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(54) **Flow nozzle assembly**

Düsenanordnung

Dispositif de buse

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(56) References cited:  
**WO-A-20/04018837 GB-A- 640 310**  
**GB-A- 2 178 342 US-A- 5 842 516**  
**US-A1- 2002 125 006 US-B1- 6 491 097**

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## Description

### BACKGROUND OF THE INVENTION

#### Field of the Invention

[0001] Embodiments of the present invention generally relate to methods and apparatuses for providing a more uniform gravel pack in a wellbore. More particularly, the invention relates to methods and apparatuses for providing an improved nozzle for a shunt tube.

#### Description of the Related Art

[0002] Hydrocarbon wells, especially those having horizontal wellbores, typically have sections of wellscreen comprising a perforated inner tube surrounded by a screen portion. The purpose of the screen is to block the flow of unwanted materials into the wellbore. Despite the wellscreen, some contaminants and other unwanted materials like sand, still enter the production tubing. The contaminants occur naturally and are also formed as part of the drilling process. As production fluids are recovered, the contaminants are also pumped out of the wellbore and retrieved at the surface of the well. By controlling and reducing the amount of contaminants that are pumped up to the surface, the production costs and valuable time associated with operating a hydrocarbon well will likewise be reduced.

[0003] One method of reducing the inflow of unwanted contaminants is through gravel packing. Normally, gravel packing involves the placement of gravel in an annular area formed between the screen portion of the wellscreen and the wellbore. In a gravel packing operation, a slurry of liquid, sand and gravel ("slurry") is pumped down the wellbore where it is redirected into the annular area with a cross-over tool. As the gravel fills the annulus, it becomes tightly packed and acts as an additional filtering layer along with the wellscreen to prevent collapse of the wellbore and to prevent the contaminants from entering the stream of production fluids pumped to the surface. Ideally, the gravel will be uniformly packed around the entire length of the wellscreen, completely filling the annulus. However, during gravel packing, the slurry may become less viscous due to loss of fluid into the surrounding formations or into the wellscreen. The loss of fluid causes sand bridges to form. Sand bridges are a wall bridging the annulus and interrupting the flow of the slurry, thereby preventing the annulus from completely filling with gravel.

[0004] The problem of sand bridges is illustrated in FIG. 1, which is a side view, partially in section of a horizontal wellbore with a wellscreen therein. The wellscreen 30 is positioned in the wellbore 14 adjacent a hydrocarbon bearing formation therearound. An annulus 16 is formed between the wellscreen 30 and the wellbore 14. The Figure illustrates the path of gravel 13 as it is pumped down the production tubing 11 in a slurry and into the

annulus 16 through a crossover tool 33.

[0005] Also illustrated in FIG. 1 is a formation including an area of highly permeable material 15. The highly permeable area 15 can draw liquid from the slurry, thereby dehydrating the slurry. As the slurry dehydrates in the permeable area 15 of the formation, the remaining solid particles form a sand bridge 20 and prevent further filling of the annulus 16 with gravel. As a result of the sand bridge, particles entering the wellbore from the formation are more likely to enter the production string and travel to the surface of the well. The particles may also travel at a high velocity, and therefore more likely to damage and abrade the wellscreen components.

[0006] In response to the sand-bridging problem, shunt tubes have been developed creating an alternative path for gravel around a sand bridge. According to this conventional solution, when a slurry of sand encounters a sand bridge, the slurry enters an apparatus and travels in a tube, thereby bypassing the sand bridge to reenter the annulus downstream. A solution of this type is described for example in US-A-5 842 516.

[0007] FIG. 2 is a sectional view of a prior art nozzle assembly 50 disposed on a shunt tube 55. The construction for an exit point from the shunt tube 55 involves drilling a hole 80 in the side of the tube, typically with an angled aspect, in approximate alignment with the slurry flow path 75, to facilitate streamlined flow. The nozzle assembly 50, having a tubular outer jacket 65, and a tubular carbide insert 60, is held in alignment with the drilled hole 80, and the outer jacket is attached to the tube 55, in alignment with the drilled hole 80. The nozzle assembly 50 also has an angled aspect, pointing downward and outward, away from the tube 55. Sand slurry exiting the tube 55 through the nozzle 50 is routed through the carbide insert 60, which is resistant to damage from the highly abrasive slurry.

[0008] Both the method of constructing the nozzle 50 and the nozzle itself suffer from significant drawbacks. Holding the nozzle assembly 50 in correct alignment while welding is cumbersome. A piece of rod (not shown) must be inserted through the nozzle assembly 50, into the drilled hole 80, to maintain alignment. This requires time, and a certain level of skill and experience. During welding, the nozzle assembly 50 can shift out of exact alignment with the drilled hole in the tube due to either translational or rotational motion. After welding, exact alignment between the nozzle 50 and the drilled hole 80 is not assured. Because the carbide insert 60 actually sits on the surface of the tube 55, the hole 80 in the tube wall is part of the exit flow path 75. Abrasive slurry, passing through the hole, may cut through the relatively soft tube 55 material, and bypass the carbide insert 60 entirely, causing tube failure.

[0009] WO 2004/018837 shows an injection string being provided with removable nozzle inserts which comprise through-going openings and which are disposed radially within bores in the pipe of the wall of the injection

string. The bores are provided with internal threads matching external threads on the inserts. This type of nozzles, which constitute a flow control device for the injection string, proves, however, ill suited for a gravel pack operation.

[0010] Therefore, there exists a need for an improved nozzle assembly for a shunt tube and a method for attaching the nozzle to the shunt tube.

### SUMMARY OF THE INVENTION

[0011] The present invention generally provides apparatuses and methods for an improved shunt nozzle which is part of an alternative pathway for a slurry to by-pass an obstruction such as a sand bridge during gravel packing.

[0012] In one aspect of the invention, a nozzle assembly is provided for use in a tool having a hole through a wall of the tool, comprising: an insert configured to at least partially line the hole and seat on a surface of the wall proximate the hole, thereby restraining movement of the insert relative to the tool.

[0013] Preferably, the insert comprises a first portion; and a shoulder portion between the first portion and a lip portion, wherein the shoulder portion is configured to seat on the surface of the wall proximate the hole. Further, the lip portion may be configured to at least partially line the hole and comprise a tapered portion that is configured to form an interference fit with a surface of the wall defining the hole. The nozzle assembly may further comprise a jacket having a bore therethrough and a recessed portion for receiving the first portion of the insert. The nozzle may be constructed from a relatively hard material, such as a carbide material. The insert may have a bore therethrough and may be configured so that a center of the bore will be substantially aligned with a center of the hole when the insert is seated on the wall of the tool.

[0014] In another aspect, a nozzle assembly is provided for use in a tool having a hole through the wall of the tool, comprising: an insert having a bore therethrough, wherein the insert is configured to mate with the tool so that a center of the bore is held in substantial alignment with a center of the hole.

[0015] In another aspect, a method is provided for attaching a nozzle assembly to a tool, comprising: inserting an insert into a hole in a wall of the tool until the insert seats on a surface of the wall proximate the hole, thereby lining at least a portion of the hole with the insert and restraining movement of the insert relative to the tool.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0016] So that the manner in which the above recited features of the present invention can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to embodiments, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended

drawings illustrate only typical embodiments of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

5 [0017] FIG. 1 is a side view, partially in section of a horizontal wellbore with a wellscreen therein.

[0018] Figure 2 is a sectional view of a prior art flow nozzle configuration.

10 [0019] Figure 3 is a top end view of a gravel pack apparatus, according to one embodiment of the present invention, positioned within a wellbore. Figure 3A is a sectional view, taken along line 3A-3A of FIG. 3, of the gravel pack apparatus positioned within wellbore adjacent a highly permeable area of a formation. FIG. 3B is a schematic of one of the shunts showing the placement of nozzles along the shunt.

15 [0020] FIG. 4 is a sectional view of a nozzle assembly, according to one embodiment of the present invention, disposed on one of the shunts. FIG. 4A is an enlargement of a portion of FIG. 4 indicated by the dotted oval labeled 4A.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

25 [0021] FIG. 3 is a top end view of a gravel pack apparatus 100, according to one embodiment of the present invention, positioned within wellbore 14. FIG. 3A is a sectional view, taken along line 3A-3A of FIG. 3, of the gravel pack apparatus 100 positioned within wellbore 14 adjacent the highly permeable area 15 of a formation. Although apparatus 100 is shown in a horizontal wellbore, it can be utilized in any wellbore. Apparatus 100 may have a "cross-over" sub 33 (see FIG. 1) connected to its upper end which, in turn, is suspended from the surface on a tubing or work string (not shown). Apparatus 100 can be of one continuous length or it may consist of sections (e.g. 6, 1 meter [20 foot sections]) connected together by subs or blanks (not shown). Preferably, all components of the apparatus 100 are constructed from a low carbon or a chrome steel unless otherwise specified, however, the material choice is not essential to the invention.

30 [0022] Apparatus 100 includes a wellscreen assembly 105. As shown, wellscreen assembly 105 comprises a base pipe 110 having perforations 120 through a wall thereof. Wound around an outer side of the base pipe 110 is a wire wrap 125 configured to permit the flow of fluids therethrough while blocking the flow of particulates. Alternatively, wellscreen assembly 105 may be any structure commonly used by the industry in gravel pack operations which permit flow of fluids therethrough while blocking the flow of particulates (e.g. commercially-available screens, slotted or perforated liners or pipes, screened pipes, prepacked screens and/or liners, or combinations thereof).

35 [0023] Also disposed on the outside of the base pipe 110 are two shunts 145. The number and configuration

of shunts 145 is not essential to the invention. The shunts 145 may be secured to the base pipe 110 by rings (not shown). At an upper end (not shown) of the apparatus 100, each shunt 145 is open to the annulus. Each one of the shunts 145 is rectangular with a flow bore there-through, however, the shape of the shunts is not essential to the invention. Disposed on a sidewall of each shunt is a nozzle 150.

**[0024]** FIG. 3B is a schematic of one of the shunts 145 showing the placement of nozzles 150 along the shunt 145. As shown, a plurality of nozzles 150 are disposed axially along each shunt 145. Each nozzle 150 provides slurry fluid communication between one of the shunts 145 and an annulus 16 between the wellscreen 105 and the wellbore 14. As shown, the nozzles 150 are oriented to face an end of the wellbore 14 distal from the surface (not shown) to facilitate streamlined flow of the slurry 13 therethrough.

**[0025]** Disposed on the outside of base pipe 110 are a plurality of centralizers 130. Disposed on the centralizers 130, at an end distal from the base pipe 110, is a tubular shroud 135 having perforations 140 through the wall thereof. The shroud protects shunts 145 and wellscreen 105 from damage during insertion of the apparatus 100 into the wellbore. The perforations 140 are configured to allow the flow of slurry 13 therethrough.

**[0026]** In operation, apparatus 100 is lowered into wellbore 14 on a workstring and is positioned adjacent a formation. A packer 18 (see FIG. 1) is set as will be understood by those skilled in the art. Gravel slurry 13 is then pumped down the workstring and out the outlet ports in cross-over sub 33 to fill the annulus 16 between the wellscreen 105 and the wellbore 14. Since shunts 145 are open at their upper ends, the slurry 13 will flow into both the shunts and the annulus 16. As the slurry 13 loses liquid to the high permeability portion 15 of the formation, the gravel carried by the slurry 13 is deposited and collects in the annulus 16 to form the gravel pack. If the liquid is lost to a permeable stratum 15 in the formation before the annulus 16 is filled, the sand bridge 20 is likely to form which will block flow through the annulus 16 and prevent further filling below the bridge. If this occurs, the gravel slurry will continue flowing through the shunts 145, bypassing the sand bridge 20, and exiting the various nozzles 150 to finish filling annulus 16. The flow of slurry 13 through one of the shunts 145 is represented by arrow 102.

**[0027]** FIG. 4 is a sectional view of a nozzle assembly 150, according to one embodiment of the present invention, disposed on one of the shunts 145. FIG. 4A is an enlargement of a portion of FIG. 4 indicated by the dotted oval labeled 4A. The nozzle assembly 150 comprises an insert 160 with a flow bore therethrough, that features a lip 160a that extends into a drilled hole 170 in a wall of the shunt 145, thereby lining a surface 145a of the shunt wall that defines the hole 170. Preferably, the insert is made from a hard material, i.e., carbide, relative to the material of the shunt 145. As shown, the length of the lip

160a is substantially the same as the wall thickness of the shunt 145. However, the lip 160a may be substantially longer or shorter than the wall thickness of the shunt 145. Preferably, the lip 160a features a slight taper on an outer surface 160c for seating on the surface 145a of the shunt wall, thereby providing a slight interference fit, however, the taper is not essential to the invention. The insert 160 also features a shoulder 160b which seats with a surface 145b of the shunt wall proximate the hole 170, thereby providing a rigid stop limiting the depth to which lip 160a can penetrate the shunt 145. An outer jacket 155 having a flow bore therethrough and a recess configured to receive a portion of the insert 160 may then be easily slipped on and secured to the shunt 145 with a weld 165. Preferably, the outer jacket 155 and insert 160 are tubular members, however, their shape is not essential to the invention. Preferably, the hole 170 is not perpendicular to the surface 145b of the shunt proximate the hole, however, the hole may be perpendicular to the surface of the shunt proximate the hole.

**[0028]** Assembly of the nozzle assembly 150 is as follows. The insert 160 is inserted into the hole 170 until the taper 160c of the hard insert 160 is press fit with the shunt surface 145a defining the hole 170 and the shoulder 160b is seated on the shunt surface 145b proximate the hole 170, so that the lip 160a lines the surface 145a and the insert 160 is secured to the shunt 145. The outer jacket 155 can be disposed over an outer surface of the insert 160 and securely welded with minimal handling. Assembly time is greatly reduced, as is the required skill level of the assembler. Once seated, the nozzle assembly 150 is restrained from translating or rotating relative to the shunt 145. Alignment of the insert bore and the jacket bore with the drilled hole 170 in the shunt 145 is assured. Sand slurry 13 exiting the tube, represented by arrows 175, passes through the lip 160a of the hard insert, not the surface 145a of the hole 170. The possibility of flow cutting the surface 145a of the hole 170 is greatly diminished.

**[0029]** As shown, the nozzle assembly 150 is used with a shunt 145 of a gravel pack apparatus 100, however, the nozzle assembly 150 may be used with various other apparatuses.

**[0030]** While the foregoing is directed to embodiments of the present invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

## Claims

1. An apparatus for use in a wellbore, comprising:

a wellscreen assembly (105) configured to permit the flow of fluid therethrough while blocking the flow of particulates; and  
a shunt (145) disposed along an outer surface

of the wellscreen assembly, the shunt comprising:

a wall (145a),  
a bore therethrough, and  
a plurality of holes (170) disposed through  
the wall and axially along the shunt;  
a plurality of nozzles (150);

said apparatus being **characterized in that**  
each nozzle comprises:

an insert (160) at least partially lining a re-  
spective hole and seated on a surface  
(145b) of the wall proximate the respective  
hole, thereby restraining movement of the  
insert relative to the wall,

wherein each insert comprises a first portion, and  
a shoulder portion (160b) between the first portion  
and a lip portion (160a), wherein the shoulder portion  
is seated on the surface of the wall proximate the  
respective hole, and  
wherein each nozzle further comprises a jacket (155)  
having a bore therethrough and a recessed portion  
that receives the first portion of the insert.

2. The apparatus of claim 1, wherein each lip portion  
at least partially lines the hole and comprises a tapered  
portion (160c) that forms an interference fit with  
[[a]] surface of the wall (145a) defining the hole.
3. The apparatus of claim 14, further comprising a weld  
(165) disposed between an outer surface of each  
jacket and the surface of the wall.
4. The apparatus of claim 1, wherein each hole is not  
perpendicular to the surface of the wall proximate  
the hole.
5. The apparatus of claim 1, wherein each insert has a  
bore therethrough and a center of the insert bore is  
substantially aligned with a center of the respective  
hole by the insert being seated on the wall of the  
shunt.
6. The apparatus of claim 1, wherein the length of each  
lip portion substantially corresponds to the thickness  
of the wall.
7. The apparatus of claim 1, wherein each insert is con-  
structed from a material substantially harder than a  
material of the shunt.
8. The apparatus of claim 1, wherein each insert is con-  
structed from a carbide material.
9. The apparatus of claim 1, further comprising a per-

forated tubular shroud disposed around the well-  
screen assembly and the shunt.

10. The apparatus of claim 5, wherein all of the insert  
bores are uniform.

11. A method of using the apparatus of claim 1, com-  
prising:

assembling the apparatus with production tub-  
ing;  
running the production tubing into the wellbore  
so that the apparatus is adjacent a hydrocarbon  
bearing formation; and  
pumping slurry into an annulus defined between  
the apparatus and the wellbore;  
diverting at least a portion of the slurry into the  
shunt, wherein the diverted portion exits the  
shunt into the annulus via the nozzles, thereby  
packing gravel in the annulus.

12. The method of claim 11, further comprising:

producing hydrocarbons through the gravel  
pack and the wellscreen assembly.

## Patentansprüche

1. Vorrichtung zum Einsatz in einem Bohrloch, die um-  
fasst:

eine Bohrlochsiebanordnung (wellscreen as-  
sembly) (105), die so aufgebaut ist, dass sie den  
Strom von Fluid durchlässt, den Strom von Teil-  
chen jedoch blockiert; und  
eine Abzwegleitung (145), die an einer Außen-  
fläche der Bohrlochsiebanordnung angeordnet  
ist, wobei die Abzwegleitung umfasst:

eine Wand (145a),  
eine Bohrung durch sie hindurch, und  
eine Vielzahl von Löchern (170), die durch  
die Wand hindurch und axial entlang der Ab-  
zwegleitung angeordnet sind;  
eine Vielzahl von Düsen (150);

wobei die Vorrichtung **dadurch gekennzeichnet  
ist, dass** jede Düse umfasst:

einen Einsatz (160), der ein entsprechendes  
Loch wenigstens teilweise auskleidet und an ei-  
ner Fläche (145b) der Wand nahe an dem ent-  
sprechenden Loch aufgenommen ist, um so Be-  
wegung des Einsatzes relativ zu der Wand ein-  
zuschränken,

wobei jeder Einsatz umfasst:

- einen ersten Abschnitt; und  
einen Schulterabschnitt (160b) zwischen dem  
ersten Abschnitt und einem Lippenabschnitt  
(160a), wobei der Schulterabschnitt an einer  
Fläche der Wand nah an dem entsprechenden  
Loch aufgenommen ist, und 5
- wobei jede Düse des Weiteren eine Ummantelung  
(155) umfasst, die eine Bohrung durch sie hindurch  
und einen ausgesparten Abschnitt aufweist, der den  
ersten Abschnitt des Einsatzes aufnimmt. 10
2. Vorrichtung nach Anspruch 1, wobei jeder Lippen-  
abschnitt das Loch wenigstens teilweise auskleidet  
und einen konischen Abschnitt (160c) umfasst, der  
eine Presspassung mit einer Fläche der Wand  
(145a) bildet, die das Loch begrenzt. 15
3. Vorrichtung nach Anspruch 1, die des Weiteren eine  
Schweißnaht (165) umfasst, die zwischen einer Au-  
ßenfläche jeder Ummantelung und der Fläche der  
Wand angeordnet ist. 20
4. Vorrichtung nach Anspruch 1, wobei nicht jedes  
Loch senkrecht zu der Fläche der Wand nah an dem  
Loch ist. 25
5. Vorrichtung nach Anspruch 1, wobei jeder Einsatz  
eine Bohrung durch selbigen hindurch aufweist und  
eine Mitte der Einsatz-Bohrung im Wesentlichen mit  
einer Mitte des entsprechenden Lochs fluchtend ist,  
da der Einsatz an der Wand der Abzweigung auf-  
genommen ist. 30
6. Vorrichtung nach Anspruch 1, wobei die Länge jedes  
Lippenabschnitts im Wesentlichen der Dicke der  
Wand entspricht. 35
7. Vorrichtung nach Anspruch 1, wobei jeder Einsatz  
aus einem Material besteht, das im Wesentlichen  
härter ist als ein Material der Abzweigung. 40
8. Vorrichtung nach Anspruch 1, wobei jeder Einsatz  
aus einem Karbidmaterial aufgebaut ist. 45
9. Vorrichtung nach Anspruch 1, die des Weiteren ein-  
nen perforierten röhrenförmigen Schutzmantel um-  
fasst, der um die Bohrlochsiebordnung und die  
Abzweigung herum angeordnet ist. 50
10. Vorrichtung nach Anspruch 7, wobei alle Einsatz-  
bohrungen einheitlich sind.
11. Verfahren zum Einsatz der Vorrichtung nach An-  
spruch 1, das umfasst: 55
- Zusammensetzen der Vorrichtung mit Steig-  
rohr;
- Führen des Steigrohrs in das Bohrloch, so dass  
die Vorrichtung an eine Kohlenwasserstoff füh-  
rende Formation angrenzt; und  
Pumpen von Schlamm in einen Ringraum, der  
zwischen der Vorrichtung und dem Bohrloch  
ausgebildet ist;  
Ableiten wenigstens eines Teils des Schlammes  
in die Abzweigung, wobei der abgeleitete Teil  
aus der Abzweigung über die Düsen in den  
Ringraum austritt und so den Ringraum mit Kies  
füllt.
12. Verfahren nach Anspruch 11, das des Weiteren um-  
fasst:
- Fördern von Kohlenwasserstoffen durch die  
Kiesfüllung und die Bohrlochsiebordnung  
hindurch.

### Revendications

1. Appareil destiné à être utilisé dans un forage,  
comprenant :

un ensemble de filtre de puits (105) configuré  
pour permettre l'écoulement du fluide à travers  
celui-ci tout en bloquant l'écoulement des  
particules ; et  
une dérivation (145) disposée le long d'une sur-  
face externe de l'ensemble de filtre de puits, la  
dérivation comprenant :

une paroi (145a),  
un alésage à travers celle-ci, et  
une pluralité de trous (170) disposés à tra-  
vers la paroi et axialement le long de la  
dérivation ;  
une pluralité de buses (150) ;  
ledit appareil étant **caractérisé en ce que**  
chaque buse comprend :

un insert (160) recouvrant au moins  
partiellement un trou respectif et instal-  
lé sur une surface (145b) de la paroi à  
proximité du trou respectif, limitant ainsi  
le mouvement de l'insert par rapport à  
la paroi,

dans lequel chaque insert comprend :

une première partie ; et  
une partie d'épaulement (160b) entre la premiè-  
re partie et une partie de lèvre (160a), dans le-  
quel la partie d'épaulement est installée sur la  
surface de la paroi à proximité du trou respectif,  
et

dans lequel chaque buse comprend en outre une chemise (155) ayant un alésage à travers celle-ci et une partie évidée qui reçoit la première partie de l'insert.

2. Appareil selon la revendication 1, dans lequel chaque partie de lèvre recouvre au moins partiellement le trou et comprend une partie progressivement rétrécie (160c) qui forme un ajustement avec serrage avec une surface de la paroi (145a) définissant le trou. 10
3. Appareil selon la revendication 14 comprenant en outre une soudure (165) disposée entre une surface externe de chaque chemise et la surface de la paroi. 15
4. Appareil selon la revendication 1, dans lequel chaque trou n'est pas perpendiculaire à la surface de la paroi à proximité du trou. 20
5. Appareil selon revendication 1, dans lequel chaque insert a un alésage à travers celui-ci et un centre de l'alésage d'insert est sensiblement aligné avec un centre du trou respectif grâce à l'insert qui est installé sur la paroi de la dérivation. 25
6. Appareil selon la revendication 1, dans lequel la longueur de chaque partie de lèvre correspond sensiblement à l'épaisseur de la paroi. 30
7. Appareil selon la revendication 1, dans lequel chaque insert est construit à partir d'un matériau sensiblement plus dur qu'un matériau de la dérivation.
8. Appareil selon la revendication 1, dans lequel chaque insert est construit à partir d'un matériau de carbure. 35
9. Appareil selon la revendication 1, comprenant en outre un flasque tubulaire perforé disposé autour de l'ensemble de filtre de puits et de la dérivation. 40
10. Appareil selon la revendication 5, dans lequel tous les alésages d'insert sont uniformes. 45
11. Procédé d'utilisation de l'appareil selon la revendication 1, comprenant les étapes consistant à :

assembler l'appareil avec la colonne de production ; 50

faire fonctionner la colonne de production dans le forage de sorte que l'appareil est adjacent à une formation de gisement d'hydrocarbure ; et pomper la boue dans un espace annulaire défini entre l'appareil et le forage ; 55

écarter au moins une partie de la boue dans la dérivation, dans lequel la partie écartée sort de la dérivation dans l'espace annulaire via les bu-

ses, filtrant ainsi le gravier dans l'espace annulaire.

12. Appareil selon la revendication 11, comprenant en outre l'étape consistant à :

produire des hydrocarbures par l'intermédiaire du filtre à gravier et de l'ensemble de filtre de puits.



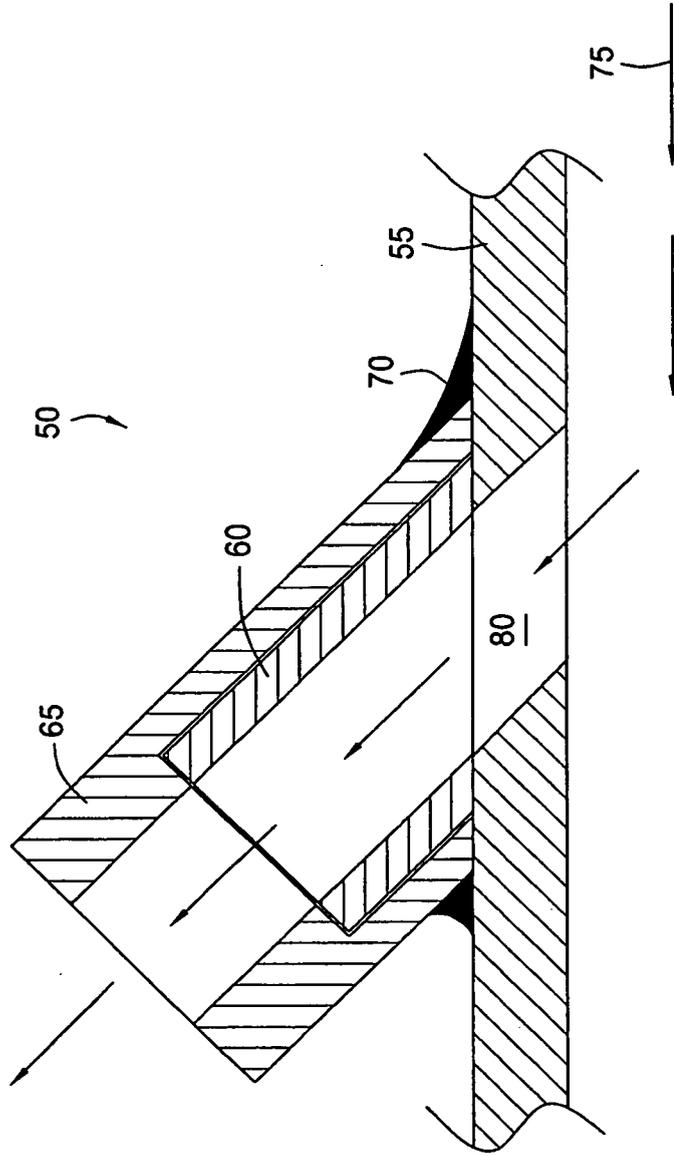


FIG. 2  
(PRIOR ART)

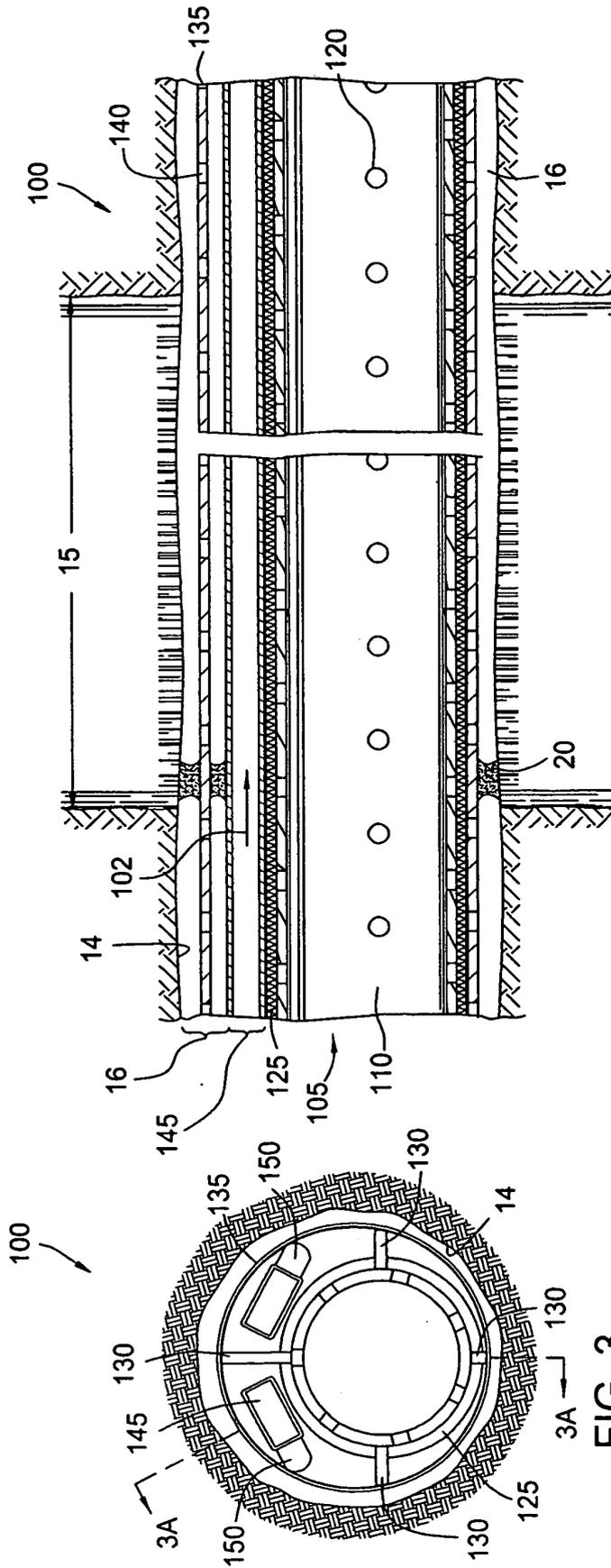


FIG. 3A

FIG. 3B

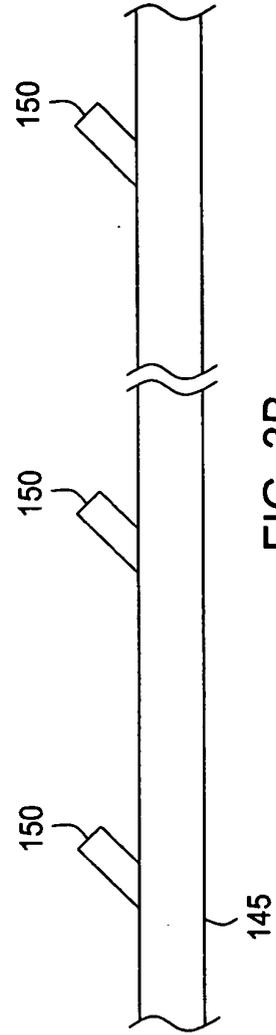


FIG. 3B

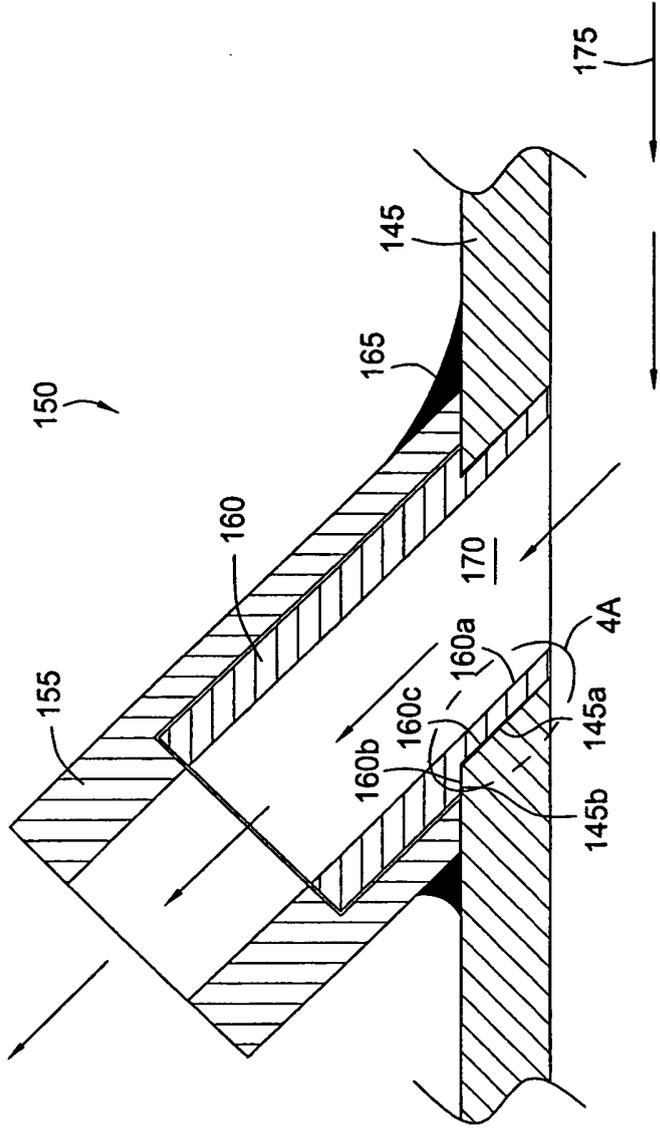


FIG. 4

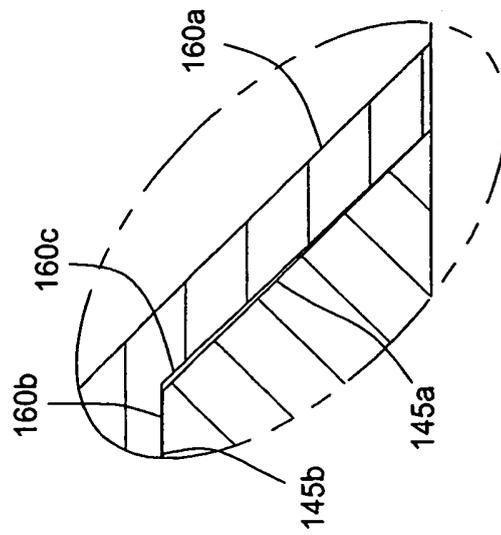


FIG. 4A

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- US 5842516 A [0006]
- WO 2004018837 A [0009]