressible packer;

(viii) a lower portion of said dual-acting plunger valve configured to uncover said bypass port and thereby allow fluid communication between an exterior of the tool uphole of the packer member and a hollow interior of said mandrel below said packer member when said dual-acting valve is in a position covering said jetting ports, and to close said bypass valve when said dual-acting valve is in a position uncovering said jetting ports;

wherein when said pin member in said 'j'-slot is moved to said "run-in " position said compressible packer member is uncompressed and said jaw member is not forceably frictionally engages said casing; and

wherein when said pin in said 'j'-slot is moved to said "jetting" position said wedge shaped member compresses said compressible packer member and further forces said jaw member radially outwardly and in frictional fixed engagement with said cased wellbore.

5. The perforating tool as claimed in claim 2, further comprising a plurality of jetting ports within a periphery of said tubular mandrel, all in a plane substantially perpendicular to a longitudinal axis of said tubular mandrel.

6. The perforating tool as claimed in claim 5 wherein said plurality of jetting ports are uniformly and circumferentially spaced around said periphery.

7. The perforating tool as claimed in claim 6, wherein an upper portion of said spring-based plunger is an upwardly-facing cone which directs said jetting fluid substantially uniformly to each of said circumferentially-spaced jetting ports.

8. The perforating tool as claimed in claim 4, further having a radial wiper seal extending about the periphery of the tool, positioned on said tool immediately above said bypass port and below said jetting ports.

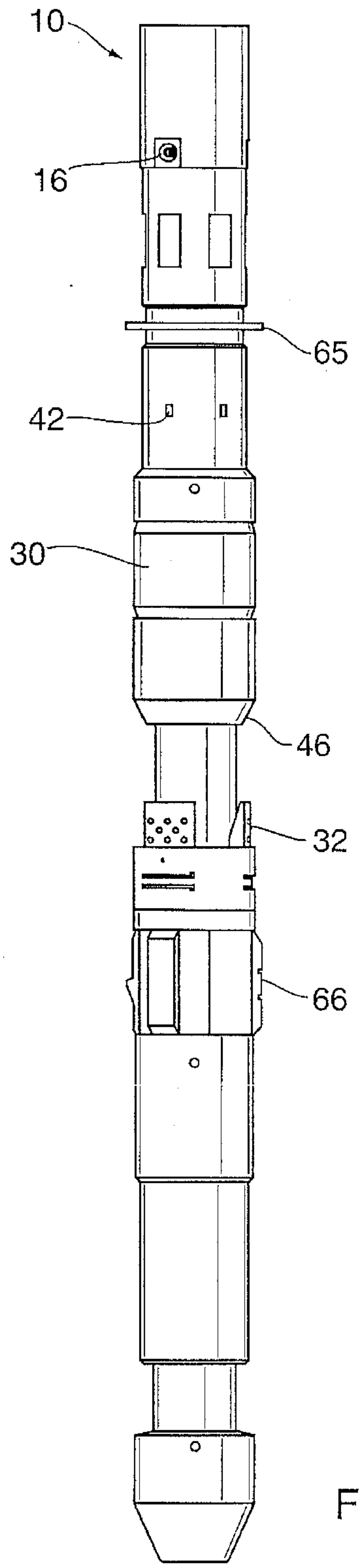
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Fig. 1A

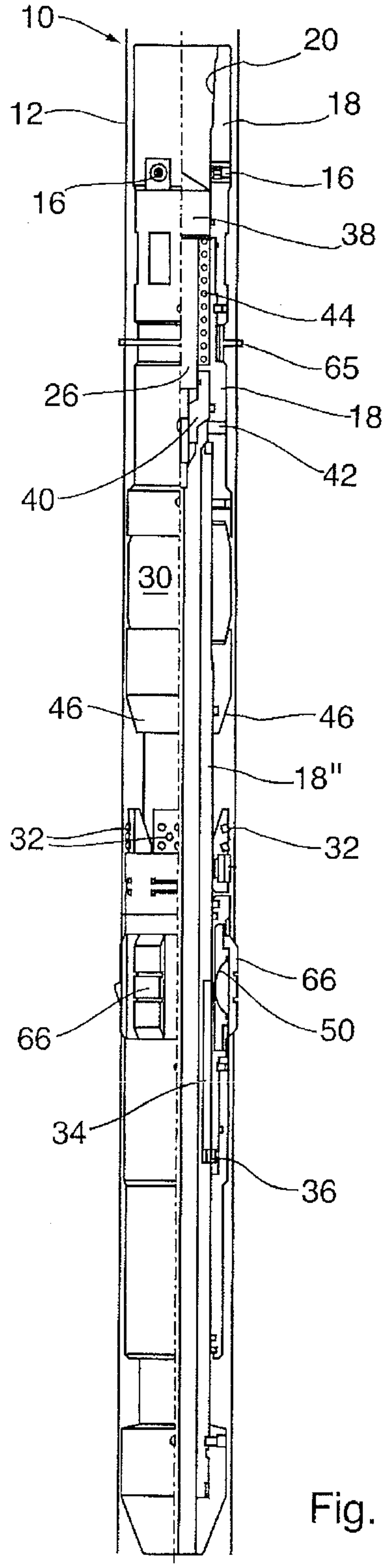
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Fig. 1B

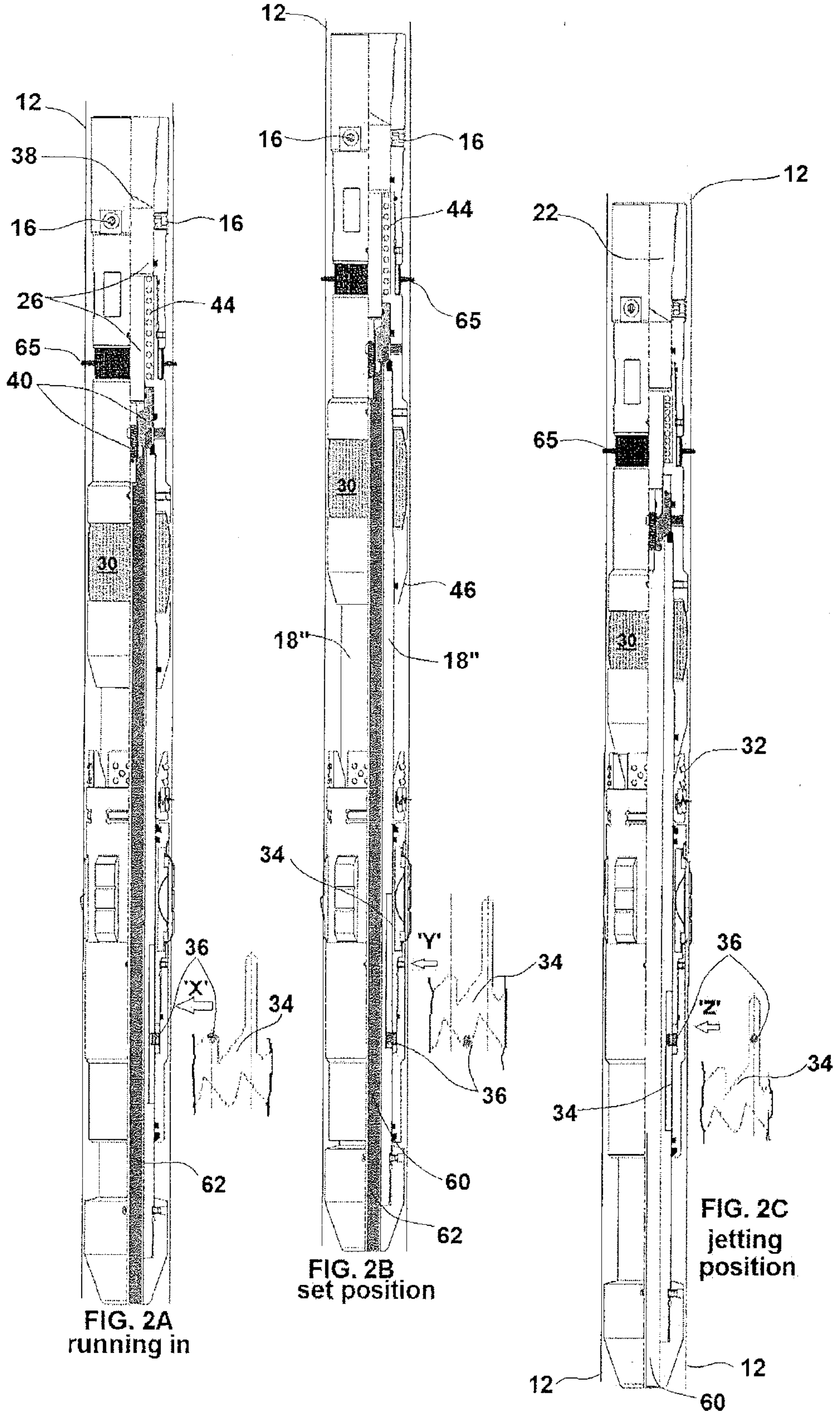


FIG. 2A
running in

FIG. 2B
set position

FIG. 2C
jetting
position

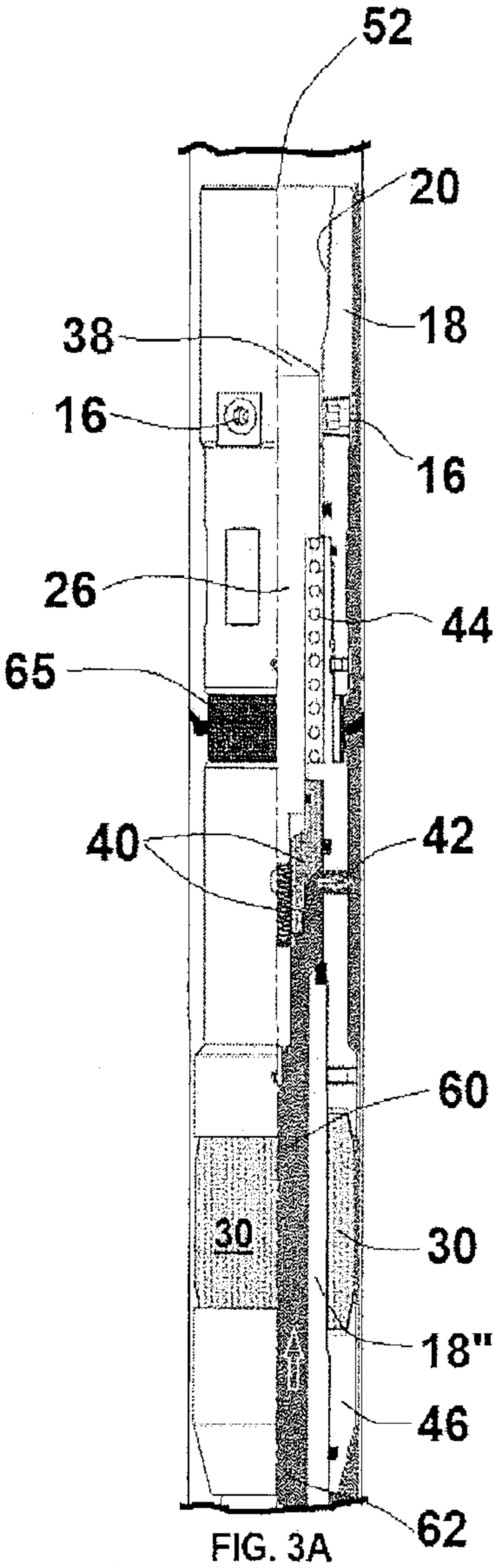


FIG. 3A
running-in

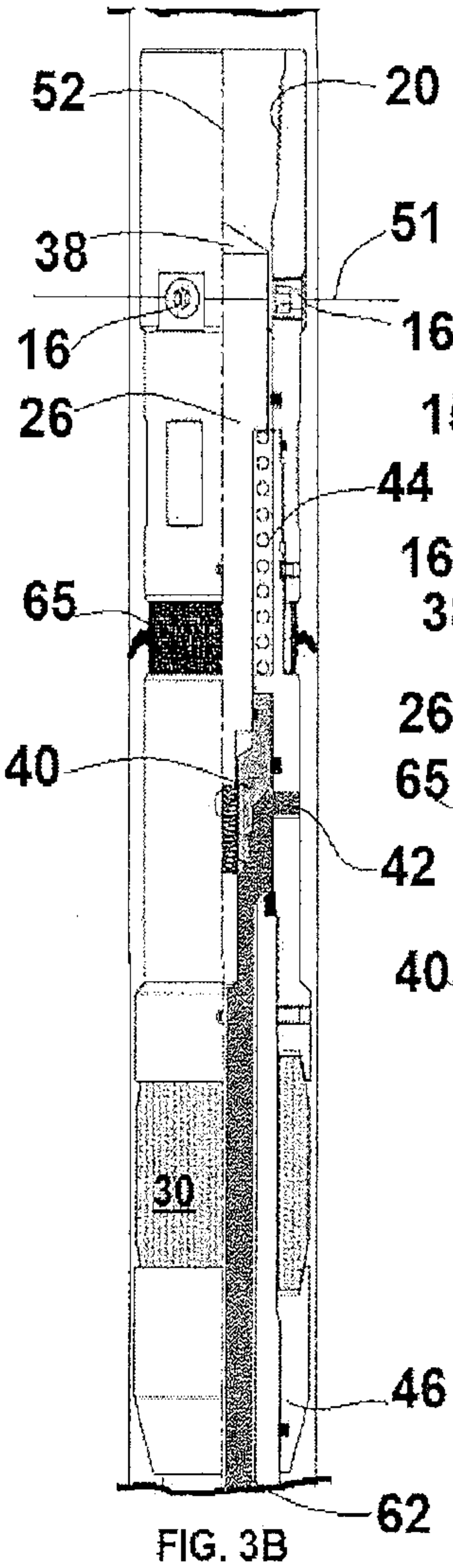


FIG. 3B
set position

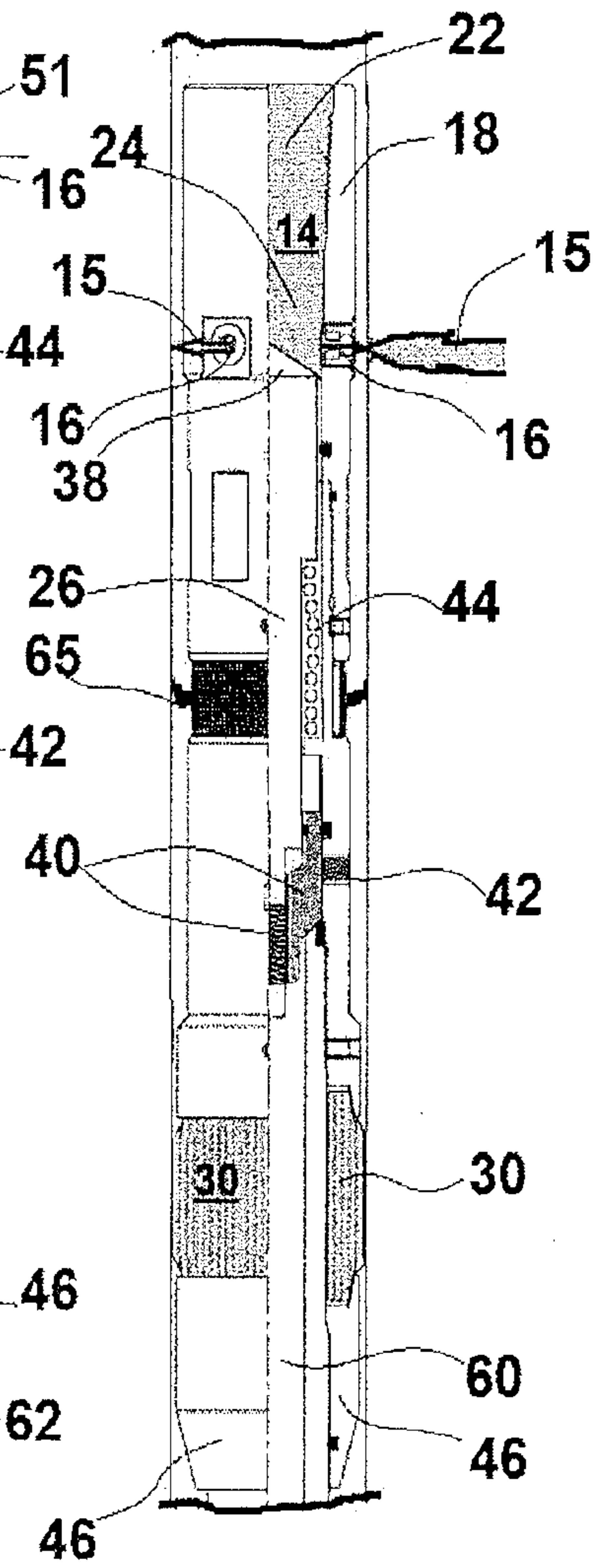


FIG. 3C
jetting position

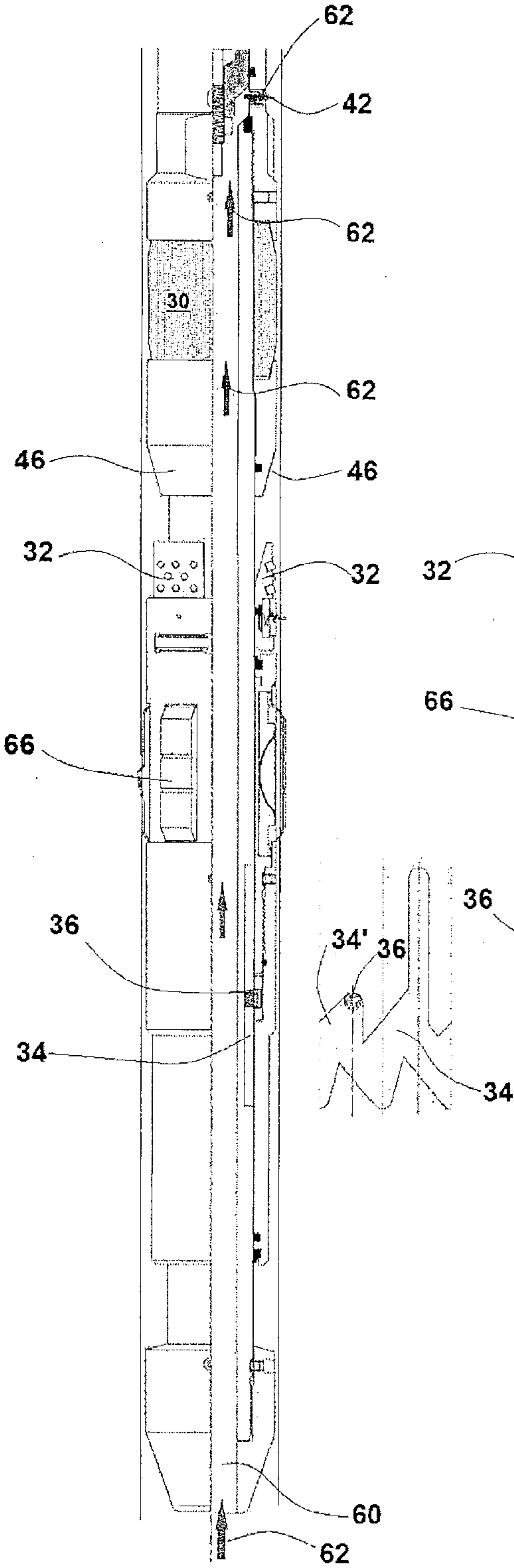


FIG. 4A

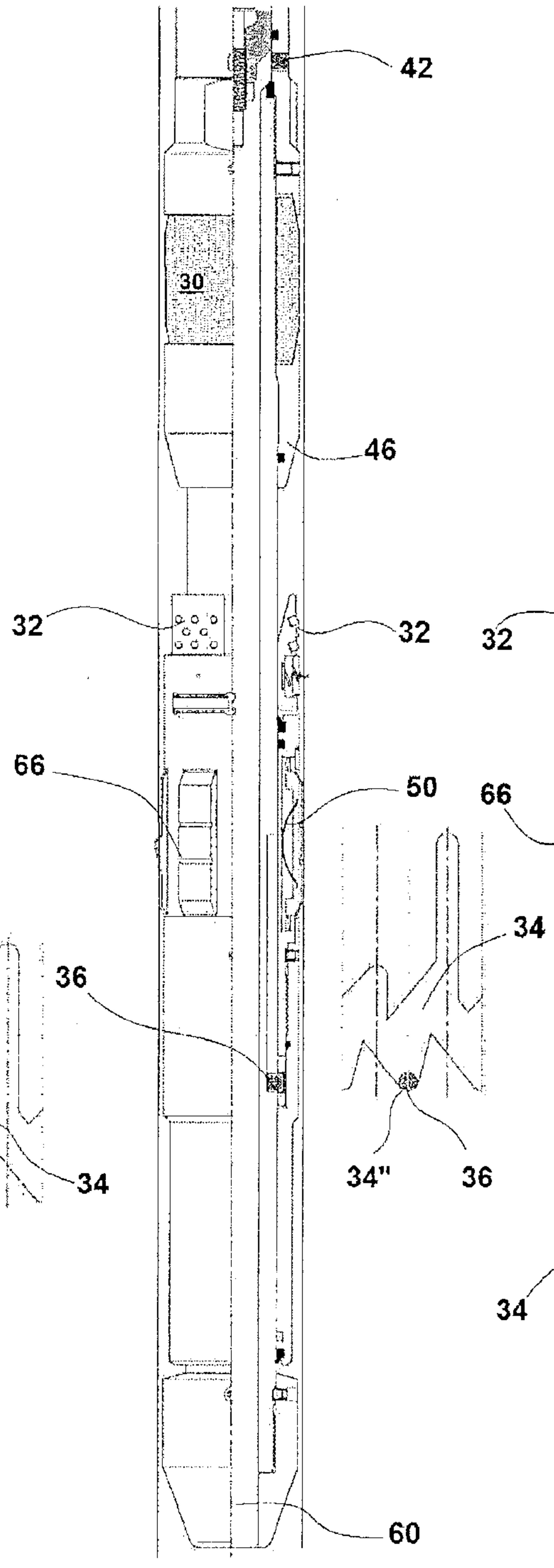


FIG. 4B

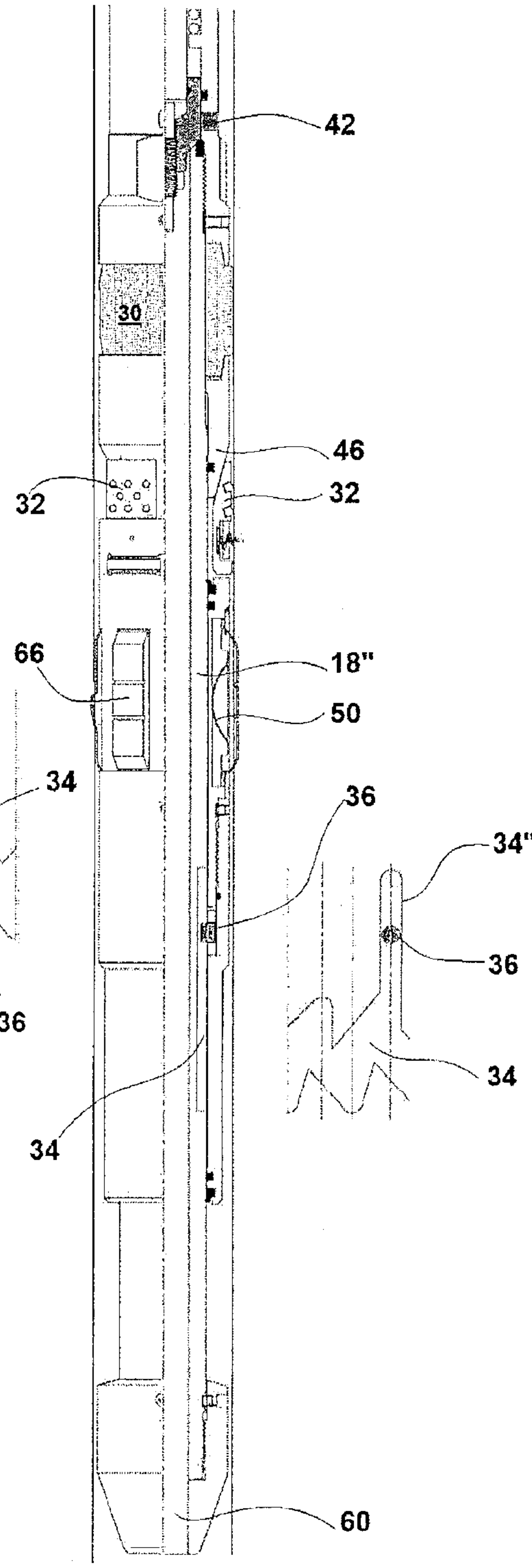
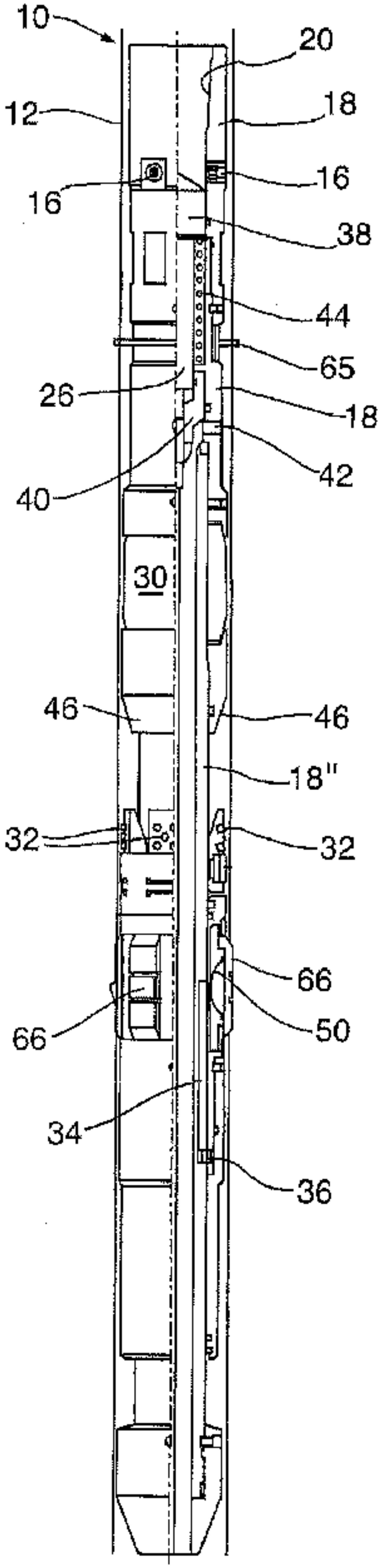


FIG. 4C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