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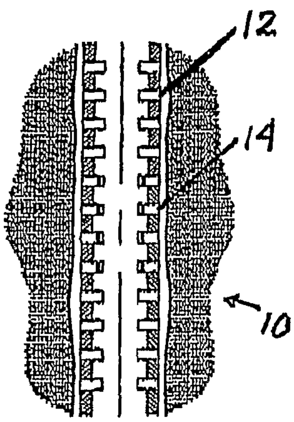
(54) **Title:** COMPLETION WITH TELESCOPING PERFORATION & FRACTURING TOOL



(57) **Abstract:** An apparatus and method for perforating a liner, fracturing a formation, and injecting or producing fluid, all in one trip with a single tool. The tool has a plurality of outwardly telescoping elements (12, 14) for perforation and fracturing. The tool also has a mechanical control device for selectively controlling the fracturing of the formation and the injection or producing of fluids through the telescoping elements.

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TITLE OF THE INVENTION

Completion with Telescoping Perforation & Fracturing Tool

CROSS REFERENCE TO RELATED APPLICATIONS

Not Applicable

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

BACKGROUND OF THE INVENTION

Field of the Invention - The present invention is in the field of apparatus and methods used in fracturing an underground formation in an oil or gas well, and producing hydrocarbons from the well or injecting fluids into the well.

Background Art - In the drilling and completion of oil and gas wells, it is common to position a liner in the well bore, to perforate the liner at a desired depth, to fracture the formation at that depth, and to provide for the sand free production of hydrocarbons from the well or the injection of fluids into the well. These operations are typically performed in several steps, requiring multiple trips into and out of the well bore with the work string. Since rig time is expensive, it would be helpful to be able to perform all of these operations with a single tool, and on a single trip into the well bore.

BRIEF SUMMARY OF THE INVENTION

The present invention provides a tool and method for perforating a well bore liner, fracturing a formation, and producing or injecting fluids, all in a single trip. The apparatus includes a tubular tool body having a plurality of radially outwardly telescoping tubular elements, with a mechanical means for selectively controlling the hydrostatic fracturing of the formation through one or more of the telescoping elements and for selectively controlling the sand-free injection or production of fluids through one or more of the telescoping elements. The mechanical control device can be either one or more shifting sleeves, or one or more check valves.

One embodiment of the apparatus has a built-in sand control medium in one or more of the telescoping elements, to allow for injection or production, and a check valve in one or more of the telescoping elements, to allow for one way flow to hydrostatically fracture the formation without allowing sand intrusion after fracturing.

Another embodiment of the apparatus has a sleeve which shifts between a fracturing position and an injection/production position, to convert the tool between these two types of operation. The sleeve can shift longitudinally or it can rotate.

The sleeve can be a solid walled sleeve which shifts to selectively open and close the different telescoping elements, with some telescoping elements having a built-in sand control medium (which may be referred to in this case as "sand control elements") and other telescoping elements having no built-in sand control medium (which may be referred to in this case as "fracturing elements").

Or, the sleeve itself can be a sand control medium, such as a screen, which shifts to selectively convert the telescoping elements between the fracturing mode and the injection/production mode. In this embodiment, none of the telescoping elements would have a built-in sand control medium.

Or, the sleeve can have ports which are shifted to selectively open and close the different telescoping elements, with some telescoping elements having a built-in sand control medium (which may be referred to in this case as "sand control elements") and other telescoping elements having no built-in sand control medium (which may be referred to in this case as "fracturing elements"). In this embodiment, the sleeve shifts to selectively place the ports over either the "sand control elements" or the "fracturing elements".

Or, the sleeve can have ports, some of which contain a sand control medium (which may be referred to in this case as "sand control ports") and some of which do not (which may be referred to in this case as "fracturing ports"). In this embodiment, none of the telescoping elements would have a built-in sand control medium, and the sleeve shifts to selectively place either the "sand control ports" or the "fracturing ports" over the telescoping elements.

The novel features of this invention, as well as the invention itself, will be best understood from the attached drawings, taken along with the following description, in which similar reference characters refer to similar parts, and in which:

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Figures 1 through 3 show an embodiment of the invention having a shifting sleeve, some sand control elements, and some fracturing elements, arranged to apply fracturing pressure both above and below a production or injection zone;

Figures 4 through 6 show an embodiment of the invention having a shifting sleeve, some sand control elements, and some fracturing elements, arranged to apply fracturing pressure only below a production or injection zone;

Figures 7 through 9 show an embodiment of the invention having no shifting sleeve, but with some sand control elements, and some fracturing elements having a mechanical check valve;

Figures 10 and 11 show an embodiment of the invention having a solid walled shifting sleeve, some sand control elements, and some fracturing elements;

Figures 12 and 13 show an embodiment of the invention having a shifting sleeve incorporating a sand control medium, where none of the telescoping elements have a sand control medium;

Figures 14 and 15 show an embodiment of the invention having a shifting sleeve with ports, some sand control elements, and some fracturing elements; and

Figures 16 and 17 show an embodiment of the invention having a shifting sleeve with some sand control ports, and some fracturing ports.

DETAILED DESCRIPTION OF THE INVENTION

As shown in Figure 1, in one embodiment, the tool 10 of the present invention has a plurality of telescoping elements 12, 14. All of these telescoping elements 12, 14 are shown retracted radially into the body of the tool 10, in the run-in position. A first group of these elements 12 have no sand control medium therein, while a second group of these elements 14 have a sand control medium incorporated therein. The sand control medium prevents intrusion of sand or other particulate matter from the formation into the tool body. Figure 2 shows the telescoping elements 12, 14 extended radially outwardly from the body of the tool 10 to contact the underground formation, such as by the application of hydraulic pressure from the fluid flowing through the tool 10. If any of the elements 12, 14 fail to fully extend upon application of this hydraulic pressure, they can be mechanically extended by the passage of a tapered plug (not shown) through the body of the tool 10, as is known in the art. After extension of the telescoping elements 12, 14 to contact the formation, a proppant laden fluid is pumped through the tool 10, as is known in the art, to apply sufficient pressure to fracture the formation and to maintain the formation cracks open for the injection or production of fluids. This proppant laden fluid will pass through the fracturing elements 12, but it will not damage the sand control elements 14. After fracturing, a shifting sleeve 16 is shifted longitudinally, in a sliding fashion, as shown in Figure 3, to cover the fracturing elements 12, while leaving the sand control elements 14 uncovered. Shifting of the sleeve 16 can be by means of any kind of shifting tool (not shown) known in the art. It can be seen that in this case, the fracturing elements 12 are arrayed in two fracturing zones 18, both above and below the desired production/injection zone where the sand control elements 14 are arrayed. When the upper and lower fracturing zones 18 are fractured, the formation cracks will propagate throughout the depth of the injection/production zone therebetween.

Figures 4 through 6 show a similar type of tool 10 to that shown in Figures 1 through 3, except that the fracturing zone 18 is only below the injection/production zone 20. This type of arrangement might be used where it is not desired to fracture a water bearing formation immediately above the injection/production zone 20.

Figures 7 through 9 show another embodiment of the tool 10 which has no shifting sleeve. This embodiment, however, has a different type of mechanical control device for controlling the fracturing and production/injection through the telescoping elements 12, 14. That is, while as before, each of the sand control elements 14 incorporates a built-in sand control medium, each of the fracturing elements 12 incorporates a check valve 22 therein. So, in this embodiment, once the tool 10 is at the desired depth, and the telescoping elements 12, 14 have been extended, the fracturing fluid passes through the check valves in the fracturing elements 12 into the formation. Thereafter, the hydrocarbon fluids can be produced from the formation through the sand control elements 14, or fluid can be injected into the formation through the sand control elements 14.

It can be seen that in Figures 7 through 9, the fracturing elements 12 alternate both above and below the sand control elements 14, instead of being grouped above or below as shown in two different types of arrangement in Figures 1 through 6. It should be understood, however, that any of these three types of arrangement could be achieved with either the shifting sleeve type of tool or the check valve type of tool.

Other embodiments of the apparatus 10 can also be used to achieve any of the three types of arrangement of the telescoping elements 12, 14 shown in Figures 1 through 9. First, a longitudinally sliding type of shifting sleeve 16 is shown in Figures 10 and 11. In this embodiment, the shifting sleeve 16 is a solid walled sleeve as before, but it can be positioned and adapted to shift in front of, as in Figure 10, or away from, as in Figure 11, a single row of fracturing elements 12, as well as the multiple row coverage shown in Figure 3. It can be seen that the fracturing elements 12 have an open central bore for the passage of proppant laden fracturing fluid. The sand control elements 14 can have any type of built-in sand control medium therein, with examples of metallic beads and screen material being shown in the Figures. Whether or not the shifting sleeve 16 covers the sand control elements 14 when it uncovers the fracturing elements 12 is immaterial to the efficacy of the tool 10.

A second type of shifting sleeve 16 is shown in Figures 12 and 13. This longitudinally sliding shifting sleeve 16 is constructed principally of a sand control medium such as a screen. Figure 12 shows the sleeve 16 positioned in front of the telescoping elements 12, for injection or production of fluid. Figure 13 shows the sleeve 16 positioned away from the telescoping elements 12, for pumping of proppant laden fluid into the formation. In this embodiment, none of the telescoping elements has a built-in sand control medium.

A third type of shifting sleeve 16 is shown in Figures 14 and 15. This shifting sleeve 16 is a longitudinally shifting solid walled sleeve having a plurality of ports 24. The sleeve 16 shifts longitudinally to position the ports 24 either in front of or away from the fracturing elements 12. Figure 14 shows the ports 24 of the sleeve 16 positioned away from the fracturing elements 12, for injection or production of fluid through the sand control elements 14. Figure 15 shows the ports 24 of the sleeve 16 positioned in front of the fracturing elements 12, for pumping of proppant laden fluid into the formation. In this embodiment, the fracturing elements 12 have an open central bore for the passage of proppant laden fracturing fluid. The sand control elements 14 can have any type of built-in sand control medium therein. Here again, whether or not the shifting sleeve 16 covers the sand control elements 14 when it uncovers the fracturing elements 12 is immaterial to the efficacy of the tool 10.

A fourth type of shifting sleeve 16 is shown in Figures 16 and 17. This shifting sleeve 16 is a rotationally shifting solid walled sleeve having a plurality of ports 24, 26. A first plurality of the ports 26 (the sand control ports) have a sand control medium incorporated therein, while a second plurality of ports 24 (the fracturing ports) have no sand control medium therein. The sleeve 16 shifts rotationally to position either the fracturing ports 24 or the sand control ports 26 in front of the telescoping elements 12. Figure 16 shows the fracturing ports 24 of the sleeve 16 positioned in front of the elements 12, for pumping of proppant laden fluid into the formation. Figure 17 shows the sand control ports 26 of the sleeve 16 positioned in front of the telescoping elements 12, for injection or production of fluid through the elements 12. In this embodiment, all of the telescoping elements 12 have an open central bore; none of the telescoping elements has a built-in sand control medium.

It should be understood that a rotationally shifting type of sleeve, as shown in Figures 16 and 17, could be used with only open ports, as shown in Figures 14 and 15, with both fracturing elements 12 and sand control elements 14, without departing from the present invention. It should be further understood that a longitudinally shifting type of sleeve, as shown in Figures 14 and 15, could be used with both open ports and sand control ports, as shown in Figures 16 and 17, with only open telescoping elements 12, without departing from the present invention.

While the particular invention as herein shown and disclosed in detail is fully capable of obtaining the objects and providing the advantages hereinbefore stated, it is to be understood that this disclosure is merely illustrative of the presently preferred embodiments of the invention and that no limitations are intended other than as described in the appended claims.

CLAIMS

We claim:

1. A method for completing a well, comprising:

providing a completion assembly having at least one outwardly telescoping tubular element and at least one mechanical control device adapted to prevent intrusion of particulate matter through said at least one telescoping element;

running said completion assembly into a well to position said at least one telescoping element in alignment with a selected earth formation;

telescopically extending said at least one telescoping element outwardly to contact the formation;

hydrostatically fracturing the formation through said at least one telescoping element;

preventing inward flow of particulate matter through said at least one telescoping element, with said at least one mechanical control device; and

flowing fluid through said at least one telescoping element.

2. The method recited in claim 1, further comprising flowing injection fluid outwardly through said at least one telescoping element.

3. The method recited in claim 1, further comprising flowing formation fluid inwardly through said at least one telescoping element.

4. The method recited in claim 1, wherein said at least one mechanical control device comprises at least one shifting sleeve, said method further comprising:

positioning said at least one shifting sleeve to open a fracturing path through said at least one telescoping element; and

positioning said at least one shifting sleeve to prevent inward flow of particulate matter through said at least one telescoping element, after said fracturing of said formation.

5. The method recited in claim 4, further comprising providing a plurality of said outwardly telescoping tubular elements, said method further comprising:

providing a sand control element in at least a first said telescoping element, said sand control element being adapted to allow said fluid flow while preventing intrusion of particulate matter into said completion assembly;

providing at least a second said telescoping element having no sand control element;

positioning said at least one shifting sleeve to open a fracturing path through at least said second telescoping element, before said fracturing of said formation through said second telescoping element; and

positioning said at least one shifting sleeve to prevent flow through at least said second telescoping element, after said fracturing of said formation.

6. The method recited in claim 4, wherein said at least one shifting sleeve comprises at least one sand control element adapted to allow fluid flow while preventing intrusion of particulate matter, said method further comprising:

positioning said at least one shifting sleeve to remove said at least one sand control element from a fluid flow path through said at least one telescoping element, before said fracturing of said formation; and

positioning said at least one shifting sleeve to align said at least one sand control element in said fluid flow path through said at least one telescoping element, after said fracturing of said formation.

7. The method recited in claim 6, wherein said at least one shifting sleeve is provided with at least one open port not having a sand control element therein, said method further comprising:

positioning said at least one shifting sleeve to align said at least one open port in said fluid flow path through said at least one telescoping element, before said fracturing of said formation; and

positioning said at least one shifting sleeve to remove said at least one open port from said fluid flow path through said at least one telescoping element, after said fracturing of said formation.

8. The method recited in claim 6, wherein said at least one shifting sleeve comprises a solid walled sleeve provided with at least one sand control port having said at least one sand control element therein, said method further comprising:

positioning said at least one shifting sleeve to remove said at least one sand control port from said fluid flow path through said at least one telescoping element, before said fracturing of said formation; and

positioning said at least one shifting sleeve to align said at least one sand control port in said fluid flow path through said at least one telescoping element, after said fracturing of said formation.

9. The method recited in claim 4, further comprising sliding said sleeve longitudinally relative to said completion assembly to accomplish said positioning.

10. The method recited in claim 4, further comprising rotating said sleeve relative to said completion assembly to accomplish said positioning.

11. The method recited in claim 1, further comprising providing a plurality of said outwardly telescoping tubular elements, said method further comprising:

providing a sand control element in at least a first said telescoping element, said sand control element being adapted to allow said fluid flow while preventing intrusion of particulate matter into said completion assembly;

providing at least a second said telescoping element having no sand control element;

wherein said at least one mechanical control device comprises a check valve provided in said second telescoping element, said check valve being oriented to allow outward flow through said second telescoping element, and to prevent inward flow through said second telescoping element;

hydrostatically fracturing the formation through said second telescoping element; and

flowing said fluid through at least said first telescoping element.

12. An apparatus for completing a well, comprising:

a hollow tubular body adapted for lowering into a well bore;

at least one outwardly telescoping tubular element on said body;

at least one mechanical control device adapted to prevent intrusion of particulate matter into said body through said at least one telescoping element; and

a source of hydrostatic pressure adapted to provide a fracturing fluid via said body to selectively fracture the formation through said at least one telescoping element.

13. The apparatus recited in claim 12, wherein:

said at least one mechanical control device comprises at least one shifting sleeve;

said at least one shifting sleeve has a first position adapted to open a fracturing path through said at least one telescoping element; and

said at least one shifting sleeve has a second position adapted to prevent inward flow of particulate matter through said at least one telescoping element.

14. The apparatus recited in claim 13, further comprising:

a plurality of said outwardly telescoping tubular elements on said body; and

a sand control element in at least a first said telescoping element, said sand control element being adapted to allow fluid flow while preventing intrusion of particulate matter into said body;

wherein at least a second said telescoping element has no sand control element;

wherein said first position of said at least one shifting sleeve is adapted to open said fracturing path through at least said second telescoping element; and

wherein said second position of said at least one shifting sleeve is adapted to prevent flow through at least said second telescoping element.

15. The apparatus recited in claim 13, wherein:

said at least one shifting sleeve comprises at least one sand control element adapted to allow fluid flow while preventing intrusion of particulate matter into said body;

said first position of said at least one shifting sleeve is adapted to remove said at least one sand control element from said fracturing path through said at least one telescoping element; and

said second position of said at least one shifting sleeve is adapted to align said at least one sand control element in a fluid flow path through said at least one telescoping element.

16. The apparatus recited in claim 15, further comprising:

at least one open port in said at least one shifting sleeve, said at least one open port not having a sand control element therein;

wherein said first position of said at least one shifting sleeve is adapted to align said at least one open port in said fracturing path through said at least one telescoping element; and

wherein said second position of said at least one shifting sleeve is adapted to remove said at least one open port from said fracturing path through said at least one telescoping element.

17. The apparatus recited in claim 15, wherein said at least one shifting sleeve comprises a solid walled sleeve, further comprising:

at least one sand control port in said shifting sleeve, said at least one sand control port having said at least one sand control element therein;

wherein said first position of said at least one shifting sleeve is adapted to remove said at least one sand control port from said fracturing path through said at least one telescoping element; and

wherein said second position of said at least one shifting sleeve is adapted to align said at least one sand control port in said fluid flow path through said at least one telescoping element.

18. The apparatus recited in claim 13, wherein said shifting sleeve is further adapted to slide longitudinally relative to said body, between said first and second positions.

19. The apparatus recited in claim 13, wherein said shifting sleeve is further adapted to rotate relative to said body, between said first and second positions.

20. The apparatus recited in claim 12, further comprising:

a plurality of said outwardly telescoping tubular elements on said body; and

a sand control element in at least a first said telescoping element, said sand control element being adapted to allow fluid flow while preventing intrusion of particulate matter into said body;

wherein at least a second said telescoping element has no sand control element; and

wherein said at least one mechanical control device comprises a check valve in said second telescoping element, said check valve being oriented to allow outward flow through said second telescoping element for fracturing the formation, and to prevent inward flow through said second telescoping element.

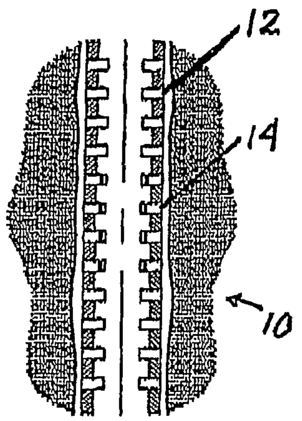

FIG. 1

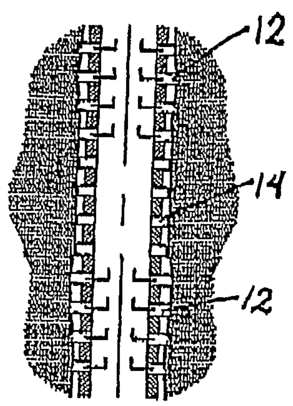

FIG. 2

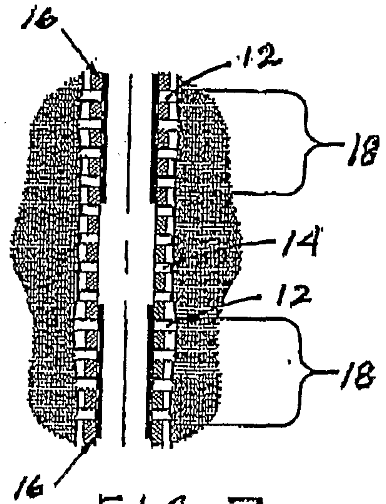

FIG. 3

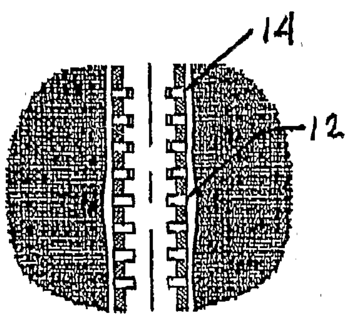

FIG. 4

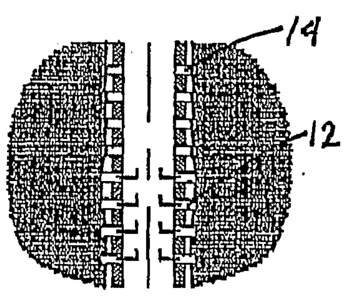

FIG. 5

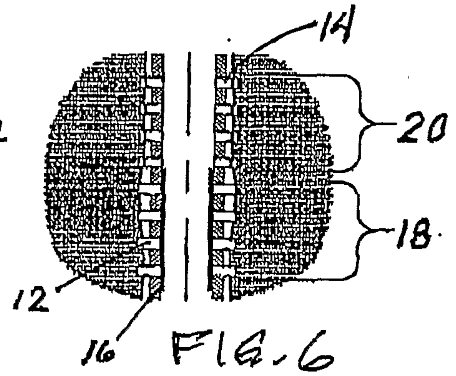

FIG. 6

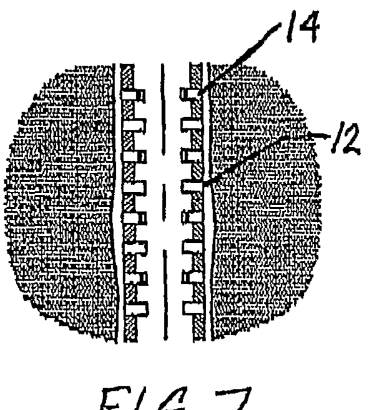

FIG. 7

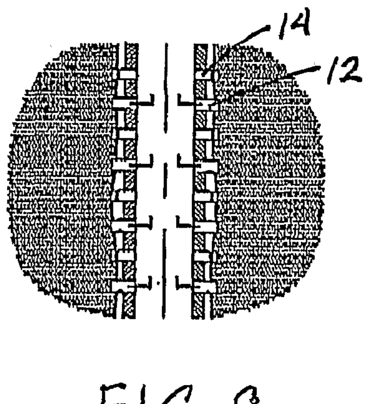

FIG. 8

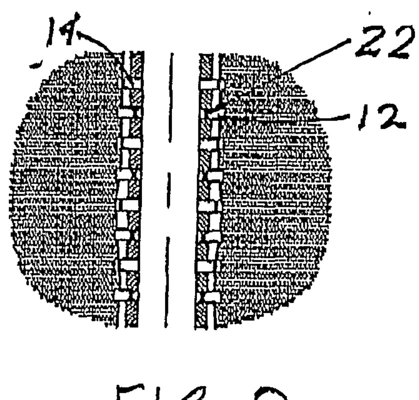

FIG. 9

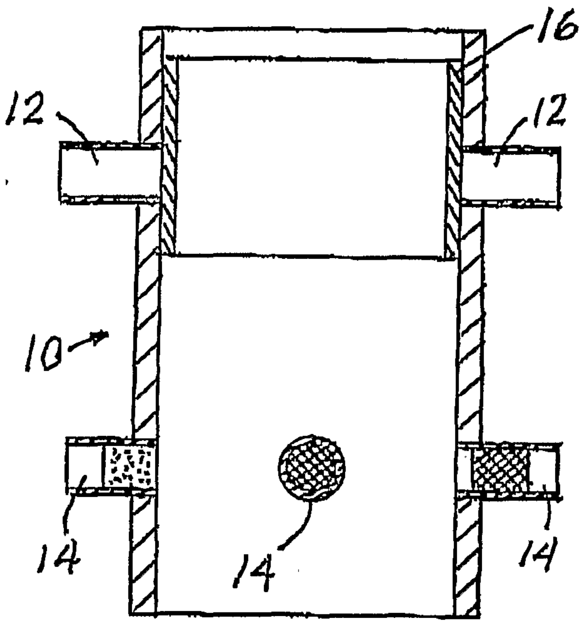

FIG.10

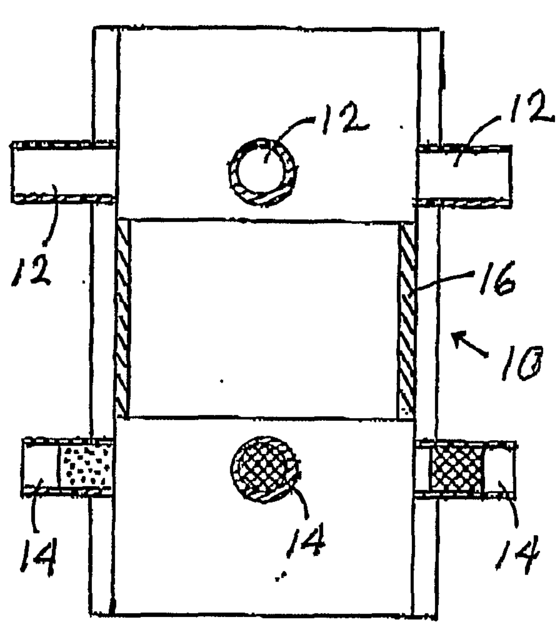

FIG.11

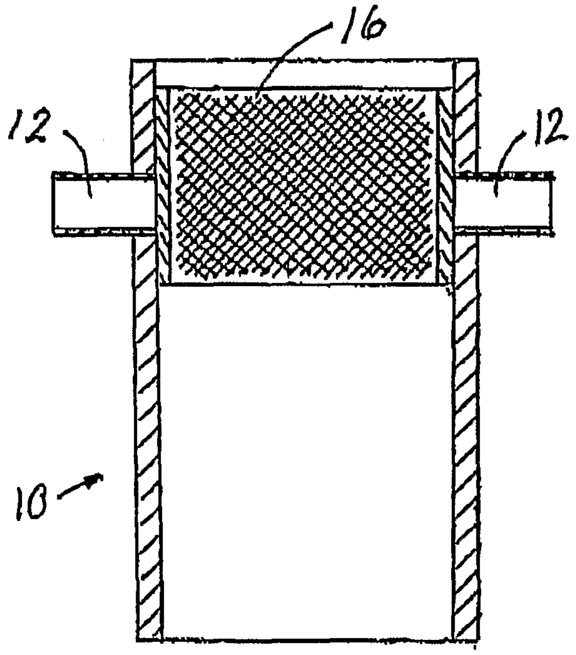

FIG.12

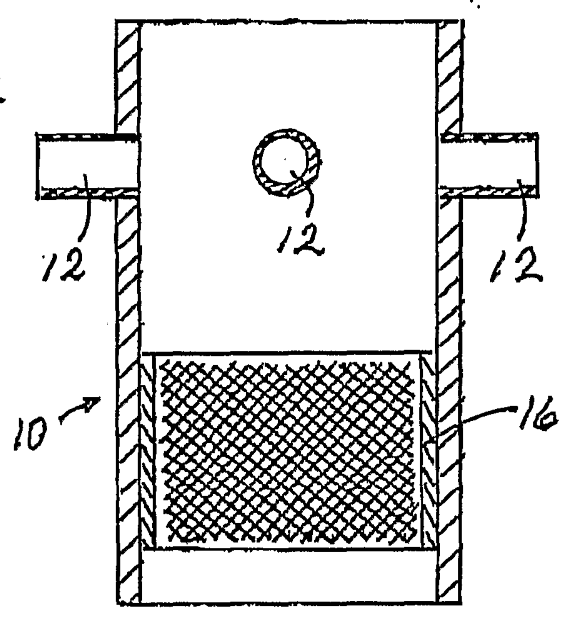

FIG.13

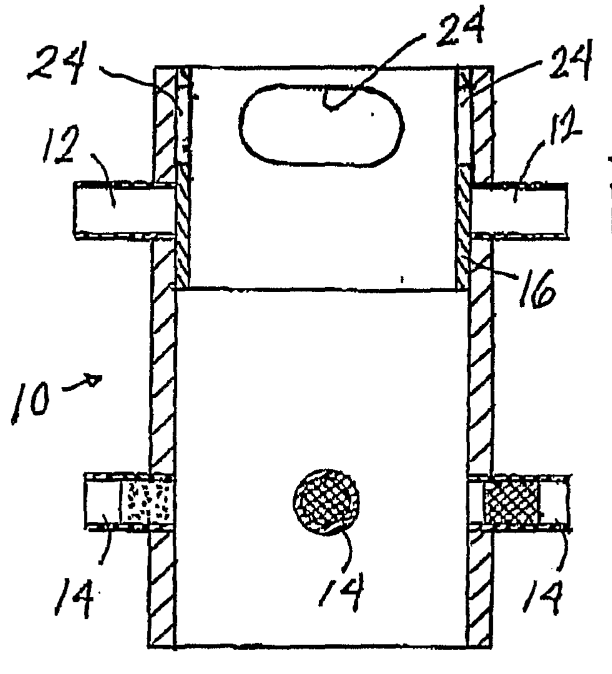

FIG. 14

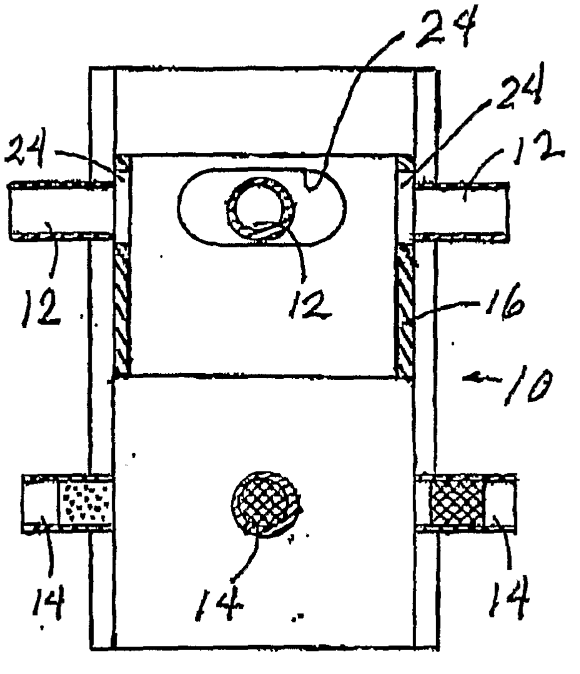

FIG. 15

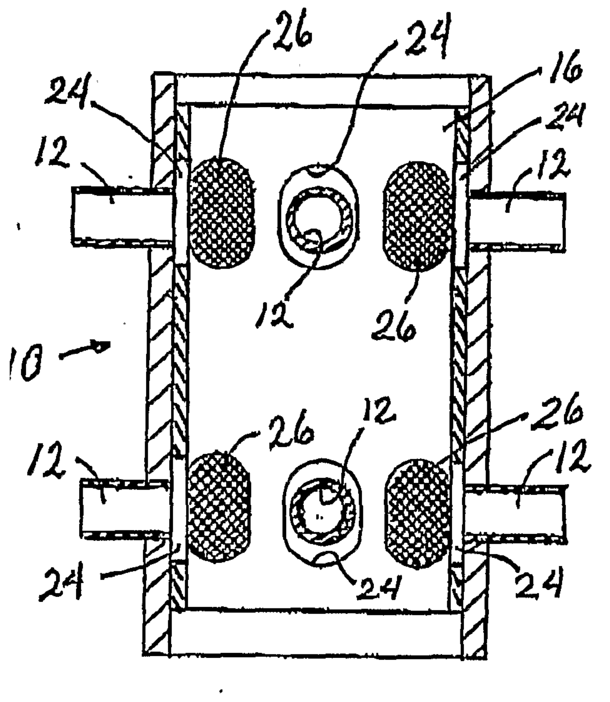

FIG. 16

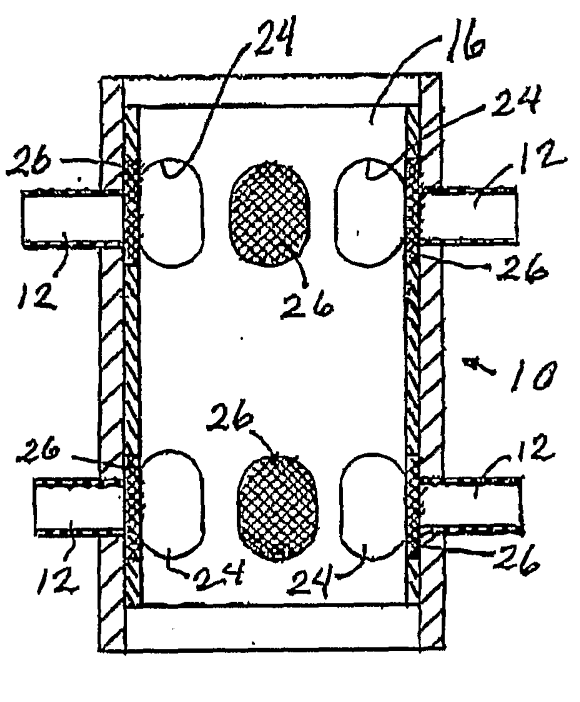

FIG. 17

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2005/011869

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B43/112

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/136562 A1 (ROBISON CLARK E ET AL) 24 July 2003 (2003-07-24) paragraphs '0050!, '0051!, '0064! - '0066!	1-3,12
X	WO 03/104611 A (SAND CONTROL, INC; JOHNSON, MICHAEL, H) 18 December 2003 (2003-12-18) abstract	1,12
X	GB 2 277 337 A (* CONOCO INC) 26 October 1994 (1994-10-26) abstract; figures 1-3	1-3,12
A	WO 03/052238 A (SAND CONTROL, INC; JOHNSON, MICHAEL, H) 26 June 2003 (2003-06-26) the whole document	1,12
	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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27 June 2005	04/07/2005

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European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Stroemmen, H.

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INTERNATIONAL SEARCH REPORT

International Application No
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