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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	HES 2005-IP-018647
First Inventor	Lloyd McNeel
Title	Method and Apparatus...
Express Mail Label No.	EV590026461US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☐ Fee Transmittal Form (e.g., PTO/SB/17) *(Submit an original and a duplicate for fee processing)*
2. ☐ Applicant claims small entity status. See 37 CFR 1.27.
3. ☑ Specification [*Total Pages* 25] *(preferred arrangement set forth below)*
   - Descriptive title of the invention
   - Cross Reference to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to sequence listing, a table, or a computer program listing appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
4. ☑ Drawing(s) (*35 U.S.C. 113*) [*Total Sheets* 7]
5. Oath or Declaration [*Total Sheets* _____]
   a. ☐ Newly executed (original or copy)
   b. ☐ Copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional with Box 18 completed)*
      i. ☐ DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) name in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
6. ☐ Application Data Sheet. See 37 CFR 1.76
7. ☐ CD-ROM or CD-R in duplicate, large table or Computer Program *(Appendix)*
8. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. ☐ Computer Readable Form (CRF)
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ACCOMPANYING APPLICATION PARTS

9. ☐ Assignment Papers (cover sheet & document(s))
10. ☐ 37 CFR 3.73(b) Statement *(when there is an assignee)* ☐ Power of Attorney
11. ☐ English Translation Document *(if applicable)*
12. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
13. ☐ Preliminary Amendment
14. ☑ Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
15. ☐ Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. ☐ Nonpublication Request under 35 U.S.C. 122 (b)(2)(B)(i). Applicant must attach form PTO/SB/35 or its equivalent.
17. ☐ Other:

18. If a CONTINUING APPLICATION, *check appropriate box, and supply the requisite information below and in the first sentence of the specification following the title, or in an Application Data Sheet under 37 CFR 1.76:*

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No.:

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For CONTINUATION OR DIVISIONAL APPS only; The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

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ATTY. DOCKET NO.: HES 2005-IP-018647

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PATENT APPLICATION FOR LETTERS PATENT

FOR

METHOD AND APPARATUS FOR CENTRALIZED WELL TREATMENT

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ATTORNEY DOCKET NO.: HES 2005-IP-018647

METHOD AND APPARATUS FOR CENTRALIZED WELL TREATMENT

FIELD OF THE INVENTION

[0001] The present invention relates generally to well operations, and more particularly to methods and apparatuses for simultaneously treating multiple wells from a centralized location and simultaneously connecting multiple wells to a single manifold, so as to conserve labor, infrastructure, and environmental impact.

BACKGROUND

[0002] In the production of oil and gas in the field, it is often required to stimulate and treat several well locations within a designated amount of time. Stimulation and treatment processes often involve mobile equipment that is set up and put in place at a pad and then moved by truck from pad to pad within short time periods. Only during non-stimulation activities, such as water flood operations, can some operations occur simultaneously.

[0003] This movement of equipment and personnel can involve complex logistics. The servicing and stimulation of wells can require a series of coordinated operations that begin with the supply by truck of equipment, supplies, fuel, and chemicals to the wellhead. The equipment is then set up and made ready with proppant and chemicals. After completion of the well services, equipment must be broken down and made ready for transport to the next pad for service. Often, the next pad will be less than 500 feet away from the previously treated pad. In addition, due to the limited storage capacity of the moving equipment for chemicals and equipment, additional trucks are often required to resupply and reequip an existing operation. This movement of equipment and supplies has environmental impacts, and the exposure of

mobile equipment to adverse weather conditions can jeopardize well treatment operations and worker safety.

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SUMMARY

[0004] In general, one aspect of the invention features a method of stimulating multiple wells from a central location. The method includes the steps of stimulating a first well from the central location using a first stimulation fluid through a first fluid line; and simultaneously stimulating a second well from the central location using a second stimulation fluid through a second fluid line. The fluid can be any combination of proppant, fracturing fluid, gelling agent, friction reducer, and acid. The first fluid and the second fluid may have the same composition.

[0005] Another aspect of the invention features a method of stimulating multiple wells. The method includes the steps of stimulating a first well location through a first stimulation fluid from a central manifold; and simultaneously stimulating a second well location through a second stimulation fluid from the central manifold. The fluid can be any combination of proppant, fracturing fluid, gelling agent, friction reducer, and acid. The first fluid and the second fluid may have the same composition.

[0006] Another aspect of the invention features an apparatus for centralized well operations. The apparatus includes a well operations factory which manufactures and pumps a well treatment fluid, a first connection between a first well location and the factory, and a second connection between a second well location and the factory. The well treatment operations factory comprises a means for simultaneously flowing a first stimulation fluid to the first well location via the first connection and a second stimulation fluid to the second well location via the second connection. The fluid can be any combination of proppant, fracturing fluid, gelling agent, friction reducer, and acid. The first fluid and the second fluid may have the same

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composition. The means for simultaneously flowing can be a manifold. The well treatment operations factory can include a power unit, a proppant storage system, chemical storage system, a pumping grid, and a blending unit. It can be enclosed in a supported fabric structure, a collapsible structure, a prefabricated structure, a retractable structure, a composite structure, a temporary structure, a prefabricated wall and roof structure, a deployable structure, a modular structure, a preformed structure, a mobile accommodation structure, and combinations thereof. The first connection is operable to deliver a fluid from the first well location to the manifold. This fluid can be a stimulation fluid, a drilling fluid, or a production fluid. The second connection is operable to deliver a fluid from the second well location to the manifold. This fluid can be a production fluid or a stimulation fluid. The manifold can be connected to a second manifold. The second manifold is operable to connect to multiple wells simultaneously. The apparatus can include a third connection between the manifold and the first well location. The third connection is operable to deliver a fluid from the first well location to the manifold. This fluid can be a production fluid or a stimulation fluid. The apparatus can include a fourth connection between the manifold and the second well location. The fourth connection is operable to deliver a fluid from the second well location to the manifold. This fluid can be a production fluid or a stimulation fluid.

[0007] Another aspect of the invention features an apparatus for directing stimulation fluid that includes a first input for accepting pressurized stimulation fluid; a first line connected to the first input, the first line including: a first valve connected to a first pressure sensor, the first pressure sensor further connected to a second valve; the first line connected to a first wellhead; a second line connected to the first input, the second line including a third valve

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connected to a second pressure sensor, the second pressure sensor further connected to a fourth valve; the second line connected to a second wellhead.

[0008] Another aspect of the invention features an apparatus for directing stimulation fluid that includes a first input for accepting a first pressurized stimulation fluid; a second input for accepting a second pressurized stimulation fluid; a first line connected to the first input, the first line comprising a first valve; a second line connected to the second input, the second line comprising a second valve; the first line and the second line connected together at a first junction, the first junction further connected to a first wellhead; a third line connected to the first input, the third line comprising a third valve; a fourth line connected to the second input, the fourth line comprising a fourth valve; and the third line and the fourth line connected together at a second junction, the second junction further connected to a second wellhead. Each line can further include a pressure sensor and an additional valve.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0009] A more complete understanding of the present disclosure and advantages thereof may be acquired by referring to the following description taken in conjunction with the accompanying drawings. The drawings illustrate only exemplary embodiments and are not intended to be limiting against the invention.

[0010] Figure 1 is a diagram of a centralized well treatment facility.

[0011] Figure 2 is a flow diagram of a centralized well treatment facility.

[0012] Figure 3 is a flow diagram of central manifold used to treat wells and recover production fluid.

[0013] Figure 4 is a diagram of a multiple manifold well treatment system.

[0014] Figure 5 is a schematic of a manifold apparatus for directing treatment fluid.

[0015] Figure 6 is a schematic of a manifold apparatus for directing treatment fluid.

[0016] Figure 7 is a schematic of a simultaneous fracturing method.

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DETAILED DESCRIPTION

[0017] The details of the methods and apparatuses according to the present invention will now be described with reference to the accompanying drawings.

[0018] In reference to Figure 1, in one embodiment, a well treatment operations factory 100 includes one or more of the following: a centralized power unit 103; a pumping grid 111; a central manifold 107; a proppant storage system 106; a chemical storage system 112; and a blending unit 105. In this and other embodiments, the well treatment factory may be set upon a pad from which many other wellheads on other pads 110 may be serviced. The well treatment operations factory may be connected via the central manifold 107 to at least a first pad 101 containing one or more wellheads via a first connection 108 and at least a second pad 102 containing one or more wellheads via a second connection 109. The connection may be a standard piping or tubing known to one of ordinary skill in the art. The factory may be open, or it may be enclosed at its location in various combinations of structures including a supported fabric structure, a collapsible structure, a prefabricated structure, a retractable structure, a composite structure, a temporary building, a prefabricated wall and roof unit, a deployable structure, a modular structure, a preformed structure, or a mobile accommodation unit.

[0019] In one embodiment of the centralized power unit 103, the unit provides electrical power to all of the subunits within the well operations factory 100 via electrical connections. The centralized power unit 103 can be powered by liquid fuel, natural gas or other equivalent fuel and may optionally be a cogeneration power unit. The unit may comprise a single trailer with subunits, each subunit with the ability to operate independently. The unit may also be operable to extend power to one or more outlying wellheads.

[0020] In one embodiment, the proppant storage system 106 is connected to the blending unit 105 and includes automatic valves and a set of tanks that contain proppant. Each tank can be monitored for level, material weight, and the rate at which proppant is being consumed. This information can be transmitted to a controller or control area. Each tank is capable of being filled pneumatically and can be emptied through a calibrated discharge shoot by gravity. Tanks may be added to or removed from the storage system as needed. Empty storage tanks may be in the process of being filled by proppant at the same time full or partially full tanks are being used, allowing for continuous operation. The tanks can be arranged around a calibrated v-belt conveyor. In addition, a resin-coated proppant may be used by the addition of a mechanical proppant coating system. The coating system may be a Muller System.

[0021] In one embodiment, the chemical storage system 112 is connected to the blending unit and can include tanks for breakers, gel additives, crosslinkers, and liquid gel concentrate. The tanks can have level control systems such as a wireless hydrostatic pressure system and may be insulated and heated. Pressurized tanks may be used to provide positive pressure displacement to move chemicals, and some tanks may be agitated and circulated. The chemical storage system can continuously meter chemicals through the use of additive pumps which are able to meter chemical solutions to the blending unit 105 at specified rates as determined by the required final concentrations and the pump rates of the main treatment fluid from the blending unit. Chemical storage tanks are pressurized to drive fluid flow. The quantities and rates of chemicals added to the main fluid stream are controlled by valve-metering control systems. In addition, chemical additives could be added to the main treatment fluid via aspiration (Venturi Effect). The rates that the chemical additives are aspirated into the main fluid stream can be controlled via adjustable, calibrated apertures located between the chemical

storage tank and the main fluid stream. In the case of fracturing operations, the main fluid stream may be either the main fracture fluid being pumped or may be a slip stream off of a main fracture fluid stream. In one embodiment, the components of the chemical storage system are modularized allowing pumps, tanks, or blenders to be added or removed independently.

[0022] In reference to Figure 2, in one embodiment, the blending unit 105 is connected to the chemical storage system 112, the proppant storage system 106, a water source 202, and a pumping grid 111 and may prepare a fracturing fluid, complete with proppant and chemical additives or modifiers, by mixing and blending fluids and chemicals at continuous rates according to the needs of a well formation. The blending unit 105 comprises a preblending unit 201 wherein water is fed from a water supply 202 and dry powder (guar) can be metered from a storage tank by way of a screw conveyor into the preblender's fluid stream where it is mixed with water and blended with various chemical additives and modifiers provided by the chemical storage system 112. These chemicals may include crosslinkers, gelling agents, viscosity altering chemicals, PH buffers, modifiers, surfactants, breakers, and stabilizers. This mixture is fed into the blending unit's hydration device, which provides a first-in-first-out laminar flow. This now near fully hydrated fluid stream is blended in the mixer 202 of the blending unit 105 with proppant from the proppant storage system to create the final fracturing fluid. This process can be accomplished at downhole pump rates. In one embodiment, the mixing apparatus is a modified Halliburton Growler mixer modified to blend proppant and chemical additives to the base fluid without destroying the base fluid properties but still providing ample energy for the blending of proppant into a near fully hydrated fracturing fluid. The final fluid can be directed to a pumping grid 111 and subsequently directed to a central manifold 107, which can connect and direct the fluid via connections 109, 204, or 205 to multiple wells 110 simultaneously.

[0023] In one embodiment, the means for simultaneously flowing treatment fluid is a central manifold 107. The central manifold 107 is connected to the pumping grid 111 and is operable to flow stimulation fluid, for example, to multiple wells at different pads simultaneously. The stimulation fluid can comprise proppant, gelling agents, friction reducers, reactive fluid such as hydrochloric acid, and can be aqueous or hydrocarbon based. The manifold 107 is operable to treat simultaneously two separate wells, for example, as shown in Figure 2 via connections 204 and 205. In this example, multiple wells can be fractured simultaneously, or a treatment fluid can be flowed simultaneously to multiple wells. The treatment fluid flowed can be of the same composition or different. These flows can be coordinated depending on a well's specific treatment needs. In addition, in reference to Figure 3, the connection 109 between the central manifold 107 and a well location can be used in the opposite direction as shown in Figure 2 to flow a production fluid, such as water or hydrocarbons, or return the well treatment fluid 301 from the well location to the manifold. From the central manifold 107, the production fluid can be directed to a production system 303 where it can be stored or processed or, in the case of the returning well treatment fluid, to a reclamation system that can allow components of returning fluid to be reused. The manifold is operable to receive production fluid or well treatment fluid from a first well location 101 while simultaneously flowing treatment fluid 302 using a second connection 108 to a second well location 102. The central manifold 107 is also operable to receive production fluid from both the first well location and the second well location simultaneously. In this embodiment, the first and second well locations can be at the same or different pads (as shown in Figure 3). The manifold is also operable to extend multiple connections to a single well location. In reference to Figure 2, in one embodiment, two connections are extended from the manifold to a single well location.

One connection 109 may be used to deliver well treatment fluid to the well location while the other connection 203 may be used to deliver production fluid or return well treatment fluid from the well location to the central manifold 107.

[0024] In reference to Figure 4, in one embodiment, the central manifold 107 can be connected to one or more additional manifolds 405. The additional manifolds are operable to connect to multiple well locations 401-404 and deliver well treatment fluids and receive production fluids via connections 406-409, respectively, in the same way as the central manifold 107 described above in reference to Figures 2 and 3. The additional manifolds can be located at the well pads.

[0025] In reference to Figure 5, in one embodiment, the central manifold has an input 501 that accepts pressurized stimulating fluid, fracturing fluid, or well treatment fluid from a pump truck or a pumping grid 111. The fluid flows into input 501 and through junctions 502 and 503 to lines 504 and 505. Line 504 contains a valve 506, a pressure sensor 507, and an additional valve 508. The line is connected to well head 101. Line 505 contains a valve 511, a pressure sensor 512, and an additional valve 513. These valves may be either plug valves or check valves and can be manually or electronically monitored and controlled. The pressure sensor may be a pressure transducer and may also be manually or electronically monitored or controlled. Line 504 is connected to well head 101 and line 505 is connected to well head 102. This configuration allows wells 101 and 102 to be stimulated individually and at a higher rate, by opening the valves along the line to the well to be treated while the valves along the other line are closed, or simultaneously at a lower rate, by opening the valves on both lines at the same time. As shown in Figure 5, this architecture can be easily expanded to accommodate additional wells by the addition of junctions, lines, valves, and pressure sensors as illustrated. This

architecture also allows monitoring the operations of the manifold and detecting leaks. By placing pressure sensors 507 and 512 between valves 506 and 508 and valves 511 and 513 respectively, the pressure of lines 504 and 505 can be readily determined during various phases of operation. For instance, when the manifold is configured to stimulate only well 101, valves 511 and 513 are closed. Pressure sensor 507 can detect the pressure within the active line 504, and pressure sensor 512 can be used to detect if there is any leakage, as it would be expected that the pressure in line 505 in this configuration would be minimal. In another embodiment, only a single valve is used along each of lines 504 and 505. This embodiment can be used to stimulate wells simultaneously or singly as well. Furthermore, as described in reference to Figure 4, the manifold of this embodiment can also work in reverse and transfer fluid from the wellhead back through the manifold and to the central location. In this configuration, input 501 can be connected to a production system or reclamation system, for example, and the valves along the line connected to the wellhead in which it is desirable to recover fluid are open. The valves along the other lines may be open or closed depending on whether it is desirable to recover fluids from the wellheads connected to those lines. Production fluid or stimulation fluid can be returned from the wellhead to those systems respectively. This manifold can be located at the central location or at a remote pad.

[0026] In reference to Figure 6, in one embodiment, the central manifold contains two inputs 601 and 602 that accept pressurized stimulating fluid, fracturing fluid, or well treatment fluid from pump trucks or a pumping grid 111. Inputs 601 and 602 can accept fluid of different or the same compositions at similar or different pressures and rates. The fluid pumped through input 602 travels through junctions 603 and 605. The junctions are further connected to lines 610 and 611. The fluid pumped through input 601 travels through junctions 604 and 615.

The junctions are further connected to lines 609 and 612. Lines 609, 610, 611, and 612 may each contain a valve 606, a pressure sensor 607, and an additional valve 608, or may contain only a single valve. These valves may be either plug valves or check valves and can be manually or electronically monitored and controlled. The pressure sensor may be a pressure transducer and may also be manually or electronically monitored or controlled. When, for example, the fluid from input 602 is desired to be delivered to well 101 only, the valves on line 610 are open and the valves on line 611 are closed. When the fluid from input 601 is desired to be delivered to well 101 only, the valves on line 609 are open and the valves on line 612 are closed. When it is desired that fluid from both inputs 601 and 602 are to be delivered to well 101 only, the valves on lines 609 and 610 are open and the valves on lines 611 and 612 are closed. Lines 609 and 610 are coupled to wellhead 101 through junction 616. When it is desired that fluid from input 602 be delivered to both wells 101 and 102 simultaneously, the valves on lines 610 and 611 are both open. Fluid from input 601 can be delivered to well 101 and fluid from input 602 can be delivered to well 102 simultaneously by closing the valves on lines 610 and 612 and opening the valves on lines 611 and 609. The delivery of fluid to well 102 works analogously. As shown in Figure 6, the manifold can be easily expanded to include additional wells through additional junctions, lines, and valves. Furthermore, as described in reference to Figure 4, the manifold of this embodiment can also work in reverse and transfer fluid from the wellhead back through the manifold and to the central location. In this configuration, either or both inputs 601 and 602 can be connected to a production system or reclamation system, for example, and the valves along the line connected to the wellhead in which it is desirable to recover fluid are open. The valves along the other lines may be open or closed depending on whether it is desirable to recover fluids from the wellheads connected to those lines. Production fluid or stimulation fluid can be

returned from the wellhead to those systems respectively. This manifold can be located at the central location or at a remote pad.

[0027] In reference to Figure 7, in one embodiment, multiple manifold trailers 701 and 702 may be used at the central location where the stimulation fluid is manufactured and pressurized. The manifold trailers themselves are well known in the art. Each manifold trailer is connected to pressurized stimulating fluid through pump trucks 703 or a pumping grid 111. A line from each manifold trailer can connect directly to a well head to stimulate it directly, or it can further be connected to the manifolds described that are further connected to well locations.

[0028] In one embodiment of the pumping grid 111, the grid comprises one or more pumps that can be electric, gas, diesel, or natural gas powered. The grid can also contain spaces operable to receive equipment, such as pumps and other devices, modularized to fit within such spaces. The grid can be prewired and preplumbed and can contain lube oil and cooling capabilities. The grid is operable to accept connections to proppant storage and metering systems, chemical storage and metering systems, and blending units. The pumping grid can also have a crane that can assist in the replacement or movement of pumps, manifolds, or other equipment. A central manifold 107 can accept connections to wells and can be connected to the pumping grid. In one embodiment, the central manifold and pumping grid are operable to simultaneously treat both a first well head connected via a first connection and a second well head connected via a second connection with the stimulation fluid manufactured by the factory and connected to the pumping grid.

[0029] In some embodiments, the operations of the chemical storage system, proppant storage system, blending unit, pumping grid, power unit, and manifolds are controlled, coordinated, and monitored by a central control system. The central control system may use all

of the sensor data from all units and the drive signals from their individual subcontrollers to determine subsystem trajectories. For example, control over the manufacture, pumping, gelling, blending, and resin coating of proppant by the control system can be driven by desired product properties such as density, rate, viscosity, etc. Control can also be driven by external factors affecting the subunits such as dynamic or steady-state bottlenecks. The central control system can include such features as: (1) virtual inertia, whereby the rates of the subsystems (chemical, proppant, power, etc.) are coupled despite differing individual responses; (2) backward capacitance control whereby the tub level controls cascade backward through the system; (3) volumetric observer whereby sand rate errors are decoupled and proportional ration control is allowed without steady-state error. The central control system can also be used to monitor equipment health and status.

[0030] The present invention can be used both for onshore and offshore operations using existing or specialized equipment or a combination of both. Such equipment can be modularized to expedite installation or replacement. The present invention may be enclosed in a permanent, semipermanent, or mobile structure.

[0031] As those of ordinary skill in the art will appreciate, the present invention can be adapted for multiple uses. By way of example only, multiple well sites may be treated, produced, or treated and produced sequentially or simultaneously from a single central location. The invention is capable of considerable additional modification, alteration, and equivalents in form and function, as will occur to those ordinarily skilled in the art having the benefit of this disclosure. The depicted and described embodiments of the invention are exemplary only, and are not exhaustive of the scope of the invention. Consequently, the invention is intended to be limited only by the spirit and scope of the appended claims.

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What is claimed is:

1. A method of stimulating multiple wells from a central location, comprising the steps of:

stimulating a first well from the central location using a first stimulation fluid through a first fluid line; and

simultaneously stimulating a second well from the central location using a second stimulation fluid through a second fluid line.

2. The method of claim 1 wherein the first stimulation fluid comprises a compound selected from the group consisting of proppant, fracturing fluid, gelling agents, friction reducers, acid, and combinations thereof.

3. The method of claim 1 wherein the second stimulation fluid comprises a compound selected from the group consisting of proppant, fracturing fluid, gelling agents, friction reducers, acid, and combinations thereof.

4. The method of claim 1 wherein the first stimulation fluid and the second stimulation fluid have the same composition.

5. A method of stimulating multiple wells comprising the steps of:

stimulating a first well location through a first stimulation fluid from a central manifold; and

simultaneously stimulating a second well location through a second stimulation fluid from the central manifold.

6. The method of claim 5 wherein the first stimulation fluid comprises a compound selected from the group consisting of proppant, fracturing fluid, gelling agents, friction reducers, acid, and combinations thereof.

7. The method of claim 5 wherein the second stimulation fluid comprises a compound selected from the group consisting of proppant, fracturing fluid, gelling agents, friction reducers, acid, and combinations thereof.

8. The method according to claim 5 wherein the first well location and the second well location are at the same pad.

9. The method according to claim 5 wherein the first well location and the second well location are at different pads.

10. The method of claim 5 wherein the first stimulation fluid and the second stimulation fluid have the same composition.

11. An system for centralized well operations comprising:

a well treatment operations factory which manufactures and pumps a well stimulation fluid;

a first connection between a first well location and the well operations factory;

a second connection between a second well location and the well operations factory; and

means for simultaneously flowing a first stimulation fluid to the first well location and a second stimulation fluid to a second well location.

12. The system of claim 11 wherein the means for simultaneously flowing treatment fluid comprises a manifold.

13. The system of claim 12 wherein the well operations factory comprises a pumping grid wherein the pumping grid is operable to connect to the manifold.

14. The system of claim 13 wherein the well operations factory comprises a blending unit wherein the blending unit is operable to connect to the pumping grid.

15. The system of claim 14 wherein the well operations factory comprises a proppant storage system wherein the proppant storage system is operable to connect to the blending unit.

16. The system of claim 14 wherein the well operations factory comprises a chemical storage system wherein the chemical storage system is operable to connect to the blending unit.

17. The system of claim 15 wherein the well operations factory comprises a power unit operable to connect to the manifold, pumping grid, blending unit, the proppant storage system, the first well location, and the second well location.

18. The system of claim 16 wherein the well operations factory comprises a power unit operable to connect to the manifold, pumping grid, blending unit, chemical storage system, the first well location, and the second well location.

19. The system of claim 17 wherein the well operations factory is enclosed in a structure selected from the group consisting of a supported fabric structure, a collapsible structure, a prefabricated structure, a retractable structure, a composite structure, a temporary structure, a prefabricated wall and roof structure, a deployable structure, a modular structure, a preformed structure, a mobile accommodation structure, and combinations thereof.

20. The system of claim 12 wherein the first connection is operable to deliver a fluid from the first well location to the manifold.

21. The system of claim 12 wherein the second connection is operable to deliver a fluid from the second well location to the manifold.

22. The system of claim 20 wherein the fluid comprises a stimulation fluid.

23. The system of claim 21 wherein the fluid comprises a stimulation fluid.

24. The system of claim 12 wherein the manifold is connected to a second manifold.

25. The system of claim 24 wherein the second manifold is operable to simultaneously flow a first stimulation fluid to a first well location and a second stimulation fluid to a second well location.

26. The system of claim 12 comprising a third connection between the manifold and the first well location.

27. The system of claim 26 wherein the third connection is operable to deliver a fluid from the first well location to the manifold.

28. The system of claim 27 comprising a fourth connection between the manifold and the second well location.

29. The system of claim 28 wherein the fourth connection is operable to deliver a fluid from the second well location to the manifold.

30. The system of claim 11 wherein the well operations factory and means for simultaneously flowing treatment fluid are located on a boat.

31. The system of claim 11 wherein the first fluid comprises a compound selected from the group consisting of proppant, fracturing fluid, gelling agents, friction reducers, acid, and combinations thereof.

32. The system of claim 11 wherein the second stimulation fluid comprises a compound selected from the group consisting of proppant, fracturing fluid, gelling agents, friction reducers, acid, and combinations thereof.

33. The system of claim 11 wherein the first stimulation fluid and the second stimulation fluid have the same composition.

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U.S. Well Services, LLC
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34. An apparatus for directing stimulation fluid comprising:

a first input for accepting pressurized stimulation fluid;

a first line connected to said first input, said first line comprising:

a first valve connected to a first pressure sensor, said first pressure sensor further connected to a second valve;

said first line connected to a first wellhead;

a second line connected to said first input, said second line comprising

a third valve connected to a second pressure sensor, said second pressure sensor further connected to a fourth valve;

said second line connected to a second wellhead.

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35. An apparatus for directing stimulation fluid comprising:

a first input for accepting a first pressurized stimulation fluid;

a second input for accepting a second pressurized stimulation fluid;

a first line connected to said first input, said first line comprising a first valve;

a second line connected to said second input, said second line comprising a second valve;

said first line and said second line connected together at a first junction, said first junction further connected to a first wellhead;

a third line connected to said first input, said third line comprising a third valve;

a fourth line connected to said second input, said fourth line comprising a fourth valve; and

said third line and said fourth line connected together at a second junction, said second junction further connected to a second wellhead.

36. The apparatus according to claim 35 wherein

said first line further comprises a fifth valve and a first pressure sensor, said first pressure sensor located between said first valve and said fifth valve.

37. The apparatus according to claim 36 wherein

said second line further comprises a sixth valve and a second pressure sensor, said second pressure sensor located between said second valve and said sixth valve.

38. The apparatus according to claim 37 wherein

said third line further comprises a seventh valve and a third pressure sensor, said third pressure sensor located between said third valve and said seventh valve.

39. The apparatus according to claim 38 wherein

said fourth line further comprises an eighth valve and a fourth pressure sensor, said fourth pressure sensor located between said fourth valve and said eighth valve.

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METHOD AND APPARATUS FOR CENTRALIZED WELL TREATMENT

ABSTRACT

A method of communicating between a central location and multiple well locations is disclosed that includes the steps of stimulating a first well from the central location using a first stimulation fluid through a first fluid line; and simultaneously stimulating a second well from the central location using a second stimulation fluid through a second fluid line. An apparatus for centralized well operations is disclosed that includes a well treatment operations factory which manufactures and pumps a well stimulation fluid; a first connection between a first well location and the well operations factory; a second connection between a second well location and the well operations factory; and means for simultaneously flowing a first stimulation fluid to the first well location and a second stimulation fluid to a second well location. Manifolds for centralized well stimulation are disclosed.

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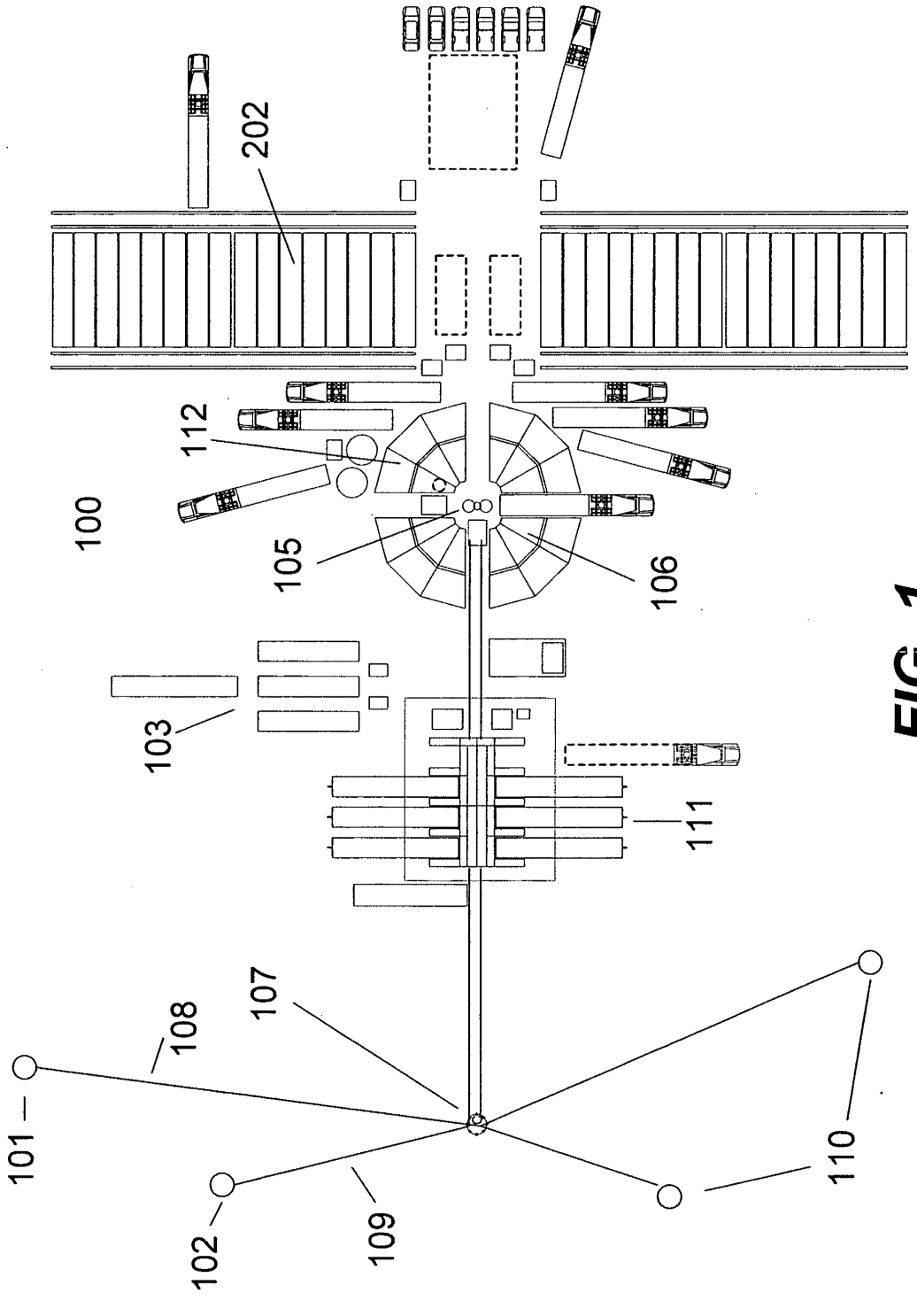


FIG. 1

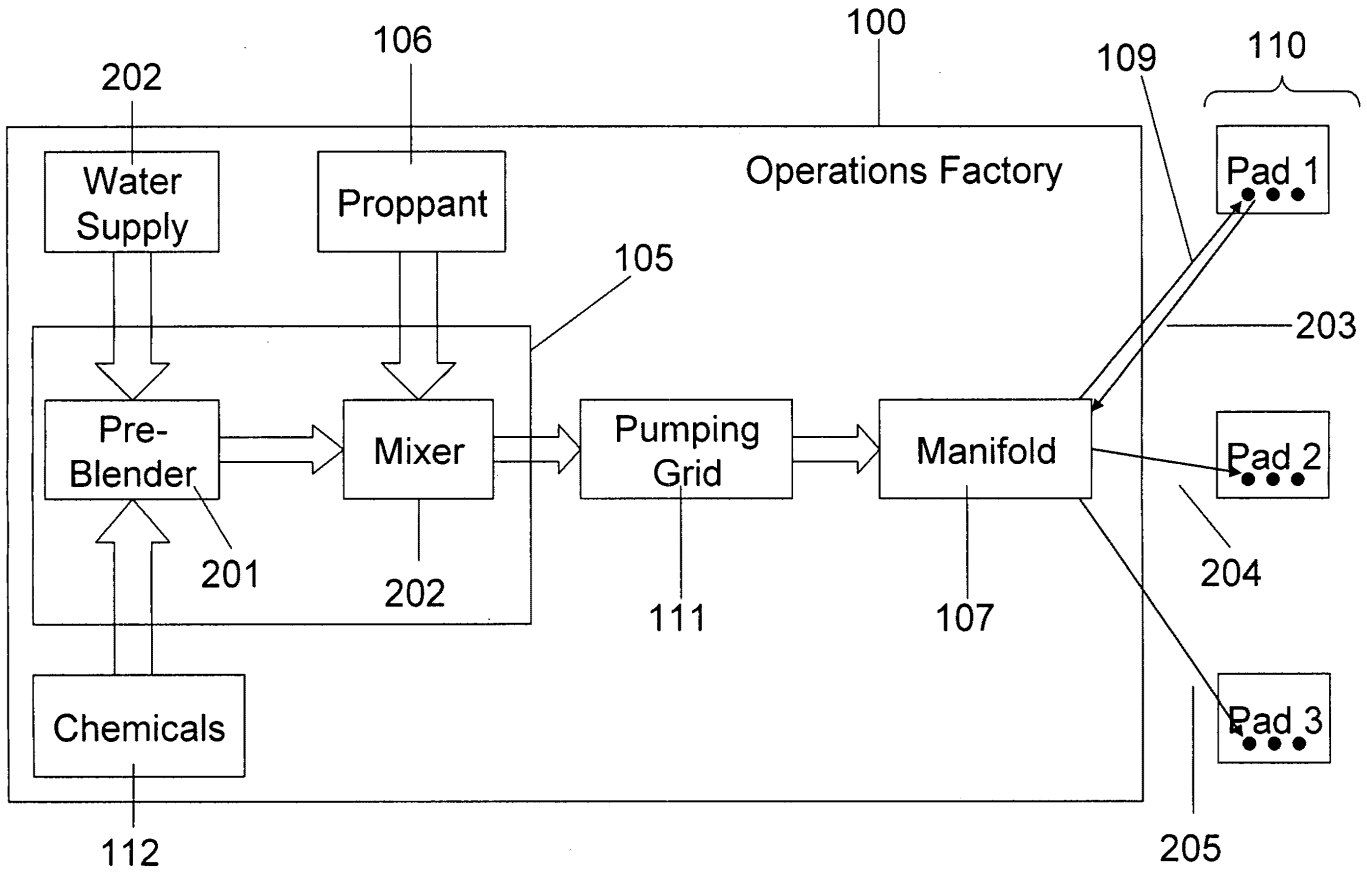

100
106
202
109
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Water Supply
Proppant
Operations Factory
Pad 1
105
203
Pre-Blender
Mixer
Pumping Grid
Manifold
Pad 2
201
202
111
107
204
Chemicals
Pad 3
112
205

FIG. 2

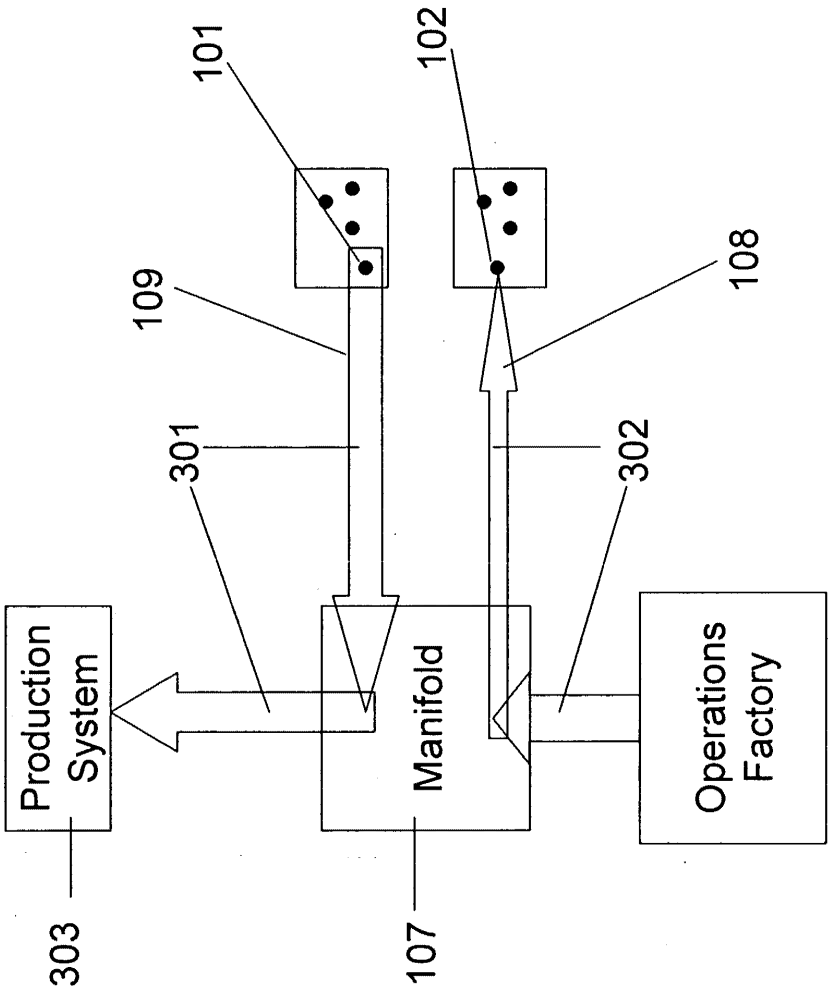

101
102
109
108
301
302
Production System
Manifold
Operations Factory
303
107

FIG. 3

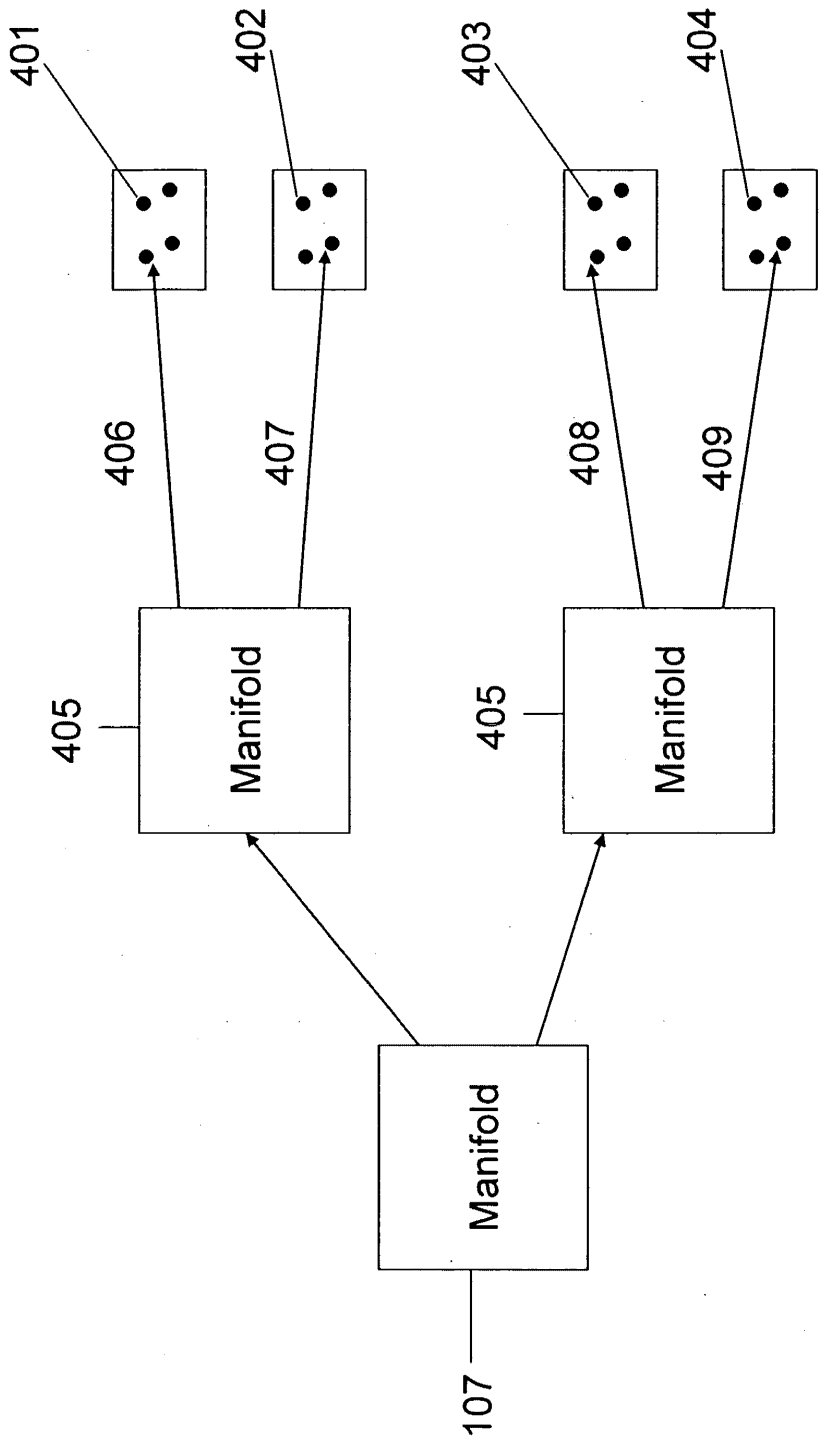

401
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Manifold
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Manifold
Manifold
107

FIG. 4

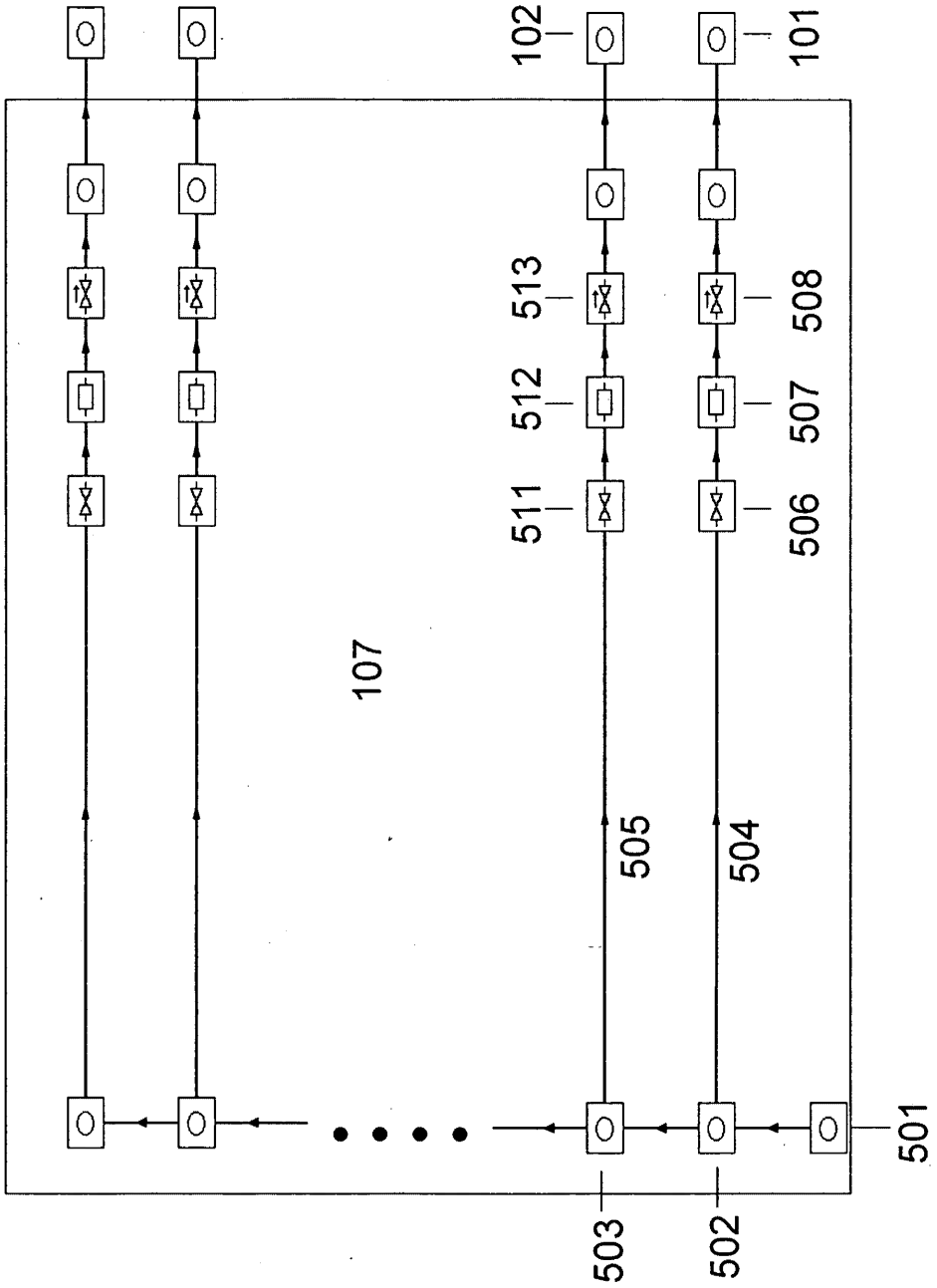


FIG. 5

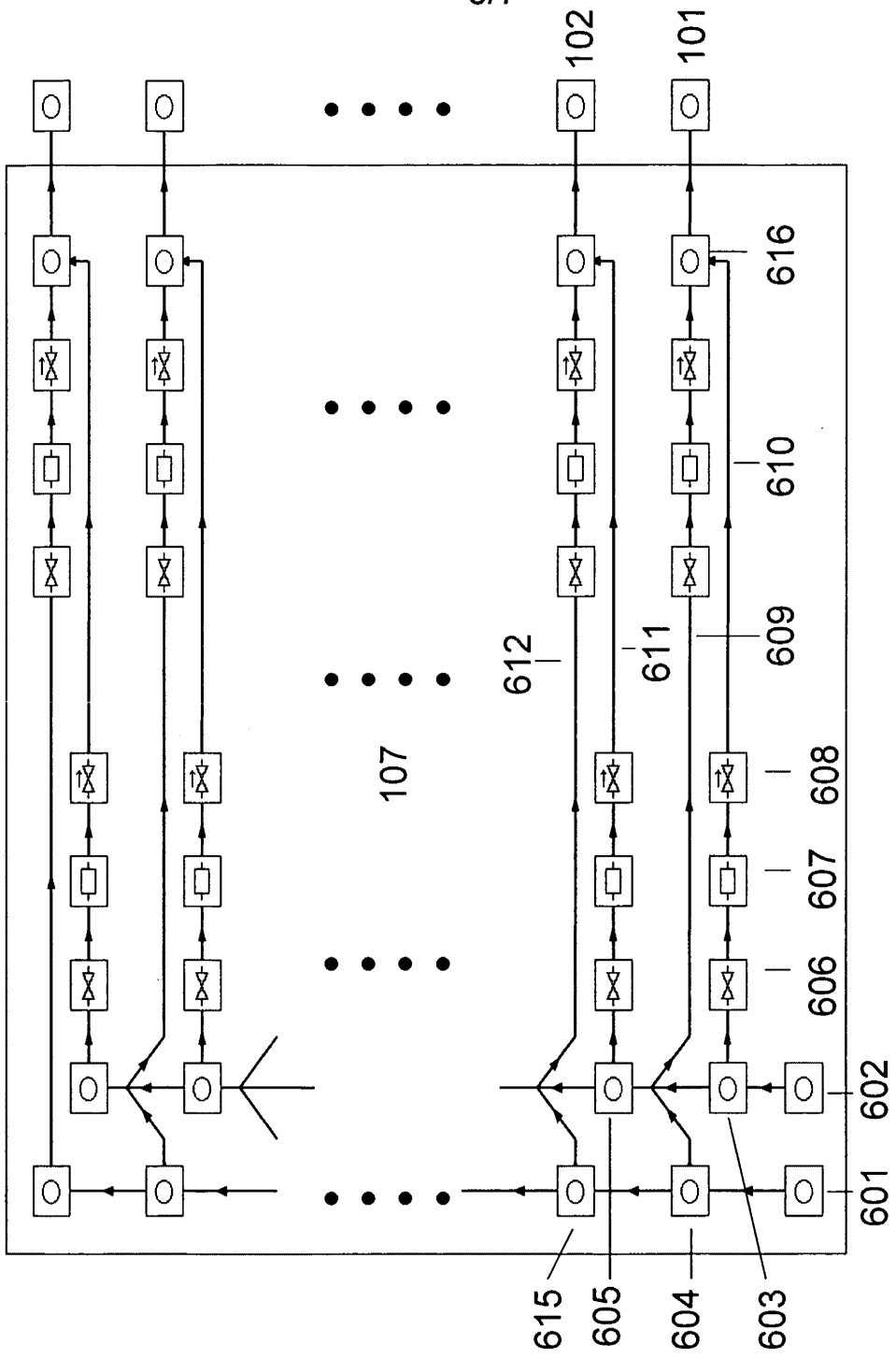

102
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603

FIG. 6

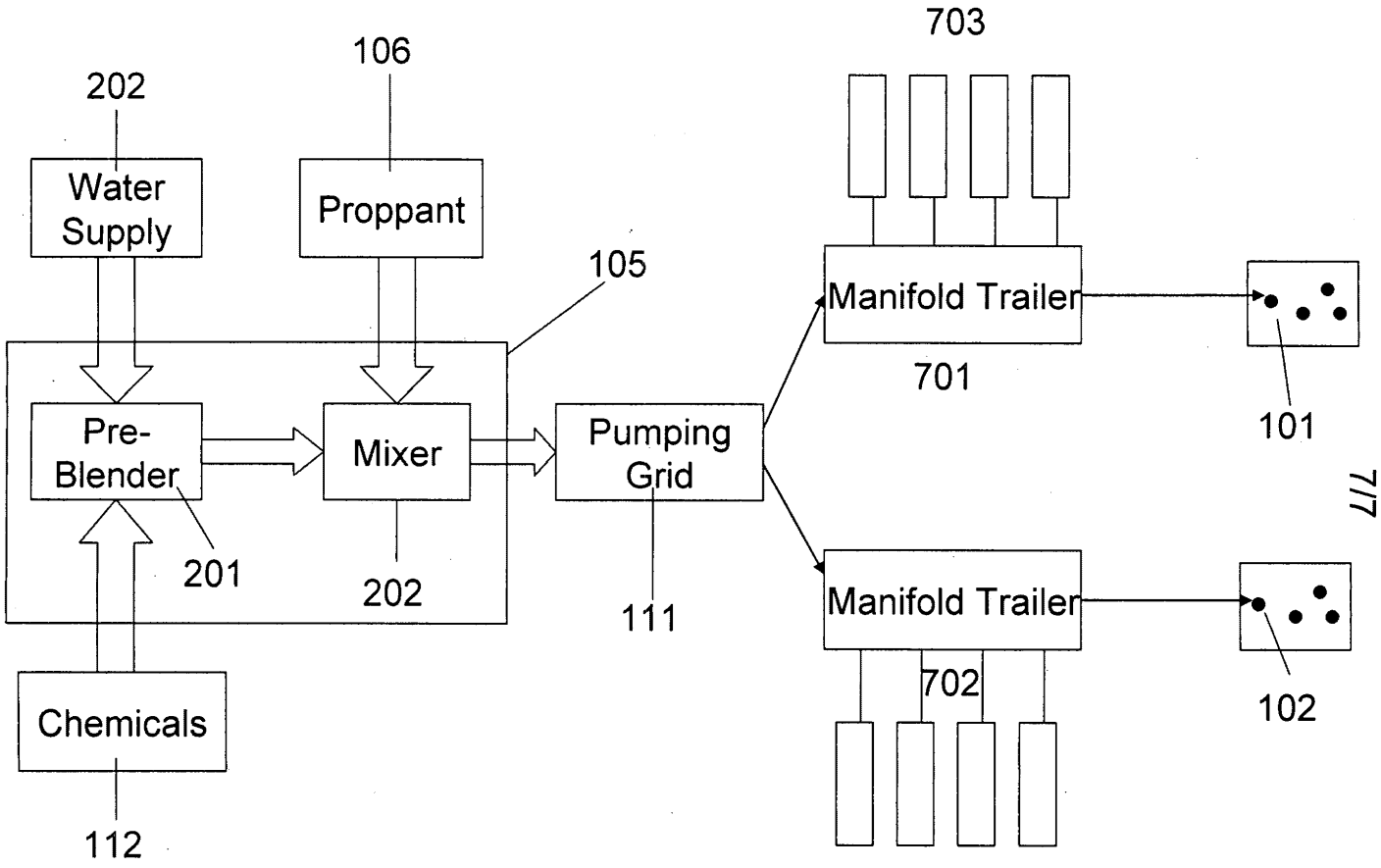

703
106
202
Water Supply
Proppant
105
Manifold Trailer
701
Pre-Blender
Mixer
Pumping Grid
101
201
202
111
Manifold Trailer
Chemicals
702
102
112
703

FIG. 7

PTO/SB/06 (12-04)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 11291496

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))							300
SEARCH FEE (37 CFR 1.16(k), (l), or (m))							500
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))							200
TOTAL CLAIMS (37 CFR 1.16(i))	39 minus 20 =	* 19	X$ 25=		OR	X$50=	950
INDEPENDENT CLAIMS (37 CFR 1.16(h))	5 minus 3 =	* 2	X$100=			X$200=	400
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR						
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))			N/A			N/A	
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	2350

APPLICATION AS AMENDED – PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDI-TIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDI-TIONAL FEE ($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	X =		OR	X =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X =		OR	X =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
						TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDI-TIONAL FEE ($)	OR	RATE ($)	ADDI-TIONAL FEE ($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	X =		OR	X =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X =		OR	X =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
						TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371 (c) DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
11/291,496	12/01/2005	Lloyd McNeel	HES 2005-IP-018647

CONFIRMATION NO. 7986

29920
JOHN W. WUSTENBERG
P.O. BOX 1431
DUNCAN, OK 73536

FORMALITIES LETTER

Date Mailed: 01/09/2006

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
  Applicant must submit $ **300** *to complete the basic filing fee for a non-small entity. If appropriate, applicant may make a written assertion of entitlement to small entity status and pay the small entity filing fee (37 CFR 1.27).*
- The oath or declaration is missing. *A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.*
  Note: If a petition under 37 CFR 1.47 is being filed, an oath or declaration in compliance with 37 CFR 1.63 signed by all available joint inventors, or if no inventor is available by a party with sufficient proprietary interest, is required.

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- Additional claim fees of **$1350** as a non-small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.
- To avoid abandonment, a surcharge (for late submission of filing fee, search fee, examination fee or oath or declaration) as set forth in 37 CFR 1.16(f) of $130 for a non-small entity, must be submitted with the missing items identified in this letter.

SUMMARY OF FEES DUE:

Total additional fee(s) required for this application is **$2480** for a Large Entity

- **$300** Statutory basic filing fee.
- **$130** Surcharge.

- The application search fee has not been paid. Applicant must submit **$500** to complete the search fee.
- The application examination fee has not been paid. Applicant must submit **$200** to complete the examination fee for a large entity

- Total additional claim fee(s) for this application is **$1350**

  - **$400** for **2** independent claims over 3.
  - **$950** for **19** total claims over 20.

Replies should be mailed to: Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

A copy of this notice MUST be returned with the reply.

Office of Initial Patent Examination (571) 272-4000, or 1-800-PTO-9199, or 1-800-972-6382
PART 3 - OFFICE COPY

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PTO/SB/21 (09-04)
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TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Total Number of Pages in This Submission

Application Number	11/291,496
Filing Date	12/01/2005
First Named Inventor	Lloyd McNeel, et al.
Art Unit	3672
Examiner Name	unknown
Attorney Docket Number	2005-IP-018647U1

ENCLOSURES *(Check all that apply)*

- [x] Fee Transmittal Form
  - [x] Fee Attached
- [ ] Amendment/Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [x] Reply to Missing Parts/ Incomplete Application
  - [x] Reply to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [x] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
  - [ ] Landscape Table on CD
- [ ] After Allowance Communication to TC
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) (please Identify below):
  - Statement Under 37 CFR 3.73(b)
  - Assignment with recordal Sheet
  - Signed Declaration
  - Return Post Card

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	Halliburton Energy Services, Inc.		
Signature	John W. Wustenberg		
Printed name	John W. Wustenberg		
Date	24 MAR 06	Reg. No.	35,415

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:

Signature	Chasidy Smith		
Typed or printed name	Chasidy Smith	Date	3-24-06

This collection of information is required by 37 CFR 1.5. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and1.14. This collection is estimated to 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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OIPE MAR 28 2006 PATENT & TRADEMARK OFFICE

PTO/SB/17 (01-06)
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Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL
For FY 2006

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 2640.00

Complete if Known	
Application Number	11/291,496
Filing Date	12/01/2005
First Named Inventor	Lloyd McNeel, et al.
Examiner Name	
Art Unit	3672
Attorney Docket No.	2005-IP-018647U1

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☑ Deposit Account Deposit Account Number: 08-0300 Deposit Account Name: Halliburton

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☑ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☑ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☑ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION (All the fees below are due upon filing or may be subject to a surcharge.)

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
		Small Entity		Small Entity		Small Entity	
Application Type	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fees Paid ($)
Utility	300	150	500	250	200	100	1000.00
Design	200	100	100	50	130	65	
Plant	200	100	300	150	160	80	
Reissue	300	150	500	250	600	300	
Provisional	200	100	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	Fee ($)	Small Entity Fee ($)
Each claim over 20 (including Reissues)	50	25
Each independent claim over 3 (including Reissues)	200	100
Multiple dependent claims	360	180

Total Claims		Extra Claims		Fee ($)		Fee Paid ($)
39	- 20 or HP =	19	x	50.00	=	950.00

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims		Extra Claims		Fee ($)		Fee Paid ($)
5	- 3 or HP =	2,600.00	x	200.00	=	400.00

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims	
Fee ($)	Fee Paid ($)

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		Extra Sheets		Number of each additional 50 or fraction thereof		Fee ($)		Fee Paid ($)
	- 100 =		/ 50 =		(round up to a whole number) x		=	

4. OTHER FEE(S)

	Fees Paid ($)
Non-English Specification, $130 fee (no small entity discount)	
Other (e.g., late filing surcharge): Late oath; recordation of assisgnment; extension of time	290.00

SUBMITTED BY

Signature	John W. Wustenberg	Registration No. (Attorney/Agent) 35,415	Telephone 580-251-3782
Name (Print/Type)	John W. Wustenberg		Date 24 MAR 06

This collection of information is required by 37 CFR 1.136. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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OIPE MAR 28 2006 PATENT & TRADEMARK OFFICE

Practitioner's Docket No. 2005-IP-018647U1 **PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Lloyd McNeel, et al.
Application No.: 11/291,496 **Group No.:** 3672
Filed: 12/1/05 **Examiner:** unknown
For: METHOD AND APPARATUS FOR CENTRALIZED WELL TREATMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

COMPLETION OF FILING REQUIREMENTS —NONPROVISIONAL APPLICATION

(check and complete this item, if applicable)

I. ☒ This replies to the Notice to File Missing Parts of Application (PTO-1533) mailed 01/09/2006

NOTE: If these papers are filed before the office letter issues, adequate identification of the original papers should be made, e.g., in addition to the name of the inventor and title of invention, the filing date based on the "Express Mail" procedure, the serial number from the return post card or the attorney's docket number added.

☒ A copy of the Notice to File Missing Parts of Application—Filing Date Granted (Form PTO-1533) is enclosed.

NOTE: The PTO requires that a copy of Form PTO-1533 be returned with the response to the notice to file missing parts to the application.

CERTIFICATION UNDER 37 C.F.R. §§ 1.8(a) and 1.10*
(When using Express Mail, the Express Mail label number is mandatory; Express Mail certification is optional.)

I hereby certify that, on the date shown below, this correspondence is being:

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☒ deposited with the United States Postal Service in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

37 C.F.R. § 1.8(a)

☒ with sufficient postage as first class mail.

37 C.F.R. § 1.10 *

☐ as "Express Mail Post Office to Addressee" Mailing Label No. _____ (mandatory)

TRANSMISSION

☐ facsimile transmitted to the Patent and Trademark Office, (703) _____-_____

Date: 3/24/06

Signature

Chasidy Smith

(type or print name of person certifying)

** Only the date of filing (§ 1.6) will be the date used in a patent term adjustment calculation, although the date on any certificate of mailing or transmission under § 1.8 continues to be taken into account in determining timeliness. See § 1.703(f). Consider "Express Mail Post Office to Addressee" (§ 1.10) or facsimile transmission (§ 1.6(d)) for the reply to be accorded the earliest possible filing date for patent term adjustment calculations.*

03/29/2006 WABDELR1 00000135 080300 11291496
07 FC:1251 120.00 DA

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Ex. 1002, p. 40 of 988

IPR2023-01319

Profrac Holding Corporation
U.S. Well Services, LLC

DECLARATION OR OATH

II. ☒ No declaration or oath was filed. Enclosed is the original declaration or oath for this application.

NOTE: If the correct inventor or inventors are not named on filing a nonprovisional application under § 1.53(b) without an executed oath or declaration under § 1.63, the later submission of an executed oath or declaration under § 1.63 during the pendency of the application will act to correct the earlier identification of inventorship. 37 C.F.R. § 1.48(f)(1).

OR

☐ The declaration or oath that was filed was determined to be defective. A new original oath or declaration is attached.

NOTE: For surcharge fee for filing declaration after filing date complete item VI(3) below.

NOTE: "The following combinations of information supplied in an oath or declaration filed after the filing date are acceptable as minimums for identifying a specification and compliance with any one of the items below will be accepted as complying with the identification requirement of 37 C.F.R. § 1.63:

"(A) application number (consisting of the series code and the serial number, e.g., 08/123,456);

"(B) serial number and filing date;

"(C) attorney docket number which was on the specification as filed;

"(D) title which was on the specification as filed and reference to an attached specification which is both attached to the oath or declaration at the time of execution and submitted with the oath or declaration; or

"(E) title which was on the specification as filed and accompanied by a cover letter accurately identifying the application for which it was intended by either the application number (consisting of the series code and the serial number, e.g., 08/123,456), or serial number and filing date. Absent any statement(s) to the contrary, it will be presumed that the application filed in the PTO is the application which the inventor(s) executed by signing the oath or declaration."

M.P.E.P. § 601.01(a), 7th Ed.

NOTE: Another minimum found acceptable in the declaration is the filing date (i.e., date of express mail) and the express mail number, useful where the serial number is not yet known. But note the practice where the express mail deposit is a Saturday, Sunday or holiday within the District of Columbia. 37 C.F.R. § 1.10(c).

(complete (c) or (d), if applicable)

Attached is a

(c) ☐ Statement by a registered attorney that the application filed in the PTO is the application that the inventor executed by signing the declaration.

(d) ☐ Statement that the "attached" specification is a copy of the specification and any amendments thereto that were filed in the PTO to obtain the filing date.

AMENDMENT CANCELLING CLAIMS

III. ☐ Cancel claims _____ inclusive.

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TRANSMITTAL OF ENGLISH TRANSLATION OF NON-ENGLISH LANGUAGE PAPERS

IV. ☐ Submitted herewith is an English translation of the non-English language application papers as originally filed. Also submitted herewith is a statement by the translator of the accuracy of the translation. It is requested that this translation be used as the copy for examination purposes in the PTO.

NOTE: For fee processing a non-English application, complete item VI(3) below.

NOTE: A non-English oath or declaration in the form provided by the PTO need not be translated. 37 C.F.R. § 1.69(b).

SMALL ENTITY STATUS

V.

a. ☐ An assertion that this filing is by a small entity

(check and complete applicable items)

- ☐ is attached.
- ☐ was filed on _____ (original).
- ☐ was made by paying the basic filing fee as a small entity.
- ☐ is being made now by paying the basic filing fee as a small entity.

b. ☐ A separate refund request accompanies this paper.

COMPLETION FEES

VI.

WARNING: Failure to submit the surcharge fees where required will cause the application to become abandoned. 37 C.F.R. § 1.53.

NOTE: For effect on fees of failure to establish status, or change status, as a small entity, see 37 C.F.R. § 1.28(a).

1. Filing fee

- ☐ original patent application (37 C.F.R. § 1.16(a)—$770.00; Small entity—$385.00) $_____
- ☐ design application (37 C.F.R. § 1.16(f)—$340.00; small entity—$170.00) $_____

$ _____

2. Fees for claims

- ☐ each independent claim in excess of 3 (37 C.F.R. § 1.16(b)—$86.00; small entity—$43.00) $_____
- ☐ each claim in excess of 20 (37 C.F.R. § 1.16(c)—$18.00; small entity—$9.00) $_____
- ☐ multiple dependent claim(s) (37 C.F.R. § 1.16(d)—$290.00; small entity—$145.00) $_____

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3. Surcharge fees

☒ declaration or oath late payment of filing fee and/or late filing of original (37 C.F.R. § 1.16(e)—$130.00; small entity—$65.00); $ 130.00

NOTE: If both the filing fee and declaration or oath were missing from the original papers, the Office practice under § 37 C.F.R. § 1.16(a) is that only one surcharge Fee need be paid whether the later filed oath or declaration and/or the filing fee are submitted afterwards at the same time or at different times.

4. ☐ Petition and fee for filing by other than all the inventors or a person not the inventor (37 C.F.R. §§ 1.17(i) and 1.47—$130.00) $ _____

5. ☐ Fee for processing an application filed with a specification in a non-English language (37 C.F.R. §§ 1.17(k) and 1.52(d)—$130.00) $ _____

6. ☐ Fee for processing and retention of application (37 C.F.R. §§ 1.21(l) and 1.53(d)—$130.00) $ _____

7. ☒ Assignment (See "ASSIGNMENT COVER SHEET".)

NOTE: 37 C.F.R. § 1.21(l) establishes a fee for processing and retaining any application which is abandoned for failing to complete the application pursuant to 37 C.F.R. § 1.53(f) and this, as well as, the changes to 37 C.F.R. §§ 1.53 and 1.78 indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing fee or the processing and retention fee of § 1.21(l) within 1 year of notification under §1.53(f) must be paid.

Total completion fees $ 130.00

EXTENSION OF TIME

VII.

(complete (a) or (b), as applicable)

NOTE: 37 C.F.R. § 1.704(b) "... an applicant shall be deemed to have failed to engage in reasonable efforts to conclude processing or examination of an application for the cumulative total of any periods of time in excess of three months that are taken to reply to any notice or action by the Office making any rejection, objection, argument, or other request, measuring such three-month period from the date the notice or action was mailed or given to the applicant, in which case the period of adjustment set forth in § 1.703 shall be reduced by the number of days, if any, beginning on the day after the date that is three months after the date of mailing or transmission of the Office communication notifying the applicant of the rejection, objection, argument, or other request and ending on the date the reply was filed. The period, or shortened statutory period, for reply that is set in the Office action or notice has no effect on the three-month period set forth in this paragraph."

The proceedings herein are for a patent application, and the provisions of 37 C.F.R. § 1.136(a) apply.

(a) ☐ Applicant petitions\ for an extension of time, the fees for which are set out in 37 C.F.R. § 1.17(a)(1)-(4), for the total number of months checked below:

Extension (months)	Fee for other than small entity	Fee for small entity
☒ one month	$ 120.00	$ 55.00
☐ two months	$ 420.00	$ 210.00
☐ three months	$ 950.00	$ 475.00
☐ four months	$ 1,480.00	$ 740.00

Fee: $ 120.00

If an additional extension of time is required, please consider this a petition therefor.

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(check and complete the next item, if applicable)

☐ An extension for _____ months has already been secured, and the fee paid therefor of $ _____ is deducted from the total fee due for the total months of extension now requested.

Extension fee due with this request $ _____

or

(b) ☐ Applicant believes that no extension of term is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition and fee for extension of time.

TOTAL FEE DUE

VIII.

The total fee due is

Completion fee(s) $ 130.00

Extension fee *(if any)* $ 120.00

Total Fee Due $ 250.00

PAYMENT OF FEES

IX.

☐ Attached is a ☐ check ☐ money order in the amount of $ _____

☒ Authorization is hereby made to charge the amount of $ 250.00

☒ to Deposit Account No. 08-0300

☐ to Credit card as shown on the attached credit card information authorization form PTO-2038.

WARNING: *Credit card information should not be included on this form as it may become public.*

☒ Charge any additional fees required by this paper or credit any overpayment in the manner authorized above.

A duplicate of this paper is attached.

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AUTHORIZATION TO CHARGE ADDITIONAL FEES

X.

WARNING: Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges if extra claims are authorized.

NOTE: "Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

☒ The Office is hereby authorized to charge, in the manner shown above, the following additional fees that may be required by this paper and during the entire pendency of this application.

- ☐ 37 C.F.R. § 1.16(a), (f) or (g) (filing fees)
- ☐ 37 C.F.R. § 1.16(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. § 1.16(d)), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.

- ☒ 37 C.F.R. § 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)
- ☐ 37 C.F.R. § 1.17(a)(1)–(5) (extension fees pursuant to § 1.136(a))
- ☐ 37 C.F.R. § 1.17 (application processing fees)

NOTE: "A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).

- ☐ 37 C.F.R. § 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. § 1.311(b))

NOTE: Section 1.311(b) provides that an authorization to charge the issue fee (§ 1.18) to a deposit account may be filed in an individual application only after the mailing of the notice of allowance. Accordingly, general authorizations to pay fees and specific authorizations to pay the issue fee that are filed prior to the mailing of a notice of allowance will generally not be treated as requesting payment of the issue fee and will not be given effect to act as a reply to the notice of allowance. Applicant, when paying the issue fee, should submit a new authorization to charge fees, such as by completing box 6b on the current PTOL-85B form. Where no reply to the notice of allowance is received, the application will stand abandoned notwithstanding the presence of general authorizations to pay fees or a specific authorization to pay the issue fee that were submitted prior to mailing of the notice of allowance. Where an attempt is made to pay the issue fee but an incorrect amount is submitted, § 1.311(b)(1), or where the Office's issue fee transmittal form (currently PTOL-85(B)) is completed by applicant and submitted, § 1.311(b)(2), in reply to a notice of allowance, an exception will be made. Such submissions will operate as a request to charge the issue fee to any deposit account identified in a previously filed (i.e., submitted prior to the mailing of the notice of allowance) authorization to charge fees, and will be allowed to act as payment of the correct issue fee. § 1.311(b). See also the change to § 1.26(b). Notice of September 8, 2000, Fed. Reg. 54603-54683, at 54648 and 54647.

NOTE: 37 C.F.R. § 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying . . . issue fee . . ." From the wording of 37 C.F.R. § 1.28(b): (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

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SIGNATURE OF PRACTITIONER

Reg. No. 35,415

John W. Wustenberg
(type or print name of practitioner)

Tel. No.: (580)251-3782

PO BOX 1431
P.O. Address

Customer No.: 29920

DUNCAN OK 73536 0440

$1fw

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MAR 28 2006
1600

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371 (c) DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
11/291,496	12/01/2005	Lloyd McNeel	HES 2005-IP-018647

CONFIRMATION NO. 7986

29920
JOHN W. WUSTENBERG
P.O. BOX 1431
DUNCAN, OK 73536

FORMALITIES LETTER

Date Mailed: 01/09/2006

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

03/29/2006 WABDELR1 00000135 080300 11291496
01 FC:1011 300.00 DA
02 FC:1111 500.00 DA
03 FC:1311 200.00 DA
04 FC:1051 130.00 DA
05 FC:1201 400.00 DA
06 FC:1202 950.00 DA

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
  Applicant must submit $ **300** *to complete the basic filing fee for a non-small entity. If appropriate, applicant may make a written assertion of entitlement to small entity status and pay the small entity filing fee (37 CFR 1.27).*
- The oath or declaration is missing. *A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.*
  Note: If a petition under 37 CFR 1.47 is being filed, an oath or declaration in compliance with 37 CFR 1.63 signed by all available joint inventors, or if no inventor is available by a party with sufficient proprietary interest, is required.

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- Additional claim fees of **$1350** as a non-small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.
- To avoid abandonment, a surcharge (for late submission of filing fee, search fee, examination fee or oath or declaration) as set forth in 37 CFR 1.16(f) of $130 for a non-small entity, must be submitted with the missing items identified in this letter.

SUMMARY OF FEES DUE:

Total additional fee(s) required for this application is **$2480** for a Large Entity

- **$300** Statutory basic filing fee.
- **$130** Surcharge.

- The application search fee has not been paid. Applicant must submit **$500** to complete the search fee.
- The application examination fee has not been paid. Applicant must submit **$200** to complete the examination fee for a large entity

- Total additional claim fee(s) for this application is **$1350**

  - **$400** for **2** independent claims over 3.
  - **$950** for **19** total claims over 20.

Replies should be mailed to: Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

A copy of this notice MUST be returned with the reply.

Office of Initial Patent Examination (571) 272-4000, or 1-800-PTO-9199, or 1-800-972-6382
PART 1 - ATTORNEY/APPLICANT COPY

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted With Initial Filing **OR** ☑ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	2005-IP-018647U1
First Named Inventor	Lloyd McNeel, et al.
COMPLETE IF KNOWN	
Application Number	11/291,496
Filing Date	12/01/2005
Art Unit	3672
Examiner Name	unknown

I hereby declare that:

Each inventor's residence, mailing address, and citizenship are as stated below next to their name.

I believe the inventor(s) named below to be the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD AND APPARATUS FOR CENTRALIZED WELL TREATMENT

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☑ was filed on (MM/DD/YYYY) 12/01/2005 as United States Application Number or PCT International Application Number 11/291,496 and was amended on (MM/DD/YYYY) _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 21 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance completing the form, call 1-800-PTO-9199 and select option 2.

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DECLARATION — Utility or Design Patent Application

Direct all correspondence to:	☑ The address associated with Customer Number:	29920	OR	☐	Correspondence address below

Name		
Address		
City	State	ZIP
Country	Telephone	Email

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

NAME OF SOLE OR FIRST INVENTOR:	☐ A petition has been filed for this unsigned inventor
Given Name (first and middle [if any]) W. ~~Lloyd~~ William Lloyd ~~McNeel~~	Family Name or Surname McNeel
Inventor's Signature W. Lloyd McNeel	Date Feb 27th 06

Residence: City	State	Country	Citizenship
~~Rock Springs~~ Green River	WY	US	US

Mailing Address			
~~1700 Elk Street~~ 2035 Wyoming Dr WFA			
City ~~Rock Springs~~ Green River WFA	State WY	Zip WFA ~~82901~~ 82935	Country US

☐ Additional inventors or a legal representative are being named on the _____ supplemental sheet(s) PTO/SB/02A or 02LR attached hereto.

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FEB 1 6 2006
JOHN W. WUSTENBERG

OIPE
MAR 2 8 2006
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DECLARATION

ADDITIONAL INVENTOR(S)
Supplemental Sheet
Page ____ of ____

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle (if any))	Family Name or Surname		
Steve	Harris		
Inventor's Signature		Date	
Denver Residence: City	CO State	US Country	US Citizenship
7065 S. Dahlia Street Mailing Address			
Denver City	CO State	80122 Zip	US Country
Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle (if any))	Family Name or Surname		
Dave	McLeod		
Inventor's Signature	Dave McLeod	Date	2/10/06
Houston Residence: City	TX State	US Country	US Citizenship
10200 Bellaire Blvd Mailing Address			
Houston City	TX State	77072 Zip	US Country
Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle (if any))	Family Name or Surname		
Inventor's Signature		Date	
Residence: City	State	Country	Citizenship
Mailing Address			
City	State	Zip	Country

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 21 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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DECLARATION

ADDITIONAL INVENTOR(S)
Supplemental Sheet
Page ____ of ____

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle (if any))	Family Name or Surname		
Steve	Harris		
Inventor's Signature		Date 3/15/06	
~~Denver~~ PALISADE Residence: City	CO State	US Country	US Citizenship
~~7665 S. Dahlia Street~~ 3289 C 1/2 Road Mailing Address			
~~Denver~~ PALISADE City	CO State	81526 Zip	US Country

SIGN DATE

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle (if any))	Family Name or Surname		
Dave	McLeod		
Inventor's Signature		Date 2/10/06	
Houston Residence: City	TX State	US Country	US Citizenship
10200 Bellaire Blvd Mailing Address			
Houston City	TX State	77072 Zip	US Country

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle (if any))	Family Name or Surname		
Inventor's Signature		Date	
Residence: City	State	Country	Citizenship
Mailing Address			
City	State	Zip	Country

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 21 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:

☐ Practitioners associated with the Customer Number: _____

OR

☒ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number
William E. Shull	29,438	Mitchell D. Lukin	30,772
Paul I. Herman	37,349	Carey C. Jordan	47,646
Robert A. Kent	28,626	Thomas M. Morrow	55,469
Craig W. Roddy	36,256	Paul R. Morico	35,960
John W. Wustenberg	35,415		

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(b) to:

☐ The address associated with Customer Number: _____

OR

☐ Firm or Individual Name			
Address			
City		State	Zip
Country			
Telephone		Email	

Assignee Name and Address:

Halliburton Energy Services, Inc.
10200 Bellaire Blvd.
Houston TX 77072

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature	John W. Wustenberg	Date	24 MAR 06
Name	John W. Wustenberg	Telephone	580-251-3782
Title	Counsel		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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OIPE MAR 28 2006 PATENT & TRADEMARK OFFICE

PTO/SB/21 (09-04)
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TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Total Number of Pages in This Submission

Application Number	11/291,496
Filing Date	12/01/2005
First Named Inventor	Lloyd McNeel, et al.
Art Unit	3672
Examiner Name	unknown
Attorney Docket Number	2005-IP-018647U1

ENCLOSURES *(Check all that apply)*

- [x] Fee Transmittal Form
  - [x] Fee Attached
- [ ] Amendment/Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [x] Reply to Missing Parts/ Incomplete Application
  - [x] Reply to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [x] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
  - [ ] Landscape Table on CD
- [ ] After Allowance Communication to TC
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) (please Identify below):
  - Statement Under 37 CFR 3.73(b)
  - Assignment with recordal Sheet
  - Signed Declaration
  - Return Post Card

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	Halliburton Energy Services, Inc.		
Signature	John W. Wustenberg		
Printed name	John W. Wustenberg		
Date	24 MAR 06	Reg. No.	35,415

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:

Signature	Chasidy Smith		
Typed or printed name	Chasidy Smith	Date	3-24-06

This collection of information is required by 37 CFR 1.5. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and1.14. This collection is estimated to 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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OIPE MAR 28 2006 PATENT & TRADEMARK OFFICE

PTO/SB/17 (01-06)
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Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL
For FY 2006

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 2640.00

Complete if Known	
Application Number	11/291,496
Filing Date	12/01/2005
First Named Inventor	Lloyd McNeel, et al.
Examiner Name	
Art Unit	3672
Attorney Docket No.	2005-IP-018647U1

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☑ Deposit Account Deposit Account Number: 08-0300 Deposit Account Name: Halliburton

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☑ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☑ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☑ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION (All the fees below are due upon filing or may be subject to a surcharge.)

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
		Small Entity		Small Entity		Small Entity	
Application Type	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fees Paid ($)
Utility	300	150	500	250	200	100	1000.00
Design	200	100	100	50	130	65	
Plant	200	100	300	150	160	80	
Reissue	300	150	500	250	600	300	
Provisional	200	100	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	Fee ($)	Small Entity Fee ($)
Each claim over 20 (including Reissues)	50	25
Each independent claim over 3 (including Reissues)	200	100
Multiple dependent claims	360	180

Total Claims		Extra Claims		Fee ($)		Fee Paid ($)
39	- 20 or HP =	19	x	50.00	=	950.00

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims		Extra Claims		Fee ($)		Fee Paid ($)
5	- 3 or HP =	2,600.00	x	200.00	=	400.00

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims	
Fee ($)	Fee Paid ($)

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		Extra Sheets		Number of each additional 50 or fraction thereof		Fee ($)		Fee Paid ($)
	- 100 =		/ 50 =		(round up to a whole number) x		=	

4. OTHER FEE(S)

	Fees Paid ($)
Non-English Specification, $130 fee (no small entity discount)	
Other (e.g., late filing surcharge): Late oath; recordation of assisgnment; extension of time	290.00

SUBMITTED BY

Signature	John W. Wustenberg	Registration No. (Attorney/Agent) 35,415	Telephone 580-251-3782
Name (Print/Type)	John W. Wustenberg		Date 24 MAR 06

This collection of information is required by 37 CFR 1.136. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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OIPE MAR 28 2006 PATENT & TRADEMARK OFFICE

Practitioner's Docket No. 2005-IP-018647U1 **PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Lloyd McNeel, et al.
Application No.: 11/291,496 **Group No.:** 3672
Filed: 12/1/05 **Examiner:** unknown
For: METHOD AND APPARATUS FOR CENTRALIZED WELL TREATMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

COMPLETION OF FILING REQUIREMENTS —NONPROVISIONAL APPLICATION

(check and complete this item, if applicable)

I. ☒ This replies to the Notice to File Missing Parts of Application (PTO-1533) mailed 01/09/2006

NOTE: If these papers are filed before the office letter issues, adequate identification of the original papers should be made, e.g., in addition to the name of the inventor and title of invention, the filing date based on the "Express Mail" procedure, the serial number from the return post card or the attorney's docket number added.

☒ A copy of the Notice to File Missing Parts of Application—Filing Date Granted (Form PTO-1533) is enclosed.

NOTE: The PTO requires that a copy of Form PTO-1533 be returned with the response to the notice to file missing parts to the application.

CERTIFICATION UNDER 37 C.F.R. §§ 1.8(a) and 1.10*
(When using Express Mail, the Express Mail label number is mandatory; Express Mail certification is optional.)

I hereby certify that, on the date shown below, this correspondence is being:

MAILING

☒ deposited with the United States Postal Service in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

37 C.F.R. § 1.8(a)

☒ with sufficient postage as first class mail.

37 C.F.R. § 1.10 *

☐ as "Express Mail Post Office to Addressee" Mailing Label No. _____ (mandatory)

TRANSMISSION

☐ facsimile transmitted to the Patent and Trademark Office, (703) _____-_____

Date: 3/24/06

Signature

Chasidy Smith

(type or print name of person certifying)

** Only the date of filing (§ 1.6) will be the date used in a patent term adjustment calculation, although the date on any certificate of mailing or transmission under § 1.8 continues to be taken into account in determining timeliness. See § 1.703(f). Consider "Express Mail Post Office to Addressee" (§ 1.10) or facsimile transmission (§ 1.6(d)) for the reply to be accorded the earliest possible filing date for patent term adjustment calculations.*

03/29/2006 WABDELR1 00000135 080300 11291496
07 FC:1251 120.00 DA

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Ex. 1002, p. 56 of 988

IPR2023-01319

Profrac Holding Corporation
U.S. Well Services, LLC

DECLARATION OR OATH

II. ☒ No declaration or oath was filed. Enclosed is the original declaration or oath for this application.

NOTE: If the correct inventor or inventors are not named on filing a nonprovisional application under § 1.53(b) without an executed oath or declaration under § 1.63, the later submission of an executed oath or declaration under § 1.63 during the pendency of the application will act to correct the earlier identification of inventorship. 37 C.F.R. § 1.48(f)(1).

OR

☐ The declaration or oath that was filed was determined to be defective. A new original oath or declaration is attached.

NOTE: For surcharge fee for filing declaration after filing date complete item VI(3) below.

NOTE: "The following combinations of information supplied in an oath or declaration filed after the filing date are acceptable as minimums for identifying a specification and compliance with any one of the items below will be accepted as complying with the identification requirement of 37 C.F.R. § 1.63:

"(A) application number (consisting of the series code and the serial number, e.g., 08/123,456);

"(B) serial number and filing date;

"(C) attorney docket number which was on the specification as filed;

"(D) title which was on the specification as filed and reference to an attached specification which is both attached to the oath or declaration at the time of execution and submitted with the oath or declaration; or

"(E) title which was on the specification as filed and accompanied by a cover letter accurately identifying the application for which it was intended by either the application number (consisting of the series code and the serial number, e.g., 08/123,456), or serial number and filing date. Absent any statement(s) to the contrary, it will be presumed that the application filed in the PTO is the application which the inventor(s) executed by signing the oath or declaration."

M.P.E.P. § 601.01(a), 7th Ed.

NOTE: Another minimum found acceptable in the declaration is the filing date (i.e., date of express mail) and the express mail number, useful where the serial number is not yet known. But note the practice where the express mail deposit is a Saturday, Sunday or holiday within the District of Columbia. 37 C.F.R. § 1.10(c).

(complete (c) or (d), if applicable)

Attached is a

(c) ☐ Statement by a registered attorney that the application filed in the PTO is the application that the inventor executed by signing the declaration.

(d) ☐ Statement that the "attached" specification is a copy of the specification and any amendments thereto that were filed in the PTO to obtain the filing date.

AMENDMENT CANCELLING CLAIMS

III. ☐ Cancel claims _____ inclusive.

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TRANSMITTAL OF ENGLISH TRANSLATION OF NON-ENGLISH LANGUAGE PAPERS

IV. ☐ Submitted herewith is an English translation of the non-English language application papers as originally filed. Also submitted herewith is a statement by the translator of the accuracy of the translation. It is requested that this translation be used as the copy for examination purposes in the PTO.

NOTE: For fee processing a non-English application, complete item VI(3) below.

NOTE: A non-English oath or declaration in the form provided by the PTO need not be translated. 37 C.F.R. § 1.69(b).

SMALL ENTITY STATUS

V.

a. ☐ An assertion that this filing is by a small entity

(check and complete applicable items)

- ☐ is attached.
- ☐ was filed on _____ (original).
- ☐ was made by paying the basic filing fee as a small entity.
- ☐ is being made now by paying the basic filing fee as a small entity.

b. ☐ A separate refund request accompanies this paper.

COMPLETION FEES

VI.

WARNING: Failure to submit the surcharge fees where required will cause the application to become abandoned. 37 C.F.R. § 1.53.

NOTE: For effect on fees of failure to establish status, or change status, as a small entity, see 37 C.F.R. § 1.28(a).

1. Filing fee

- ☐ original patent application (37 C.F.R. § 1.16(a)—$770.00; Small entity—$385.00) $_____
- ☐ design application (37 C.F.R. § 1.16(f)—$340.00; small entity—$170.00) $_____

$ _____

2. Fees for claims

- ☐ each independent claim in excess of 3 (37 C.F.R. § 1.16(b)—$86.00; small entity—$43.00) $_____
- ☐ each claim in excess of 20 (37 C.F.R. § 1.16(c)—$18.00; small entity—$9.00) $_____
- ☐ multiple dependent claim(s) (37 C.F.R. § 1.16(d)—$290.00; small entity—$145.00) $_____

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3. Surcharge fees

☒ declaration or oath late payment of filing fee and/or late filing of original (37 C.F.R. § 1.16(e)—$130.00; small entity—$65.00); $ 130.00

NOTE: If both the filing fee and declaration or oath were missing from the original papers, the Office practice under § 37 C.F.R. § 1.16(a) is that only one surcharge Fee need be paid whether the later filed oath or declaration and/or the filing fee are submitted afterwards at the same time or at different times.

4. ☐ Petition and fee for filing by other than all the inventors or a person not the inventor (37 C.F.R. §§ 1.17(i) and 1.47—$130.00) $ _____

5. ☐ Fee for processing an application filed with a specification in a non-English language (37 C.F.R. §§ 1.17(k) and 1.52(d)—$130.00) $ _____

6. ☐ Fee for processing and retention of application (37 C.F.R. §§ 1.21(l) and 1.53(d)—$130.00) $ _____

7. ☒ Assignment (See "ASSIGNMENT COVER SHEET".)

NOTE: 37 C.F.R. § 1.21(l) establishes a fee for processing and retaining any application which is abandoned for failing to complete the application pursuant to 37 C.F.R. § 1.53(f) and this, as well as, the changes to 37 C.F.R. §§ 1.53 and 1.78 indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing fee or the processing and retention fee of § 1.21(l) within 1 year of notification under §1.53(f) must be paid.

Total completion fees $ 130.00

EXTENSION OF TIME

VII.

(complete (a) or (b), as applicable)

NOTE: 37 C.F.R. § 1.704(b) "... an applicant shall be deemed to have failed to engage in reasonable efforts to conclude processing or examination of an application for the cumulative total of any periods of time in excess of three months that are taken to reply to any notice or action by the Office making any rejection, objection, argument, or other request, measuring such three-month period from the date the notice or action was mailed or given to the applicant, in which case the period of adjustment set forth in § 1.703 shall be reduced by the number of days, if any, beginning on the day after the date that is three months after the date of mailing or transmission of the Office communication notifying the applicant of the rejection, objection, argument, or other request and ending on the date the reply was filed. The period, or shortened statutory period, for reply that is set in the Office action or notice has no effect on the three-month period set forth in this paragraph."

The proceedings herein are for a patent application, and the provisions of 37 C.F.R. § 1.136(a) apply.

(a) ☐ Applicant petitions\ for an extension of time, the fees for which are set out in 37 C.F.R. § 1.17(a)(1)-(4), for the total number of months checked below:

Extension (months)	Fee for other than small entity	Fee for small entity
☒ one month	$ 120.00	$ 55.00
☐ two months	$ 420.00	$ 210.00
☐ three months	$ 950.00	$ 475.00
☐ four months	$ 1,480.00	$ 740.00

Fee: $ 120.00

If an additional extension of time is required, please consider this a petition therefor.

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(check and complete the next item, if applicable)

☐ An extension for _____ months has already been secured, and the fee paid therefor of $ _____ is deducted from the total fee due for the total months of extension now requested.

Extension fee due with this request $ _____

or

(b) ☐ Applicant believes that no extension of term is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition and fee for extension of time.

TOTAL FEE DUE

VIII.

The total fee due is

Completion fee(s) $ 130.00

Extension fee *(if any)* $ 120.00

Total Fee Due $ 250.00

PAYMENT OF FEES

IX.

☐ Attached is a ☐ check ☐ money order in the amount of $ _____

☒ Authorization is hereby made to charge the amount of $ 250.00

☒ to Deposit Account No. 08-0300

☐ to Credit card as shown on the attached credit card information authorization form PTO-2038.

WARNING: *Credit card information should not be included on this form as it may become public.*

☒ Charge any additional fees required by this paper or credit any overpayment in the manner authorized above.

A duplicate of this paper is attached.

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AUTHORIZATION TO CHARGE ADDITIONAL FEES

X.

WARNING: Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges if extra claims are authorized.

NOTE: "Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

☒ The Office is hereby authorized to charge, in the manner shown above, the following additional fees that may be required by this paper and during the entire pendency of this application.

- ☐ 37 C.F.R. § 1.16(a), (f) or (g) (filing fees)
- ☐ 37 C.F.R. § 1.16(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. § 1.16(d)), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.

- ☒ 37 C.F.R. § 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)
- ☐ 37 C.F.R. § 1.17(a)(1)–(5) (extension fees pursuant to § 1.136(a))
- ☐ 37 C.F.R. § 1.17 (application processing fees)

NOTE: "A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).

- ☐ 37 C.F.R. § 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. § 1.311(b))

NOTE: Section 1.311(b) provides that an authorization to charge the issue fee (§ 1.18) to a deposit account may be filed in an individual application only after the mailing of the notice of allowance. Accordingly, general authorizations to pay fees and specific authorizations to pay the issue fee that are filed prior to the mailing of a notice of allowance will generally not be treated as requesting payment of the issue fee and will not be given effect to act as a reply to the notice of allowance. Applicant, when paying the issue fee, should submit a new authorization to charge fees, such as by completing box 6b on the current PTOL-85B form. Where no reply to the notice of allowance is received, the application will stand abandoned notwithstanding the presence of general authorizations to pay fees or a specific authorization to pay the issue fee that were submitted prior to mailing of the notice of allowance. Where an attempt is made to pay the issue fee but an incorrect amount is submitted, § 1.311(b)(1), or where the Office's issue fee transmittal form (currently PTOL-85(B)) is completed by applicant and submitted, § 1.311(b)(2), in reply to a notice of allowance, an exception will be made. Such submissions will operate as a request to charge the issue fee to any deposit account identified in a previously filed (i.e., submitted prior to the mailing of the notice of allowance) authorization to charge fees, and will be allowed to act as payment of the correct issue fee. § 1.311(b). See also the change to § 1.26(b). Notice of September 8, 2000, Fed. Reg. 54603-54683, at 54648 and 54647.

NOTE: 37 C.F.R. § 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying . . . issue fee . . ." From the wording of 37 C.F.R. § 1.28(b): (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

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SIGNATURE OF PRACTITIONER

Reg. No. 35,415

John W. Wustenberg
(type or print name of practitioner)

Tel. No.: (580)251-3782

PO BOX 1431
P.O. Address

Customer No.: 29920

DUNCAN OK 73536 0440

$1fw

OIPE
MAR 28 2006
1600

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371 (c) DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
11/291,496	12/01/2005	Lloyd McNeel	HES 2005-IP-018647

CONFIRMATION NO. 7986

29920
JOHN W. WUSTENBERG
P.O. BOX 1431
DUNCAN, OK 73536

FORMALITIES LETTER

Date Mailed: 01/09/2006

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

03/29/2006 WABDELR1 00000135 080300 11291496
01 FC:1011 300.00 DA
02 FC:1111 500.00 DA
03 FC:1311 200.00 DA
04 FC:1051 130.00 DA
05 FC:1201 400.00 DA
06 FC:1202 950.00 DA

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
  Applicant must submit $ **300** *to complete the basic filing fee for a non-small entity. If appropriate, applicant may make a written assertion of entitlement to small entity status and pay the small entity filing fee (37 CFR 1.27).*
- The oath or declaration is missing. *A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.*
  Note: If a petition under 37 CFR 1.47 is being filed, an oath or declaration in compliance with 37 CFR 1.63 signed by all available joint inventors, or if no inventor is available by a party with sufficient proprietary interest, is required.

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- Additional claim fees of **$1350** as a non-small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.
- To avoid abandonment, a surcharge (for late submission of filing fee, search fee, examination fee or oath or declaration) as set forth in 37 CFR 1.16(f) of $130 for a non-small entity, must be submitted with the missing items identified in this letter.

SUMMARY OF FEES DUE:

Total additional fee(s) required for this application is **$2480** for a Large Entity

- **$300** Statutory basic filing fee.
- **$130** Surcharge.

- The application search fee has not been paid. Applicant must submit **$500** to complete the search fee.
- The application examination fee has not been paid. Applicant must submit **$200** to complete the examination fee for a large entity

- Total additional claim fee(s) for this application is **$1350**

  - **$400** for **2** independent claims over 3.
  - **$950** for **19** total claims over 20.

Replies should be mailed to: Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

A copy of this notice MUST be returned with the reply.

Office of Initial Patent Examination (571) 272-4000, or 1-800-PTO-9199, or 1-800-972-6382
PART 1 - ATTORNEY/APPLICANT COPY

OIPE MAR 28 2006 PATENT & TRADEMARK OFFICE

PTO/SB/21 (09-04)
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TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Total Number of Pages in This Submission

Application Number	11/291,496
Filing Date	12/01/2005
First Named Inventor	Lloyd McNeel, et al.
Art Unit	3672
Examiner Name	unknown
Attorney Docket Number	2005-IP-018647U1

ENCLOSURES *(Check all that apply)*

- [x] Fee Transmittal Form
  - [x] Fee Attached
- [ ] Amendment/Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [x] Reply to Missing Parts/ Incomplete Application
  - [x] Reply to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [x] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
  - [ ] Landscape Table on CD
- [ ] After Allowance Communication to TC
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) (please Identify below):
  - Statement Under 37 CFR 3.73(b)
  - Assignment with recordal Sheet
  - Signed Declaration
  - Return Post Card

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	Halliburton Energy Services, Inc.		
Signature	John W. Wustenberg		
Printed name	John W. Wustenberg		
Date	24 MAR 06	Reg. No.	35,415

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:

Signature	Chasidy Smith		
Typed or printed name	Chasidy Smith	Date	3-24-06

This collection of information is required by 37 CFR 1.5. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and1.14. This collection is estimated to 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

OIPE MAR 28 2006 PATENT & TRADEMARK OFFICE

PTO/SB/17 (01-06)
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Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL
For FY 2006

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 2640.00

Complete if Known	
Application Number	11/291,496
Filing Date	12/01/2005
First Named Inventor	Lloyd McNeel, et al.
Examiner Name	
Art Unit	3672
Attorney Docket No.	2005-IP-018647U1

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☑ Deposit Account Deposit Account Number: 08-0300 Deposit Account Name: Halliburton

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☑ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☑ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☑ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION (All the fees below are due upon filing or may be subject to a surcharge.)

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
		Small Entity		Small Entity		Small Entity	
Application Type	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fees Paid ($)
Utility	300	150	500	250	200	100	1000.00
Design	200	100	100	50	130	65	
Plant	200	100	300	150	160	80	
Reissue	300	150	500	250	600	300	
Provisional	200	100	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	Fee ($)	Small Entity Fee ($)
Each claim over 20 (including Reissues)	50	25
Each independent claim over 3 (including Reissues)	200	100
Multiple dependent claims	360	180

Total Claims		Extra Claims		Fee ($)		Fee Paid ($)
39	- 20 or HP =	19	x	50.00	=	950.00

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims		Extra Claims		Fee ($)		Fee Paid ($)
5	- 3 or HP =	2,600.00	x	200.00	=	400.00

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims	
Fee ($)	Fee Paid ($)

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		Extra Sheets		Number of each additional 50 or fraction thereof		Fee ($)		Fee Paid ($)
	- 100 =		/ 50 =		(round up to a whole number) x		=	

4. OTHER FEE(S)

	Fees Paid ($)
Non-English Specification, $130 fee (no small entity discount)	
Other (e.g., late filing surcharge): Late oath; recordation of assisgnment; extension of time	290.00

SUBMITTED BY

Signature	John W. Wustenberg	Registration No. (Attorney/Agent) 35,415	Telephone 580-251-3782
Name (Print/Type)	John W. Wustenberg		Date 24 MAR 06

This collection of information is required by 37 CFR 1.136. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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OIPE MAR 28 2006 PATENT & TRADEMARK OFFICE

Practitioner's Docket No. 2005-IP-018647U1 **PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Lloyd McNeel, et al.
Application No.: 11/291,496 **Group No.:** 3672
Filed: 12/1/05 **Examiner:** unknown
For: METHOD AND APPARATUS FOR CENTRALIZED WELL TREATMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

COMPLETION OF FILING REQUIREMENTS —NONPROVISIONAL APPLICATION

(check and complete this item, if applicable)

I. ☒ This replies to the Notice to File Missing Parts of Application (PTO-1533) mailed 01/09/2006

NOTE: If these papers are filed before the office letter issues, adequate identification of the original papers should be made, e.g., in addition to the name of the inventor and title of invention, the filing date based on the "Express Mail" procedure, the serial number from the return post card or the attorney's docket number added.

☒ A copy of the Notice to File Missing Parts of Application—Filing Date Granted (Form PTO-1533) is enclosed.

NOTE: The PTO requires that a copy of Form PTO-1533 be returned with the response to the notice to file missing parts to the application.

CERTIFICATION UNDER 37 C.F.R. §§ 1.8(a) and 1.10*
(When using Express Mail, the Express Mail label number is mandatory; Express Mail certification is optional.)

I hereby certify that, on the date shown below, this correspondence is being:

MAILING

☒ deposited with the United States Postal Service in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

37 C.F.R. § 1.8(a)

☒ with sufficient postage as first class mail.

37 C.F.R. § 1.10 *

☐ as "Express Mail Post Office to Addressee" Mailing Label No. _____ (mandatory)

TRANSMISSION

☐ facsimile transmitted to the Patent and Trademark Office, (703) _____-_____

Date: 3/24/06

Signature

Chasidy Smith

(type or print name of person certifying)

** Only the date of filing (§ 1.6) will be the date used in a patent term adjustment calculation, although the date on any certificate of mailing or transmission under § 1.8 continues to be taken into account in determining timeliness. See § 1.703(f). Consider "Express Mail Post Office to Addressee" (§ 1.10) or facsimile transmission (§ 1.6(d)) for the reply to be accorded the earliest possible filing date for patent term adjustment calculations.*

03/29/2006 WABDELR1 00000135 080300 11291496
07 FC:1251 120.00 DA

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Ex. 1002, p. 67 of 988

IPR2023-01319

Profrac Holding Corporation
U.S. Well Services, LLC

DECLARATION OR OATH

II. ☒ No declaration or oath was filed. Enclosed is the original declaration or oath for this application.

NOTE: If the correct inventor or inventors are not named on filing a nonprovisional application under § 1.53(b) without an executed oath or declaration under § 1.63, the later submission of an executed oath or declaration under § 1.63 during the pendency of the application will act to correct the earlier identification of inventorship. 37 C.F.R. § 1.48(f)(1).

OR

☐ The declaration or oath that was filed was determined to be defective. A new original oath or declaration is attached.

NOTE: For surcharge fee for filing declaration after filing date complete item VI(3) below.

NOTE: "The following combinations of information supplied in an oath or declaration filed after the filing date are acceptable as minimums for identifying a specification and compliance with any one of the items below will be accepted as complying with the identification requirement of 37 C.F.R. § 1.63:

"(A) application number (consisting of the series code and the serial number, e.g., 08/123,456);

"(B) serial number and filing date;

"(C) attorney docket number which was on the specification as filed;

"(D) title which was on the specification as filed and reference to an attached specification which is both attached to the oath or declaration at the time of execution and submitted with the oath or declaration; or

"(E) title which was on the specification as filed and accompanied by a cover letter accurately identifying the application for which it was intended by either the application number (consisting of the series code and the serial number, e.g., 08/123,456), or serial number and filing date. Absent any statement(s) to the contrary, it will be presumed that the application filed in the PTO is the application which the inventor(s) executed by signing the oath or declaration."

M.P.E.P. § 601.01(a), 7th Ed.

NOTE: Another minimum found acceptable in the declaration is the filing date (i.e., date of express mail) and the express mail number, useful where the serial number is not yet known. But note the practice where the express mail deposit is a Saturday, Sunday or holiday within the District of Columbia. 37 C.F.R. § 1.10(c).

(complete (c) or (d), if applicable)

Attached is a

(c) ☐ Statement by a registered attorney that the application filed in the PTO is the application that the inventor executed by signing the declaration.

(d) ☐ Statement that the "attached" specification is a copy of the specification and any amendments thereto that were filed in the PTO to obtain the filing date.

AMENDMENT CANCELLING CLAIMS

III. ☐ Cancel claims _____ inclusive.

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TRANSMITTAL OF ENGLISH TRANSLATION OF NON-ENGLISH LANGUAGE PAPERS

IV. ☐ Submitted herewith is an English translation of the non-English language application papers as originally filed. Also submitted herewith is a statement by the translator of the accuracy of the translation. It is requested that this translation be used as the copy for examination purposes in the PTO.

NOTE: For fee processing a non-English application, complete item VI(5) below.

NOTE: A non-English oath or declaration in the form provided by the PTO need not be translated. 37 C.F.R. § 1.69(b).

SMALL ENTITY STATUS

V.

a. ☐ An assertion that this filing is by a small entity

(check and complete applicable items)

- ☐ is attached.
- ☐ was filed on _____ (original).
- ☐ was made by paying the basic filing fee as a small entity.
- ☐ is being made now by paying the basic filing fee as a small entity.

b. ☐ A separate refund request accompanies this paper.

COMPLETION FEES

VI.

WARNING: Failure to submit the surcharge fees where required will cause the application to become abandoned. 37 C.F.R. § 1.53.

NOTE: For effect on fees of failure to establish status, or change status, as a small entity, see 37 C.F.R. § 1.28(a).

1. Filing fee

- ☐ original patent application (37 C.F.R. § 1.16(a)—$770.00; Small entity—$385.00) $_____
- ☐ design application (37 C.F.R. § 1.16(f)—$340.00; small entity—$170.00) $_____

$ _____

2. Fees for claims

- ☐ each independent claim in excess of 3 (37 C.F.R. § 1.16(b)—$86.00; small entity—$43.00) $_____
- ☐ each claim in excess of 20 (37 C.F.R. § 1.16(c)—$18.00; small entity—$9.00) $_____
- ☐ multiple dependent claim(s) (37 C.F.R. § 1.16(d)—$290.00; small entity—$145.00) $_____

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3. Surcharge fees

☒ declaration or oath late payment of filing fee and/or late filing of original (37 C.F.R. § 1.16(e)—$130.00; small entity—$65.00); $ 130.00

NOTE: If both the filing fee and declaration or oath were missing from the original papers, the Office practice under § 37 C.F.R. § 1.16(a) is that only one surcharge Fee need be paid whether the later filed oath or declaration and/or the filing fee are submitted afterwards at the same time or at different times.

4. ☐ Petition and fee for filing by other than all the inventors or a person not the inventor (37 C.F.R. §§ 1.17(i) and 1.47—$130.00) $ _____

5. ☐ Fee for processing an application filed with a specification in a non-English language (37 C.F.R. §§ 1.17(k) and 1.52(d)—$130.00) $ _____

6. ☐ Fee for processing and retention of application (37 C.F.R. §§ 1.21(l) and 1.53(d)—$130.00) $ _____

7. ☒ Assignment (See "ASSIGNMENT COVER SHEET".)

NOTE: 37 C.F.R. § 1.21(l) establishes a fee for processing and retaining any application which is abandoned for failing to complete the application pursuant to 37 C.F.R. § 1.53(f) and this, as well as, the changes to 37 C.F.R. §§ 1.53 and 1.78 indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing fee or the processing and retention fee of § 1.21(l) within 1 year of notification under §1.53(f) must be paid.

Total completion fees $ 130.00

EXTENSION OF TIME

VII.

(complete (a) or (b), as applicable)

NOTE: 37 C.F.R. § 1.704(b) "... an applicant shall be deemed to have failed to engage in reasonable efforts to conclude processing or examination of an application for the cumulative total of any periods of time in excess of three months that are taken to reply to any notice or action by the Office making any rejection, objection, argument, or other request, measuring such three-month period from the date the notice or action was mailed or given to the applicant, in which case the period of adjustment set forth in § 1.703 shall be reduced by the number of days, if any, beginning on the day after the date that is three months after the date of mailing or transmission of the Office communication notifying the applicant of the rejection, objection, argument, or other request and ending on the date the reply was filed. The period, or shortened statutory period, for reply that is set in the Office action or notice has no effect on the three-month period set forth in this paragraph."

The proceedings herein are for a patent application, and the provisions of 37 C.F.R. § 1.136(a) apply.

(a) ☐ Applicant petitions\ for an extension of time, the fees for which are set out in 37 C.F.R. § 1.17(a)(1)-(4), for the total number of months checked below:

Extension (months)	Fee for other than small entity	Fee for small entity
☒ one month	$ 120.00	$ 55.00
☐ two months	$ 420.00	$ 210.00
☐ three months	$ 950.00	$ 475.00
☐ four months	$ 1,480.00	$ 740.00

Fee: $ 120.00

If an additional extension of time is required, please consider this a petition therefor.

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(check and complete the next item, if applicable)

☐ An extension for _____ months has already been secured, and the fee paid therefor of $ _____ is deducted from the total fee due for the total months of extension now requested.

Extension fee due with this request $ _____

or

(b) ☐ Applicant believes that no extension of term is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition and fee for extension of time.

TOTAL FEE DUE

VIII.

The total fee due is

Completion fee(s) $ 130.00

Extension fee *(if any)* $ 120.00

Total Fee Due $ 250.00

PAYMENT OF FEES

IX.

☐ Attached is a ☐ check ☐ money order in the amount of $ _____

☒ Authorization is hereby made to charge the amount of $ 250.00

☒ to Deposit Account No. 08-0300

☐ to Credit card as shown on the attached credit card information authorization form PTO-2038.

WARNING: *Credit card information should not be included on this form as it may become public.*

☒ Charge any additional fees required by this paper or credit any overpayment in the manner authorized above.

A duplicate of this paper is attached.

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AUTHORIZATION TO CHARGE ADDITIONAL FEES

X.

WARNING: Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges if extra claims are authorized.

NOTE: "Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

☒ The Office is hereby authorized to charge, in the manner shown above, the following additional fees that may be required by this paper and during the entire pendency of this application.

- ☐ 37 C.F.R. § 1.16(a), (f) or (g) (filing fees)
- ☐ 37 C.F.R. § 1.16(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. § 1.16(d)), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.

- ☒ 37 C.F.R. § 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)
- ☐ 37 C.F.R. § 1.17(a)(1)–(5) (extension fees pursuant to § 1.136(a))
- ☐ 37 C.F.R. § 1.17 (application processing fees)

NOTE: "A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).

- ☐ 37 C.F.R. § 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. § 1.311(b))

NOTE: Section 1.311(b) provides that an authorization to charge the issue fee (§ 1.18) to a deposit account may be filed in an individual application only after the mailing of the notice of allowance. Accordingly, general authorizations to pay fees and specific authorizations to pay the issue fee that are filed prior to the mailing of a notice of allowance will generally not be treated as requesting payment of the issue fee and will not be given effect to act as a reply to the notice of allowance. Applicant, when paying the issue fee, should submit a new authorization to charge fees, such as by completing box 6b on the current PTOL-85B form. Where no reply to the notice of allowance is received, the application will stand abandoned notwithstanding the presence of general authorizations to pay fees or a specific authorization to pay the issue fee that were submitted prior to mailing of the notice of allowance. Where an attempt is made to pay the issue fee but an incorrect amount is submitted, § 1.311(b)(1), or where the Office's issue fee transmittal form (currently PTOL-85(B)) is completed by applicant and submitted, § 1.311(b)(2), in reply to a notice of allowance, an exception will be made. Such submissions will operate as a request to charge the issue fee to any deposit account identified in a previously filed (i.e., submitted prior to the mailing of the notice of allowance) authorization to charge fees, and will be allowed to act as payment of the correct issue fee. § 1.311(b). See also the change to § 1.26(b). Notice of September 8, 2000, Fed. Reg. 54603-54683, at 54648 and 54647.

NOTE: 37 C.F.R. § 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying . . . issue fee . . ." From the wording of 37 C.F.R. § 1.28(b): (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

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SIGNATURE OF PRACTITIONER

Reg. No. 35,415

John W. Wustenberg

(type or print name of practitioner)

Tel. No.: (580)251-3782

PO BOX 1431

P.O. Address

Customer No.: 29920

DUNCAN OK 73536 0440

$1716

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MAR 28 2006
1600

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371 (c) DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
11/291,496	12/01/2005	Lloyd McNeel	HES 2005-IP-018647

CONFIRMATION NO. 7986

29920
JOHN W. WUSTENBERG
P.O. BOX 1431
DUNCAN, OK 73536

FORMALITIES LETTER

Date Mailed: 01/09/2006

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

03/29/2006 WABDELR1 00000135 080300 11291496
01 FC:1011 300.00 DA
02 FC:1111 500.00 DA
03 FC:1311 200.00 DA
04 FC:1051 130.00 DA
05 FC:1201 400.00 DA
06 FC:1202 950.00 DA

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
  Applicant must submit $ **300** *to complete the basic filing fee for a non-small entity. If appropriate, applicant may make a written assertion of entitlement to small entity status and pay the small entity filing fee (37 CFR 1.27).*
- The oath or declaration is missing. *A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.*
  Note: If a petition under 37 CFR 1.47 is being filed, an oath or declaration in compliance with 37 CFR 1.63 signed by all available joint inventors, or if no inventor is available by a party with sufficient proprietary interest, is required.

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- Additional claim fees of **$1350** as a non-small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.
- To avoid abandonment, a surcharge (for late submission of filing fee, search fee, examination fee or oath or declaration) as set forth in 37 CFR 1.16(f) of $130 for a non-small entity, must be submitted with the missing items identified in this letter.

SUMMARY OF FEES DUE:

Total additional fee(s) required for this application is **$2480** for a Large Entity

- **$300** Statutory basic filing fee.
- **$130** Surcharge.

- The application search fee has not been paid. Applicant must submit **$500** to complete the search fee.
- The application examination fee has not been paid. Applicant must submit **$200** to complete the examination fee for a large entity

- Total additional claim fee(s) for this application is **$1350**

  - **$400** for **2** independent claims over 3.
  - **$950** for **19** total claims over 20.

Replies should be mailed to: Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

A copy of this notice MUST be returned with the reply.

Office of Initial Patent Examination (571) 272-4000, or 1-800-PTO-9199, or 1-800-972-6382
PART 1 - ATTORNEY/APPLICANT COPY

IPE MAR 22
MAR 28 2006
U.S. PATENT & TRADEMARK OFFICE

PTO/SB/17 (01-06)
Approved for use through 07/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995 no persons are required to respond to a collection of information unless it displays a valid OMB control number

Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL
For FY 2006

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 2640.00

Complete if Known	
Application Number	11/291,496
Filing Date	12/01/2005
First Named Inventor	Lloyd McNeel, et al.
Examiner Name	
Art Unit	3672
Attorney Docket No.	2005-IP-018647U1

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☑ Deposit Account Deposit Account Number: 08-0300 Deposit Account Name: Halliburton

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☑ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☑ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☑ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION (All the fees below are due upon filing or may be subject to a surcharge.)

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
		Small Entity		Small Entity		Small Entity	
Application Type	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fees Paid ($)
Utility	300	150	500	250	200	100	1000.00
Design	200	100	100	50	130	65	
Plant	200	100	300	150	160	80	
Reissue	300	150	500	250	600	300	
Provisional	200	100	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	Fee ($)	Small Entity Fee ($)
Each claim over 20 (including Reissues)	50	25
Each independent claim over 3 (including Reissues)	200	100
Multiple dependent claims	360	180

Total Claims		Extra Claims	Fee ($)		Fee Paid ($)
39	- 20 or HP =	19	x 50.00	=	950.00

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims		Extra Claims	Fee ($)		Fee Paid ($)
5	- 3 or HP =	2.600.00	x 200.00	=	400.00

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims	
Fee ($)	Fee Paid ($)

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		Extra Sheets		Number of each additional 50 or fraction thereof	Fee ($)	Fee Paid ($)
	- 100 =		/ 50 =	(round up to a whole number)	x	=

4. OTHER FEE(S)

	Fees Paid ($)
Non-English Specification, $130 fee (no small entity discount)	
Other (e.g., late filing surcharge): Late oath; recordation of assignment; extension of time	290.00

SUBMITTED BY

Signature	John W. Wustenberg	Registration No. (Attorney/Agent) 35,415	Telephone 580-251-3782
Name (Print/Type)	John W. Wustenberg		Date 24 MAR 06

This collection of information is required by 37 CFR 1.136. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

OIPE
MAR 28 2006
PATENT & TRADEMARK OFFICE

PTO/SB/96 (12-05)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Lloyd McNeel, et al.

Application No./Patent No./Control No.: 11/291,496 Filed/Issue Date: 12/01/2005

Entitled: METHOD AND APPARATUS FOR CENTRALIZED WELL TREATMENT

Halliburton Energy Services, Inc., a Corporation
(Name of Assignee) (Type of Assignee: corporation, partnership, university, government agency, etc.)

states that it is:

1. ☑ the assignee of the entire right, title, and interest; or

2. ☐ an assignee of less than the entire right, title and interest
(The extent (by percentage) of its ownership interest is _____%)

in the patent application/patent identified above by virtue of either:

A. ☑ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or a true copy of the original assignment is attached.

OR

B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

2. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

3. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet.

As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (*i.e.*, a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

John W. Wustenberg	24 MAR 06
Signature	Date
John W. Wustenberg	580-251-3782
Printed or Typed Name	Telephone Number
Counsel	
Title	

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Docket No. 2005-IP-018647U1

ASSIGNMENT

Whereas, I/We, Lloyd McNeel of Rock Springs WY, Steven D. Harris of Denver CO, and Dave McLeod Houston TX have invented "METHOD AND APPARATUS FOR CENTRALIZED WELL TREATMENT" for which I have made application for Letters Patent of the United States; and

Whereas, HALLIBURTON ENERGY SERVICES, INC., a Delaware Corporation, having a place of business at 10200 Bellaire Boulevard, Houston, Texas 77072 is desirous of acquiring an interest therein;

NOW, THEREFORE, for good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, I/We, by these presents do sell, assign and transfer and convey unto HALLIBURTON ENERGY SERVICES, INC., its successors and assigns, the full and exclusive right, for the United States of America and its territorial possessions and for any and all foreign countries, in and to the said invention, described in the Patent Application serial number 11/291,496 filed on December 1 2005, and any divisional, continuing or reissue application based on the present application preparatory to obtaining Letters Patent of the United States therefor; said invention, application and any and all Letters Patent issuing therefor to be held and enjoyed by HALLIBURTON ENERGY SERVICES, INC., for its own use and behoof, and for its legal representatives, successors and assigns, to the full end of the term for which said Letters Patent may be granted, as fully and entirely as the same would have been held by me and had this assignment and sale not been made.

And I do further agree to sign all papers, make all rightful oaths and do all requisite acts for the filing of any disclaimer or for the filing and assignment of any divisional, continuing or reissue application or applications for patent based on the present application, as well as for any other U.S. or foreign application for patent which relates to the said invention.

And I do further agree to communicate to HALLIBURTON ENERGY SERVICES, INC., its successors, assign or other legal representatives, such facts relating to the invention disclosed in the present application or Letters Patent issuing thereon as may be known to me, and to testify as to such facts in any interference or other litigation.

Executed this 15 day of March 2006, at Denver Co.

Steve Harris
3/15/06

STATE OF)
) ss
COUNTY OF)

Before me personally appeared said Steve Harris and acknowledged the foregoing instrument to be his free act and deed this _____ day of _____, 2006.

Seal

(Notary)

My Commission Expires:
Commission Number:

Executed this 27th day of Feb, 2006, at Rock Springs, WY

W. Lloyd McNeel
Lloyd McNeel

STATE OF Wyoming)
) ss
COUNTY OF Sweetwater)

Before me personally appeared said ~~Lloyd McNeel~~ William Lloyd McNeal JR and acknowledged the foregoing instrument to be his free act and deed this 27th day of February 2006.

Linda J. Stith Notary Public
COUNTY OF SWEETWATER STATE OF WYOMING
Seal
MY COMMISSION EXPIRES 5/6/09

Linda J. Stith
(Notary)

My Commission Expires:
Commission Number:

Executed this 1st day of FEB, 2006, at HOUSTON TEXAS USA, U.S.A.

Dave McLeod

Before me personally appeared said Dave McLeod and acknowledged the foregoing instrument to be his free act and deed this _____ day of _____, 2006.

Seal

_____
(Notary)

My Commission Expires:
Commission Number:

ATTORNEY DOCKET NO.
HES 2005-IP-018647

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:		§	
	LLOYD MCNEEL ET AL.	§	Group Art Unit: ***Unassigned***
		§	
Serial No.:	**11/291,496**	§	
		§	Examiner: ***Unassigned***
Filed:	**DECEMBER 1, 2005**	§	
		§	
Title:	**"METHOD AND APPARATUS FOR CENTRALIZED WELL TREATMENT"**	§	Atty. Docket No: **HES 2005-IP-018647 (063718.0930)**

MAIL STOP PETITION
Honorable Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

CERTIFICATE OF FILING ELECTRONICALLY VIA EFS
MPEP 503

I HEREBY CERTIFY THAT I HAVE A REASONABLE BASIS FOR BELIEF THAT THIS CORRESPONDENCE IS BEING SUBMITTED TO THE UNITED STATES PATENT AND TRADEMARK OFFICE VIA EFS (ELECTRONICALLY) ON THE DATE INDICATED BELOW, AND IS ADDRESSED TO:

MAIL STOP PETITION
HONORABLE COMMISSIONER FOR PATENTS
P.O. BOX 1450
ALEXANDRIA, VA 22313-1450

DEBBIE ALLEN

DATE OF SUBMISSION: NOVEMBER 21, 2006
ELECTRONIC FILING (EFS)

PETITION TO MAKE SPECIAL UNDER 37 C.F.R. § 1.102(C)(2)(I)

Applicants submit this Petition under 37 C.F.R § 1.102(c)(2)(i) to make this Application special. This Application should be made special because the invention will materially enhance the quality of the environment. This Petition is accompanied by a statement of Applicants' Attorney, Paul R. Morico, pursuant to MPEP § 708.02 V.

Applicants respectfully request, under 37 C.F.R § 1.102(c)(2)(i), that this Application be granted special status. Applicants believe that no fees are due. However, should the Commissioner deem that any fees are due, the Commissioner is authorized to debit Baker Botts

Profrac Holding Corporation
U.S. Well Services, LLC
IPR2023-01319
Ex. 1002, p. 81 of 988

L.L.P. Deposit Account No. 02-0383, Order Number 063718.0930, for any payment of associated fees, underpayment of fees, or to credit same with any overpayment of fees that may occur in association with this filing.

Respectfully submitted,

BAKER BOTTS L.L.P. (023640)

Date: November 21, 2006

By: _____

Paul R. Morico
Registration No. 35,960
One Shell Plaza
910 Louisiana Street
Houston, Texas 77002-4995
Telephone:713.229.1732
Facsimile: 713.229.7732
email: paul.morico@bakerbotts.com

ATTORNEY FOR APPLICANTS

Profrac Holding Corporation
U.S. Well Services, LLC

IPR2023-01319

Ex. 1002, p. 82 of 988

ATTORNEY DOCKET NO.
063718.0930

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:		§	
	LLOYD MCNEEL ET AL.	§	Group Art Unit: ***Unassigned***
		§	
Serial No.:	**11/291,496**	§	
		§	Examiner: ***Unassigned***
Filed:	**DECEMBER 1, 2005**	§	
		§	
Title:	**"METHOD AND APPARATUS FOR CENTRALIZED WELL TREATMENT"**	§	Atty. Docket No: **HES 2005-IP-018647 (063718.0930)**

MAIL STOP PETITION
Honorable Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

CERTIFICATE OF FILING ELECTRONICALLY VIA EFS
MPEP 503

I HEREBY CERTIFY THAT I HAVE A REASONABLE BASIS FOR BELIEF THAT THIS CORRESPONDENCE IS BEING SUBMITTED TO THE UNITED STATES PATENT AND TRADEMARK OFFICE VIA EFS (ELECTRONICALLY) ON THE DATE INDICATED BELOW, AND IS ADDRESSED TO:

MAIL STOP PETITION
HONORABLE COMMISSIONER FOR PATENTS
P.O. BOX 1450
ALEXANDRIA, VA 22313-1450

DEBBIE ALLEN

DATE OF SUBMISSION: NOVEMBER 21, 2006
ELECTRONIC FILING (EFS)

STATEMENT OF APPLICANTS PURSUANT TO MPEP § 708.02 V

The invention will materially enhance the quality of the environment of mankind by contributing to the restoration and maintenance of the basic life-sustaining natural elements, i.e., air, water, and soil. The servicing and stimulation of wells can require a series of coordinated operations that begin with the supply by truck of equipment, supplies, fuel, and chemicals to the wellhead. The equipment is then set up and made ready with proppant and chemicals. After completion of the well services, equipment must be broken down and made ready for transport to the next pad for service. Often, the next pad will be less than 500 feet

Profrac Holding Corporation
U.S. Well Services, LLC

IPR2023-01319

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away from the previously treated pad. This movement of equipment often leads to damage to flora and fauna in areas where the equipment is moved. In addition, due to the limited storage capacity of the moving equipment for chemicals and equipment, additional trucks are often required to resupply and reequip an existing operation. This additional movement of equipment and supplies also has negative environmental impacts. Furthermore, prior well stimulation activities often allowed only the one time use of stimulation fluids and made their disposal difficult. These fluids can be highly toxic and dangerous to the environment. In one non-limiting embodiment of the Applicants' invention, well stimulation activities are centralized and can be performed for multiple wells from a single central location. This centralization significantly reduces the traffic of stimulation equipment and chemicals and, consequently, the environmental damage caused by such traffic. Moreover, in the same and other non-limiting embodiments of Applicants' invention, the stimulation fluid at a well can be reclaimed, reused, or disposed of in an environmentally safe and clean manner.

Respectfully submitted,

BAKER BOTTS L.L.P. (023640)

Date: November 21, 2006

By: _____

Paul R. Morico
Registration No. 35,960
One Shell Plaza
910 Louisiana Street
Houston, Texas 77002-4995
Telephone:713.229.1732
Facsimile: 713.229.7732
email: paul.morico@bakerbotts.com

ATTORNEY FOR APPLICANTS

Profrac Holding Corporation
U.S. Well Services, LLC

IPR2023-01319

Ex. 1002, p. 84 of 988

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

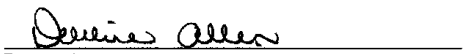
In re Application of:		§	
	LLOYD MCNEEL ET AL.	§	Group Art Unit: ***Unassigned***
		§	
Serial No.:	**11/291,496**	§	
		§	Examiner: ***Unassigned***
Filed:	**DECEMBER 1, 2005**	§	
		§	
Title:	**"METHOD AND APPARATUS FOR CENTRALIZED WELL TREATMENT"**	§	Atty. Docket No: **HES 2005-IP-018647 (063718.0930)**

Honorable Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

CERTIFICATE OF FILING ELECTRONICALLY VIA EFS
MPEP 503

I HEREBY CERTIFY THAT I HAVE A REASONABLE BASIS FOR BELIEF THAT THIS CORRESPONDENCE IS BEING SUBMITTED TO THE UNITED STATES PATENT AND TRADEMARK OFFICE VIA EFS (ELECTRONICALLY) ON THE DATE INDICATED BELOW, AND IS ADDRESSED TO:

HONORABLE COMMISSIONER FOR PATENTS
P.O. BOX 1450
ALEXANDRIA, VA 22313-1450



DEBBIE ALLEN

DATE OF SUBMISSION: NOVEMBER 21, 2006
ELECTRONIC FILING (EFS)

INFORMATION DISCLOSURE STATEMENT

Dear Sir:

Applicants respectfully request, pursuant to 37 C.F.R. §§1.56, 1.97 and 1.98, that the art identified in the statement below and listed on the attached PTO-1449 form be considered and cited in the examination of the above-identified application. Furthermore, pursuant to 37 C.F.R. §§1.97(g) and (h), no representation is made that these references are material to the patentability of the present application.

Profrac Holding Corporation
U.S. Well Services, LLC
IPR2023-01319
Ex. 1002, p. 85 of 988

Beginning in the late 1980s, Halliburton and other companies assembled centrally located well treatment equipment in Bakersfield, California amid several production pads. Proppant, chemicals, water supplies, a blending unit, and a pumping grid, among other equipment, were present and used to make and pressurize fracturing fluid. The fluid was pressurized in a ground trailer or manifold and multiple lines extended from the pressure manifold to multiple wells. Only one well could be treated at a time.

Beginning in 1994, Halliburton and other companies assembled centrally located well treatment equipment in Bakersfield, California amid several production pads. Proppant, chemicals, water supplies, a blending unit, and a pumping grid, among other equipment, were present and used to make and pressurize fracturing fluid. The fluid was pressurized in a ground trailer or manifold at the central location. An additional ground manifold was connected to the central manifold and multiple lines connected multiple wells to the additional manifold. Only one well could be treated at a time.

Beginning in 1994, Halliburton assembled centrally located well treatment equipment in Bakersfield, California amid several production pads. Proppant, chemicals, water supplies, a blending unit, and a pumping grid, among other equipment, were present and used to make and pressurize fracturing fluid. The fluid was subsequently pumped down a central line through a well field. Several lines branched off of the central line to individual wells. A well was treated by opening a valve that connected the line going to the well and the central well and closing all other valves to other wells. Only one well could be treated at a time. Schlumberger practiced this operation in 1996 in

Lost Hills, treating only one well at a time. BJ Services began using this procedure in late 2004, treating only one well at a time.

Beginning in March 2005 in Rock Springs, Wyoming, Halliburton assembled centrally located well treatment equipment amid several production pads. Proppant, chemicals, water supplies, a blending unit, and a pumping grid, among other equipment, were located at a pad and used to make and pressurize fracturing fluid. The fluid was pressurized in a ground trailer or manifold at the central location. Two configurations were used. In the first configuration, an additional secondary ground manifold at an individual pad was connected to the central manifold and multiple lines connected multiple wells to the secondary manifold. Only one well could be treated at a time. In the second configuration, the setup did not include a secondary manifold and only one well was connected to the manifold at the central location at a time. This configuration was also used by Schlumberger during the same time period.

Applicants believe that no fees are due in connection with the filing of this Information Disclosure Statement. However, should the Commissioner deem that any fees are due, the Commissioner is authorized to debit Baker Botts L.L.P. Deposit Account No. 02-0383, Order Number 063718.0930, for any payment of associated fees, underpayment of fees, or to credit same with any overpayment of fees that may occur in association with this filing.

Respectfully submitted,

BAKER BOTTS L.L.P. (023640)

Date: November 21, 2006

By: _____

Paul R. Morico
Registration No. 35,960
One Shell Plaza
910 Louisiana Street
Houston, Texas 77002-4995
Telephone:713.229.1732
Facsimile: 713.229.7732
email: paul.morico@bakerbotts.com

ATTORNEY FOR APPLICANTS

Profrac Holding Corporation
U.S. Well Services, LLC
IPR2023-01319
Ex. 1002, p. 88 of 988

PTO-1449 **Information Disclosure Citation In an Application**	**Application No.** 11/291,496		**Applicant(s)** Lloyd McNeel, et al.
	Docket Number 063718.0930	**Group Art Unit** Unassigned	**Filing Date** December 1, 2005

U.S. PATENT DOCUMENTS

		DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS	FILING DATE

FOREIGN PATENT DOCUMENTS

		DOCUMENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION

NON-PATENT DOCUMENTS

		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	DATE
		Information Disclosure Statement, page 1. Jobs performed by Halliburton and other companies at Bakersfield, California in the late 1980s.	1980s
		Information Disclosure Statement, page 2. Jobs performed by Halliburton and other companies at Bakersfield, California in 1994.	1994
		Information Disclosure Statement, page 2. Jobs performed by Halliburton at Bakersfield, California in 1994.	1994
		Information Disclosure Statement, page 2. Jobs performed by Schlumberger at Bakersfield, California in 1994.	1994
		Information Disclosure Statement, page 2. Jobs performed by Schlumberger at Lost Hills in 1996.	1996
		Information Disclosure Statement, page 2. Jobs performed by BJ Services in 2004.	2004
		Information Disclosure Statement, page 2-3. Jobs performed by Halliburton in Rock Springs, Wyoming in March 2005.	3/2005

EXAMINER	DATE CONSIDERED

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP § 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.

Electronic Acknowledgement Receipt	
EFS ID:	1327008
Application Number:	11291496
International Application Number:	
Confirmation Number:	7986
Title of Invention:	Method and apparatus for centralized well treatment
First Named Inventor/Applicant Name:	William Lloyd McNeel
Customer Number:	29920
Filer:	Howard Lyman Speight/Debbie Allen
Filer Authorized By:	Howard Lyman Speight
Attorney Docket Number:	2005-IP-018647U1
Receipt Date:	21-NOV-2006
Filing Date:	01-DEC-2005
Time Stamp:	13:13:48
Application Type:	Utility

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)	Multi Part /.zip	Pages (if appl.)
1		0637180930PetSpecl.pdf	301248	yes	9

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Petition for review by the Technology Center SPRE.	1	4
	Information Disclosure Statement (IDS) Filed	5	9
Warnings:			
Information:			
	Total Files Size (in bytes):	301248	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

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FROM DIRECTOR'S OFFICE

DEC 0 5 2006

TECHNOLOGY CENTER 3600

John W. Wustenberg
P.O. Box 1431
Duncan, OK 73536

In re application of : **DECISION ON PETITION**
William Lloyd McNeel et al. : **TO MAKE SPECIAL FOR**
Application No. 11/291,496 : **NEW APPLICATION**
Filed: December 1, 2005 : **UNDER 37 CFR 1.102**
For: METHOD AND APPARATUS FOR CENTRALIZED WELL TREATMENT

This is a decision on the petition filed on November 21, 2006 to make the above-identified application special for Environmental Quality under 37 C.F.R. § 1.102(d).

The petition to make the application special is **DENIED**.

REGULATION AND PRACTICE

To be eligible for accelerated examination under 37 C.F.R. § 1.102(d) and pursuant to the "Change to Practice for Petitions in Patent Applications to Make Special and for Accelerated Examination" published in the Federal Register on June 26, 2006 (71 Fed. Reg. 36323), the following conditions must be satisfied:

1. The application must be a non-reissue utility or design application filed under 37 CFR 1.111(a);
2. The application, the petition and the required fees must be filed electronically using the USPTO's electronic filing system (EFS), or EFS-web; if not filed electronically, a statement asserting that EFS and EFS-web were not available during the normal business hours;
3. The application, at the time of filing, must be complete under 37 CFR 1.51 and in condition for examination;
4. The application must contain three or fewer independent claims and twenty or fewer total claims and the claims must be directed to a single invention.

The petition to make special for Environmental Quality under 37 C.F.R. § 1.102(d) is not acceptable at least because it was not filed with the application as required in the above Federal Register Notice of June 26, 2006. It appears that the petition was filed under the guidelines for making an application special that were in effect prior to August 25, 2006. As of August 25, 2006 the new guidelines replaced the old guidelines. Since applicant's petition was received on November 21, 2006 with a Certificate of Mail date of November 21, 2006, the petition must be considered under the new guidelines and thus is properly **DENIED**.

For the above-stated reasons, the petition is denied. The application will therefore be taken up by the examiner for action in its regular turn.

Any inquiry regarding this decision should be directed to Steven N. Meyers, Special Program Examiner, at (571) 272-6611.

Steven N. Meyers,
Quality Assurance Specialist
Technology Center 3600

Sm/sm: 11/26/06

PTO/SB/08a (09-06)
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(54) Title: METHOD AND APPARATUS ASSOCIATED WITH STIMULATION TREATMENTS FOR WELLS

(57) Abstract: A method and apparatus associated with the production of hydrocarbons. In one embodiment, the method describes connecting multiple wells to a stimulation fluid pumping system via a pumping system manifold. The pumping system manifold is adjusted to provide a first well flow path from the stimulation fluid pumping system to a first well. Then, a first stimulation treatment is pumped into the first well. Concurrently with the pumping of the first stimulation treatment, a second well is prepared for a second stimulation treatment.

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METHOD AND APPARATUS ASSOCIATED WITH STIMULATION TREATMENTS FOR WELLS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application 60/709,586, filed 19 August, 2005.

BACKGROUND

[0002] This section is intended to introduce the reader to various aspects of art, which may be associated with exemplary embodiments of the present techniques, which are described and/or claimed below. This discussion is believed to be helpful in providing the reader with information to facilitate a better understanding of particular aspects of the present techniques. Accordingly, it should be understood that these statements are to be read in this light, and not necessarily as admissions of prior art.

[0003] The production of hydrocarbons, such as oil and gas, has been performed for numerous years. To produce these hydrocarbons, one or more wells in a field are typically drilled to subsurface locations, which are generally referred to as subterranean formations, reservoirs or basins. The process of producing hydrocarbons from the subsurface formations typically involves drilling one or more wells to access the subsurface formations. With the wells drilled, completion and stimulation activities or operations may be utilized to produce the hydrocarbons, such as oil and gas, from the subsurface formations.

[0004] Because a single well may be utilized to access various regions of subsurface formations, drilling multiple wells from a single location, such as a surface pad or offshore platform, may be beneficial for certain applications. For example, in an offshore application, wells are routinely drilled from a single offshore platform due to the substantial platform installation and operational costs. Also, drilling of multiple wells from a single surface pad on land may reduce surface disturbance and environmental impact associated with well construction activities. Further, well construction activities for multiple wells at a single location may be effectively managed in the presence of surface constraints, such as topography, proximity to other buildings, and existing surface easements and right-of-ways. As such, wells

located on a single surface pad may be utilized to reduce costs and enhance operations.

[0005] Despite the benefits from having multiple wells at a single location, certain combinations of operations may be complicated, restricted, or prevented by the presence of multiple wells. That is, when performing completion operations on one of the wells, the operations performed on other wells may be limited. For instance, when stimulating a well on a surface pad having multiple wells, stimulation operations are typically performed on only the single well. When the well is being stimulated, equipment and personnel have to wait because the stimulation operations are performed in a sequential manner and initiation of additional wellbore preparation operations may be deferred until completion of the stimulation operations. As a result, equipment and personnel are not efficiently utilized at the surface pad.

[0006] Accordingly, the need exists for a method, apparatus and system for enhancing operations involving multiple wells on a surface pad to reduce the time and cost associated with stimulation treatments. In particular, there is a need for new apparatus, method, and system to enable reliable and cost-effective execution of concurrent or simultaneous wellbore preparation and stimulation operations in multiple wellbores located at a single surface location.

[0007] For additional information please reference Ammer et al., "Unconventional Gas: Reserve Opportunities and Technology Needs", GasTIPS, Fall 2004, pp. 22-26; U.S. Patent No. 5,890,536; U.S. Patent No. 6,186,230; U.S. Patent No. 6,394,184, U.S. Patent No. 6,520,255, U.S. Patent No. 6,543,538, U.S. Patent No. 6,575,247; U.S. Patent No. 6,672,405; U.S. Patent Publication No. 2003/0075335; and/or U.K. Patent No. 1,243,062; and/or U.K. Patent No. 2,028,400.

SUMMARY OF INVENTION

[0008] In one embodiment, a method associated with the production of hydrocarbons is described. The method describes connecting multiple wells to a stimulation fluid pumping system via a pumping system manifold. The pumping system manifold is adjusted to provide a first well flow path from the stimulation fluid pumping system to a first well. Then, a first stimulation treatment is pumped into the first well. Concurrently with the pumping of the first stimulation treatment, a second well is prepared for a second stimulation treatment.

[0009] In an alternative embodiment, another method associated with the production of hydrocarbons is described. In this method, a plurality of wells is connected to a stimulation fluid pumping system via a pumping system manifold. Then, the pumping system manifold is adjusted to provide a stimulation treatment from the stimulation fluid pumping system to one of the plurality of wells, while isolating another of the plurality of wells from the stimulation treatment concurrently with the pumping of the stimulation treatment to prepare the another well for another stimulation treatment. These adjustments to provide the stimulation fluid and isolation of the other well are repeated until each of the plurality of wells have received stimulation treatments. Then, hydrocarbons are produced from the plurality of wells once the stimulation treatments have been performed.

[0010] In a second alternative embodiment, a well system is described. In this well system, a plurality of oil field trees is located on a surface pad, wherein each of the plurality of oil field trees is associated with one of a plurality of wells. A pumping system manifold connects a stimulation fluid pumping system to the plurality of oil field trees. The pumping system manifold is configured to provide a flow path from the stimulation fluid pumping system into at least one selected well of the plurality of wells and to isolate at least one non-selected well of the plurality of wells from the stimulation fluid pumping system. Further, the wells, stimulation fluid pumping system, and pumping system manifold may be located on a single surface pad.

[0011] In a third alternative embodiment, an apparatus is disclosed. The apparatus includes a main valve associated with a stimulation fluid pumping system, well valves and piping that couples the main valve to the well valves. In this apparatus, each of the well valves is associated with one of the wells and the piping is directly supported by the surface of the Earth. The apparatus may also include a densitometer, a manifold check valve, a pressure gauge, a flow meter, and a ball-seal injector, which are each coupled to the main valve and the well valves.

[0012] In a fourth alternative embodiment, a method associated with the production of hydrocarbons is described. The method comprises connecting a first well and a second well to a first stimulation fluid pumping system via a first pumping system manifold; connecting a third well and a fourth well to a second stimulation fluid pumping system via a second pumping manifold; adjusting the first pumping

system manifold to provide a first stimulation treatment to the first well and to isolate the second well for other operations; adjusting the second pumping system manifold to provide a second stimulation treatment to the third well and to isolate the fourth well; and pumping the first stimulation treatment into the first well and the second stimulation treatment into the third well concurrently with the pumping of the first stimulation treatment. Further, the method may also comprise preparing the second well for a third stimulation treatment concurrently with the pumping of the first stimulation treatment; and preparing the fourth well for a fourth stimulation treatment concurrently with the pumping of the second stimulation treatment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The foregoing and other advantages of the present technique may become apparent upon reading the following detailed description and upon reference to the drawings in which:

[0014] FIG. 1 is an exemplary production system having multiple wells located on a surface pad in accordance with certain aspects of the present techniques;

[0015] FIG. 2 is an exemplary surface pad configuration with equipment and wells for use with the production system of FIG. 1 in accordance with certain aspects of the present techniques;

[0016] FIG. 3 is an exemplary flow chart of operations performed on the wells located on the surface pad of FIG. 1 in accordance with aspects of the present techniques; and

[0017] FIGs. 4-6 are partial views of wells being utilized in concurrent operations associated with stimulation treatments according to the process of FIG. 3 in accordance with certain aspects of the present techniques.

DETAILED DESCRIPTION

[0018] In the following detailed description, the specific embodiments of the present invention will be described in connection with its preferred embodiments. However, to the extent that the following description is specific to a particular embodiment or a particular use of the present techniques, this is intended to be

illustrative only and merely provides a concise description of the exemplary embodiments. Accordingly, the invention is not limited to the specific embodiments described below, but rather, the invention includes all alternatives, modifications, and equivalents falling within the true scope of the appended claims.

[0019] The present technique is direct to drilling, treating, completing and producing hydrocarbons, such as oil and gas, from subterranean formations in a manner that reduces the overall costs to enable economic hydrocarbon production. In particular, the present techniques describe an apparatus and method for reducing and/or eliminating the non-productive time and resource utilization for drilling, stimulating, and completing multiple wells from a single surface pad or location. That is, the present techniques provide mechanisms to enhance production economics by enabling simultaneous or concurrent operations in the stimulation of multiple wells in a manner that reduces non-productive time for equipment, material, and/or personnel. As such, the present techniques may reduce the cost and time associated with performing operations for stimulation treatments of wells.

[0020] Accordingly, the present techniques may be applicable to land-based wells with two or more wells are located on a single surface pad and/or offshore-based wells where two or more wells are located on a single platform location. The present techniques utilize procedures and equipment that allow stimulation treatments to be performed more efficiently. In particular, the present techniques involve connecting two or more wells to a stimulation fluid pumping system via a well coupling system, such as a pumping system manifold. This pumping system manifold contains multiple valves to enable stimulation fluid to be pumped into any selected well, while the other remaining wells are hydraulically isolated from the pressure and energy created by the stimulation fluid pumping system. By isolating the other wells, other operations or activities, such as preparations for the next well to be stimulated or producing hydrocarbons, may be performed on the other wells. As a result, the present techniques enhance the stimulation process for multiple wells located at a single location, such as a surface pad.

[0021] Turning now to the drawings, and referring initially to FIG. 1, an exemplary production system **100** having multiple wells located at a single surface pad in accordance with certain aspects of the present techniques is illustrated. In the production system **100**, a surface pad **102** has two or more wells **104a-104n.** Each

of the wells **104a-104n** has an oil field tree **106a-106n** located over the wellbore **108a-108n** and are positioned in a specific configuration. These wellbores **108a-108n** follow specific trajectories that access one or more specific zones or regions **110a-110n** of a subsurface formation **112**. The wellbores **108a-108n** along with any casing or tubing strings utilized may provide flow paths from the respective regions **110a-110n** to one of the trees **106a-106n** for hydrocarbons, such as oil and gas. Within the wellbores **108a-108n**, casing strings or tubing (not shown) may be disposed to support the walls of the wellbore **108a-108n**. It should be understood that "n" may be any number of such units that can be utilized. Further, it should be noted that the production system **100** is illustrated for exemplary purposes and the present techniques may be useful in the production of fluids from any location, which may include offshore or onshore applications and other equipment, as well.

[0022] Because the wells **104a-104n** may be drilled in a variety of directions with different trajectories, drilling the wellbores **108a-108n** from a single location may provide access to various lateral and vertical locations, such as the regions **110a-110n** of the subsurface formation **112**. In fact, the wellbores **108a-108n** may penetrate the subsurface formation **112** at specific target locations or regions **110a-110n** that extend substantial lateral distances from the location of the surface pad **102**. The effective drainage area associated with regions **110a-110n** may vary because the resource recovery is influenced by a number of parameters, such as the number of wells drilled, spacing of wells, reservoir properties, and stimulation treatment design and effectiveness. For example, deviated wells may be drilled to depths greater than 20,000 ft with lateral throws greater than 5,000 ft. As such, a single surface pad **102** may include wells **104a-104n** that access and effectively drain hydrocarbon reservoirs, such as subsurface formation **112**, which may be an area greater than approximately 640 acres.

[0023] For certain types of subsurface formations **112**, such as low permeability ("tight") gas formations, different stimulation treatments may be utilized to access intervals or zones within the wellbore **108a-108n**. These stimulation techniques or treatments may include hydraulic proppant fracture stimulation and completion technologies to enable commercial development of this type of subsurface formations. For instance, new multi-zone stimulation and completion methods and equipment for the use of these methods are described in U.S. Patent No. 6,394,184,

U.S. Patent No. 6,520,255, U.S. Patent No. 6,543,538, U.S. Patent No. 6,575,247 and U.S. Patent No. 6,672,405, which are incorporated by reference, which describe techniques and tools for stimulating subsurface formations containing multiple hydrocarbon targets at reduced cost compared to conventional single-zone treatment approaches. As disclosed in the patents, the Just-in-Time Perforating ("JITP") and the Annular-Coiled Tubing Fracturing ("ACT-Frac") technologies, methods, and devices provide stimulation treatments to multiple subsurface formations targets within a single wellbore. In particular, the JITP and the ACT-Frac techniques: (1) enable stimulation of multiple target zones or regions via a single deployment of downhole equipment; (2) enable selective placement of each stimulation treatment for each individual zone to enhance well productivity; (3) provide diversion between zones to ensure each zone is treated per design and previously treated zones are not inadvertently damaged; and (4) allow for stimulation treatments to be pumped at high flow rates to facilitate efficient and effective stimulation. As a result, these multi-zone stimulation techniques have been developed to enhance hydrocarbon recovery from subsurface formations that contain multiple stacked subsurface intervals of hydrocarbons within regions of a well.

[0024] However, performing these stimulations may include a range of supporting operations that preclude pumping operations in the well at the time of the supporting operation is performed. For instance, non-pumping operations are usually performed when applying these multi-zone stimulation technologies to wells that are stimulated over one or more days. Accordingly, in performing these operations, it may be preferred to set bridge plugs or frac plugs between sets of intervals being treated by the stimulations. Setting these plugs may take substantial time, such as two or more hours depending on the well depth and operating speed of the wireline equipment. During the installation of the plug, it is not possible to perform stimulation treatment pumping operations in the well, which are an expensive portion of the stimulation operation. As a result, for wells containing many zones, the time associated with non-pumping operations may result in substantial incremental costs due to the cost structure associated with time-based equipment and crew fees.

[0025] As a specific example, nine wells may be drilled from a single surface location, such as the surface pad **102**, which is six-acre section of land. Each of the nine wells may be drilled with trees positioned in two rows on the surface pad **102**

and separated from each other by approximately fifteen feet. In this manner, the wells may be clustered in a relatively small portion of the surface pad **102** to provide additional space for other equipment that may be used in the stimulation treatments. Eight of the wells may be drilled with s-shape well trajectories, while one of the wells may have a vertical trajectory. Each of these wells may end at a bottomhole location that provides drainage for subsurface formation **112** for about a nominally 20 acre well spacing. Hence, the nine wells may drain about 180 acres from a single six acre surface location.

[0026] To enhance the stimulation, completion and production process from these wells on a surface pad, the operations performed on the individual wells may be coordinated and utilize mechanisms to perform these operations in an efficient manner. Accordingly, in FIG. 2, a surface pad configuration is shown with different equipment that may be utilized to perform the stimulation treatments in accordance with the present techniques. An exemplary flow chart is shown in FIG. 3 that describes possible concurrent operations that may be performed to enhance the operation of the wells of FIGs. 1 and 2. FIGs. 4-6 illustrate views of wells with different operations being performed on the wells in accordance with the process of FIG. 3. Accordingly, by utilizing the present techniques, simultaneous or concurrent operations involving stimulation of two or more wells located at a single surface pad may be performed in an efficient manner.

[0027] FIG. 2 is an exemplary surface pad configuration with equipment and wells for use with the production system **100** of FIG. 1 in accordance with certain aspects of the present techniques. In FIG. 2, the configuration of surface equipment involved with stimulation treatments by a JITP hydraulic proppant fracture stimulation of three wells **104a-104c** on the surface pad **102** is shown. In particular, to support the JITP hydraulic proppant fracture stimulation operations, the equipment on the surface pad **102** may include a stimulation fluid pumping system **202**, a stimulation storage system **204**, a well coupling system, such as a pumping system manifold **206**, and flowback manifolds **230a-230c**, for example. However, it should be understood that the JITP hydraulic proppant fracture stimulation system is only for exemplary purposes as other types of stimulation systems may also be utilized, including both multiple stage stimulation and single stage stimulation systems.

[0028] Generally, the wells **104a-104c** produce hydrocarbons through piping **228a-228c** that is coupled between the respective oil field trees **106a-106c** and the flowback manifolds **230a-230c**. The piping **228a-228c** may include high pressure steel lines utilized in oil field applications. The flowback manifolds **230a-230c** may also be coupled to one or more flowlines **234a-234c, 236a-236c** and **238a-238c**, respectively. These flowlines **234a-234c, 236a-236c** and **238a-238c** may be coupled to flowback pits, flow test units, sales lines, tankage, oil/gas/water separating and processing units and/or other similar devices. Thus, the hydrocarbons from the wells **104a-104c** typically flow through the flowback manifolds **230a-230c** for further processing or sales.

[0029] To provide a stimulation treatment, the JITP system may include the stimulation fluid pumping system **202** and stimulation fluid storage system **204**. The stimulation fluid pumping system **202** couples to the stimulation fluid storage system **204** via piping **203**, which may be high pressure steel lines or low pressure hoses depending on the specific application. The stimulation fluid storage system **204** is a vessel that holds a sufficient volume of fluid for the planned stimulation treatments. It is noted that the stimulation fluid storage system **204** may include tanks located on the surface pad **102**, a pit dug on the surface pad **102**, and/or a pond, lake, river or water storage facility located in close proximity to the surface pad **102**.

[0030] To couple the stimulation fluid pumping system **202** to the trees **106a-106c**, the pumping system manifold **206** is utilized. The pumping system manifold **206** may include various components utilized to manage access to the wells **104a-104c** from the stimulation fluid pumping system **202**. For instance, the pumping system manifold **206** may include a set of pipes **208** to interface each of the trees **106a-106c** with the stimulation fluid pumping system **202**. To manage the flow paths through the pipes **208**, a main manifold valve **210** and a manifold check valve **212** may be located near the stimulation fluid pumping system **202**, while a first manifold well valve **214**, second manifold well valve **216**, and a third manifold well valve **218** may be located near each of the trees **106a-106c**, respectively. Each of the trees **106a-106c** may be connected to the first manifold well valve **214**, second manifold well valve **216**, and a third manifold well valve **218**, respectively, or utilize other devices to couple to the trees **106a-106c**. Valves **210, 214, 216** and **218** may be any type of valve, including those routinely used in oil-field applications, such as gate

valves or ball valves, while the manifold check valve **212** may be configured to allow fluid flow from the stimulation fluid pumping system **202**, but to prevent reverse flow of fluids into the stimulation fluid pumping system **202**. These valves **210, 214, 216** and **218** may be actuated or positioned to a full-open or full-closed position to provide hydraulic isolation between individual wells **104a-104c** and the stimulation fluid pumping system **202**. While it may be beneficial for the valves **210, 212, 214, 216** and **218** to seal in a "leak-tight" position, in some applications, it may be acceptable to perform operations with leaky hydraulic seals. In addition, the pumping system manifold **206** may include a densitometer **220**, pressure gauge **222**, ball-sealer injector **224** and/or flowmeter **226**, which may be coupled along the piping **208** near the main manifold valve **210**. However, it should be understood that the specific configuration of components described in the pumping system manifold **206** is for exemplary purposes, and other configurations and placement of components may be utilized for additional functionality.

[0031] Through the coupling of the valves **210, 212, 214, 216** and **218**, flow paths may be provided through the pumping system manifold **206**. Because the first manifold well valve **214**, second manifold well valve **216**, and a third manifold well valve **218** may be set to an open or closed position, stimulation fluid may be injected into one or more of the wells **104a-104c**, while the other wells **104a-104c** may be isolated by at least one of the valves **214-218** from the stimulation fluid pumping system **202**. To enhance reliability, it may be preferred that two valves, such as a manifold well valve **214-218** and a valve (not shown) on the tree **106a-106c**, are closed during any given isolation from the other wells. Additionally, it may also be preferred that at least one or more valves be installed on trees **106a-106c** and that valves in the open position are marked during the stimulation operations.

[0032] Further, other equipment may also be utilized on the surface pad **102**. For instance, a first crane **240** and a second crane **242** may be utilized to suspend stimulation equipment, such as a JITP lubricator system. These cranes **240** and **242** may be located in a fixed position that may access any of the wells **104a-104c** or may be mobile to provide access to any of the wells **104a-104c**. Also, a first wireline unit **244** and a second wireline unit **246** may be used for deploying and activating JITP perforating tools **248**, such as perforating guns, and plug-setting tools **250**, which may include plugs, in the wells **104a-104c**. In addition, a coiled tubing unit

and/or workover rig **252** may be utilized to remove plugs and install production tubing within the wells. The use of the stimulation equipment is further explained below in FIG. 3.

[0033] FIG. 3 is an exemplary flow chart of operations that may be performed on the wells **104a-104c** located on the surface pad **102** of FIG. 1 in accordance with aspects of the present techniques. This flow chart, which is referred to by reference numeral **300**, may be best understood by concurrently viewing FIGs. 1 and 2. In this flow chart **300**, various operations may be performed on wells **104a-104n** in a concurrent or substantially simultaneous manner to reduce costs and time associated with stimulating wells. For exemplary purposes, these operations may be specific to JITP hydraulic proppant fracture stimulation operations, which may include the equipment described in FIG. 2. However, it should again be noted that other stimulation techniques or other operations may be performed under the present techniques.

[0034] The flow chart begins at block **302**. At block **304**, the wells **104a-104c** are drilled on the surface pad **102**. The drilling operations may include installing the production casing and cementing the production casing into the wellbore **108a-108c**. The drilling operations may also include setting the trees **106a-106c**. Then, the target zones to be stimulated within the completion interval may be identified, as shown by block **306**. The identification of the target zones may be performed by using open-hole and/or cased-hole logs to identify zones that include hydrocarbons.

[0035] Once the target zones are identified, the stimulation operations may be performed, as shown in blocks **308-318**. To begin, it should be noted that these stimulation operations may include various activities, such as pumping operations, wireline operations, flowback operations, and other logistical coordination operations. The pumping operations may include high pressure pumping; JITP ball arrival and pressure events; screen-out mitigation and sand flowback; and manipulating pumping manifold valves, wellhead tree valves and/or flowback manifold valves. The wireline operations may include wireless radio and hard wired radios communications; arming perforating guns and plug setting tools; picking-up and laying down perforating guns and plug setting tools; moving wireline in and out of the wellbores; pulling on the wireline to free stuck tools; installing or retrieving perforating guns; and/or raising or lowering man-lifts for personnel access to equipment located

off the surface pad **102**. The flowback operations may include flowing back the well, manipulating choke manifold valves; producing gas to the sales line; and/or venting and flaring gas to the atmosphere. Logistical coordination operations may include water recycling pumping and filtering; proppant delivery; chemical delivery; water hauling; and/or communicating with crews via cellular phones or radios.

[0036] In addition, other drilling-related operations, completion-related and production-related operations may be performed on another or a second well. For instance, other operations may include drilling another well; installing tubing into another well; installing a plug within another well; removing debris from another well; removing the plug from another well; installing production tubing in another well; removing production tubing from another well; moving equipment on the surface pad; delivering material on the surface pad; injecting fluid in another well; manipulating valves; performing coiled tubing operations in another well; performing logging operations in another well; producing hydrocarbons from another well; delivering equipment or materials on the surface pad and/or removing equipment or materials from the surface pad.

[0037] Accordingly, the surface pad **102** is prepared for the stimulation operations, as shown in block **308**. The preparations may include coupling the piping **228a-228c**, manifold valves **230a-230c** and flowlines **234a-234c, 236a-236c** and **238a-238c** together and coupling the pumping system manifold **206** to the trees **106a-106c** and the stimulation fluid pumping system **202**. The pumping system manifold **206** may be coupled to any number of wells with the appropriate valves, flow measurements devices, flow control devices. With the equipment in place, the pumping system manifold **206** may be adjusted to prepare a specific well to receive the stimulation treatment, while the other wells are isolated from the stimulation treatment, as shown in block **310**. As an example, for the stimulation treatment to flow into the first well **104a**, the main manifold valve **210** and first manifold well valve **214** may be placed in the open position, while the second manifold well valve **216** and third manifold well valve **218** may be placed in the closed position to isolate the second and third wells **104b** and **104c**.

[0038] Once the pumping system manifold **206** is configured, a stimulation treatment may be pumped into the one of the wells, as shown in block **312**. Concurrently, with the stimulation treatment of one of the wells, another well may be

prepared for stimulation treatments, as shown in block **314**, while other operations may be conducted in the remaining wells, as shown in block **316**. The preparations may include using the crane **240** and wireline unit **244** to install and run the JITP perforating tools **248** and plug-setting tools **250** into the another well, performing flow-back operations, performing other wireline operations, injecting fluids or materials, and performing plug removal operations and/or other operations, as discussed further below. By preparing another well concurrently with the stimulation of a first well, the other well may be ready for the stimulation treatment when the stimulation treatment is completed in the first well. In this manner, the execution of simultaneous operations performed on the other wells may reduce "non-pumping" time between the first stimulation treatment of the first well and a second stimulation treatment of another well, and reduce the time and cost of the stimulation operation.

[0039] After the first stimulation treatment is completed, a determination is made whether the planned stimulation treatments for the wells are completed, as shown in block **318**. If the planned stimulation treatments for the wells are not complete, then the pumping system manifold **206** may be adjusted to prepare for the next well. That is, the valves in the pumping system manifold **206** are positioned in the appropriate open or closed positions to enable stimulation fluid injection into another of the wells, which is to receive the second stimulation treatment. Again, concurrent or simultaneous operations, such as conveyance of JITP perforating tools **248** and plug-setting tools **250** downhole on wireline and/or flow-back operations may be performed if a third stimulation treatment is to be performed. These simultaneous operations are conducted to prepare other wells for the stimulation treatments with reduced non-pumping time between each of the stimulation treatments. The above process of sequentially manipulating the valves of the pumping system manifold, as shown in block **310**, and pumping stimulation treatments in the wells, while simultaneously performing operations to prepare other wells for further stimulation treatments may be repeated until each of the planned stimulation treatments is completed.

[0040] If the planned stimulation treatments for the wells are complete, then the equipment associated with the stimulation treatments may be rigged-down and moved off the surface pad **102**, as shown in block **320**. Then, a workover rig or coiled tubing unit **252** may be located at the surface pad **102** to drill-out the plugs and

run production tubing in each of the wells, as shown in block **322**. With the production tubing installed, the wells may be utilized to produce hydrocarbons, as shown in block **324**. Accordingly, the process ends at block **326**.

[0041] Beneficially, the present technique reduces the time associated with stimulating multiple wells on a surface pad by performing concurrent operations on two or more of the wells. Also, by saving time, the present technique reduces the cost of performing stimulations on these wells. Further, the use of the pumping system manifold reduces or eliminates the potential safety hazards and additional time delays associated with rig up and/or rig down of high pressure lines from the stimulation fluid pumping system to the individual wells, which may occur multiple times over the course of many days with the use of conventional methods. A specific example of the present techniques is process below and described in greater detail in FIGs. 4-6.

[0042] FIGs. 4-6 are partial views of wells **104a-104c** being utilized to perform concurrent stimulation operations according to the process of FIG. 3 in accordance with certain aspects of the present techniques. The partial views of FIG. 4-6, which are referred to by reference numerals **400, 500** and **600**, respectively, may be best understood by concurrently viewing FIGs. 1 and 2. In these partial views **400, 500** and **600**, three wells **104a-104c** from the surface pad **102** are shown with different operations being performed on each of the wells **104a-104c** in a concurrent or substantially simultaneous manner.

[0043] For exemplary purposes, the operations performed in FIGs. 4-6 may be specific to a five-stage JITP hydraulic proppant fracture treatment, which may be referred to as a stimulation treatment or JITP fracture treatment. Accordingly, each stage of the JITP fracture treatment includes different sub-stages. These sub-stages are as follows: (a) 5,000 gallons of 2% potassium chloride water solution; (b) 2,000 gallons of guar-based linear gel fracture fluid containing 1 pound-per-gallon of proppant; (c) 3,000 gallons of guar-based linear gel fracture fluid containing 2 pounds-per-gallon of proppant; (d) 10,000 gallons of guar-based linear gel fracture fluid containing 3 pounds-per-gallon of proppant; and (e) 3,000 gallons of guar-based linear gel fracture fluid containing 4 pound-per-gallon of proppant such that 50,000 pounds of proppant and 23,000 gallons (approximately 547 barrels of fluid) of stimulation fluid are used in each stage of the JITP fracture treatment. Then, the

pumping may be performed at an average rate of 20 barrels/minute. As a result, the pumping time for each stage may take approximately 27 minutes. Hence, the pumping time for a JITP fracture treatment may be approximately 2 hours and 15 minutes for each well. The following partial views **400, 500** and **600** are described in greater detail in each of the FIGs 4-6 below.

[0044] To begin, in FIG. 4, the first well **104a** may be stimulated using the JITP fracture treatment. It should be noted that for this stimulation treatment, the main manifold valve **210** and first manifold well valve **214** are in the open position, while the second manifold well valve **216** and third manifold well valve **218** are in the closed position to create a first well flow path. Also, a wireline-deployed JITP perforating gun **402**, which may be one of the JITP perforating tools **248**, is suspended via wireline **403** in the wellbore **108a** using the first crane **240**. This JITP perforating gun **402** is actuated and controlled from the first wireline unit **244**. In the first well **104a**, proppant fracture **404** has been placed into the region **110a** of the subsurface formation **112**. The stimulation fluid is pumped down the wellbore **108a** to create a proppant fracture **406**.

[0045] Concurrently, preparation operations may also be performed in the second well **104b**. In the second well **104b**, a wireline-deployed JITP perforating gun **408**, which is another of the JITP perforating tools **248**, and a frac plug setting system **410** having a composite frac plug **409**, which is one of the JITP plug-setting tools **250**, may be deployed via a wireline **411** down the second wellbore **108b** by the second crane **242** and second wireline unit **246**. The second well **104b** may have received a previous stimulation treatment, which has resulted in proppant fractures **412, 414, 416, 418** and **420** in the region **110b** of the subsurface formation **112**. Because these proppant fractures **412, 414, 416, 418** and **420** were previously placed in the subsurface formation **112**, the operations in the second well **104b** may be to place a composite frac plug **409** within the wellbore **108b** above the proppant fractures **412, 414, 416, 418** and **420.**

[0046] In addition to the concurrent operations being performed in the second well **104b**, other operations may also be performed in the third well **104c**. For example, in the third well **104c**, proppant fractures **422, 424, 426, 428** and **430** may have been previously formed in the region **110c** of the subsurface formation **112**. Because these proppant fractures **422, 424, 426, 428** and **430** were previously

formed, flowback operations may be performed to force close the proppant fractures **422, 424, 426, 428** and **430** and recover the stimulation fluid used to form the proppant fractures **422, 424, 426, 428** and **430**, and produce hydrocarbons to the sales lines.

[0047] Next, FIG. 5 illustrates the wells **104a-104c** after the operations performed in FIG. 4 are completed. As shown in the partial view **500**, the proppant fractures **404, 406, 502, 504** and **506** were created with the pumping of the five-stage JITP treatment in FIG. 4. However, in FIG. 5, the first well **104a** is being flowed back after the placement of proppant fractures **404, 406, 502, 504** and **506** in the region **110a** of the subsurface formation **112** to force close the proppant fractures **404, 406, 502, 504** and **506** and recover the stimulation fluid used to place the proppant fractures **404, 406, 502, 504** and **506**, and produce hydrocarbons to the sales lines.

[0048] Concurrently, the second well **104b** may be receiving the five-stage JITP hydraulic proppant fracture treatment. It should be noted that for this stimulation operation, the main manifold valve **210** and second manifold well valve **216** are in the open position, while the first manifold well valve **214** and third manifold well valve **218** are in the closed position to create a second well flow path. Again, as discussed in FIG. 4, the wireline-deployed JITP perforating gun **408** and frac plug setting system **410** are suspended via wireline **411** in the wellbore **108b** using the second crane **242**, which is also actuated and controlled from the second wireline unit **246**. However, in this view, the composite frac plug **409** is set above the proppant fracture **420**. With this composite frac plug **409** installed, the five-stage JITP proppant fracture treatment is underway with the stimulation fluid pumped down the wellbore **108b** to create proppant fracture **510**.

[0049] Another concurrent operation is also being performed in the third well **104c**. In this well, the flowback operation has been completed and the well **104c** is now shut-in. Accordingly, to prepare for the next stimulation treatment, a wireline-deployed JITP perforating gun **512**, which is another of the JITP perforating tools **248**, and a frac plug setting system **514** having a composite frac plug **516**, which is one of the JITP plug-setting tools **250**, are deployed down the wellbore **108c**. The JITP perforating gun **512** and a frac plug setting system **514** are suspended via wireline **403** in the wellbore **108c** using the first crane **240**, and are actuated and controlled from the first wireline unit **244**. The JITP perforating gun **512** and frac plug

setting system **514** may then be utilized to JITP stimulate and place additional proppant fractures above the proppant fractures **430**.

[0050] Finally, FIG. 6 illustrates the wells **104a-104c** after the operations performed in FIG. 5 are completed. As shown in the partial view **600**, the flowback operation has been completed and the first well **104a** has been shut-in. In this view, the wireline-deployed JITP perforating gun **601**, which is another of the JITP perforating tools **248**, and a frac plug setting system **602** having a composite frac plug **603**, which is one of the JITP plug-setting tools **250**, are deployed down the wellbore **108a**. The JITP perforating gun **601** and frac plug setting system **602** are suspended via wireline **411** in the wellbore **108a** using the second crane **242**, and are actuated and controlled from the second wireline unit **246**. The frac plug setting system **602** may be utilized to set the composite frac plug **603**, while the JITP perforating gun **601** may be utilized in the next five-stage JITP treatment to create proppant fractures above proppant fracture **506** during the next stimulation treatment.

[0051] Concurrently, in the second well **104b**, stimulation treatments are completed and the proppant fracture **510, 604, 606, 608** and **610** have been placed into the region **110b** of the subsurface formation **112**. Accordingly, the second well **104b** is flowed back after placement of proppant fractures **510, 604, 606, 608** and **610** to force close the fractures and recover the stimulation fluid used when placing the proppant fractures, and produce hydrocarbons to the sales lines.

[0052] Also, in another concurrent operation, the composite frac plug **516** has been set in the third well **104c** and the pumping of a five-stage JITP proppant fracture treatment has created proppant fractures **614** and **616**. It should be noted that for this stimulation treatment, the main manifold valve **210** and third manifold well valve **218** are in the open position, while the first manifold well valve **214** and second manifold well valve **216** are in the closed position to create a third well fluid flow path. Again, as discussed in FIG. 5, the wireline-deployed JITP perforating gun **512** and frac plug setting system **514** are suspended via wireline **403** in the wellbore **108c** using the first crane **240** and is actuated and controlled from the first wireline unit **244**. In this view, a composite frac plug **516** is set above the proppant fracture **430**. With this composite frac plug **516** installed, the JITP proppant fracture treatment is performed to form the proppant fractures **614** and **616** by having the stimulation fluid pumped down the wellbore **108c**.

[0053] Beneficially, in this example, the concurrent operations enhance the stimulation treatment process. For instance, if the wireline running speeds is approximately 150 ft/min (feet/minute) to 300 ft/min for the assumed approximate 12,000 ft well depth, then, the time to pump a total of fifteen proppant fracture treatments is approximately ten hours. Accordingly, each well receiving the stimulation treatment may be flowed back overnight for several hours of stimulation fluid recovery and for oil and gas sales. In this manner, the stimulation treatments for multiple wells may be performed in an efficient manner that reduces time and cost.

[0054] To further explain the benefits of the present techniques, another example is described. In this example, nine wells may be drilled on a single surface pad of approximately six acres. These wells may target gas-productive reservoir targets, such as sand bodies, within a subsurface formation, and are configured to drain an area of approximately 20 acres. For these wells, the well depths may range between approximately 12,000 ft to 15,000 ft with lateral throws of approximately 1,400 ft to 2,000 ft relative to the surface pad. The size and location of the surface pad may be determined by the geological and reservoir characteristics, governmental regulations, surface topography and terrain, and consideration of environmental or regulatory requirements that are identified during the pad selection/location process. The characteristic features of the subsurface formation may be gas resources contained in multiple (e.g., 20+ to 40+) low permeability ("tight") gas sands of limited areal extent distributed over a large vertical section of approximately 4,000 ft to 6,000 ft thick interval. Accordingly, each well includes up to forty or more reservoir targets or zones.

[0055] To access these target zones, the wells are stimulated with the JITP stimulation techniques with each five stage JITP fracture treatment separated by a plug. The wireline plug-setting operation, which may be approximately two to four hours depending on well depth, running speed, and rig-up/rig-down time, may be completed while the stimulation treatment pumping operations are performed on another well. The stimulation treatment pumping operations for the five zones may be completed in approximately 3 hours. Accordingly, fifteen to twenty zones may be pumped each work day, which results in approximately two or three work days to complete a forty zone stimulation operation. Thus, by performing the stimulation operations in a concurrent manner, a total of approximately one or two work days

associated with "non-pumping time" may be saved on each well during the stimulation treatments.

[0056] In addition, it should be noted that these stimulation operations may include various activities. For instance, as noted above, the stimulation operations may include pumping operations, wireline operations, flowback operations, and logistical coordination operations. Because these stimulation operations may be performed concurrently or simultaneously on different wells on a single surface pad, several risks associated with the different operations may be present. Accordingly, certain stimulation operations may be performed concurrently to reduce the risks and maintain the operational integrity of the simultaneous operations.

[0057] To begin, in performing the concurrent stimulation operations, different combinations of pumping operations, wireline operations, flowback operations, and logistical coordination operations may be performed on the different wells with certain monitoring procedures. The monitoring procedures may include using a spotter for certain operations, a light or audible warning, obtaining supervisor approval for certain operations, communicating between personnel, flagging or labeling valve positions, following lock-out tag-out procedures, and other similar processes. For instance, when the stimulation operations are being performed on the first well, operations, such as proppant delivery, chemical delivery, and/or water hauling, on the second well may be performed within designated areas and using a spotter, which is discussed below. As another example, supervisor approval may be obtained before venting gas when the operations on the other well involve high pressure pumping, manipulating pumping manifold/frac valves and gas to sales line operations. Further, when the operations on the first well involve high pressure pumping, operations on the second well, such as arming the perforating gun or setting tool and picking-up or laying down the perforating gun or setting tool, may utilize lights and audible notifications. Finally, it may be preferred to not perform certain operations concurrently. For instance, if the operations on the first well involve high pressure pumping or JITP ball sealing pressure events, the manipulating the manifold well valves and wellhead tree valves should not be concurrently performed. Also, if operations on the first well include wireless radio and cell phone communications, then the operations should not be performed concurrently with arming perforating guns and setting tools.

[0058] Another method of reducing risk may include assigning personnel to manage the operations. For instance, if a crane, such as cranes **240** and **242** of FIG. 2, are used as part of the stimulation operations, it may be preferred that the personnel operating the crane include a designated spotter to assist with crane operations. Further, the crane may be positioned to reduce potential collisions with other equipment on the surface pad. Also, based on the potential for hydraulically-energized lines associated with injection and flowback from the wells, it may be preferred that one of the personnel associated with the stimulation system manage the stimulation pumping valve positions and the flowback valve positions, while concurrent operations are being performed.

[0059] In another embodiment, it may be preferred to include monitoring equipment at the surface pad **102** of FIG. 2, which may detect gases, such as hydrocarbon gases. For example, the surface pad **102** and/or personnel may be equipped with portable Lower-Explosive Limit ("LEL") detectors. Accordingly, during flowback operations, the LEL detectors may continuously monitor the surface pad **102** for the presence of hazardous gas levels. If hazardous gas levels are detected, the flowback operations may be suspended and appropriate activities may be performed to solve any problems with equipment. Also, it may be preferred that windsocks are installed at various points and heights on the surface pad **102** to aid in determining wind direction, as well.

[0060] Further, in another alternative embodiment, it may be beneficial to have automated devices, such as processor based devices, which are utilized for the stimulation operations. For instance, the stimulation fluid pumping system **202** may be automated and controlled by a processor based device, such as a computer system. With the computer system, the stimulation treatment schedules for each individual stimulation treatment may be pre-programmed into the computer system. Also, the pumping system manifold **206** may include a processor based device, such as a computer system, as well. The computer system for the pumping system manifold **206** may include mechanisms to adjust the valves **210, 214, 216** and **218** between the open and closed positions, and communicate with the various gauges **220, 222** and **226** and ball-sealer injector **224**. In fact, the computer systems of the stimulation fluid pumping system **202** and the pumping system manifold **206** may be

configured to interact with each other to manage the pumping stimulation treatment process for the plurality of wells **104a-104c**.

[0061] In a third alternative embodiment, the designation of specific work areas for certain operations for handling associated tools and equipment may be performed between blocks **306** and **318** of FIG. 3. That is, the process may include designating different areas, such as high-pressure pumping area, wireline/crane areas, and flowback areas, on the surface pad **102** of FIG. 2 to prevent unauthorized personnel from entering restricted areas. The designation of work areas may include providing detailed drawings of piping, valves, and flow control/measurement devices for the operations for each of the work areas and wells. For instance, if cranes **240** and **242** and wireline units **244** and **246** of FIG. 2 are used, it may be preferred that a designated wireline/crane area be located surrounding and adjacent to each of the cranes **240** and **242**. Also, it may be preferred that stimulation equipment, such as the stimulation fluid pumping system **202**, stimulation fluid storage system **204** and pumping system manifold **206** of FIG. 2, are arranged on the surface pad **102** with pathways or routes around the outer perimeter of the high-pressure pumping area to provide access for reloading of stimulation materials and supplies. Further, it may be preferred that piping and valves be identified using different unique colored markings or other labels for each of the different wells to assist in visual observations and understanding of the flow paths and equipment tie-in points.

[0062] Also, in a fourth alternative embodiment, it may be preferable for a communication protocol to be established between blocks **306** and **318** of FIG. 3. For example, when executing simultaneous wireline operations, if select-fire perforating guns are used, it may be preferred that wireless communication devices, such as radios and other cellular devices, are turned off and/or stored in a central location when a gun is armed and placed in the wellbore or removed from the wellbore. Alternatively, it may be preferred that "hard-wired" radios and communication devices are used as the primary communication devices with wireless communication devices only utilized as back-up equipment. Further, strobe-warning lights and/or a loudspeaker system may be used to provide an indication of the status of the gun arming sequence and depth of gun during the operations.

[0063] It should be noted that the pumping system manifold **206** of FIG. 2 may not include each of the components described above. Indeed, in alternative

embodiments, additional measurement devices, flow control devices, fluid injection or withdrawal ports, and/or material injection or withdrawal ports may be included in the pumping system manifold **206** and/or upstream or downstream of the pumping system manifold **206**.

[0064] Furthermore, it should also be noted that the number of wells and geometry of the surface location may be influenced by a number of factors to conform to appropriate regulatory requirements and other factors. Accordingly, wells may possess vertical, deviated, S-shaped, and/or horizontal trajectories. For example, these trajectories may target multiple hydrocarbon bearing targets being drilled, stimulated, and completed on approximately 5/8 acre spacing in low-permeability oil fields; on approximately 10 to 40 acre well spacing in tight gas fields; and on approximately 40 acre, 80 acre and/or 160 acre spacing associated with in-fill drilling processes. Also, wells may be completed as cased-hole completions or open-hole completions. In addition, the present techniques may include a single unique surface area (i.e. pad) or two or more surface pads in sufficiently close proximity for performing the drilling, stimulation, completion, and production operations objectives. The possible use of wells from two or more surface pads may be determined based on local geographic conditions, material supply routes, and/or overall field infrastructure, specific operational requirements, and/or economic considerations.

[0065] As noted above, the present techniques may also be used for stimulation treatments involving hydraulic fracturing or acid stimulation in production or injection wells. Hydraulic fracturing may include injecting fluids into a formation at high pressures and rates that the reservoir rock fails and granular proppant material, such as sand, ceramic beads, or other materials, is injected to hold the fracture(s) open. Increased reservoir production capacity or injection capacity results from the flow path left between the grains of the proppant material within the fracture(s). In chemical stimulation treatments, such as matrix acidizing treatments or acid fracturing treatments, flow capacity is improved by dissolving materials in the formation or otherwise changing formation properties.

[0066] Moreover, the present techniques may be used for stimulation treatments involving multiple stage treatments or single-stage treatments. Multiple stage stimulation treatments may include the JITP or ACT-Frac treatment methods, which

are discussed above. In addition, the multiple stage stimulation treatments may include other multiple stage treatments, such as stimulation treatments disclosed in U.S. Patent 5,890,536 and U.S. Patent No. 6,186,230, which are herein incorporated by reference. Also, other methods utilized in oil and gas operations, such as "limited-entry" diverted multi-stage treatments, annular coiled-tubing, coiled-tubing, ball-sealer multi-stage treatments, modified limited entry multi-stage treatments, induced stress diverted treatments, or multiple single-stage treatments separated by plugs, or any combination of treatments, may also be utilized with the present techniques.

[0067] In addition, it should be appreciated that the surface pad, such as surface pad 102, may include two or more stimulation fluid pumping systems. For instance, a surface pad may include two stimulation fluid pumping system, which are stimulation fluid pumping system **202** of FIG. 2. This configuration for the surface pad may also include two stimulation storage systems **204**, two pumping system manifolds **206**, and other associated piping. Each of the stimulation storage systems, pumping system manifolds, and other associated piping may each be associated with two different groups or sets of wells. In this manner, two wells may be stimulated concurrently or simultaneously. That is, one well associated with each of the stimulation fluid pumping systems may receive stimulation treatments, while other wells from the well groups may be prepared for stimulation treatments.

[0068] While the present techniques of the invention may be susceptible to various modifications and alternative forms, the exemplary embodiments discussed above have been shown by way of example. However, it should again be understood that the invention is not intended to be limited to the particular embodiments disclosed herein. Indeed, the present techniques of the invention are to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the following appended claims.

CLAIMS

What is claimed is:

1. A method associated with the production of hydrocarbons comprising:

connecting a plurality of wells to a stimulation fluid pumping system via a pumping system manifold;

adjusting the pumping system manifold to provide a first well flow path from the stimulation fluid pumping system to a first well of the plurality of wells;

pumping a first stimulation treatment into the first well; and

preparing a second well of the plurality of wells for a second stimulation treatment concurrently with the pumping of the first stimulation treatment.

2. The method of claim 1 wherein adjusting the pumping system manifold comprises configuring at least one of a plurality of valves to provide the first well flow path and configuring at least one of the plurality of valves to isolate the first stimulation treatment from entering the second well.

3. The method of claim 1 further comprising adjusting the pumping system manifold to provide a second well flow path from the stimulation fluid pumping system to the second well.

4. The method of claim 3 further comprising pumping the second stimulation treatment in the second well.

5. The method of claim 1 wherein the first stimulation treatment comprises one of hydraulic proppant fracture treatment, acid fracture treatment, matrix acid treatment and any combination thereof.

6. The method of claim 1 wherein the first stimulation treatment comprises one of just-in-time perforating, annular coiled-tubing, coiled-tubing, limited-entry, ball-sealer, modified limited entry, induced stress diverted, or one or more single-stage stimulation treatments separated by plugs and any combination thereof.

7. The method of claim 1 wherein the first stimulation treatment comprises a multi-zone just-in-time perforating hydraulic proppant fracture stimulation treatment.

8. The method of claim 1 wherein preparing the second well comprises one of drilling the second well, installing tubing into the second well, installing a plug within the second well, flowing back the second well, removing debris from the second well, removing the plug from the second well, removing tubing from the second well, moving equipment on a surface pad, delivering material on the surface pad, communicating by radio or cellular phone on the surface pad, injecting fluid in the second well, manipulating valves, performing wireline operations in the second well, performing coiled tubing operations in the second well, installing or retrieving perforating guns in the second well, performing logging operations in the second well, producing hydrocarbons from the second well, venting gas on the surface pad, flaring gas on the surface pad, delivering equipment or materials on the surface pad, removing equipment or materials from the surface pad and performing logging operations.

9. The method of claim 1 further comprising producing hydrocarbons from the plurality of wells.

10. The method of claim 1 further comprising drilling the plurality of wells from a single surface pad.

11. The method of claim 1 wherein the plurality of wells are located on a single surface pad.

12. The method of claim 1 wherein the plurality of wells are in close proximity to each other on one or more surface pads or platforms.

13. The method of claim 1 further comprising installing production tubing into each of the plurality of wells.

14. A method associated with the production of hydrocarbons comprising the steps of:

a) connecting a plurality of wells to a stimulation fluid pumping system via a pumping system manifold;

b) adjusting the pumping system manifold to provide a stimulation treatment from the stimulation fluid pumping system to one of the plurality of wells;

c) isolating another of the plurality of wells from the stimulation treatment concurrently with the pumping of the stimulation treatment to prepare the another well for another stimulation treatment;

d) repeating steps b and c until each of the plurality of wells have received stimulation treatments; and

e) producing hydrocarbons from the plurality of wells once the stimulation treatments have been performed.

15. The method of claim 14 wherein the plurality of wells are located on a single surface pad.

16. A well system comprising:

a plurality of oil field trees located on a surface pad, wherein each of the plurality of oil field trees is associated with one of a plurality of wells;

a stimulation fluid pumping system; and

a pumping system manifold connecting the stimulation fluid pumping system to the plurality of oil field trees.

17. The well system of claim 16 wherein the pumping system manifold is configured to:

provide a flow path from the stimulation fluid pumping system into at least one selected well of the plurality of wells; and

isolate at least one non-selected well of the plurality of wells from the stimulation fluid pumping system.

18. The well system of claim 16 wherein the pumping system manifold comprises a plurality of valves.

19. The well system of claim 18 wherein the plurality of valves comprises at least one of a ball valve, gate valve and any combination thereof.

20. The well system of claim 16 wherein the plurality of wells are associated with a single surface pad.

21. The well system of claim 16 wherein the plurality of wells are in close proximity to each other on one or more surface pads.

22. The well system of claim 16 further comprising a stimulation fluid storage system coupled to the stimulation fluid pumping system.

23. The well system of claim 16 wherein at least two of the plurality of wells penetrate multiple hydrocarbon-bearing reservoirs.

24. The well system of claim 16 wherein the stimulation fluid pumping system and the pumping system manifold provide multi-zone stimulation treatments to the multiple hydrocarbon-bearing reservoirs penetrated by the at least two of the plurality of wells.

25. The well system of claim 16 wherein the stimulation fluid pumping system is a hydraulic proppant fracture stimulation system.

26. The well system of claim 16, wherein the stimulation fluid pumping system is one of a Just-in-Time Perforating system and a Annular-Coiled Tubing Fracturing system.

27. The well system of claim 16 further comprising:

a plurality of additional oil field trees located on the surface pad, wherein each of the plurality of additional oil field trees are associated with one of a plurality of additional wells;

an additional stimulation fluid pumping system; and

an additional pumping system manifold connecting the additional stimulation fluid pumping system to the plurality of additional oil field trees.

28. An apparatus for stimulating surface wells comprising:

a main valve associated with a stimulation fluid pumping system;

a plurality of well valves, wherein each of the plurality of well valves is associated with one of a plurality of wells; and

piping coupling the main valve to the plurality of well valves, wherein the piping is directly supported by the surface of the Earth.

29. The apparatus of claim 28 further comprising a densitometer coupled to the main valve and the plurality of well valves.

30. The apparatus of claim 28 wherein the plurality of well valves comprises at least one of a ball valve, gate valve and any combination thereof.

31. The apparatus of claim 28 further comprising at least one manifold check valve coupled to the main valve and the plurality of well valves.

32. The apparatus of claim 28 further comprising at least one pressure gauge coupled to the main valve and the plurality of well valves.

33. The apparatus of claim 28 further comprising at least one flow meter coupled to the main valve and the plurality of well valves.

34. The apparatus of claim 28 further comprising at least one ball-seal injector coupled to the main valve and the plurality of well valves.

35. A method associated with the production of hydrocarbons comprising:

connecting a first well and a second well to a first stimulation fluid pumping system via a first pumping system manifold;

connecting a third well and a fourth well to a second stimulation fluid pumping system via a second pumping manifold;

adjusting the first pumping system manifold to provide a first stimulation treatment to the first well and to isolate the second well for other operations;

adjusting the second pumping system manifold to provide a second stimulation treatment to the third well and to isolate the fourth well; and

pumping the first stimulation treatment into the first well and the second stimulation treatment into the third well concurrently with the pumping of the first stimulation treatment.

36. The method of claim 35 further comprising:

preparing the second well for a third stimulation treatment concurrently with the pumping of the first stimulation treatment; and

preparing the fourth well for a fourth stimulation treatment concurrently with the pumping of the second stimulation treatment.

37. The method of claim 36 wherein the preparing the second well for a third stimulation treatment comprises disposing a JITP perforating tool into the second well.

38. The method of claim 36 wherein the first stimulation treatment comprises one of hydraulic proppant fracture treatment, acid fracture treatment, matrix acid treatment and any combination thereof.

39. The method of claim 35 wherein the first stimulation treatment and the second stimulation treatment comprise one of just-in-time perforating, annular coiled-tubing, coiled-tubing, limited-entry, ball-sealer, modified limited entry, induced stress diverted, or one or more single-stage stimulation treatments separated by plugs and any combination thereof.

40. The method of claim 35 wherein the first stimulation treatment comprises a multi-zone just-in-time perforating hydraulic proppant fracture stimulation treatment.

41. The method of claim 36 wherein preparing the second well comprises one of drilling the second well, installing tubing into the second well, installing a plug within the second well, flowing back the second well, removing debris from the second well, removing the plug from the second well, removing tubing from the second well, moving equipment on a surface pad, delivering material on the surface pad, communicating by radio or cellular phone on the surface pad, injecting fluid in the second well, manipulating valves, performing wireline operations in the second well, performing coiled tubing operations in the second well, installing or retrieving perforating guns in the second well, performing logging operations in the second well, producing hydrocarbons from the second well, venting gas on the surface pad, flaring gas on the surface pad, delivering equipment or materials on the surface pad,

removing equipment or materials from the surface pad and performing logging operations.

42. The method of claim 35 comprising producing hydrocarbons from the first well once the stimulation treatment is completed.

43. The method of claim 35 further comprising drilling the first well, second well, third well and fourth well from a single surface pad.

44. The method of claim 35 wherein the first well, second well, third well and fourth well are located on a single surface pad.

45. The method of claim 35 wherein the first well, second well, third well and fourth well are in close proximity to each other on one or more surface pads or platforms.

46. The method of claim 35 comprising installing production tubing into each of the first well, second well, third well and fourth well.

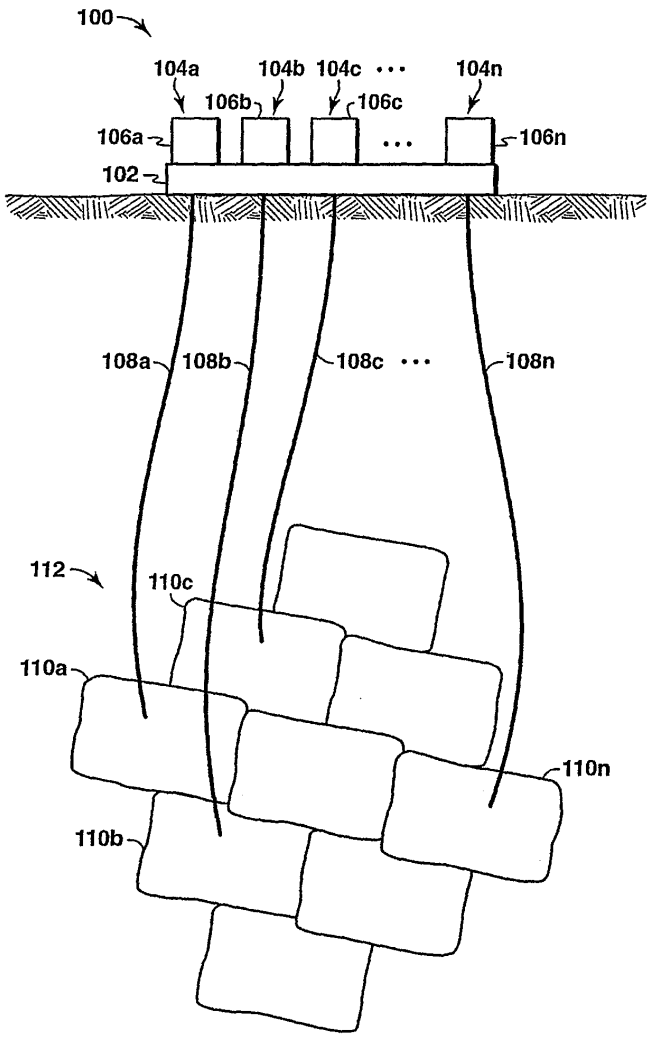

100
104a
104b
104c
104n
106b
106c
106a
106n
102
108a
108b
108c
108n
112
110c
110a
110n
110b

FIG. 1

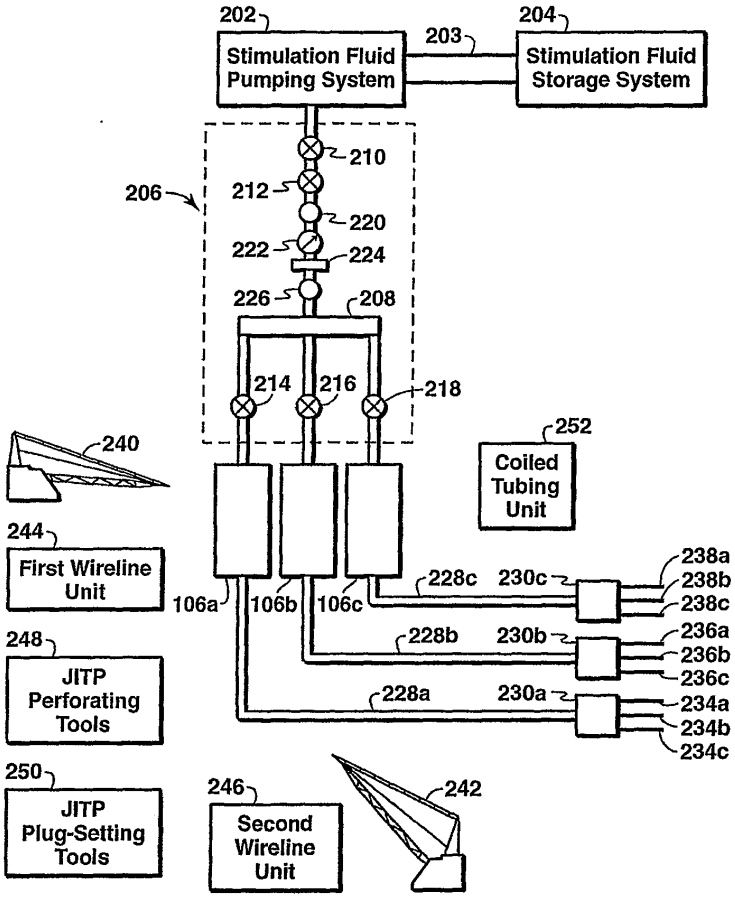

202
Stimulation Fluid Pumping System
203
204
Stimulation Fluid Storage System
206
210
212
220
222
224
226
208
214
216
218
240
252
Coiled Tubing Unit
244
First Wireline Unit
106a
106b
106c
228c
230c
238a
238b
238c
228b
230b
236a
236b
236c
248
JITP Perforating Tools
228a
230a
234a
234b
234c
250
JITP Plug-Setting Tools
246
Second Wireline Unit
242

FIG. 2

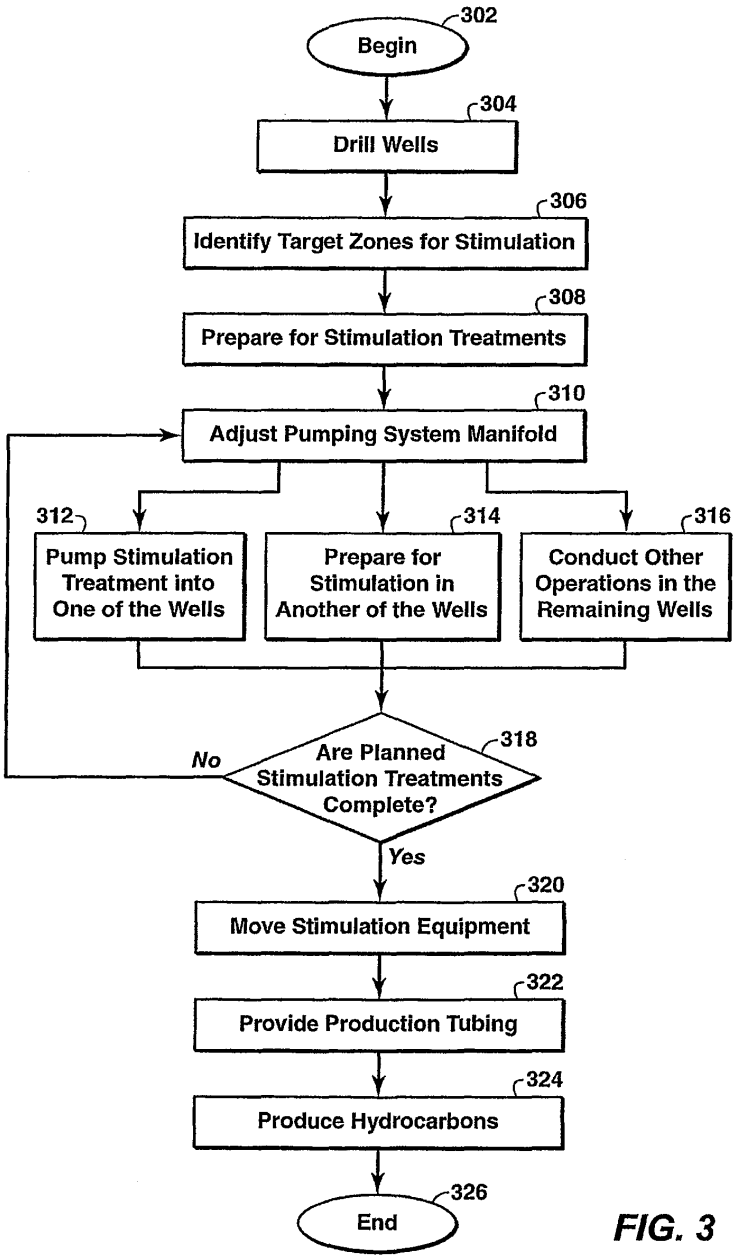

302
Begin
304
Drill Wells
306
Identify Target Zones for Stimulation
308
Prepare for Stimulation Treatments
310
Adjust Pumping System Manifold
312
Pump Stimulation Treatment into One of the Wells
314
Prepare for Stimulation in Another of the Wells
316
Conduct Other Operations in the Remaining Wells
318
Are Planned Stimulation Treatments Complete?
No
Yes
320
Move Stimulation Equipment
322
Provide Production Tubing
324
Produce Hydrocarbons
326
End

FIG. 3

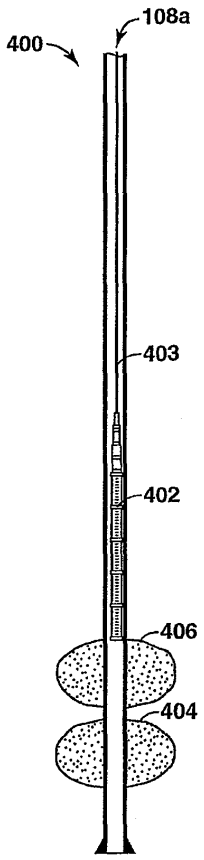


FIG. 4A

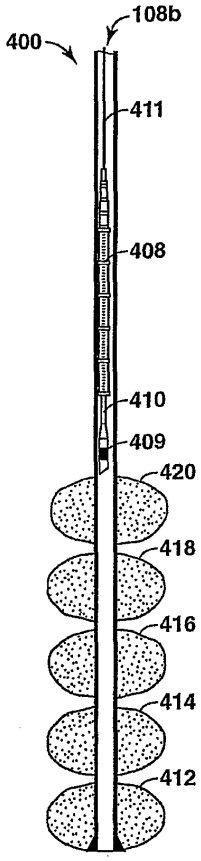


FIG. 4B

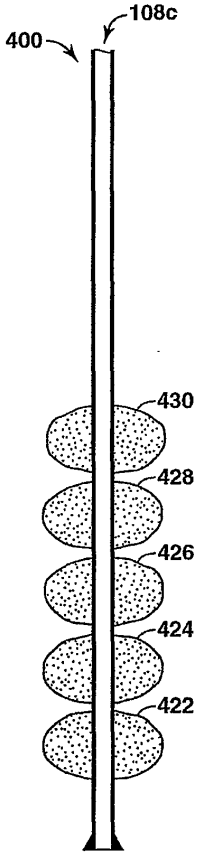


FIG. 4C

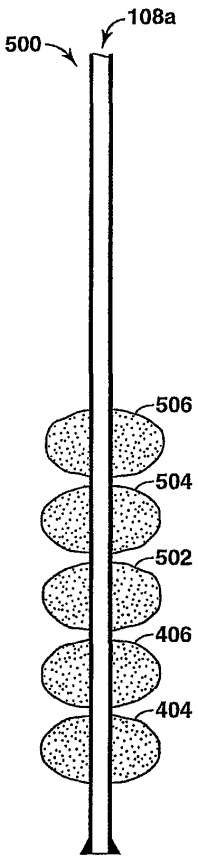


FIG. 5A

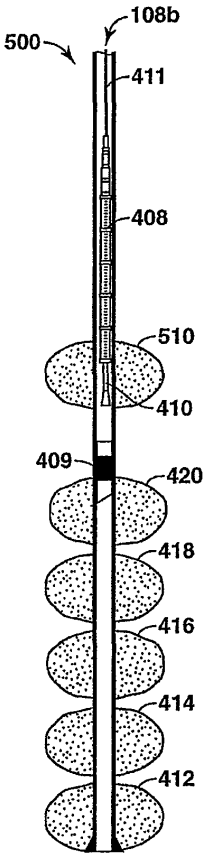


FIG. 5B

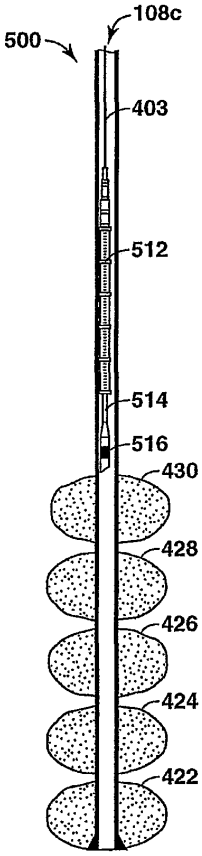


FIG. 5C

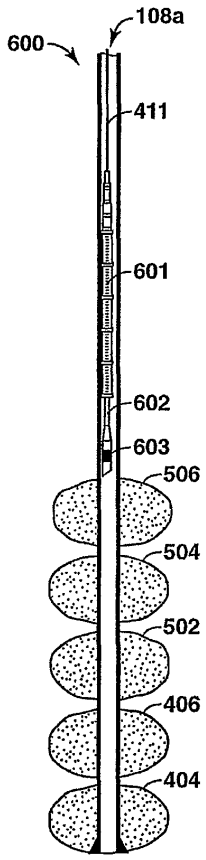


FIG. 6A

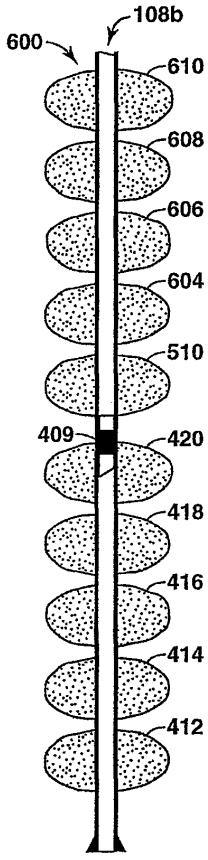


FIG. 6B

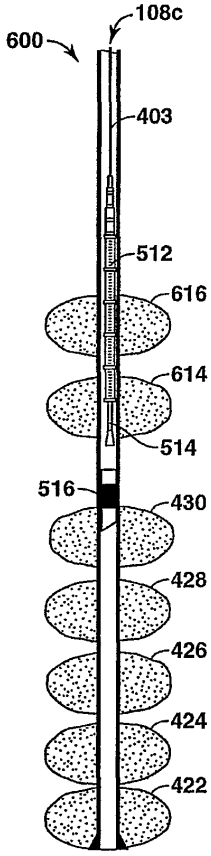


FIG. 6C

Electronic Acknowledgement Receipt	
EFS ID:	1615480
Application Number:	11291496
International Application Number:	
Confirmation Number:	7986
Title of Invention:	Method and apparatus for centralized well treatment
First Named Inventor/Applicant Name:	William Lloyd McNeel
Customer Number:	29920
Filer:	Paul N. Katz/Debbie Allen
Filer Authorized By:	Paul N. Katz
Attorney Docket Number:	2005-IP-018647U1
Receipt Date:	22-MAR-2007
Filing Date:	01-DEC-2005
Time Stamp:	15:10:38
Application Type:	Utility

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)	Multi Part /.zip	Pages (if appl.)
1		0637180930SuppIDS.pdf	1859181	yes	40

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Miscellaneous Incoming Letter	1	2
	Information Disclosure Statement (IDS) Filed	3	3
	Foreign Reference	4	40
Warnings:			
Information:			
	Total Files Size (in bytes):	1859181	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:		§	
	LLOYD MCNEEL ET AL.	§	Group Art Unit: ***Unassigned***
Serial No.:	**11/291,496**	§	
		§	Examiner: ***Unassigned***
Filed:	**DECEMBER 1, 2005**	§	
Title:	**"METHOD AND APPARATUS FOR CENTRALIZED WELL TREATMENT"**	§	Atty. Docket No: **HES 2005-IP-018647 (063718.0930)**

Honorable Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

CERTIFICATE OF FILING ELECTRONICALLY VIA EFS
MPEP 503

I HEREBY CERTIFY THAT I HAVE A REASONABLE BASIS FOR BELIEF THAT THIS CORRESPONDENCE IS BEING SUBMITTED TO THE UNITED STATES PATENT AND TRADEMARK OFFICE VIA EFS (ELECTRONICALLY) ON THE DATE INDICATED BELOW, AND IS ADDRESSED TO:

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DEBBIE ALLEN

DATE OF SUBMISSION: MARCH 22, 2007
ELECTRONIC FILING (EFS)

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

Dear Sir:

Applicants respectfully request, pursuant to 37 C.F.R. §§1.56, 1.97 and 1.98, that the art identified in the statement below and listed on the attached PTO-1449 form be considered and cited in the examination of the above-identified application. Furthermore, pursuant to 37 C.F.R. §§1.97(g) and (h), no representation is made that these references are material to the patentability of the present application.

Profrac Holding Corporation
U.S. Well Services, LLC
IPR2023-01319
Ex. 1002, p. 134 of 988

Applicants believe that no fees are due in connection with the filing of this Information Disclosure Statement. However, should the Commissioner deem that any fees are due, the Commissioner is authorized to debit Baker Botts L.L.P. Deposit Account No. 02-0383, Order Number 063718.0930, for any payment of associated fees, underpayment of fees, or to credit same with any overpayment of fees that may occur in association with this filing.

Respectfully submitted,

BAKER BOTTS L.L.P. (023640)

Date: March 22, 2007

By: _____

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U.S. Well Services, LLC
IPR2023-01319
Ex. 1002, p. 135 of 988

EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
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S2	4886454	pressur$5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/18 14:12
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S4	2225	S3 and dock$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/17 15:11
S5	1155	S4 and cool$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/17 15:14
S6	12	"024383"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/18 14:12
S7	766	tolman.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/18 14:13

EAST Search History

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S19	7836	S18 and subterranean	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	OR	OFF	2007/04/19 16:56
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S21	2179	S20 and pump$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	OR	OFF	2007/04/19 16:57

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S27	31169	fractur$3 and pump$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 12:23
S28	27358	S27 and well$5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 12:24

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S35	337	166/52	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 15:22

EAST Search History

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/291,496	12/01/2005	William Lloyd McNeel	2005-IP-018647U1	7986

29920 7590 05/03/2007
JOHN W. WUSTENBERG
P.O. BOX 1431
DUNCAN, OK 73536

EXAMINER	
LEONARD, KERRY W	
ART UNIT	PAPER NUMBER
3676	
MAIL DATE	DELIVERY MODE
05/03/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

PTOL-90A (Rev. 04/07)

Office Action Summary	Application No.	Applicant(s)	
	11/291,496	MCNEEL ET AL.	
	Examiner	Art Unit	
	Kerry W. Leonard	3676	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *01 December 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-39* is/are pending in the application.

4a) Of the above claim(s) *1-10 and 34-39* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *11-29 and 31-33* is/are rejected.

7)☒ Claim(s) *30* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

   I. Claims 1-10, drawn to a method of stimulating a subterranean formation, classified in class 166/305.1.

   II. Claims 11-33, drawn to a system of operations for stimulating a subterranean formation, classified in class 166/75.11

   III. Claims 34-39, drawn to an apparatus for stimulating a subterranean formation, classified in class 166/75.15.

The inventions are distinct, each from the other because of the following reasons:

2. Inventions I and III are related as process and apparatus for its practice. The inventions are distinct if it can be shown that either: (1) the process as claimed can be practiced by another and materially different apparatus or by hand, or (2) the apparatus as claimed can be used to practice another and materially different process. (MPEP § 806.05(e)). In this case the method of stimulating the formation can be practiced by a materially different apparatus.

3. Inventions I and II are related as process and apparatus for its practice. The inventions are distinct if it can be shown that either: (1) the process as claimed can be practiced by another and materially different apparatus or by hand, or (2) the apparatus as claimed can be used to practice another and materially different process. (MPEP § 806.05(e)). In this case the method of stimulating the formation can be practiced by a materially different fracturing system.

4. Inventions II and III are directed to related products. The related inventions are distinct if the (1) the inventions as claimed are either not capable of use together or can have a materially different design, mode of operation, function, or effect; (2) the inventions do not overlap in scope, i.e., are mutually exclusive; and (3) the inventions as claimed are not obvious variants. See MPEP § 806.05(j). In the instant case, the inventions as claimed can have a materially different design and mode of operation. The system of Invention II does not require the multiple pressure sensors and valves of Invention III in order to operate. Furthermore, the inventions as claimed do not encompass overlapping subject matter and there is nothing of record to show them to be obvious variants.

5. Because these inventions are independent or distinct for the reasons given above and there would be a serious burden on the examiner if restriction is not required because the inventions have acquired a separate status in the art in view of their different classification, restriction for examination purposes as indicated is proper.

6. During a telephone conversation with Mr. Paul Morico on April 13, 2007 a provisional election was made without traverse to prosecute the invention of II, claims 11-33. Affirmation of this election must be made by applicant in replying to this Office action. Claims 1-10 and 34-39 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Claim Rejections - 35 USC § 102

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

8. Claims 11-13, 20-29, and 31-33 are rejected under 35 U.S.C. 102(b) as being anticipated by ZAKIEWICZ (US 4,305,463).

With respect to claim 11, ZAKIEWICZ discloses a system for centralized well operations comprising a well treatment operations factory which manufactures and pumps a well stimulation fluid, a first connection between a first well location and the well operations factory, a second connection between a second well location and the well operations factory and means for simultaneously flowing a first stimulation fluid to the first well location and a second stimulation fluid to a second well location (column 4, lines 12-68 and Figure 1). With respect to the depending claims, the reference discloses that the means for simultaneously flowing treatment fluid comprises a manifold (Figure 1, items 11, 12, 13, 14, 21), that the well operations factory comprises a pumping grid wherein the pumping grid is operable to connect to the manifold, that the fist connection is operable to deliver a fluid from the first well location to the manifold, that the second connection is operable to deliver a fluid from the second well location to the manifold, that the fluid comprises a stimulation fluid, that the manifold is connected to a second manifold, that the second manifold is operable to simultaneously flow a first stimulation fluid to a first well location and a second stimulation fluid to a second well

location, a third connection between the manifold and the first well location, that the third connection is operable to deliver a fluid from the first well location to the manifold, that there is a fourth connection between the manifold and the second well location, wherein the fourth connection is operable to deliver a fluid from the second well location to the manifold, that the first fluid comprises a compound selected from the group of claims 31 and 32, and that the first simulation fluid and the second stimulation fluid have the same composition.

9. Claims 11-16, 20-25, and 31-32 are rejected under 35 U.S.C. 102(b) as being anticipated by LUK et al. (US 5,515,920).

With respect to claim 11, LUK discloses a system for centralized well operations comprising a well treatment operations factory which manufactures and pumps a well stimulation fluid, a first connection between a first well location and the well operations factory, a second connection between a second well location and the well operations factory and means for simultaneously flowing a first stimulation fluid to the first well location and a second stimulation fluid to a second well location (abstract, Figure 6, column 6, lines 26-47). With respect to the depending claims, the reference discloses that the means for simultaneously flowing treatment fluid comprises a manifold (column 4, lines 51-59 and #5), that the factory comprises a pumping grid wherein the grid is operable to connect to the manifold, that the factory comprises a blending unit wherein the blending unit is operable to connect to the pumping grid (#20 and #30 and #70), wherein the factory comprises a proppant storage system wherein the storage system is

operable to connect to the blending unit (#60), wherein the first connection is operable to deliver a fluid from the first well location to the manifold, wherein the second connection is operable to deliver a fluid from the second well location to the manifold, wherein the fluid comprises a stimulation fluid, wherein the manifold is connected to a second manifold (#40 and #5), wherein the second manifold is operable to simultaneously flow a first stimulation fluid to a first well location and a second stimulation fluid to a second well location, and wherein the first fluid comprises a compound selected from the groups of claims 31 and 32 (column 7, lines 21-26).

Claim Rejections - 35 USC § 103

10. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

11. Claims 17-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over LUK alone.

LUK discloses a system as described above. However the reference does not explicitly state that the well operations factory comprises a power unit or that the factory is enclosed. However, it would be obvious to one of ordinary skill in the art that the system of LUK would require some type of power unit in order to operate the system. In addition, the structures described in claim 19 are very well known in the art and it would be obvious to one of ordinary skill in the art to enclose some or all of the components in the well operations factory in order to protect them from the elements.

Allowable Subject Matter

12. Claims 19 and 30 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kerry W. Leonard whose telephone number is 571-272-8133. The examiner can normally be reached on Monday-Friday, 9:00am-5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Brian E. Glessner can be reached on 571-272-6843. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.



BRIAN E. GLESSNER
SUPERVISORY PATENT EXAMINER

PTO-1449 Information Disclosure Citation In an Application	Application No. 11/291,496		Applicant(s) Lloyd McNeel, et al.
	Docket Number 063718.0930	Group Art Unit Unassigned	Filing Date December 1, 2005

U.S. PATENT DOCUMENTS

		DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS	FILING DATE

FOREIGN PATENT DOCUMENTS

		DOCUMENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION

NON-PATENT DOCUMENTS

		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	DATE
KM		Information Disclosure Statement, page 1. Jobs performed by Halliburton and other companies at Bakersfield, California in the late 1980s.	1980s
		Information Disclosure Statement, page 2. Jobs performed by Halliburton and other companies at Bakersfield, California in 1994.	1994
		Information Disclosure Statement, page 2. Jobs performed by Halliburton at Bakersfield, California in 1994.	1994
		Information Disclosure Statement, page 2. Jobs performed by Schlumberger at Bakersfield, California in 1994.	1994
		Information Disclosure Statement, page 2. Jobs performed by Schlumberger at Lost Hills in 1996.	1996
		Information Disclosure Statement, page 2. Jobs performed by BJ Services in 2004.	2004
		Information Disclosure Statement, page 2-3. Jobs performed by Halliburton in Rock Springs, Wyoming in March 2005.	3/2005

EXAMINER	DATE CONSIDERED
Kenny N. Leonard	April 30, 2007

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP § 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.

PTO/SB/08a (09-06)
Approved for use through 03/31/2007. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	11/291,496
Filing Date	December 1, 2005
First Named Inventor	Lloyd McNeel
Art Unit	Unassigned
Examiner Name	Unassigned
Attorney Docket Number	HES 2005-IP-018647 (063718.0930)

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-			
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FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3] Number[4] Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
KD		WO PCT/US2006/028608	03/01/2007	Randy Tolman	Pages 1-30	

Examiner Signature	Kevin W. Lemaire	Date Considered	April 30, 2007

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached.

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Notice of References Cited	Application/Control No. 11/291,496	Applicant(s)/Patent Under Reexamination MCNEEL ET AL.	
	Examiner Kerry W. Leonard	Art Unit 3676	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-4,305,463	12-1981	Zakiewicz, Bohdan	166/245
*	B	US-5,515,920	05-1996	Luk et al.	166/280.1
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

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Bib Data Sheet

CONFIRMATION NO. 7986

SERIAL NUMBER	FILING OR 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
11/291,496	12/01/2005 RULE	166	3676	2005-IP-018647U1

APPLICANTS

William Lloyd McNeel, Green River, WY;
Steve Harris, Palisade, CO;
Dave McLeod, Houston, TX;

** CONTINUING DATA ********** NONE KD

** FOREIGN APPLICATIONS ********** NONE KD

IF REQUIRED, FOREIGN FILING LICENSE GRANTED
** 01/06/2006

Foreign Priority claimed	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
☐ yes ☑ no 35 USC 119 (a-d) conditions met ☐ yes ☑ no ☐ Met after Allowance Verified and Acknowledged Examiner's Signature Initials	WY	7	39	5

ADDRESS
29920

TITLE
Method and apparatus for centralized well treatment

FILING FEE RECEIVED	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit
2480		

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11291496	MCNEEL ET AL.
	Examiner	Art Unit
	Leonard, Kerry W	3676

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	04/27/2007								
	1	N								
	2	N								
	3	N								
	4	N								
	5	N								
	6	N								
	7	N								
	8	N								
	9	N								
	10	N								
	11	✓								
	12	✓								
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	29	✓								
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	31	✓								
	32	✓								
	33	✓								
	34	N								
	35	N								
	36	N								

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11291496	MCNEEL ET AL.
	Examiner	**Art Unit**
	Leonard, Kerry W	3676

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	04/27/2007								
	37	N								
	38	N								
	39	N								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11291496	MCNEEL ET AL.
	Examiner	Art Unit
	Leonard, Kerry W	3676

SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES		
Search Notes	Date	Examiner
Search in EAST and Google Patents (see search history)		KWL
Consulted primary examiners G Suchfield and H Dang		KWL

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

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APPLICATION NUMBER	FILING OR 371(c) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/291,496	12/01/2005	William Lloyd McNeel	2005-IP-018647U1

CONFIRMATION NO. 7986

29920
JOHN W. WUSTENBERG
P.O. BOX 1431
DUNCAN, OK73536

Title: Method and apparatus for centralized well treatment

Publication No. US-2007-0125543-A1
Publication Date: 06/07/2007

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 703-305-3028.

Pre-Grant Publication Division, 703-605-4283

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	**McNeel, et al.**	§	Group Art Unit: **3676**
Serial No.:	**11/291,496**	§	
Filed:	**December 1, 2005**	§	Examiner: **Leonard, Kerry W.**
Title:	**"Method and Apparatus for Centralized Well Treatment"**	§	Atty. Docket No.: **2005-IP-018647U1 (063718.0930)**

MAIL STOP AMENDMENT
Honorable Commissioner of Patents
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CERTIFICATE OF FILING ELECTRONICALLY VIA EFS
MPEP 503

I HEREBY CERTIFY THAT I HAVE A REASONABLE BASIS FOR BELIEF THAT THIS CORRESPONDENCE IS BEING SUBMITTED TO THE UNITED STATES PATENT AND TRADEMARK OFFICE VIA EFS (ELECTRONICALLY) ON THE DATE INDICATED BELOW, AND IS ADDRESSED TO:

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Debbie Allen 7-26-07
DEBBIE ALLEN JULY 26, 2007

DATE OF SUBMISSION:
ELECTRONIC FILING (EFS)

RESPONSE UNDER 37 C.F.R. § 1.111 TO
NON-FINAL OFFICE ACTION, MAILED MAY 3, 2007

Dear Honorable Commissioner:

In response to the Office Action mailed on May 3, 2007 (the "Office Action"), Applicants submit this Response.

- **Remarks/Arguments** begin on page 2 of this paper.

Profrac Holding Corporation **IPR2023-01319** **Ex. 1002, p. 159 of 988**
U.S. Well Services, LLC

REMARKS/ARGUMENTS

I. General Remarks.

Applicants respectfully request reconsideration of the application in view of the remarks contained herein.

II. Disposition of the Claims.

At the time of this Office Action, claims 1-39 are pending. Claims 1-10 and 34-39 are withdrawn from consideration. Claims 11-29 and 31-33 are rejected in this Office Action. The Examiner has objected to claims 19 and 30 on grounds that although otherwise allowable if written in independent form, they are dependent on rejected base claims. Applicants appreciate the Examiner's indication that claims 19 and 30 present allowable subject matter.

III. Affirmation of Election

The Office Action indicates that a restriction for examination purposes is proper under 35 U.S.C. § 121. During a telephone conference with the Examiner on April 13, 2007, Applicants made a provisional election without traverse to prosecute claims 11-33. This provisional election is hereby confirmed, and claims 1-10 and 34-39 are hereby withdrawn. Applicants reserve the right to prosecute the claims as originally filed in a continuing application.

IV. Remarks Regarding the Rejections Under 35 U.S.C. § 102(b).

Claims 11-13, 20-29 and 31-33 are rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 4,305,463 issued to Zakiewicz (hereinafter "*Zakiewicz*"). With respect to rejection of claim 11, the Office Action states that *Zakiewicz* discloses

> a system for centralized well operations comprising a well treatment operations factory which manufactures and pumps a well stimulation fluid, a first connection between a first well location and the well operations factory, a second connection between a

Profrac Holding Corporation
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> second well location and the well operations factory and means for simultaneously flowing a first stimulation fluid to the first well location and a second stimulation fluid to a second well location .

Office Action, at 4.

Applicants respectfully disagree with these rejections. *Zakiewicz* fails to disclose a "means for *simultaneously flowing* a first stimulation fluid to the first well location and a second stimulation fluid to a second well location," as indicated in independent claim 11. Instead, *Zakiewicz* provides that the:

> [d]istribution of the fluid is controlled by valve 16 which may be a four-way ball-type valve as illustrated wherein the output from pump 15 is alternately injected into manifolds 13 and 14 which feed injection wells 9 and production wells 10, respectively. It will be observed that when fluid under pressure from pump 15 is injected into manifold 13 the fluid under pressure in manifold 14 is vented to relief line 37. As the valve rotates fluid under pressure is injected into manifold 14 and manifold 13 is vented to relief line 37.

Zakiewicz, col. 7, lines 34-44.

Furthermore, *Zakiewicz* fails to disclose a "second stimulation fluid."

Accordingly, independent claim 11 is allowable over *Zakiewicz* as that patent fails to disclose every limitation of independent claim 11. Claims 12-13, 20-29 and 31-33 depend directly or indirectly from independent claim 11 and are allowable for at least the same reasons. Therefore, Applicants respectfully request a withdrawal of these rejections.

Claims 11-16, 20-25 and 31-32 are rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,515,920 issued to Luk et al. (hereinafter "*Luk*"). With respect to rejection of claim 11, the Office Action provides that *Luk* discloses:

> a system for centralized well operations comprising . . . a first connection between a first well location and the well operations factory, a second connection between a second well location and the well operations factory and means for simultaneously flowing a

Profrac Holding Corporation **IPR2023-01319** **Ex. 1002, p. 161 of 988**
U.S. Well Services, LLC

> first stimulation fluid to the first well location and a second stimulation fluid to a second well location.

Office Action, at 5.

Applicants respectfully disagree with these rejections. First, there is only a single well head 50 in *Luk*. Furthermore, *Luk* does not indicate a "second stimulation fluid:"

> The intersection 45 in the supply line 40 is the point of initial contact between the streams of CO_2 and conventional frac fluid resulting in turbulence to form the liquid CO_2/liquid emulsion, additional admixing occurring along the remaining length of the supply line and down the well bore.

Luk, col. 6, lines 48-52.

Therefore, *Luk* fails to disclose each and every limitation of independent claim 11. Accordingly, independent claim 11 is allowable over *Luk*. Claims 12-16, 20-25, and 31-32 depend directly or indirectly from independent claim 11 and are allowable over *Luk* for at least the same reasons. Applicants respectfully request a withdrawal of these rejections.

V. Remarks Regarding the Rejections Under 35 U.S.C. § 103(a).

Claims 17-19 are rejected under 35 U.S.C. § 103(a) for obviousness over *Luk* alone. Applicants respectfully disagree with these rejections.

Claims 17-19 indirectly depend on independent claim 11. As discussed above, claim 11 is allowable over *Luk*. Accordingly, claims 17-19 are allowable for at least the same reasons. Therefore, Applicants respectfully request a withdrawal of these rejections.

VI. Claim Objections

The Office Action objects to claims 19 and 30 as being dependent upon rejected base claims. As discussed above, the base claim, claim 11, is allowable over the prior art. Accordingly, Applicants respectfully request a withdrawal of these objections.

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U.S. Well Services, LLC
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VII. No Waiver

All of Applicants' arguments and amendments are without prejudice or disclaimer. Additionally, Applicants have merely discussed example distinctions from the cited references. Other distinctions may exist, and Applicants reserve the right to discuss these additional distinctions in a later Response or on Appeal, if appropriate. By not responding to additional statements made by the Examiner, Applicants do not acquiesce to the Examiner's additional statements, such as, for example, any statements relating to what would be obvious to a person of ordinary skill in the art.

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SUMMARY

In light of the above remarks, Applicants respectfully request reconsideration and withdrawal of the outstanding rejections. Applicants further submit that the application is now in condition for allowance, and earnestly solicit timely notice of the same. Should the Examiner have any questions, comments or suggestions in furtherance of the prosecution of this application, the Examiner is invited to contact the attorney of record by telephone, facsimile, or electronic mail.

Applicants believe that there are no additional fees due in association with the filing of this Response. However, should the Commissioner deem that any fees are due, including any fees for extensions of time, Applicants respectfully request that the Commissioner accept this as a Petition Therefore, and direct that any additional fees be charged to Baker Botts L.L.P. Deposit Account No. 02-0383, Order Number 063718.0930.

Respectfully submitted,

By: Melody Wirz

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ATTORNEY FOR APPLICANTS

Date: July 26, 2007

Profrac Holding Corporation
U.S. Well Services, LLC
IPR2023-01319
Ex. 1002, p. 164 of 988

Electronic Acknowledgement Receipt	
EFS ID:	2013886
Application Number:	11291496
International Application Number:	
Confirmation Number:	7986
Title of Invention:	Method and apparatus for centralized well treatment
First Named Inventor/Applicant Name:	William Lloyd McNeel
Customer Number:	29920
Filer:	Paul N. Katz/Debbie Allen
Filer Authorized By:	Paul N. Katz
Attorney Docket Number:	2005-IP-018647U1
Receipt Date:	26-JUL-2007
Filing Date:	01-DEC-2005
Time Stamp:	13:13:59
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)
1		0637180930ROA.PDF	258336 cbe4b44555142f591de60f4bbed0a0fd32079297	yes	8

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Miscellaneous Incoming Letter	1	2
	Amendment - After Non-Final Rejection	3	3
	Applicant Arguments/Remarks Made in an Amendment	4	8
Warnings:			
Information:			
	Total Files Size (in bytes):	258336	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	**McNeel, et al.**	§	Group Art Unit: **3676**
Serial No.:	**11/291,496**	§	
Filed:	**December 1, 2005**	§	Examiner: **Leonard, Kerry W.**
Title:	**"Method and Apparatus for Centralized Well Treatment"**	§	Atty. Docket No.: **2005-IP-018647U1 (063718.0930)**

MAIL STOP AMENDMENT
Honorable Commissioner of Patents
P. O. Box 1450
Alexandria, VA 22313-1450

CERTIFICATE OF FILING ELECTRONICALLY VIA EFS
MPEP 503

I hereby certify that I have a reasonable basis for belief that this correspondence is being submitted to the United States Patent and Trademark Office via EFS (Electronically) on the date indicated below, and is addressed to:

Honorable Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Debbie Allen 7-26-07
Debbie Allen July 26, 2007

Date of Submission:
Electronic Filing (EFS)

TRANSMITTAL LETTER

Dear Honorable Commissioner:

Applicants hereby submit the following documents to be filed with the United States Patent and Trademark Office:

- Response Under 37 C.F.R. § 1.111 to Non-Final Office Action, Mailed May 3, 2007.

Applicants believe that there are no fees due in association with the filing of this Response. However, should the Commissioner deem that any fees are due, including any fees

Profrac Holding Corporation
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IPR2023-01319
Ex. 1002, p. 167 of 988

for extensions of time, Applicants respectfully request that the Commissioner accept this as a Petition Therefore, and direct that any additional fees be charged to Baker Botts L.L.P. Deposit Account No. 02-0383, Order Number 063718.0930.

Respectfully submitted,

By: Melody Wirz

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email: melody.wirz@bakerbotts.com

Date: July 26, 2007

ATTORNEY FOR APPLICANTS

Profrac Holding Corporation
U.S. Well Services, LLC
IPR2023-01319
Ex. 1002, p. 168 of 988

PTO/SB/06 (12-04)
Approved for use through 7/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD
Substitute for Form PTO-875

Application or Docket Number: 11291496

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))							300
SEARCH FEE (37 CFR 1.16(k), (i), or (m))							500
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))							200
TOTAL CLAIMS (37 CFR 1.16(i))	39 minus 20 =	* 19	X$ 25=		OR	X$50=	950
INDEPENDENT CLAIMS (37 CFR 1.16(h))	5 minus 3 =	* 2	X$100=			X$200=	400
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR						
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))			N/A			N/A	
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	2350

APPLICATION AS AMENDED – PART II

AMENDMENT A 7/26/07

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDI-TIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDI-TIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
					TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDI-TIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDI-TIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
					TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:		§	
	MCNEEL *ET AL.*	§	Group Art Unit: **3676**
		§	
Serial No.:	**11/291,496**	§	
		§	Examiner: **LEONARD, KERRY W.**
Filed:	**DECEMBER 1, 2005**	§	
		§	
Title:	**"METHOD AND APPARATUS FOR CENTRALIZED WELL TREATMENT"**	§	Atty. Docket No: **HES 2005-IP-018647U1**
		§	
		§	
		§	
		§	

MAIL STOP AMENDMENT
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Alexandria, VA 22313-1450

CERTIFICATE OF FILING ELECTRONICALLY VIA EFS
MPEP 503

I HEREBY CERTIFY THAT I HAVE A REASONABLE BASIS FOR BELIEF THAT THIS CORRESPONDENCE IS BEING SUBMITTED TO THE UNITED STATES PATENT AND TRADEMARK OFFICE VIA EFS (ELECTRONICALLY) ON THE DATE INDICATED BELOW, AND IS ADDRESSED TO:

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ALEXANDRIA, VA 22313-1450

Debbie Allen
DEBBIE ALLEN

DATE OF SUBMISSION: **OCTOBER 15, 2007**
ELECTRONIC FILING (EFS)

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

Dear Honorable Commissioner:

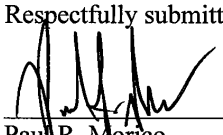
Applicants respectfully request, pursuant to 37 C.F.R. §§ 1.56, 1.97 and 1.98, that the art listed on the attached PTO-1449 form be considered and cited in the examination of the above-identified application.

Furthermore, pursuant to 37 C.F.R. §§1.97(g) and (h), no representation is made that these references are material to the patentability of the present application.

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Ex. 1002, p. 170 of 988

As this Supplemental Information Disclosure Statement transmitted herewith is being filed after the mailing date of the first Non-Final Office Action on the merits, and pursuant to 37 C.F.R. § 1.97(c), the Commissioner is hereby authorized to debit Baker Botts L.L.P.'s Deposit Account No. 02-0383, Order Number 063718.0930, in the amount of $180.00 for the fee under 37 C.F.R. § 1.17(p) for consideration of an Information Disclosure Statement after mailing of the first Non-Final Office Action on the merits. Should the Commissioner deem that any additional fees are due, including any fees for extensions of time, Applicants respectfully request that the Commissioner accept this as a Petition Therefor, and direct that any additional fees be charged to Baker Botts, L.L.P.'s Deposit Account No. 02-0383, Order Number 063718.0930.

Respectfully submitted,



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Date: October 15, 2007

Profrac Holding Corporation
U.S. Well Services, LLC
IPR2023-01319
Ex. 1002, p. 171 of 988

PTO-1449 **Information Disclosure Citation in an Application**	Application No. **11/291,496**	Applicant(s) **MCNEEL ET AL.**	
	Docket Number **HES 2005-IP-018647U1**	Group Art Unit **3676**	Filing Date **DECEMBER 1, 2005**

U.S. PATENT DOCUMENTS

		DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS	FILING DATE
	1	6,394,184	05/28/2002	Tolman et al.	166	281	02/12/2001
	2	2007/0125544	07/07/2007	Robinson et al.	166	308.3	04/03/2006

FOREIGN PATENT DOCUMENTS

		DOCUMENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION YES	TRANSLATION NO
	1	WO 2007/024383 A2	07/24/2006	PCT	E21B	43/16	X	

NON-PATENT DOCUMENTS

		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	DATE
	1	Office Action from Application Serial No. 11/396,918	05/03/2007

EXAMINER	DATE CONSIDERED

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP § 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
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(25) Filing Language: English

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(30) Priority Data:
60/709,586 19 August 2005 (19.08.2005) US

(71) Applicant *(for all designated States except US)*: **EXXONMOBIL UPSTREAM RESEARCH COMPANY** [US/US]; P.O. BOX 2189, CORP-URC-SW348, Houston, TX 77252-2189 (US).

(72) Inventors; and
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(74) Agents: **KNIGHT, Brent, R.** et al.; ExxonMobil Upstream Research Company, P.O. Box 2189, Houston, TX 77252-2189 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD AND APPARATUS ASSOCIATED WITH STIMULATION TREATMENTS FOR WELLS

(57) Abstract: A method and apparatus associated with the production of hydrocarbons. In one embodiment, the method describes connecting multiple wells to a stimulation fluid pumping system via a pumping system manifold. The pumping system manifold is adjusted to provide a first well flow path from the stimulation fluid pumping system to a first well. Then, a first stimulation treatment is pumped into the first well. Concurrently with the pumping of the first stimulation treatment, a second well is prepared for a second stimulation treatment.

WO 2007/024383 A2

METHOD AND APPARATUS ASSOCIATED WITH STIMULATION TREATMENTS FOR WELLS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application 60/709,586, filed 19 August, 2005.

BACKGROUND

[0002] This section is intended to introduce the reader to various aspects of art, which may be associated with exemplary embodiments of the present techniques, which are described and/or claimed below. This discussion is believed to be helpful in providing the reader with information to facilitate a better understanding of particular aspects of the present techniques. Accordingly, it should be understood that these statements are to be read in this light, and not necessarily as admissions of prior art.

[0003] The production of hydrocarbons, such as oil and gas, has been performed for numerous years. To produce these hydrocarbons, one or more wells in a field are typically drilled to subsurface locations, which are generally referred to as subterranean formations, reservoirs or basins. The process of producing hydrocarbons from the subsurface formations typically involves drilling one or more wells to access the subsurface formations. With the wells drilled, completion and stimulation activities or operations may be utilized to produce the hydrocarbons, such as oil and gas, from the subsurface formations.

[0004] Because a single well may be utilized to access various regions of subsurface formations, drilling multiple wells from a single location, such as a surface pad or offshore platform, may be beneficial for certain applications. For example, in an offshore application, wells are routinely drilled from a single offshore platform due to the substantial platform installation and operational costs. Also, drilling of multiple wells from a single surface pad on land may reduce surface disturbance and environmental impact associated with well construction activities. Further, well construction activities for multiple wells at a single location may be effectively managed in the presence of surface constraints, such as topography, proximity to other buildings, and existing surface easements and right-of-ways. As such, wells

located on a single surface pad may be utilized to reduce costs and enhance operations.

[0005] Despite the benefits from having multiple wells at a single location, certain combinations of operations may be complicated, restricted, or prevented by the presence of multiple wells. That is, when performing completion operations on one of the wells, the operations performed on other wells may be limited. For instance, when stimulating a well on a surface pad having multiple wells, stimulation operations are typically performed on only the single well. When the well is being stimulated, equipment and personnel have to wait because the stimulation operations are performed in a sequential manner and initiation of additional wellbore preparation operations may be deferred until completion of the stimulation operations. As a result, equipment and personnel are not efficiently utilized at the surface pad.

[0006] Accordingly, the need exists for a method, apparatus and system for enhancing operations involving multiple wells on a surface pad to reduce the time and cost associated with stimulation treatments. In particular, there is a need for new apparatus, method, and system to enable reliable and cost-effective execution of concurrent or simultaneous wellbore preparation and stimulation operations in multiple wellbores located at a single surface location.

[0007] For additional information please reference Ammer et al., "Unconventional Gas: Reserve Opportunities and Technology Needs", GasTIPS, Fall 2004, pp. 22-26; U.S. Patent No. 5,890,536; U.S. Patent No. 6,186,230; U.S. Patent No. 6,394,184, U.S. Patent No. 6,520,255, U.S. Patent No. 6,543,538, U.S. Patent No. 6,575,247; U.S. Patent No. 6,672,405; U.S. Patent Publication No. 2003/0075335; and/or U.K. Patent No. 1,243,062; and/or U.K. Patent No. 2,028,400.

SUMMARY OF INVENTION

[0008] In one embodiment, a method associated with the production of hydrocarbons is described. The method describes connecting multiple wells to a stimulation fluid pumping system via a pumping system manifold. The pumping system manifold is adjusted to provide a first well flow path from the stimulation fluid pumping system to a first well. Then, a first stimulation treatment is pumped into the first well. Concurrently with the pumping of the first stimulation treatment, a second well is prepared for a second stimulation treatment.

[0009] In an alternative embodiment, another method associated with the production of hydrocarbons is described. In this method, a plurality of wells is connected to a stimulation fluid pumping system via a pumping system manifold. Then, the pumping system manifold is adjusted to provide a stimulation treatment from the stimulation fluid pumping system to one of the plurality of wells, while isolating another of the plurality of wells from the stimulation treatment concurrently with the pumping of the stimulation treatment to prepare the another well for another stimulation treatment. These adjustments to provide the stimulation fluid and isolation of the other well are repeated until each of the plurality of wells have received stimulation treatments. Then, hydrocarbons are produced from the plurality of wells once the stimulation treatments have been performed.

[0010] In a second alternative embodiment, a well system is described. In this well system, a plurality of oil field trees is located on a surface pad, wherein each of the plurality of oil field trees is associated with one of a plurality of wells. A pumping system manifold connects a stimulation fluid pumping system to the plurality of oil field trees. The pumping system manifold is configured to provide a flow path from the stimulation fluid pumping system into at least one selected well of the plurality of wells and to isolate at least one non-selected well of the plurality of wells from the stimulation fluid pumping system. Further, the wells, stimulation fluid pumping system, and pumping system manifold may be located on a single surface pad.

[0011] In a third alternative embodiment, an apparatus is disclosed. The apparatus includes a main valve associated with a stimulation fluid pumping system, well valves and piping that couples the main valve to the well valves. In this apparatus, each of the well valves is associated with one of the wells and the piping is directly supported by the surface of the Earth. The apparatus may also include a densitometer, a manifold check valve, a pressure gauge, a flow meter, and a ball-seal injector, which are each coupled to the main valve and the well valves.

[0012] In a fourth alternative embodiment, a method associated with the production of hydrocarbons is described. The method comprises connecting a first well and a second well to a first stimulation fluid pumping system via a first pumping system manifold; connecting a third well and a fourth well to a second stimulation fluid pumping system via a second pumping manifold; adjusting the first pumping

system manifold to provide a first stimulation treatment to the first well and to isolate the second well for other operations; adjusting the second pumping system manifold to provide a second stimulation treatment to the third well and to isolate the fourth well; and pumping the first stimulation treatment into the first well and the second stimulation treatment into the third well concurrently with the pumping of the first stimulation treatment. Further, the method may also comprise preparing the second well for a third stimulation treatment concurrently with the pumping of the first stimulation treatment; and preparing the fourth well for a fourth stimulation treatment concurrently with the pumping of the second stimulation treatment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The foregoing and other advantages of the present technique may become apparent upon reading the following detailed description and upon reference to the drawings in which:

[0014] FIG. 1 is an exemplary production system having multiple wells located on a surface pad in accordance with certain aspects of the present techniques;

[0015] FIG. 2 is an exemplary surface pad configuration with equipment and wells for use with the production system of FIG. 1 in accordance with certain aspects of the present techniques;

[0016] FIG. 3 is an exemplary flow chart of operations performed on the wells located on the surface pad of FIG. 1 in accordance with aspects of the present techniques; and

[0017] FIGs. 4-6 are partial views of wells being utilized in concurrent operations associated with stimulation treatments according to the process of FIG. 3 in accordance with certain aspects of the present techniques.

DETAILED DESCRIPTION

[0018] In the following detailed description, the specific embodiments of the present invention will be described in connection with its preferred embodiments. However, to the extent that the following description is specific to a particular embodiment or a particular use of the present techniques, this is intended to be

illustrative only and merely provides a concise description of the exemplary embodiments. Accordingly, the invention is not limited to the specific embodiments described below, but rather, the invention includes all alternatives, modifications, and equivalents falling within the true scope of the appended claims.

[0019] The present technique is direct to drilling, treating, completing and producing hydrocarbons, such as oil and gas, from subterranean formations in a manner that reduces the overall costs to enable economic hydrocarbon production. In particular, the present techniques describe an apparatus and method for reducing and/or eliminating the non-productive time and resource utilization for drilling, stimulating, and completing multiple wells from a single surface pad or location. That is, the present techniques provide mechanisms to enhance production economics by enabling simultaneous or concurrent operations in the stimulation of multiple wells in a manner that reduces non-productive time for equipment, material, and/or personnel. As such, the present techniques may reduce the cost and time associated with performing operations for stimulation treatments of wells.

[0020] Accordingly, the present techniques may be applicable to land-based wells with two or more wells are located on a single surface pad and/or offshore-based wells where two or more wells are located on a single platform location. The present techniques utilize procedures and equipment that allow stimulation treatments to be performed more efficiently. In particular, the present techniques involve connecting two or more wells to a stimulation fluid pumping system via a well coupling system, such as a pumping system manifold. This pumping system manifold contains multiple valves to enable stimulation fluid to be pumped into any selected well, while the other remaining wells are hydraulically isolated from the pressure and energy created by the stimulation fluid pumping system. By isolating the other wells, other operations or activities, such as preparations for the next well to be stimulated or producing hydrocarbons, may be performed on the other wells. As a result, the present techniques enhance the stimulation process for multiple wells located at a single location, such as a surface pad.

[0021] Turning now to the drawings, and referring initially to FIG. 1, an exemplary production system **100** having multiple wells located at a single surface pad in accordance with certain aspects of the present techniques is illustrated. In the production system **100**, a surface pad **102** has two or more wells **104a-104n.** Each

of the wells **104a-104n** has an oil field tree **106a-106n** located over the wellbore **108a-108n** and are positioned in a specific configuration. These wellbores **108a-108n** follow specific trajectories that access one or more specific zones or regions **110a-110n** of a subsurface formation **112**. The wellbores **108a-108n** along with any casing or tubing strings utilized may provide flow paths from the respective regions **110a-110n** to one of the trees **106a-106n** for hydrocarbons, such as oil and gas. Within the wellbores **108a-108n**, casing strings or tubing (not shown) may be disposed to support the walls of the wellbore **108a-108n**. It should be understood that "n" may be any number of such units that can be utilized. Further, it should be noted that the production system **100** is illustrated for exemplary purposes and the present techniques may be useful in the production of fluids from any location, which may include offshore or onshore applications and other equipment, as well.

[0022] Because the wells **104a-104n** may be drilled in a variety of directions with different trajectories, drilling the wellbores **108a-108n** from a single location may provide access to various lateral and vertical locations, such as the regions **110a-110n** of the subsurface formation **112**. In fact, the wellbores **108a-108n** may penetrate the subsurface formation **112** at specific target locations or regions **110a-110n** that extend substantial lateral distances from the location of the surface pad **102**. The effective drainage area associated with regions **110a-110n** may vary because the resource recovery is influenced by a number of parameters, such as the number of wells drilled, spacing of wells, reservoir properties, and stimulation treatment design and effectiveness. For example, deviated wells may be drilled to depths greater than 20,000 ft with lateral throws greater than 5,000 ft. As such, a single surface pad **102** may include wells **104a-104n** that access and effectively drain hydrocarbon reservoirs, such as subsurface formation **112**, which may be an area greater than approximately 640 acres.

[0023] For certain types of subsurface formations **112**, such as low permeability ("tight") gas formations, different stimulation treatments may be utilized to access intervals or zones within the wellbore **108a-108n**. These stimulation techniques or treatments may include hydraulic proppant fracture stimulation and completion technologies to enable commercial development of this type of subsurface formations. For instance, new multi-zone stimulation and completion methods and equipment for the use of these methods are described in U.S. Patent No. 6,394,184,

U.S. Patent No. 6,520,255, U.S. Patent No. 6,543,538, U.S. Patent No. 6,575,247 and U.S. Patent No. 6,672,405, which are incorporated by reference, which describe techniques and tools for stimulating subsurface formations containing multiple hydrocarbon targets at reduced cost compared to conventional single-zone treatment approaches. As disclosed in the patents, the Just-in-Time Perforating ("JITP") and the Annular-Coiled Tubing Fracturing ("ACT-Frac") technologies, methods, and devices provide stimulation treatments to multiple subsurface formations targets within a single wellbore. In particular, the JITP and the ACT-Frac techniques: (1) enable stimulation of multiple target zones or regions via a single deployment of downhole equipment; (2) enable selective placement of each stimulation treatment for each individual zone to enhance well productivity; (3) provide diversion between zones to ensure each zone is treated per design and previously treated zones are not inadvertently damaged; and (4) allow for stimulation treatments to be pumped at high flow rates to facilitate efficient and effective stimulation. As a result, these multi-zone stimulation techniques have been developed to enhance hydrocarbon recovery from subsurface formations that contain multiple stacked subsurface intervals of hydrocarbons within regions of a well.

[0024] However, performing these stimulations may include a range of supporting operations that preclude pumping operations in the well at the time of the supporting operation is performed. For instance, non-pumping operations are usually performed when applying these multi-zone stimulation technologies to wells that are stimulated over one or more days. Accordingly, in performing these operations, it may be preferred to set bridge plugs or frac plugs between sets of intervals being treated by the stimulations. Setting these plugs may take substantial time, such as two or more hours depending on the well depth and operating speed of the wireline equipment. During the installation of the plug, it is not possible to perform stimulation treatment pumping operations in the well, which are an expensive portion of the stimulation operation. As a result, for wells containing many zones, the time associated with non-pumping operations may result in substantial incremental costs due to the cost structure associated with time-based equipment and crew fees.

[0025] As a specific example, nine wells may be drilled from a single surface location, such as the surface pad **102**, which is six-acre section of land. Each of the nine wells may be drilled with trees positioned in two rows on the surface pad **102**

and separated from each other by approximately fifteen feet. In this manner, the wells may be clustered in a relatively small portion of the surface pad **102** to provide additional space for other equipment that may be used in the stimulation treatments. Eight of the wells may be drilled with s-shape well trajectories, while one of the wells may have a vertical trajectory. Each of these wells may end at a bottomhole location that provides drainage for subsurface formation **112** for about a nominally 20 acre well spacing. Hence, the nine wells may drain about 180 acres from a single six acre surface location.

[0026] To enhance the stimulation, completion and production process from these wells on a surface pad, the operations performed on the individual wells may be coordinated and utilize mechanisms to perform these operations in an efficient manner. Accordingly, in FIG. 2, a surface pad configuration is shown with different equipment that may be utilized to perform the stimulation treatments in accordance with the present techniques. An exemplary flow chart is shown in FIG. 3 that describes possible concurrent operations that may be performed to enhance the operation of the wells of FIGs. 1 and 2. FIGs. 4-6 illustrate views of wells with different operations being performed on the wells in accordance with the process of FIG. 3. Accordingly, by utilizing the present techniques, simultaneous or concurrent operations involving stimulation of two or more wells located at a single surface pad may be performed in an efficient manner.

[0027] FIG. 2 is an exemplary surface pad configuration with equipment and wells for use with the production system **100** of FIG. 1 in accordance with certain aspects of the present techniques. In FIG. 2, the configuration of surface equipment involved with stimulation treatments by a JITP hydraulic proppant fracture stimulation of three wells **104a-104c** on the surface pad **102** is shown. In particular, to support the JITP hydraulic proppant fracture stimulation operations, the equipment on the surface pad **102** may include a stimulation fluid pumping system **202**, a stimulation storage system **204**, a well coupling system, such as a pumping system manifold **206,** and flowback manifolds **230a-230c**, for example. However, it should be understood that the JITP hydraulic proppant fracture stimulation system is only for exemplary purposes as other types of stimulation systems may also be utilized, including both multiple stage stimulation and single stage stimulation systems.

[0028] Generally, the wells **104a-104c** produce hydrocarbons through piping **228a-228c** that is coupled between the respective oil field trees **106a-106c** and the flowback manifolds **230a-230c**. The piping **228a-228c** may include high pressure steel lines utilized in oil field applications. The flowback manifolds **230a-230c** may also be coupled to one or more flowlines **234a-234c, 236a-236c** and **238a-238c**, respectively. These flowlines **234a-234c, 236a-236c** and **238a-238c** may be coupled to flowback pits, flow test units, sales lines, tankage, oil/gas/water separating and processing units and/or other similar devices. Thus, the hydrocarbons from the wells **104a-104c** typically flow through the flowback manifolds **230a-230c** for further processing or sales.

[0029] To provide a stimulation treatment, the JITP system may include the stimulation fluid pumping system **202** and stimulation fluid storage system **204**. The stimulation fluid pumping system **202** couples to the stimulation fluid storage system **204** via piping **203**, which may be high pressure steel lines or low pressure hoses depending on the specific application. The stimulation fluid storage system **204** is a vessel that holds a sufficient volume of fluid for the planned stimulation treatments. It is noted that the stimulation fluid storage system **204** may include tanks located on the surface pad **102**, a pit dug on the surface pad **102**, and/or a pond, lake, river or water storage facility located in close proximity to the surface pad **102**.

[0030] To couple the stimulation fluid pumping system **202** to the trees **106a-106c**, the pumping system manifold **206** is utilized. The pumping system manifold **206** may include various components utilized to manage access to the wells **104a-104c** from the stimulation fluid pumping system **202**. For instance, the pumping system manifold **206** may include a set of pipes **208** to interface each of the trees **106a-106c** with the stimulation fluid pumping system **202**. To manage the flow paths through the pipes **208**, a main manifold valve **210** and a manifold check valve **212** may be located near the stimulation fluid pumping system **202**, while a first manifold well valve **214**, second manifold well valve **216**, and a third manifold well valve **218** may be located near each of the trees **106a-106c**, respectively. Each of the trees **106a-106c** may be connected to the first manifold well valve **214**, second manifold well valve **216**, and a third manifold well valve **218**, respectively, or utilize other devices to couple to the trees **106a-106c**. Valves **210, 214, 216** and **218** may be any type of valve, including those routinely used in oil-field applications, such as gate

valves or ball valves, while the manifold check valve **212** may be configured to allow fluid flow from the stimulation fluid pumping system **202**, but to prevent reverse flow of fluids into the stimulation fluid pumping system **202**. These valves **210, 214, 216** and **218** may be actuated or positioned to a full-open or full-closed position to provide hydraulic isolation between individual wells **104a-104c** and the stimulation fluid pumping system **202**. While it may be beneficial for the valves **210, 212, 214, 216** and **218** to seal in a "leak-tight" position, in some applications, it may be acceptable to perform operations with leaky hydraulic seals. In addition, the pumping system manifold **206** may include a densitometer **220**, pressure gauge **222**, ball-sealer injector **224** and/or flowmeter **226**, which may be coupled along the piping **208** near the main manifold valve **210**. However, it should be understood that the specific configuration of components described in the pumping system manifold **206** is for exemplary purposes, and other configurations and placement of components may be utilized for additional functionality.

[0031] Through the coupling of the valves **210, 212, 214, 216** and **218**, flow paths may be provided through the pumping system manifold **206**. Because the first manifold well valve **214**, second manifold well valve **216**, and a third manifold well valve **218** may be set to an open or closed position, stimulation fluid may be injected into one or more of the wells **104a-104c**, while the other wells **104a-104c** may be isolated by at least one of the valves **214-218** from the stimulation fluid pumping system **202**. To enhance reliability, it may be preferred that two valves, such as a manifold well valve **214-218** and a valve (not shown) on the tree **106a-106c**, are closed during any given isolation from the other wells. Additionally, it may also be preferred that at least one or more valves be installed on trees **106a-106c** and that valves in the open position are marked during the stimulation operations.

[0032] Further, other equipment may also be utilized on the surface pad **102**. For instance, a first crane **240** and a second crane **242** may be utilized to suspend stimulation equipment, such as a JITP lubricator system. These cranes **240** and **242** may be located in a fixed position that may access any of the wells **104a-104c** or may be mobile to provide access to any of the wells **104a-104c**. Also, a first wireline unit **244** and a second wireline unit **246** may be used for deploying and activating JITP perforating tools **248**, such as perforating guns, and plug-setting tools **250**, which may include plugs, in the wells **104a-104c**. In addition, a coiled tubing unit

and/or workover rig **252** may be utilized to remove plugs and install production tubing within the wells. The use of the stimulation equipment is further explained below in FIG. 3.

[0033] FIG. 3 is an exemplary flow chart of operations that may be performed on the wells **104a-104c** located on the surface pad **102** of FIG. 1 in accordance with aspects of the present techniques. This flow chart, which is referred to by reference numeral **300**, may be best understood by concurrently viewing FIGs. 1 and 2. In this flow chart **300**, various operations may be performed on wells **104a-104n** in a concurrent or substantially simultaneous manner to reduce costs and time associated with stimulating wells. For exemplary purposes, these operations may be specific to JITP hydraulic proppant fracture stimulation operations, which may include the equipment described in FIG. 2. However, it should again be noted that other stimulation techniques or other operations may be performed under the present techniques.

[0034] The flow chart begins at block **302**. At block **304**, the wells **104a-104c** are drilled on the surface pad **102**. The drilling operations may include installing the production casing and cementing the production casing into the wellbore **108a-108c**. The drilling operations may also include setting the trees **106a-106c**. Then, the target zones to be stimulated within the completion interval may be identified, as shown by block **306**. The identification of the target zones may be performed by using open-hole and/or cased-hole logs to identify zones that include hydrocarbons.

[0035] Once the target zones are identified, the stimulation operations may be performed, as shown in blocks **308-318**. To begin, it should be noted that these stimulation operations may include various activities, such as pumping operations, wireline operations, flowback operations, and other logistical coordination operations. The pumping operations may include high pressure pumping; JITP ball arrival and pressure events; screen-out mitigation and sand flowback; and manipulating pumping manifold valves, wellhead tree valves and/or flowback manifold valves. The wireline operations may include wireless radio and hard wired radios communications; arming perforating guns and plug setting tools; picking-up and laying down perforating guns and plug setting tools; moving wireline in and out of the wellbores; pulling on the wireline to free stuck tools; installing or retrieving perforating guns; and/or raising or lowering man-lifts for personnel access to equipment located

off the surface pad **102**. The flowback operations may include flowing back the well, manipulating choke manifold valves; producing gas to the sales line; and/or venting and flaring gas to the atmosphere. Logistical coordination operations may include water recycling pumping and filtering; proppant delivery; chemical delivery; water hauling; and/or communicating with crews via cellular phones or radios.

[0036] In addition, other drilling-related operations, completion-related and production-related operations may be performed on another or a second well. For instance, other operations may include drilling another well; installing tubing into another well; installing a plug within another well; removing debris from another well; removing the plug from another well; installing production tubing in another well; removing production tubing from another well; moving equipment on the surface pad; delivering material on the surface pad; injecting fluid in another well; manipulating valves; performing coiled tubing operations in another well; performing logging operations in another well; producing hydrocarbons from another well; delivering equipment or materials on the surface pad and/or removing equipment or materials from the surface pad.

[0037] Accordingly, the surface pad **102** is prepared for the stimulation operations, as shown in block **308**. The preparations may include coupling the piping **228a-228c**, manifold valves **230a-230c** and flowlines **234a-234c, 236a-236c** and **238a-238c** together and coupling the pumping system manifold **206** to the trees **106a-106c** and the stimulation fluid pumping system **202**. The pumping system manifold **206** may be coupled to any number of wells with the appropriate valves, flow measurements devices, flow control devices. With the equipment in place, the pumping system manifold **206** may be adjusted to prepare a specific well to receive the stimulation treatment, while the other wells are isolated from the stimulation treatment, as shown in block **310**. As an example, for the stimulation treatment to flow into the first well **104a**, the main manifold valve **210** and first manifold well valve **214** may be placed in the open position, while the second manifold well valve **216** and third manifold well valve **218** may be placed in the closed position to isolate the second and third wells **104b** and **104c**.

[0038] Once the pumping system manifold **206** is configured, a stimulation treatment may be pumped into the one of the wells, as shown in block **312**. Concurrently, with the stimulation treatment of one of the wells, another well may be

prepared for stimulation treatments, as shown in block **314**, while other operations may be conducted in the remaining wells, as shown in block **316**. The preparations may include using the crane **240** and wireline unit **244** to install and run the JITP perforating tools **248** and plug-setting tools **250** into the another well, performing flow-back operations, performing other wireline operations, injecting fluids or materials, and performing plug removal operations and/or other operations, as discussed further below. By preparing another well concurrently with the stimulation of a first well, the other well may be ready for the stimulation treatment when the stimulation treatment is completed in the first well. In this manner, the execution of simultaneous operations performed on the other wells may reduce "non-pumping" time between the first stimulation treatment of the first well and a second stimulation treatment of another well, and reduce the time and cost of the stimulation operation.

[0039] After the first stimulation treatment is completed, a determination is made whether the planned stimulation treatments for the wells are completed, as shown in block **318**. If the planned stimulation treatments for the wells are not complete, then the pumping system manifold **206** may be adjusted to prepare for the next well. That is, the valves in the pumping system manifold **206** are positioned in the appropriate open or closed positions to enable stimulation fluid injection into another of the wells, which is to receive the second stimulation treatment. Again, concurrent or simultaneous operations, such as conveyance of JITP perforating tools **248** and plug-setting tools **250** downhole on wireline and/or flow-back operations may be performed if a third stimulation treatment is to be performed. These simultaneous operations are conducted to prepare other wells for the stimulation treatments with reduced non-pumping time between each of the stimulation treatments. The above process of sequentially manipulating the valves of the pumping system manifold, as shown in block **310**, and pumping stimulation treatments in the wells, while simultaneously performing operations to prepare other wells for further stimulation treatments may be repeated until each of the planned stimulation treatments is completed.

[0040] If the planned stimulation treatments for the wells are complete, then the equipment associated with the stimulation treatments may be rigged-down and moved off the surface pad **102**, as shown in block **320**. Then, a workover rig or coiled tubing unit **252** may be located at the surface pad **102** to drill-out the plugs and

run production tubing in each of the wells, as shown in block **322**. With the production tubing installed, the wells may be utilized to produce hydrocarbons, as shown in block **324**. Accordingly, the process ends at block **326**.

[0041] Beneficially, the present technique reduces the time associated with stimulating multiple wells on a surface pad by performing concurrent operations on two or more of the wells. Also, by saving time, the present technique reduces the cost of performing stimulations on these wells. Further, the use of the pumping system manifold reduces or eliminates the potential safety hazards and additional time delays associated with rig up and/or rig down of high pressure lines from the stimulation fluid pumping system to the individual wells, which may occur multiple times over the course of many days with the use of conventional methods. A specific example of the present techniques is process below and described in greater detail in FIGs. 4-6.

[0042] FIGs. 4-6 are partial views of wells **104a-104c** being utilized to perform concurrent stimulation operations according to the process of FIG. 3 in accordance with certain aspects of the present techniques. The partial views of FIG. 4-6, which are referred to by reference numerals **400, 500** and **600**, respectively, may be best understood by concurrently viewing FIGs. 1 and 2. In these partial views **400, 500** and **600**, three wells **104a-104c** from the surface pad **102** are shown with different operations being performed on each of the wells **104a-104c** in a concurrent or substantially simultaneous manner.

[0043] For exemplary purposes, the operations performed in FIGs. 4-6 may be specific to a five-stage JITP hydraulic proppant fracture treatment, which may be referred to as a stimulation treatment or JITP fracture treatment. Accordingly, each stage of the JITP fracture treatment includes different sub-stages. These sub-stages are as follows: (a) 5,000 gallons of 2% potassium chloride water solution; (b) 2,000 gallons of guar-based linear gel fracture fluid containing 1 pound-per-gallon of proppant; (c) 3,000 gallons of guar-based linear gel fracture fluid containing 2 pounds-per-gallon of proppant; (d) 10,000 gallons of guar-based linear gel fracture fluid containing 3 pounds-per-gallon of proppant; and (e) 3,000 gallons of guar-based linear gel fracture fluid containing 4 pound-per-gallon of proppant such that 50,000 pounds of proppant and 23,000 gallons (approximately 547 barrels of fluid) of stimulation fluid are used in each stage of the JITP fracture treatment. Then, the

pumping may be performed at an average rate of 20 barrels/minute. As a result, the pumping time for each stage may take approximately 27 minutes. Hence, the pumping time for a JITP fracture treatment may be approximately 2 hours and 15 minutes for each well. The following partial views **400, 500** and **600** are described in greater detail in each of the FIGs 4-6 below.

[0044] To begin, in FIG. 4, the first well **104a** may be stimulated using the JITP fracture treatment. It should be noted that for this stimulation treatment, the main manifold valve **210** and first manifold well valve **214** are in the open position, while the second manifold well valve **216** and third manifold well valve **218** are in the closed position to create a first well flow path. Also, a wireline-deployed JITP perforating gun **402**, which may be one of the JITP perforating tools **248**, is suspended via wireline **403** in the wellbore **108a** using the first crane **240**. This JITP perforating gun **402** is actuated and controlled from the first wireline unit **244**. In the first well **104a**, proppant fracture **404** has been placed into the region **110a** of the subsurface formation **112**. The stimulation fluid is pumped down the wellbore **108a** to create a proppant fracture **406**.

[0045] Concurrently, preparation operations may also be performed in the second well **104b**. In the second well **104b**, a wireline-deployed JITP perforating gun **408**, which is another of the JITP perforating tools **248**, and a frac plug setting system **410** having a composite frac plug **409**, which is one of the JITP plug-setting tools **250**, may be deployed via a wireline **411** down the second wellbore **108b** by the second crane **242** and second wireline unit **246**. The second well **104b** may have received a previous stimulation treatment, which has resulted in proppant fractures **412, 414, 416, 418** and **420** in the region **110b** of the subsurface formation **112**. Because these proppant fractures **412, 414, 416, 418** and **420** were previously placed in the subsurface formation **112**, the operations in the second well **104b** may be to place a composite frac plug **409** within the wellbore **108b** above the proppant fractures **412, 414, 416, 418** and **420.**

[0046] In addition to the concurrent operations being performed in the second well **104b**, other operations may also be performed in the third well **104c**. For example, in the third well **104c**, proppant fractures **422, 424, 426, 428** and **430** may have been previously formed in the region **110c** of the subsurface formation **112**. Because these proppant fractures **422, 424, 426, 428** and **430** were previously

formed, flowback operations may be performed to force close the proppant fractures **422, 424, 426, 428** and **430** and recover the stimulation fluid used to form the proppant fractures **422, 424, 426, 428** and **430**, and produce hydrocarbons to the sales lines.

[0047] Next, FIG. 5 illustrates the wells **104a-104c** after the operations performed in FIG. 4 are completed. As shown in the partial view **500**, the proppant fractures **404, 406, 502, 504** and **506** were created with the pumping of the five-stage JITP treatment in FIG. 4. However, in FIG. 5, the first well **104a** is being flowed back after the placement of proppant fractures **404, 406, 502, 504** and **506** in the region **110a** of the subsurface formation **112** to force close the proppant fractures **404, 406, 502, 504** and **506** and recover the stimulation fluid used to place the proppant fractures **404, 406, 502, 504** and **506**, and produce hydrocarbons to the sales lines.

[0048] Concurrently, the second well **104b** may be receiving the five-stage JITP hydraulic proppant fracture treatment. It should be noted that for this stimulation operation, the main manifold valve **210** and second manifold well valve **216** are in the open position, while the first manifold well valve **214** and third manifold well valve **218** are in the closed position to create a second well flow path. Again, as discussed in FIG. 4, the wireline-deployed JITP perforating gun **408** and frac plug setting system **410** are suspended via wireline **411** in the wellbore **108b** using the second crane **242**, which is also actuated and controlled from the second wireline unit **246**. However, in this view, the composite frac plug **409** is set above the proppant fracture **420**. With this composite frac plug **409** installed, the five-stage JITP proppant fracture treatment is underway with the stimulation fluid pumped down the wellbore **108b** to create proppant fracture **510**.

[0049] Another concurrent operation is also being performed in the third well **104c**. In this well, the flowback operation has been completed and the well **104c** is now shut-in. Accordingly, to prepare for the next stimulation treatment, a wireline-deployed JITP perforating gun **512**, which is another of the JITP perforating tools **248**, and a frac plug setting system **514** having a composite frac plug **516**, which is one of the JITP plug-setting tools **250**, are deployed down the wellbore **108c**. The JITP perforating gun **512** and a frac plug setting system **514** are suspended via wireline **403** in the wellbore **108c** using the first crane **240**, and are actuated and controlled from the first wireline unit **244**. The JITP perforating gun **512** and frac plug

setting system **514** may then be utilized to JITP stimulate and place additional proppant fractures above the proppant fractures **430**.

[0050] Finally, FIG. 6 illustrates the wells **104a-104c** after the operations performed in FIG. 5 are completed. As shown in the partial view **600**, the flowback operation has been completed and the first well **104a** has been shut-in. In this view, the wireline-deployed JITP perforating gun **601**, which is another of the JITP perforating tools **248**, and a frac plug setting system **602** having a composite frac plug **603**, which is one of the JITP plug-setting tools **250**, are deployed down the wellbore **108a**. The JITP perforating gun **601** and frac plug setting system **602** are suspended via wireline **411** in the wellbore **108a** using the second crane **242**, and are actuated and controlled from the second wireline unit **246**. The frac plug setting system **602** may be utilized to set the composite frac plug **603**, while the JITP perforating gun **601** may be utilized in the next five-stage JITP treatment to create proppant fractures above proppant fracture **506** during the next stimulation treatment.

[0051] Concurrently, in the second well **104b**, stimulation treatments are completed and the proppant fracture **510, 604, 606, 608** and **610** have been placed into the region **110b** of the subsurface formation **112**. Accordingly, the second well **104b** is flowed back after placement of proppant fractures **510, 604, 606, 608** and **610** to force close the fractures and recover the stimulation fluid used when placing the proppant fractures, and produce hydrocarbons to the sales lines.

[0052] Also, in another concurrent operation, the composite frac plug **516** has been set in the third well **104c** and the pumping of a five-stage JITP proppant fracture treatment has created proppant fractures **614** and **616**. It should be noted that for this stimulation treatment, the main manifold valve **210** and third manifold well valve **218** are in the open position, while the first manifold well valve **214** and second manifold well valve **216** are in the closed position to create a third well fluid flow path. Again, as discussed in FIG. 5, the wireline-deployed JITP perforating gun **512** and frac plug setting system **514** are suspended via wireline **403** in the wellbore **108c** using the first crane **240** and is actuated and controlled from the first wireline unit **244**. In this view, a composite frac plug **516** is set above the proppant fracture **430**. With this composite frac plug **516** installed, the JITP proppant fracture treatment is performed to form the proppant fractures **614** and **616** by having the stimulation fluid pumped down the wellbore **108c**.

[0053] Beneficially, in this example, the concurrent operations enhance the stimulation treatment process. For instance, if the wireline running speeds is approximately 150 ft/min (feet/minute) to 300 ft/min for the assumed approximate 12,000 ft well depth, then, the time to pump a total of fifteen proppant fracture treatments is approximately ten hours. Accordingly, each well receiving the stimulation treatment may be flowed back overnight for several hours of stimulation fluid recovery and for oil and gas sales. In this manner, the stimulation treatments for multiple wells may be performed in an efficient manner that reduces time and cost.

[0054] To further explain the benefits of the present techniques, another example is described. In this example, nine wells may be drilled on a single surface pad of approximately six acres. These wells may target gas-productive reservoir targets, such as sand bodies, within a subsurface formation, and are configured to drain an area of approximately 20 acres. For these wells, the well depths may range between approximately 12,000 ft to 15,000 ft with lateral throws of approximately 1,400 ft to 2,000 ft relative to the surface pad. The size and location of the surface pad may be determined by the geological and reservoir characteristics, governmental regulations, surface topography and terrain, and consideration of environmental or regulatory requirements that are identified during the pad selection/location process. The characteristic features of the subsurface formation may be gas resources contained in multiple (e.g., 20+ to 40+) low permeability ("tight") gas sands of limited areal extent distributed over a large vertical section of approximately 4,000 ft to 6,000 ft thick interval. Accordingly, each well includes up to forty or more reservoir targets or zones.

[0055] To access these target zones, the wells are stimulated with the JITP stimulation techniques with each five stage JITP fracture treatment separated by a plug. The wireline plug-setting operation, which may be approximately two to four hours depending on well depth, running speed, and rig-up/rig-down time, may be completed while the stimulation treatment pumping operations are performed on another well. The stimulation treatment pumping operations for the five zones may be completed in approximately 3 hours. Accordingly, fifteen to twenty zones may be pumped each work day, which results in approximately two or three work days to complete a forty zone stimulation operation. Thus, by performing the stimulation operations in a concurrent manner, a total of approximately one or two work days

associated with "non-pumping time" may be saved on each well during the stimulation treatments.

[0056] In addition, it should be noted that these stimulation operations may include various activities. For instance, as noted above, the stimulation operations may include pumping operations, wireline operations, flowback operations, and logistical coordination operations. Because these stimulation operations may be performed concurrently or simultaneously on different wells on a single surface pad, several risks associated with the different operations may be present. Accordingly, certain stimulation operations may be performed concurrently to reduce the risks and maintain the operational integrity of the simultaneous operations.

[0057] To begin, in performing the concurrent stimulation operations, different combinations of pumping operations, wireline operations, flowback operations, and logistical coordination operations may be performed on the different wells with certain monitoring procedures. The monitoring procedures may include using a spotter for certain operations, a light or audible warning, obtaining supervisor approval for certain operations, communicating between personnel, flagging or labeling valve positions, following lock-out tag-out procedures, and other similar processes. For instance, when the stimulation operations are being performed on the first well, operations, such as proppant delivery, chemical delivery, and/or water hauling, on the second well may be performed within designated areas and using a spotter, which is discussed below. As another example, supervisor approval may be obtained before venting gas when the operations on the other well involve high pressure pumping, manipulating pumping manifold/frac valves and gas to sales line operations. Further, when the operations on the first well involve high pressure pumping, operations on the second well, such as arming the perforating gun or setting tool and picking-up or laying down the perforating gun or setting tool, may utilize lights and audible notifications. Finally, it may be preferred to not perform certain operations concurrently. For instance, if the operations on the first well involve high pressure pumping or JITP ball sealing pressure events, the manipulating the manifold well valves and wellhead tree valves should not be concurrently performed. Also, if operations on the first well include wireless radio and cell phone communications, then the operations should not be performed concurrently with arming perforating guns and setting tools.

[0058] Another method of reducing risk may include assigning personnel to manage the operations. For instance, if a crane, such as cranes **240** and **242** of FIG. 2, are used as part of the stimulation operations, it may be preferred that the personnel operating the crane include a designated spotter to assist with crane operations. Further, the crane may be positioned to reduce potential collisions with other equipment on the surface pad. Also, based on the potential for hydraulically-energized lines associated with injection and flowback from the wells, it may be preferred that one of the personnel associated with the stimulation system manage the stimulation pumping valve positions and the flowback valve positions, while concurrent operations are being performed.

[0059] In another embodiment, it may be preferred to include monitoring equipment at the surface pad **102** of FIG. 2, which may detect gases, such as hydrocarbon gases. For example, the surface pad **102** and/or personnel may be equipped with portable Lower-Explosive Limit ("LEL") detectors. Accordingly, during flowback operations, the LEL detectors may continuously monitor the surface pad **102** for the presence of hazardous gas levels. If hazardous gas levels are detected, the flowback operations may be suspended and appropriate activities may be performed to solve any problems with equipment. Also, it may be preferred that windsocks are installed at various points and heights on the surface pad **102** to aid in determining wind direction, as well.

[0060] Further, in another alternative embodiment, it may be beneficial to have automated devices, such as processor based devices, which are utilized for the stimulation operations. For instance, the stimulation fluid pumping system **202** may be automated and controlled by a processor based device, such as a computer system. With the computer system, the stimulation treatment schedules for each individual stimulation treatment may be pre-programmed into the computer system. Also, the pumping system manifold **206** may include a processor based device, such as a computer system, as well. The computer system for the pumping system manifold **206** may include mechanisms to adjust the valves **210, 214, 216** and **218** between the open and closed positions, and communicate with the various gauges **220, 222** and **226** and ball-sealer injector **224**. In fact, the computer systems of the stimulation fluid pumping system **202** and the pumping system manifold **206** may be

configured to interact with each other to manage the pumping stimulation treatment process for the plurality of wells **104a-104c**.

[0061] In a third alternative embodiment, the designation of specific work areas for certain operations for handling associated tools and equipment may be performed between blocks **306** and **318** of FIG. 3. That is, the process may include designating different areas, such as high-pressure pumping area, wireline/crane areas, and flowback areas, on the surface pad **102** of FIG. 2 to prevent unauthorized personnel from entering restricted areas. The designation of work areas may include providing detailed drawings of piping, valves, and flow control/measurement devices for the operations for each of the work areas and wells. For instance, if cranes **240** and **242** and wireline units **244** and **246** of FIG. 2 are used, it may be preferred that a designated wireline/crane area be located surrounding and adjacent to each of the cranes **240** and **242**. Also, it may be preferred that stimulation equipment, such as the stimulation fluid pumping system **202**, stimulation fluid storage system **204** and pumping system manifold **206** of FIG. 2, are arranged on the surface pad **102** with pathways or routes around the outer perimeter of the high-pressure pumping area to provide access for reloading of stimulation materials and supplies. Further, it may be preferred that piping and valves be identified using different unique colored markings or other labels for each of the different wells to assist in visual observations and understanding of the flow paths and equipment tie-in points.

[0062] Also, in a fourth alternative embodiment, it may be preferable for a communication protocol to be established between blocks **306** and **318** of FIG. 3. For example, when executing simultaneous wireline operations, if select-fire perforating guns are used, it may be preferred that wireless communication devices, such as radios and other cellular devices, are turned off and/or stored in a central location when a gun is armed and placed in the wellbore or removed from the wellbore. Alternatively, it may be preferred that "hard-wired" radios and communication devices are used as the primary communication devices with wireless communication devices only utilized as back-up equipment. Further, strobe-warning lights and/or a loudspeaker system may be used to provide an indication of the status of the gun arming sequence and depth of gun during the operations.

[0063] It should be noted that the pumping system manifold **206** of FIG. 2 may not include each of the components described above. Indeed, in alternative

embodiments, additional measurement devices, flow control devices, fluid injection or withdrawal ports, and/or material injection or withdrawal ports may be included in the pumping system manifold **206** and/or upstream or downstream of the pumping system manifold **206**.

[0064] Furthermore, it should also be noted that the number of wells and geometry of the surface location may be influenced by a number of factors to conform to appropriate regulatory requirements and other factors. Accordingly, wells may possess vertical, deviated, S-shaped, and/or horizontal trajectories. For example, these trajectories may target multiple hydrocarbon bearing targets being drilled, stimulated, and completed on approximately 5/8 acre spacing in low-permeability oil fields; on approximately 10 to 40 acre well spacing in tight gas fields; and on approximately 40 acre, 80 acre and/or 160 acre spacing associated with in-fill drilling processes. Also, wells may be completed as cased-hole completions or open-hole completions. In addition, the present techniques may include a single unique surface area (i.e. pad) or two or more surface pads in sufficiently close proximity for performing the drilling, stimulation, completion, and production operations objectives. The possible use of wells from two or more surface pads may be determined based on local geographic conditions, material supply routes, and/or overall field infrastructure, specific operational requirements, and/or economic considerations.

[0065] As noted above, the present techniques may also be used for stimulation treatments involving hydraulic fracturing or acid stimulation in production or injection wells. Hydraulic fracturing may include injecting fluids into a formation at high pressures and rates that the reservoir rock fails and granular proppant material, such as sand, ceramic beads, or other materials, is injected to hold the fracture(s) open. Increased reservoir production capacity or injection capacity results from the flow path left between the grains of the proppant material within the fracture(s). In chemical stimulation treatments, such as matrix acidizing treatments or acid fracturing treatments, flow capacity is improved by dissolving materials in the formation or otherwise changing formation properties.

[0066] Moreover, the present techniques may be used for stimulation treatments involving multiple stage treatments or single-stage treatments. Multiple stage stimulation treatments may include the JITP or ACT-Frac treatment methods, which

are discussed above. In addition, the multiple stage stimulation treatments may include other multiple stage treatments, such as stimulation treatments disclosed in U.S. Patent 5,890,536 and U.S. Patent No. 6,186,230, which are herein incorporated by reference. Also, other methods utilized in oil and gas operations, such as "limited-entry" diverted multi-stage treatments, annular coiled-tubing, coiled-tubing, ball-sealer multi-stage treatments, modified limited entry multi-stage treatments, induced stress diverted treatments, or multiple single-stage treatments separated by plugs, or any combination of treatments, may also be utilized with the present techniques.

[0067] In addition, it should be appreciated that the surface pad, such as surface pad 102, may include two or more stimulation fluid pumping systems. For instance, a surface pad may include two stimulation fluid pumping system, which are stimulation fluid pumping system **202** of FIG. 2. This configuration for the surface pad may also include two stimulation storage systems **204**, two pumping system manifolds **206**, and other associated piping. Each of the stimulation storage systems, pumping system manifolds, and other associated piping may each be associated with two different groups or sets of wells. In this manner, two wells may be stimulated concurrently or simultaneously. That is, one well associated with each of the stimulation fluid pumping systems may receive stimulation treatments, while other wells from the well groups may be prepared for stimulation treatments.

[0068] While the present techniques of the invention may be susceptible to various modifications and alternative forms, the exemplary embodiments discussed above have been shown by way of example. However, it should again be understood that the invention is not intended to be limited to the particular embodiments disclosed herein. Indeed, the present techniques of the invention are to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the following appended claims.

CLAIMS

What is claimed is:

1. A method associated with the production of hydrocarbons comprising:

connecting a plurality of wells to a stimulation fluid pumping system via a pumping system manifold;

adjusting the pumping system manifold to provide a first well flow path from the stimulation fluid pumping system to a first well of the plurality of wells;

pumping a first stimulation treatment into the first well; and

preparing a second well of the plurality of wells for a second stimulation treatment concurrently with the pumping of the first stimulation treatment.

2. The method of claim 1 wherein adjusting the pumping system manifold comprises configuring at least one of a plurality of valves to provide the first well flow path and configuring at least one of the plurality of valves to isolate the first stimulation treatment from entering the second well.

3. The method of claim 1 further comprising adjusting the pumping system manifold to provide a second well flow path from the stimulation fluid pumping system to the second well.

4. The method of claim 3 further comprising pumping the second stimulation treatment in the second well.

5. The method of claim 1 wherein the first stimulation treatment comprises one of hydraulic proppant fracture treatment, acid fracture treatment, matrix acid treatment and any combination thereof.

6. The method of claim 1 wherein the first stimulation treatment comprises one of just-in-time perforating, annular coiled-tubing, coiled-tubing, limited-entry, ball-sealer, modified limited entry, induced stress diverted, or one or more single-stage stimulation treatments separated by plugs and any combination thereof.

7. The method of claim 1 wherein the first stimulation treatment comprises a multi-zone just-in-time perforating hydraulic proppant fracture stimulation treatment.

8. The method of claim 1 wherein preparing the second well comprises one of drilling the second well, installing tubing into the second well, installing a plug within the second well, flowing back the second well, removing debris from the second well, removing the plug from the second well, removing tubing from the second well, moving equipment on a surface pad, delivering material on the surface pad, communicating by radio or cellular phone on the surface pad, injecting fluid in the second well, manipulating valves, performing wireline operations in the second well, performing coiled tubing operations in the second well, installing or retrieving perforating guns in the second well, performing logging operations in the second well, producing hydrocarbons from the second well, venting gas on the surface pad, flaring gas on the surface pad, delivering equipment or materials on the surface pad, removing equipment or materials from the surface pad and performing logging operations.

9. The method of claim 1 further comprising producing hydrocarbons from the plurality of wells.

10. The method of claim 1 further comprising drilling the plurality of wells from a single surface pad.

11. The method of claim 1 wherein the plurality of wells are located on a single surface pad.

12. The method of claim 1 wherein the plurality of wells are in close proximity to each other on one or more surface pads or platforms.

13. The method of claim 1 further comprising installing production tubing into each of the plurality of wells.

14. A method associated with the production of hydrocarbons comprising the steps of:

a) connecting a plurality of wells to a stimulation fluid pumping system via a pumping system manifold;

b) adjusting the pumping system manifold to provide a stimulation treatment from the stimulation fluid pumping system to one of the plurality of wells;

c) isolating another of the plurality of wells from the stimulation treatment concurrently with the pumping of the stimulation treatment to prepare the another well for another stimulation treatment;

d) repeating steps b and c until each of the plurality of wells have received stimulation treatments; and

e) producing hydrocarbons from the plurality of wells once the stimulation treatments have been performed.

15. The method of claim 14 wherein the plurality of wells are located on a single surface pad.

16. A well system comprising:

a plurality of oil field trees located on a surface pad, wherein each of the plurality of oil field trees is associated with one of a plurality of wells;

a stimulation fluid pumping system; and

a pumping system manifold connecting the stimulation fluid pumping system to the plurality of oil field trees.

17. The well system of claim 16 wherein the pumping system manifold is configured to:

provide a flow path from the stimulation fluid pumping system into at least one selected well of the plurality of wells; and

isolate at least one non-selected well of the plurality of wells from the stimulation fluid pumping system.

18. The well system of claim 16 wherein the pumping system manifold comprises a plurality of valves.

19. The well system of claim 18 wherein the plurality of valves comprises at least one of a ball valve, gate valve and any combination thereof.

20. The well system of claim 16 wherein the plurality of wells are associated with a single surface pad.

21. The well system of claim 16 wherein the plurality of wells are in close proximity to each other on one or more surface pads.

22. The well system of claim 16 further comprising a stimulation fluid storage system coupled to the stimulation fluid pumping system.

23. The well system of claim 16 wherein at least two of the plurality of wells penetrate multiple hydrocarbon-bearing reservoirs.

24. The well system of claim 16 wherein the stimulation fluid pumping system and the pumping system manifold provide multi-zone stimulation treatments to the multiple hydrocarbon-bearing reservoirs penetrated by the at least two of the plurality of wells.

25. The well system of claim 16 wherein the stimulation fluid pumping system is a hydraulic proppant fracture stimulation system.

26. The well system of claim 16, wherein the stimulation fluid pumping system is one of a Just-in-Time Perforating system and a Annular-Coiled Tubing Fracturing system.

27. The well system of claim 16 further comprising:

a plurality of additional oil field trees located on the surface pad, wherein each of the plurality of additional oil field trees are associated with one of a plurality of additional wells;

an additional stimulation fluid pumping system; and

an additional pumping system manifold connecting the additional stimulation fluid pumping system to the plurality of additional oil field trees.

28. An apparatus for stimulating surface wells comprising:

a main valve associated with a stimulation fluid pumping system;

a plurality of well valves, wherein each of the plurality of well valves is associated with one of a plurality of wells; and

piping coupling the main valve to the plurality of well valves, wherein the piping is directly supported by the surface of the Earth.

29. The apparatus of claim 28 further comprising a densitometer coupled to the main valve and the plurality of well valves.

30. The apparatus of claim 28 wherein the plurality of well valves comprises at least one of a ball valve, gate valve and any combination thereof.

31. The apparatus of claim 28 further comprising at least one manifold check valve coupled to the main valve and the plurality of well valves.

32. The apparatus of claim 28 further comprising at least one pressure gauge coupled to the main valve and the plurality of well valves.

33. The apparatus of claim 28 further comprising at least one flow meter coupled to the main valve and the plurality of well valves.

34. The apparatus of claim 28 further comprising at least one ball-seal injector coupled to the main valve and the plurality of well valves.

35. A method associated with the production of hydrocarbons comprising:

connecting a first well and a second well to a first stimulation fluid pumping system via a first pumping system manifold;

connecting a third well and a fourth well to a second stimulation fluid pumping system via a second pumping manifold;

adjusting the first pumping system manifold to provide a first stimulation treatment to the first well and to isolate the second well for other operations;

adjusting the second pumping system manifold to provide a second stimulation treatment to the third well and to isolate the fourth well; and

pumping the first stimulation treatment into the first well and the second stimulation treatment into the third well concurrently with the pumping of the first stimulation treatment.

36. The method of claim 35 further comprising:

preparing the second well for a third stimulation treatment concurrently with the pumping of the first stimulation treatment; and

preparing the fourth well for a fourth stimulation treatment concurrently with the pumping of the second stimulation treatment.

37. The method of claim 36 wherein the preparing the second well for a third stimulation treatment comprises disposing a JITP perforating tool into the second well.

38. The method of claim 36 wherein the first stimulation treatment comprises one of hydraulic proppant fracture treatment, acid fracture treatment, matrix acid treatment and any combination thereof.

39. The method of claim 35 wherein the first stimulation treatment and the second stimulation treatment comprise one of just-in-time perforating, annular coiled-tubing, coiled-tubing, limited-entry, ball-sealer, modified limited entry, induced stress diverted, or one or more single-stage stimulation treatments separated by plugs and any combination thereof.

40. The method of claim 35 wherein the first stimulation treatment comprises a multi-zone just-in-time perforating hydraulic proppant fracture stimulation treatment.

41. The method of claim 36 wherein preparing the second well comprises one of drilling the second well, installing tubing into the second well, installing a plug within the second well, flowing back the second well, removing debris from the second well, removing the plug from the second well, removing tubing from the second well, moving equipment on a surface pad, delivering material on the surface pad, communicating by radio or cellular phone on the surface pad, injecting fluid in the second well, manipulating valves, performing wireline operations in the second well, performing coiled tubing operations in the second well, installing or retrieving perforating guns in the second well, performing logging operations in the second well, producing hydrocarbons from the second well, venting gas on the surface pad, flaring gas on the surface pad, delivering equipment or materials on the surface pad,

removing equipment or materials from the surface pad and performing logging operations.

42. The method of claim 35 comprising producing hydrocarbons from the first well once the stimulation treatment is completed.

43. The method of claim 35 further comprising drilling the first well, second well, third well and fourth well from a single surface pad.

44. The method of claim 35 wherein the first well, second well, third well and fourth well are located on a single surface pad.

45. The method of claim 35 wherein the first well, second well, third well and fourth well are in close proximity to each other on one or more surface pads or platforms.

46. The method of claim 35 comprising installing production tubing into each of the first well, second well, third well and fourth well.

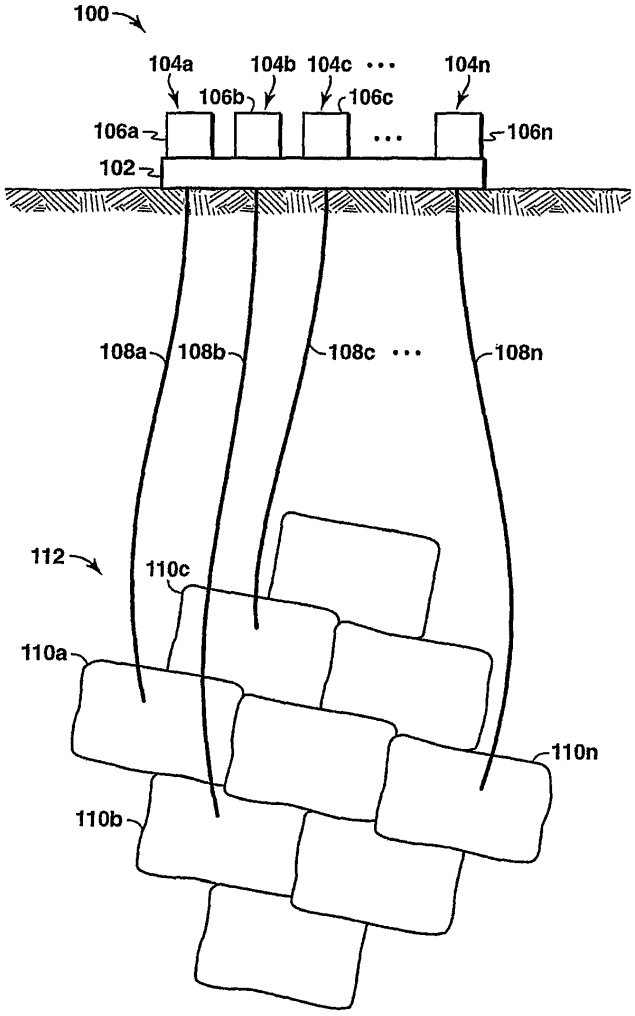

100
104a
104b
104c
104n
106b
106c
106a
106n
102
108a
108b
108c
108n
112
110c
110a
110n
110b

FIG. 1

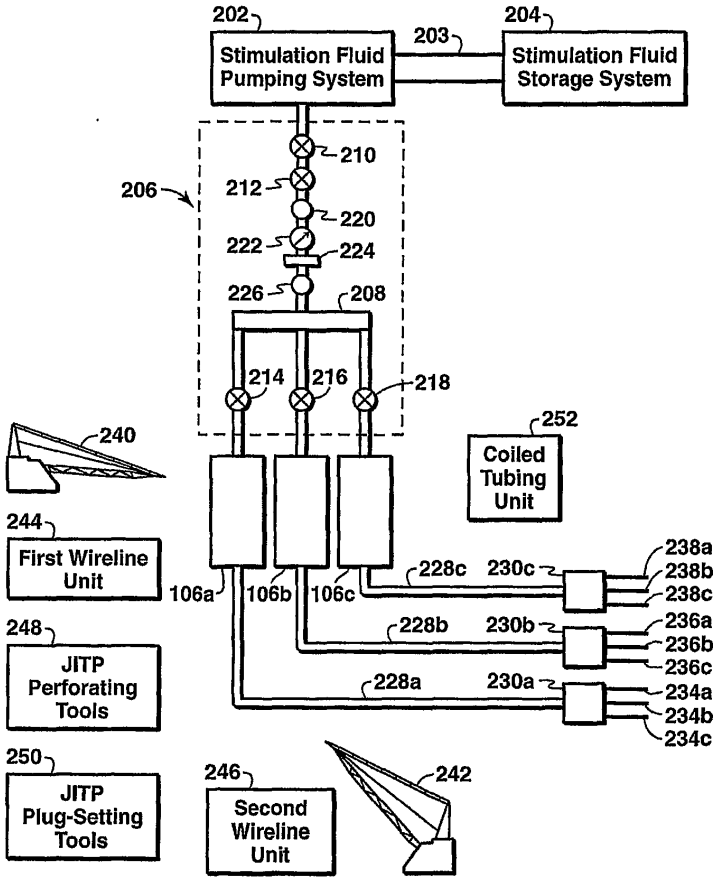

202
Stimulation Fluid Pumping System
203
204
Stimulation Fluid Storage System
206
210
212
220
222
224
226
208
214
216
218
240
252
Coiled Tubing Unit
244
First Wireline Unit
106a
106b
106c
228c
230c
238a
238b
238c
228b
230b
236a
236b
236c
248
JITP Perforating Tools
228a
230a
234a
234b
234c
250
JITP Plug-Setting Tools
246
Second Wireline Unit
242

FIG. 2

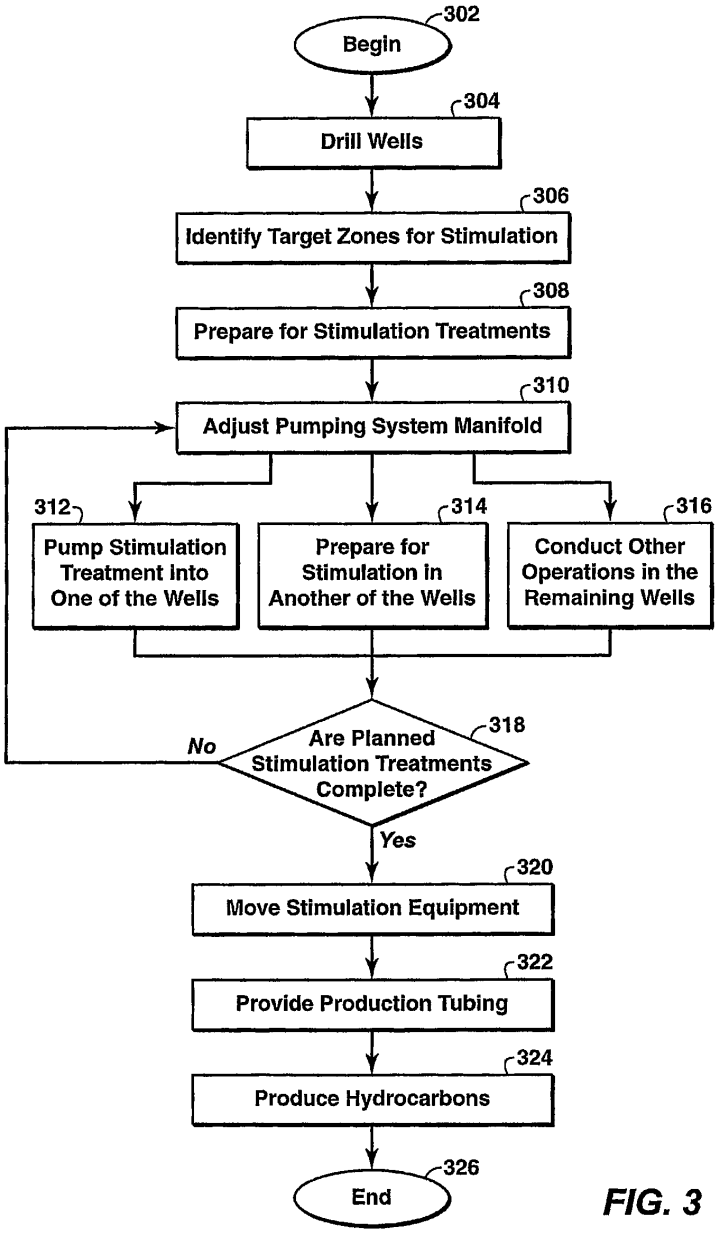

302
Begin
304
Drill Wells
306
Identify Target Zones for Stimulation
308
Prepare for Stimulation Treatments
310
Adjust Pumping System Manifold
312
Pump Stimulation Treatment into One of the Wells
314
Prepare for Stimulation in Another of the Wells
316
Conduct Other Operations in the Remaining Wells
318
Are Planned Stimulation Treatments Complete?
No
Yes
320
Move Stimulation Equipment
322
Provide Production Tubing
324
Produce Hydrocarbons
326
End

FIG. 3

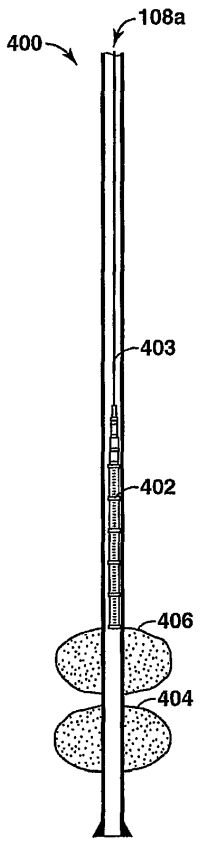


FIG. 4A

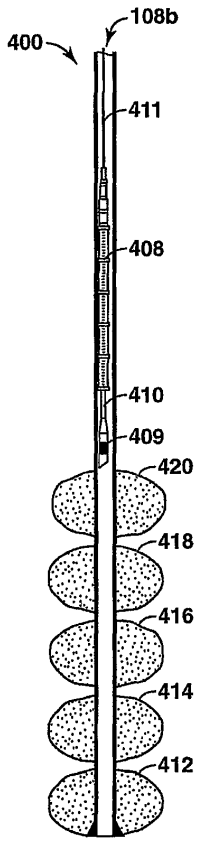


FIG. 4B

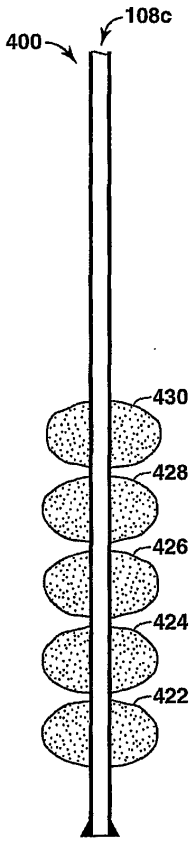


FIG. 4C

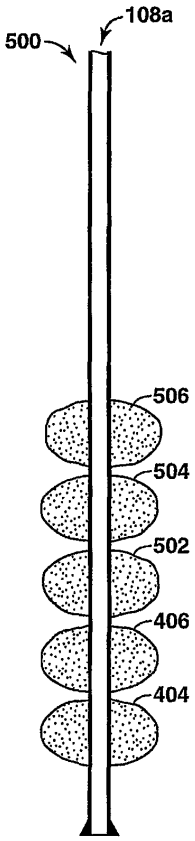


FIG. 5A

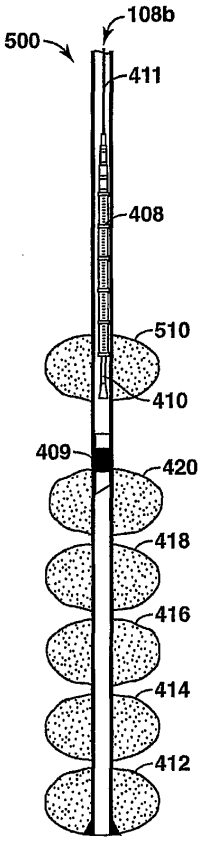


FIG. 5B

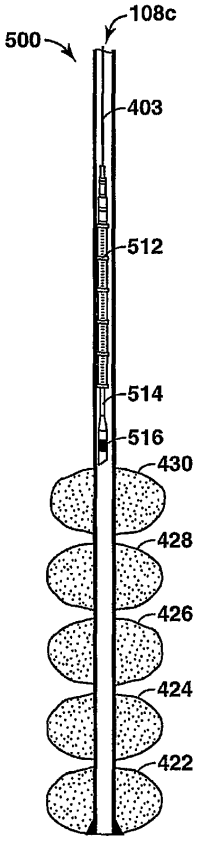


FIG. 5C

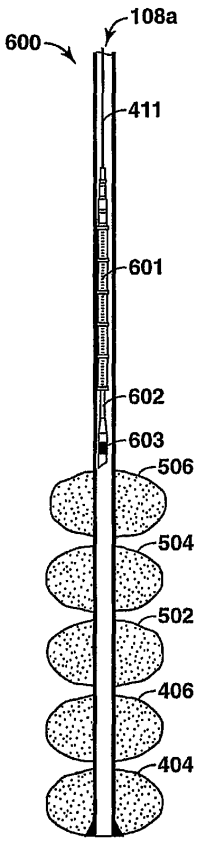


FIG. 6A

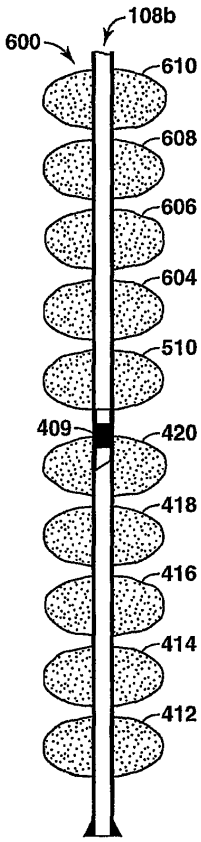


FIG. 6B

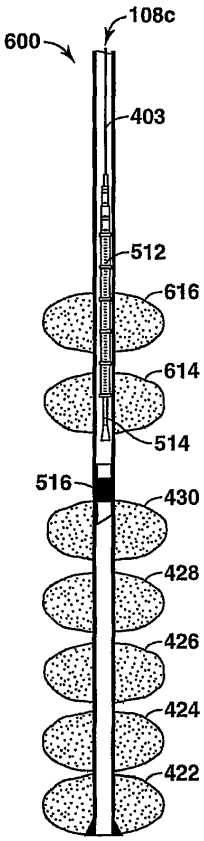


FIG. 6C

Electronic Patent Application Fee Transmittal	
Application Number:	11291496
Filing Date:	01-Dec-2005
Title of Invention:	Method and apparatus for centralized well treatment
First Named Inventor/Applicant Name:	William Lloyd McNeel
Filer:	Paul N. Katz/Debbie Allen
Attorney Docket Number:	2005-IP-018647U1
Filed as Large Entity	

Utility Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt	
EFS ID:	2322108
Application Number:	11291496
International Application Number:	
Confirmation Number:	7986
Title of Invention:	Method and apparatus for centralized well treatment
First Named Inventor/Applicant Name:	William Lloyd McNeel
Customer Number:	29920
Filer:	Paul N. Katz/Debbie Allen
Filer Authorized By:	Paul N. Katz
Attorney Docket Number:	2005-IP-018647U1
Receipt Date:	15-OCT-2007
Filing Date:	01-DEC-2005
Time Stamp:	17:20:51
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment was successfully received in RAM	$180
RAM confirmation Number	2313
Deposit Account	020383
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.16 and 1.17	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)
1		0637180930SuppIDS.PDF	2090614 58c9506a26e405725171779491ab6a060e2cb2cd	yes	49

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Information Disclosure Statement Letter	1	2
Information Disclosure Statement (IDS) Filed	3	3
Foreign Reference	4	40
NPL Documents	41	49

Warnings:					
Information:					
2	Fee Worksheet (PTO-06)	fee-info.pdf	8184 78717f9e9e9bd06bb5839102a705133dc9684956	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2098798		

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	185509	fractur$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/17 14:37
S2	4886454	pressur$5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/18 14:12
S3	95000	S1 and S2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/17 15:11
S4	2225	S3 and dock$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/17 15:11
S5	1155	S4 and cool$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/17 15:14
S6	12	"024383"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/18 14:12
S7	766	tolman.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/18 14:13

EAST Search History

S8	18	S7 and sorem.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/18 14:16
S9	0	S8 and dock$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/18 14:16
S10	12	S8 and fractur$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/18 14:17
S11	12	S10 and pump$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/18 14:18
S12	10	S11 and crane$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/18 14:43
S13	0	S12 and ventilation	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/18 14:43
S14	0	S12 and vent$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/18 14:43

EAST Search History

S15	0	S12 and cooling	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/18 14:45
S16	10	S12 and lubrica$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/19 16:14
S17	2	"5879137".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/19 16:55
S18	1169526	well$4 and factor$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/19 16:56
S19	7836	S18 and subterranean	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/19 16:56
S20	2889	S19 and fractur$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/19 16:56
S21	2179	S20 and pump$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/19 16:57

EAST Search History

S22	117	S21 and manifold$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/19 16:57
S23	21	S22 and lubric$5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/19 16:59
S24	14	S23 and cool$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/19 16:58
S25	292	S21 and crane$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 11:43
S26	5	S25 and manifold$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/19 16:59
S27	31169	fractur$3 and pump$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 12:23
S28	27358	S27 and well$5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 12:24

EAST Search History

S29	1035	S28 and dock$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 12:43
S30	27	S29 and factory	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 15:18
S31	11485847	s	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 13:02
S32	2	S29 and factories	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 13:02
S33	112	166/75.11	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 15:21
S34	11	S33 and fractur$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 15:21
S35	337	166/52	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 15:22

EAST Search History

S36	142	S35 and fractur$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 17:38
S37	232	166/90.1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 17:39
S38	66	S37 and fractur$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 17:49
S39	1096	166/305.1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 17:49
S40	614	S39 and fractur$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/20 17:49
S41	143	S40 and cool$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/23 11:53
S42	96	166/177.5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/23 13:24

EAST Search History

S43	234	166/308.1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/23 13:24
S44	2	"4305463".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/04/27 01:13

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A

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/291,496	12/01/2005	William Lloyd McNeel	2005-IP-018647U1	7986

29920 7590 10/16/2007
JOHN W. WUSTENBERG
P.O. BOX 1431
DUNCAN, OK 73536

EXAMINER	
LEONARD, KERRY W	

ART UNIT	PAPER NUMBER
3676	

MAIL DATE	DELIVERY MODE
10/16/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

PTOL-90A (Rev. 04/07)

Office Action Summary	Application No.	Applicant(s)	
	11/291,496	MCNEEL ET AL.	
	Examiner	Art Unit	
	Kerry W. Leonard	3676	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *26 July 2007*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *11-33* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *11-18,20-29 and 31-33* is/are rejected.

7)☒ Claim(s) *19 and 30* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 11-13, 20-29, and 31-33 are rejected under 35 U.S.C. 102(b) as being anticipated by ZAKIEWICZ (US 4,305,463).

With respect to claim 11, ZAKIEWICZ discloses a system for centralized well operations comprising a well treatment operations factory which manufactures and pumps a well stimulation fluid, a first connection between a first well location and the well operations factory, a second connection between a second well location and the well operations factory and means for simultaneously flowing a first stimulation fluid to the first well location and a second stimulation fluid to a second well location (column 4, lines 12-68 and Figure 1). With respect to the depending claims, the reference discloses that the means for simultaneously flowing treatment fluid comprises a manifold (Figure 1, items 11, 12, 13, 14, 21), that the well operations factory comprises a pumping grid wherein the pumping grid is operable to connect to the manifold, that the fist connection is operable to deliver a fluid from the first well location to the manifold, that the second connection is operable to deliver a fluid from the second well location to the manifold, that the fluid comprises a stimulation fluid, that the manifold is connected to a second manifold, that the second manifold is operable to simultaneously flow a first

stimulation fluid to a first well location and a second stimulation fluid to a second well location, a third connection between the manifold and the first well location, that the third connection is operable to deliver a fluid from the first well location to the manifold, that there is a fourth connection between the manifold and the second well location, wherein the fourth connection is operable to deliver a fluid from the second well location to the manifold, that the first fluid comprises a compound selected from the group of claims 31 and 32, and that the first simulation fluid and the second stimulation fluid have the same composition.

3. Claims 11-16, 20-25, and 31-32 are rejected under 35 U.S.C. 102(b) as being anticipated by LUK et al. (US 5,515,920).

With respect to claim 11, LUK discloses a system for centralized well operations comprising a well treatment operations factory which manufactures and pumps a well stimulation fluid, a first connection between a first well location and the well operations factory, a second connection between a second well location and the well operations factory and means for simultaneously flowing a first stimulation fluid to the first well location and a second stimulation fluid to a second well location (abstract, Figure 6, column 6, lines 26-47). With respect to the depending claims, the reference discloses that the means for simultaneously flowing treatment fluid comprises a manifold (column 4, lines 51-59 and #5), that the factory comprises a pumping grid wherein the grid is operable to connect to the manifold, that the factory comprises a blending unit wherein the blending unit is operable to connect to the pumping grid (#20 and #30 and #70),

wherein the factory comprises a proppant storage system wherein the storage system is operable to connect to the blending unit (#60), wherein the first connection is operable to deliver a fluid from the first well location to the manifold, wherein the second connection is operable to deliver a fluid from the second well location to the manifold, wherein the fluid comprises a stimulation fluid, wherein the manifold is connected to a second manifold (#40 and #5), wherein the second manifold is operable to simultaneously flow a first stimulation fluid to a first well location and a second stimulation fluid to a second well location, and wherein the first fluid comprises a compound selected from the groups of claims 31 and 32 (column 7, lines 21-26).

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 17-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over LUK alone.

LUK discloses a system as described above. However the reference does not explicitly state that the well operations factory comprises a power unit or that the factory is enclosed. However, it would be obvious to one of ordinary skill in the art that the system of LUK would require some type of power unit in order to operate the system. In addition, the structures described in claim 19 are very well known in the art and it

would be obvious to one of ordinary skill in the art to enclose some or all of the components in the well operations factory in order to protect them from the elements.

Allowable Subject Matter

6. Claims 19 and 30 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Response to Arguments

7. Applicant's arguments filed July 26, 2007 have been fully considered but they are not persuasive.

With respect to the arguments regarding the ZAKIEWICZ reference, the applicant states that the reference 'fails to disclose a "means for simultaneously flowing a first stimulation fluid to the first well location and a second stimulation fluid to a second well location"' and that the reference fails to disclose a second stimulation fluid.

However, the ZAKIEWICZ reference does teach a means for simultaneously flowing a first stimulation fluid and a second stimulation fluid to a first and second well location, respectively. In Figure 1 of the reference, item 9 indicates the injection wells. There are a plurality of these production wells and therefore, there is a first and second well location. Regarding the simultaneous flowing of a first and second stimulation fluid to these locations, the reference teaches that the first fluid (brine) is injected into the

wells along with a chemical reagent to further stimulate the formation (see column 8, lines 53-68).

8. With respect to the arguments regarding the LUK reference, the applicant states that the reference fails to disclose a second stimulation fluid and that there is only a single well head taught by the reference.

However, the LUK reference does teach a first and second well location; although it is not shown in Figure 6 of the reference, it is taught that the fluid is flowed from the top of the well (first well location) down into the formation (second well location) for the fracturing operation. The reference does teach a second stimulation fluid; the first fluid is carbon dioxide with a nitrogen booster and the second is the frac fluid and proppant (see column 6, lines 31-46).

Conclusion

9. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kerry W. Leonard whose telephone number is 571-272-8133. The examiner can normally be reached on Monday-Friday, 10:00am-6:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jennifer H. Gay can be reached on 571-272-7029. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Kerry W. Leonard
KWL
Oct 15, 2007

DAVID BAGNELL
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 3600

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11291496	MCNEEL ET AL.
	Examiner	Art Unit
	Leonard, Kerry W	3676

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	04/27/2007	10/15/2007							
	1	N	N							
	2	N	N							
	3	N	N							
	4	N	N							
	5	N	N							
	6	N	N							
	7	N	N							
	8	N	N							
	9	N	N							
	10	N	N							
	11	✓	✓							
	12	✓	✓							
	13	✓	✓							
	14	✓	✓							
	15	✓	✓							
	16	✓	✓							
	17	✓	✓							
	18	✓	✓							
	19	O	O							
	20	✓	✓							
	21	✓	✓							
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	23	✓	✓							
	24	✓	✓							
	25	✓	✓							
	26	✓	✓							
	27	✓	✓							
	28	✓	✓							
	29	✓	✓							
	30	O	O							
	31	✓	✓							
	32	✓	✓							
	33	✓	✓							
	34	N	N							
	35	N	N							
	36	N	N							

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11291496	MCNEEL ET AL.
	Examiner	Art Unit
	Leonard, Kerry W	3676

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	04/27/2007	10/15/2007							
	37	N	N							
	38	N	N							
	39	N	N							

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11291496	MCNEEL ET AL.
	Examiner	Art Unit
	Leonard, Kerry W	3676

SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES		
Search Notes	Date	Examiner
Search in EAST and Google Patents (see search history)		KWL
Consulted primary examiners G Suchfield and H Dang		KWL

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

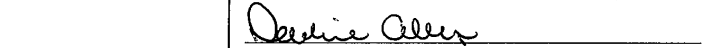
In re Application of:		§	
	LLOYD MCNEEL ET AL.	§	Group Art Unit: **3676**
		§	
Serial No.:	**11/291,496**	§	
		§	Examiner: **Leonard, Kerry W**
Filed:	**DECEMBER 1, 2005**	§	
		§	
Title:	**"METHOD AND APPARATUS FOR CENTRALIZED WELL TREATMENT"**	§	Atty. Docket No: **HES 2005-IP-018647 (063718.0930)**

MAIL STOP RCE
Honorable Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

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MPEP 503

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DEBBIE ALLEN

DATE OF SUBMISSION: JANUARY 9, 2008
ELECTRONIC FILING (EFS)

REQUEST FOR CONTINUED EXAMINATION UNDER 37 C.F.R. § 1.114

In response to the Final Office Action mailed October 16, 2007, Applicants respectfully submit a Request for Continued Examination with the remarks and amendments set forth below and request favorable action thereon.

This request is being submitted before (i) the abandonment of this application; (ii) payment of the issue fee; (iii) the filing of a notice of appeal to the U.S. Court of Appeals for the Federal Circuit; or (iv) the commencement of a civil action under 35 U.S.C. § 145 or 35 U.S.C. § 146.

Profrac Holding Corporation
U.S. Well Services, LLC

IPR2023-01319

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AMENDMENTS TO THE CLAIMS

Please amend the claims as shown directly below. This listing of claims will replace all prior versions, and listings, of claims in the application.

1-10 (Withdrawn)

11. (Currently Amended) A~~n~~ system for centralized well operations comprising: a well treatment operations factory which manufactures and pumps a well stimulation fluid; a first connection between a first well location and the well operations factory; a second connection between a second well location and the well operations factory; and means for simultaneously flowing a first stimulation fluid only to the first well location and a second stimulation fluid only to ~~a~~ the second well location.

12. (Original) The system of claim 11 wherein the means for simultaneously flowing treatment fluid comprises a manifold.

13. (Original) The system of claim 12 wherein the well operations factory comprises a pumping grid wherein the pumping grid is operable to connect to the manifold.

14. (Original) The system of claim 13 wherein the well operations factory comprises a blending unit wherein the blending unit is operable to connect to the pumping grid.

15. (Currently Amended) The system of claim 14 wherein the well operations factory comprises a proppant storage system wherein the proppant storage system is operable to ~~connect~~ deliver proppant to the blending unit.

Profrac Holding Corporation
U.S. Well Services, LLC

IPR2023-01319

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16. (Original) The system of claim 14 wherein the well operations factory comprises a chemical storage system wherein the chemical storage system is operable to connect to the blending unit.

17. (Original) The system of claim 15 wherein the well operations factory comprises a power unit operable to connect to the manifold, pumping grid, blending unit, the proppant storage system, the first well location, and the second well location.

18. (Original) The system of claim 16 wherein the well operations factory comprises a power unit operable to connect to the manifold, pumping grid, blending unit, chemical storage system, the first well location, and the second well location.

19. (Original) The system of claim 17 wherein the well operations factory is enclosed in a structure selected from the group consisting of a supported fabric structure, a collapsible structure, a prefabricated structure, a retractable structure, a composite structure, a temporary structure, a prefabricated wall and roof structure, a deployable structure, a modular structure, a preformed structure, a mobile accommodation structure, and combinations thereof.

20. (Original) The system of claim 12 wherein the first connection is operable to deliver a fluid from the first well location to the manifold.

21. (Original) The system of claim 12 wherein the second connection is operable to deliver a fluid from the second well location to the manifold.

Profrac Holding Corporation
U.S. Well Services, LLC

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22. (Original) The system of claim 20 wherein the fluid comprises a stimulation fluid.

23. (Original) The system of claim 21 wherein the fluid comprises a stimulation fluid.

24. (Original) The system of claim 12 wherein the manifold is connected to a second manifold.

25. (Original) The system of claim 24 wherein the second manifold is operable to simultaneously flow a first stimulation fluid to a first well location and a second stimulation fluid to a second well location.

26. (Original) The system of claim 12 comprising a third connection between the manifold and the first well location.

27. (Original) The system of claim 26 wherein the third connection is operable to deliver a fluid from the first well location to the manifold.

28. (Original) The system of claim 27 comprising a fourth connection between the manifold and the second well location.

29. (Original) The system of claim 28 wherein the fourth connection is operable to deliver a fluid from the second well location to the manifold.

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30. (Original) The system of claim 11 wherein the well operations factory and means for simultaneously flowing treatment fluid are located on a boat.

31. (Original) The system of claim 11 wherein the first fluid comprises a compound selected from the group consisting of proppant, fracturing fluid, gelling agents, friction reducers, acid, and combinations thereof.

32. (Original) The system of claim 11 wherein the second stimulation fluid comprises a compound selected from the group consisting of proppant, fracturing fluid, gelling agents, friction reducers, acid, and combinations thereof.

33. (Original) The system of claim 11 wherein the first stimulation fluid and the second stimulation fluid have the same composition.

34 – 39 (Withdrawn)

40. (New) A system for centralized well operations comprising: a well treatment operations factory which manufactures and pumps a well stimulation fluid; a first connection between a first pad and the well operations factory; a second connection between a second pad and the well operations factory; and means for simultaneously flowing a first stimulation fluid to the first pad and a second stimulation fluid to the second pad.

41. (New) A system for centralized well operations comprising: a well treatment operations

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factory which dynamically manufactures and pumps a well stimulation fluid; a first connection between a first well location and the well operations factory; a second connection between a second well location and the well operations factory; and means for simultaneously flowing a first stimulation fluid to the first well location and a second stimulation fluid to the second well location.

42. (New) The system of claim 11, wherein the well locations are pads and wherein the well treatment operations factory dynamically manufactures and pumps a well stimulation fluid.

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REMARKS / ARGUMENTS

I. Disposition of Claims

Claims 1-39 are pending in this application. Claims 1-10 and 34-39 are withdrawn from further consideration. Claims 11-16, 20-29, and 31-33 stand rejected. Claims 19 and 30 are objected to as depending from a rejected base claim. Claims 11 and 15 have been amended herein. Claims 40-42 are new. Support for these claims can be found throughout the specification.

II. Remarks Regarding 35 U.S.C. § 102 Rejections - Zakiewicz

Examiner has rejected claims 11-13, 20-29, and 31-33 under 35 U.S.C. § 102(b) as being anticipated by Zakiewicz (US 4,305,463). Applicants respectfully traverse. As to amended independent claim 11, Zakiewicz does not disclose "simultaneously flowing a first stimulation fluid *only* to the first well location and a second stimulation fluid *only* to the second well location." Instead, brine is injected into the wells *along with* a chemical reagent (Office Action at 5-6).

Although Examiner has not yet rejected claims 40-42, in the interest of compact prosecution, Applicants will discuss claims 40-42. As to new claim 40, Zakiewicz does not disclose "a first pad . . . [and] a second pad." As to new claim 41, Zakiewicz does not teach "a well treatment operations factory which *dynamically* manufactures and pumps a well stimulation fluid." In fact, it does not appear that Zakiewicz teaches a well treatment operations factory that manufactures and pumps a fluid at all. As to new claim 42, it depends from claim 11 and has similar features to claims 40 and 41, and is patentable for at least the same reasons that each of those claims is patentable. As to the remaining rejected claims, they all depend from claim 11 and are allowable for at least the same reasons.

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III. Remarks Regarding 35 U.S.C. § 102 Rejections - Luk

Examiner has rejected claims 11-16, 20-25, and 31-32 under 35 U.S.C. § 102(b) as being anticipated by Luk (US 5,515,920). Applicants respectfully traverse. As to amended independent claim 11, Luk does not disclose "simultaneously flowing a first stimulation fluid *only* to the first well location and a second stimulation fluid *only* to the second well location." As to new claim 40, Luk does not disclose "a first pad . . . [and] a second pad." As to new claim 41, Luk does not teach "a well treatment operations factory which *dynamically* manufactures and pumps a well stimulation fluid." In fact, it does not appear that Luk teaches a well treatment operations factory that manufactures and pumps a fluid at all. As to new claim 42, it depends from claim 11 and has similar features to claims 40 and 41, and is patentable for at least the same reasons that each of those claims is patentable. As to the remaining rejected claims, they all depend from claim 11 and are allowable for at least the same reasons.

IV. Remarks Regarding 35 U.S.C. § 103 Rejections - Luk

Examiner has rejected claims 17-19 under 35 U.S.C. § 103(a) as being unpatentable over Luk alone. Applicants respectfully traverse. Examiner acknowledges that "the reference does not eplicitly state that the well operations factory comprises power unit or that the factory is enclosed." Examiner asserts that "it would be obvious to one of ordinary skill in the art that the system of Luk would require some type of power unit in order to operate the system. In addition, the structures described in claim 19 are very well known in the art and it would be obvious to one of ordinary skill in the art to enclose some or all of the components in the well operations factory in order to protect them from the elements." Examiner does not indicate where this is disclosed in any of the cited documents, and Applicants have been unable to find such a disclosure after a careful review of the documents. Thus, it appears that Examiner has relied on

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purported common knowledge. As such, Applicants point out that this is not considered to be common knowledge or well-known in the art. Thus Applicants respectfully traverse Examiner's assertion, and request specific factual basis for the statements. See M.P.E.P. § 2144.03(C).

SUMMARY

In light of the above remarks, Applicants respectfully request reconsideration and withdrawal of the outstanding rejections. Applicants further submit that the application is now in condition for allowance, and solicit timely notice of the same. Should the Examiner have any questions, comments, or suggestions in furtherance of the prosecution of this application, the Examiner is invited to contact the attorney of record.

Applicants have submitted payment of $810.00 herewith for the RCE fee under 37 C.F.R. § 1.117(e). Applicants believe that there are no other fees due in association with the filing of this Response. However, should the Commissioner deem that any fees are due, the Commissioner is authorized to debit Baker Botts L.L.P. Deposit Account No. 02-0383, Order Number 063718.0930, for any payment of associated fees, underpayment of fees, or to credit same with any overpayment of fees that may occur in association with this filing.

Respectfully submitted,

BAKER BOTTS L.L.P. (023640)

Date: January 9, 2008

By: 

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ATTORNEY FOR APPLICANTS

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U.S. Well Services, LLC

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Electronic Patent Application Fee Transmittal	
Application Number:	11291496
Filing Date:	01-Dec-2005
Title of Invention:	Method and apparatus for centralized well treatment
First Named Inventor/Applicant Name:	William Lloyd McNeel
Filer:	Paul N. Katz/Debbie Allen
Attorney Docket Number:	2005-IP-018647U1
Filed as Large Entity	

Utility Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Request for continued examination	1801	1	810	810
		Total in USD ($)		**810**

Electronic Acknowledgement Receipt	
EFS ID:	2692761
Application Number:	11291496
International Application Number:	
Confirmation Number:	7986
Title of Invention:	Method and apparatus for centralized well treatment
First Named Inventor/Applicant Name:	William Lloyd McNeel
Customer Number:	29920
Filer:	Paul N. Katz/Debbie Allen
Filer Authorized By:	Paul N. Katz
Attorney Docket Number:	2005-IP-018647U1
Receipt Date:	09-JAN-2008
Filing Date:	01-DEC-2005
Time Stamp:	16:04:51
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$810
RAM confirmation Number	1351
Deposit Account	020383
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees) Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)	

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment Submitted/Entered with Filing of CPA/RCE	0637180930RCE.PDF	318546 ded4a98266ceada1958364dfe80230cdd881fda8	no	9
Warnings:					
Information:					
2	Fee Worksheet (PTO-06)	fee-info.pdf	8182 4edc1295b21832528e4d3db7360b9f1dad77c722	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	326728		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Document code: WFEE

United States Patent and Trademark Office
Sales Receipt for Accounting Date: 01/28/2008

KWANZER	SALE	#00000001	Mailroom Dt:	01/09/2008	020383	11291496	
		01	FC : 1201	420.00	DA		
		02	FC : 1202	200.00	DA		

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Approved for use through 1/31/2007. OMB 0651-0032
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 11/291,496	Filing Date 12/01/2005	☐ To be Mailed

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)	SMALL ENTITY ☐		OR	OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	01/09/2008	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 43	Minus	** 39	= 4	X $ =		OR	X $50=	200
	Independent (37 CFR 1.16(h))	* 7	Minus	***5	= 2	X $ =		OR	X $210=	420
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	620

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/Katischa R. Wanzer/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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29920 e 01/28/2008

JOHN W. WUSTENBERG
P.O. BOX 1431
DUNCAN, OK 73536

Paper No.

Application No.:	**11/291,496**	**Date Mailed:**	**01/28/2008**
First Named Inventor:	McNeel, William Lloyd,	Examiner:	LEONARD, KERRY W
Attorney Docket No.:	2005-IP-018647U1	Art Unit:	3676
Confirmation No.:	7986	Filing Date:	12/01/2005

Please find attached an Office communication concerning this application or proceeding.

Commissioner for Patents

PTO-90c (Rev.08-06)

Notice of Non-Compliant Amendment (37 CFR 1.121)	Application No. 11/291,496	Applicant(s) MCNEEL ET AL.	
		Art Unit 3676	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

The amendment document filed on *09 January, 2008* is considered non-compliant because it has failed to meet the requirements of 37 CFR 1.121 or 1.4. In order for the amendment document to be compliant, correction of the following item(s) is required.

THE FOLLOWING MARKED (X) ITEM(S) CAUSE THE AMENDMENT DOCUMENT TO BE NON-COMPLIANT:

- ☐ 1. Amendments to the specification:
  - ☐ A. Amended paragraph(s) do not include markings.
  - ☐ B. New paragraph(s) should not be underlined.
  - ☐ C. Other _____.
- ☐ 2. Abstract:
  - ☐ A. Not presented on a separate sheet. 37 CFR 1.72.
  - ☐ B. Other _____.
- ☐ 3. Amendments to the drawings:
  - ☐ A. The drawings are not properly identified in the top margin as "Replacement Sheet," "New Sheet," or "Annotated Sheet" as required by 37 CFR 1.121(d).
  - ☐ B. The practice of submitting proposed drawing correction has been eliminated. Replacement drawings showing amended figures, without markings, in compliance with 37 CFR 1.84 are required.
  - ☐ C. Other _____.
- ☒ 4. Amendments to the claims:
  - ☐ A. A complete listing of all of the claims is not present.
  - ☒ B. The listing of claims does not include the text of all pending claims (including withdrawn claims)
  - ☐ C. Each claim has not been provided with the proper status identifier, and as such, the individual status of each claim cannot be identified. Note: the status of every claim must be indicated after its claim number by using one of the following status identifiers: (Original), (Currently amended), (Canceled), (Previously presented), (New), (Not entered), (Withdrawn) and (Withdrawn-currently amended).
  - ☐ D. The claims of this amendment paper have not been presented in ascending numerical order.
  - ☒ E. Other: *See claims 1-10 and 34-39. Text MUST be included*.
- ☐ 5. Other (e.g., the amendment is unsigned or not signed in accordance with 37 CFR 1.4): For further explanation of the amendment format required by 37 CFR 1.121, see MPEP § 714.

TIME PERIODS FOR FILING A REPLY TO THIS NOTICE:

1. Applicant is given **no new time period** if the non-compliant amendment is an after-final amendment or an amendment filed after allowance, or a drawing submission (only) If applicant wishes to resubmit the non-compliant after-final amendment with corrections, the **entire corrected amendment** must be resubmitted.

2. Applicant is given **one month**, or thirty (30) days, whichever is longer, from the mail date of this notice to supply the correction, if the non-compliant amendment is one of the following: a preliminary amendment, a non-final amendment (including a submission for a request for continued examination (RCE) under 37 CFR 1.114), a supplemental amendment filed within a suspension period under 37 CFR 1.103(a) or (c), and an amendment filed in response to a Quayle action. If any of above boxes 1 to 4 are checked, the correction required is only the corrected section of the non-compliant amendment in compliance with 37 CFR 1.121.

   Extensions of time are available under 37 CFR 1.136(a) only if the non-compliant amendment is a non-final amendment or an amendment filed in response to a *Quayle* action.
   Failure to timely respond to this notice will result in:
   Abandonment of the application if the non-compliant amendment is a non-final amendment or an amendment filed in response to a *Quayle* action; or
   Non-entry of the amendment if the non-compliant amendment is a preliminary amendment or supplemental amendment.

Legal Instruments Examiner (LIE), if applicable /Katischa R. Wanzer/ Telephone No: 571-272-1059

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IPR2023-01319
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:		§	
	McNeel et al.	§	Group Art Unit: **3676**
		§	
Serial No.:	**11/291,496**	§	
		§	Examiner: **Leonard, Kerry W.**
Filed:	**December 1, 2005**	§	
		§	
Title:	**"Method and Apparatus for Centralized Well Treatment"**	§	Atty. Docket No: **HES 2005-IP-018647U1**
		§	

MAIL STOP AMENDMENT
Honorable Commissioner of Patents
P. O. Box 1450
Alexandria, VA 22313-1450

CERTIFICATE OF FILING ELECTRONICALLY VIA EFS
MPEP 503

I HEREBY CERTIFY THAT I HAVE A REASONABLE BASIS FOR BELIEF THAT THIS CORRESPONDENCE IS BEING SUBMITTED TO THE UNITED STATES PATENT AND TRADEMARK OFFICE VIA EFS (ELECTRONICALLY) ON THE DATE INDICATED BELOW, AND IS ADDRESSED TO:

HONORABLE COMMISSIONER FOR PATENTS
P.O. BOX 1450
ALEXANDRIA, VA 22313-1450

DEBBIE ALLEN

DATE OF SUBMISSION: FEBRUARY 12, 2008
ELECTRONIC FILING (EFS)

TRANSMITTAL OF INFORMATION DISCLOSURE STATEMENT

Dear Honorable Commissioner:

Applicants respectfully request, pursuant to 37 C.F.R. §§ 1.56, 1.97 and 1.98, that the art listed on the attached form be considered and cited in the examination of the above-identified application.

Furthermore, pursuant to 37 C.F.R. §§ 1.97(g) and (h), no representation is made that these references are material to the patentability of the present application.

As the Supplemental Information Disclosure Statement transmitted herewith is being filed before the mailing date of the first Non-Final Office Action on the merits and pursuant to 37 C.F.R. § 1.97(b), Applicants believe that there are no fees due at this time. Should the Commissioner deem that any fees are due, including any fees for extensions of time,

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Applicants respectfully request that the Commissioner accept this as a Petition Therefor, and direct that any additional fees be charged to Baker Botts, L.L.P.'s Deposit Account No. 02-0383, Order Number 063718.0930.

Respectfully submitted,

BAKER BOTTS L.L.P. (023640)

Date: February 12, 2008

By: _____

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ATTORNEY FOR APPLICANTS

Profrac Holding Corporation
U.S. Well Services, LLC
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Ex. 1002, p. 250 of 988

Information Disclosure Citation in an Application	Application No. 11/291,496	Applicant(s) MCNEEL ET AL.	
	Docket Number HES 2005-IP-018647U1	Group Art Unit 3676	Filing Date December 1, 2005

U.S. PATENT DOCUMENTS

	CITE NO.	DOCUMENT NO.	PUB/ISSUE DATE	NAME	CLASS	SUBCLASS	FILING DATE
	1	4,209,278	6/24/1980	Cooper *et al.*			
	2	4,265,266	5/4/1981	Kierbow *et al.*			
	3	4,353,482	10/22/1982	Tomlinson *et al.*			
	4	4,409,927	10/18/1983	Loesch *et al.*			
	5	5,014,218	5/7/1991	Crain *et al.*			
	6	6,193,402	2/27/2001	Grimland *et al.*			
	7	2007/0201305	8/30/2007	Heilman *et al.*			

FOREIGN PATENT DOCUMENTS

	CITE NO.	DOCUMENT NO.	PUB/ISSUE DATE	NAME	CLASS	SUBCLASS	TRANSLATION YES	TRANSLATION NO
	F1	EP 0124251	11/7/1984	Crain				
	F2	EP 0508817	10/14/1992	Stromberg				
	F3	WO 2004/007894	1/22/2004	Coody *et al.*				

NON-PATENT DOCUMENTS

	CITE NO.	DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	DATE
	N1	Foreign communication related to a counter part application	6/11/2007
	N2	Foreign communication related to a counter part application	9/5/2007
	N3	Final rejection of US Patent Application Serial No. 11/396,918	1/25/2008

EXAMINER	DATE CONSIDERED

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP § 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 124 251**
A2

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: 84302060.3

(22) Date of filing: 27.03.84

(51) Int. Cl.³: **B 01 F 15/04**

(30) Priority: 06.04.83 US 483001

(43) Date of publication of application: 07.11.84
Bulletin 84/45

(84) Designated Contracting States: DE FR GB IT NL

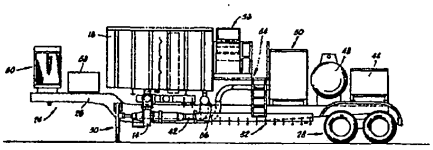
(71) Applicant: HALLIBURTON COMPANY, P.O. Drawer 1431, Duncan Oklahoma 73536 (US)

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Inventor: Arnold, Edward Paul, 540 Blackjack Lane, Duncan Oklahoma 73533 (US)
Inventor: Gray, Steven Howard, 3305 Spencer, Duncan Oklahoma 73533 (US)
Inventor: Dodd, Timothy John, 1106 North 10th, Duncan Oklahoma 73533 (US)

(74) Representative: Wain, Christopher Paul et al, A.A. THORNTON & CO. Northumberland House 303-306 High Holborn, London WC1V 7LE (GB)

(54) **Apparatus and method for mixing a plurality of substances.**

(57) A transportable apparatus for controlling the production of a mixture of a fluid (supplied at 32) and a plurality of additives (from tanks e. g. 44, 46) utilizes a unified control panel (on an operator's platform 54) having all of the necessary controls compactly contained in a single housing (56) for providing both automatic and manual control of each of the additive channels through which the additives are mixed with the primary fluid, for flow into a holding tank (16). The control of each additive channel is achieved through a software controlled algorithm by which errors are only incrementally, rather than totally, applied to prior drive signals at any one time.



EP 0 124 251 A2

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APPARATUS AND METHOD FOR MIXING A PLURALITY OF SUBSTANCES

This invention relates generally to apparatus and methods for mixing a plurality of substances and, more particularly, but not by way of limitation, to a liquid gel concentrate continuous blending trailer having an electrical control system located thereon for controlling the production of a fracturing gel.

The necessity for the proper control of the blending of substances used in the drilling and completing of oil or gas wells has been recognized as set forth in U.S. Patent 4,353,482 to Tomlinson et al. It is also known that additive substances used in the oil and gas industry can be contained on and transported by a portable trailer as dislcosed in U.S. Patent 4,265,266 to Kierbow et al. Despite the recognition of these needs and the disclosures of apparatus to meet these needs, there has arisen a more specific need for an improved self-contained portable unit and method which control the preparation of a fracturing fluid containing a liquid gel concentrate. With such an apparatus and a method for controlling the preparation of a fracturing fluid, the considerable time spent pre-gelling a job can be decreased, the running time and associated wear on blenders can be reduced, and waste (and the costs associated therewith) can be cut. Additionally, viscosity, which is important to the ability of the fluid to carry sand, can be carefully controlled.

A preferred embodiment of apparatus and method, which will be described herein, performs three basic functions:

1. mix a liquid gel concentrate, and preferably other additives (such as a buffering agent), with water to form a fully yielded gel capable of carrying high sand concentrations;

2. store liquid chemical additives in bulk quantities in a closed system; and

3. meter additional additives with a minimum of hand manipulation and error.

The first function is carried out, in the preferred embodiment, by drawing water from a water source, adding liquid gel concentrate and other necessary chemicals, and then allowing sufficient holding time for the gel to fully yield. The mixture is to be held until it has fully yielded so that very high sand concentrations can be added in a blender tub into which the mixture is pumped. To allow the mixture to fully yield, there is a holding tank having a sufficient capacity to meet the flow rate at which the mixture is to be pumped while allowing adequate reaction time. However, it is also desirable for the holding tank to hold only a minimum mixture so that in the event of a premature sandout, for example, only a minimum amount of mixture will need to be discarded.

The second function of bulk storage of liquid chemical additives is needed for containing surfactants, clay stabilizing agents, cross-linking agents, breakers, pH control (buffering) agents and other additives. By maintaining these substances in bulk on the self-contained unit, spillage waste from drums will be eliminated, on-location labor requirements will be descreased, and bulk purchasing economies will be allowed.

Maintaining bulk quantities on the self-contained unit in a closed system reduces safety hazards which can

arise from handling 55-gallon drums in which the additives would frequently otherwise be maintained. For example, formic acid, which is used in oil and gas well operations, is a particularly hazardous chemical to handle under field conditions. By utilizing a closed system having a bulk tank reduces the potential for inadvertent human contact with the formic acid.

The use of a closed bulk storage system on the self-contained unit also minimizes wastes which would otherwise likely occur if individual storage drums were used. For example, with a closed system, no pumps or lines need to be flushed; therefore, the residue chemicals which would otherwise be flushed are not lost. Additionally, when individual drums are used, significant monetary loss occurs if the entire drum contents are not used because each gallon of additive can cost from $20.00 to $50.00, for example. A self-contained closed system can also prevent waste by allowing more accurate inventory control of the chemicals.

The third function of metering additional additives with a minimum of hand manipulation and error necessitates a suitable metering system capable of metering various flows in response to different master flows without the continual monitoring by an operator. Accurate control of each of these additives must be continually maintained because of fluctuations in the master and additive flows. If exclusively manual metering were used, these fluctuations could result in a gel that is not fully yielded, thereby resulting in the blender tub sanding out or the pumping system being damaged, because the manual operation would likely not be able to achieve the necessary response.

The preferred embodiment of apparatus includes a unified control panel so that field personnel can readily and conveniently control the mixing and blending

of several substances at one time. Such a unified control panel also permits enhanced space utilization by providing a relatively compact unit which includes a manual control back-up system.

The unified control panel also includes alternative data entry means for concurrently setting up alternative flow rate determining parameters so that quick control changeovers can be made. There is a control system which has thermostatically controlled heating and cooling means to maintain proper electronic operating temperatures in harsh environments. Use is made of an improved control algorithm by which additive metering error control is performed in manually selectable increments to reduce the chances of overdamped or underdamped control.

The embodiment of apparatus and method to be described herein enables a proper fracturing fluid to be obtained within a reduced time. A fracturing gel may be produced from a liquid gel concentrate, a buffering agent and water. Other additives can also be included. This is accomplished by metering the additives into a water stream, thoroughly mixing the substances, and pumping them into a holding tank to allow the mixture to properly react and yield (e.g., by hydration of the gelling agent in the liquid gel concentrate). The fully yielded mixture is then pumped into a blender tub from which a flow into a well is achieved. The embodiment is also capable of adding further additives to the mixture as it passes from the blender tub into the well. The embodiment includes the necessary control means for properly metering the additives into their respective primary flows, such as the mixture flow into the holding tank and the flow from the holding tank to the blender tub.

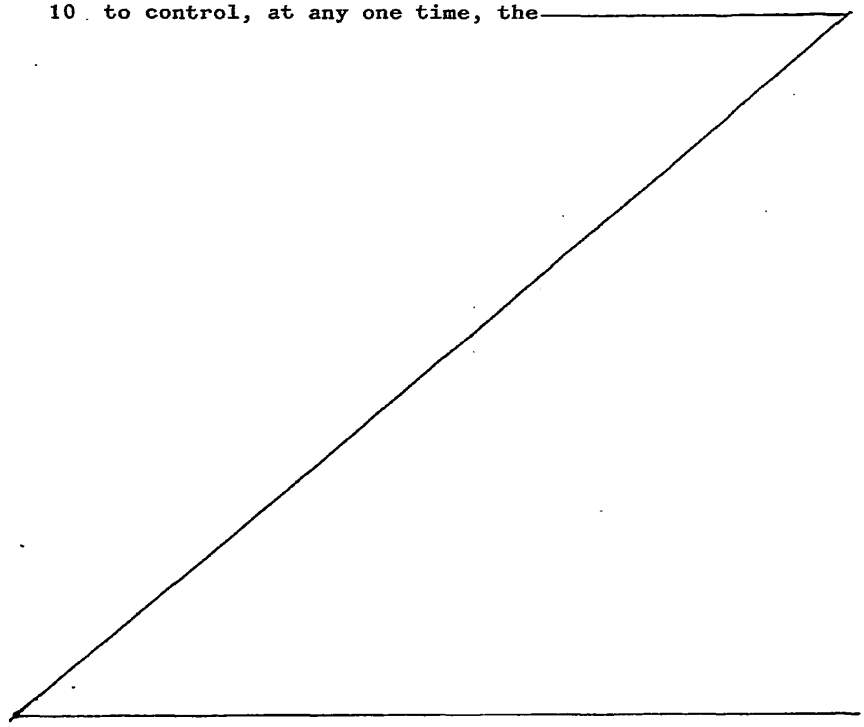
In accordance with the present invention, and as

seen from one aspect thereof, there is provided an apparatus for controlling the addition of a substance to a primary flow, the apparatus being characterised by conduit means for providing a path for said primary flow additive means for flowing said substance into said conduit means, first detector means for detecting a rate of said primary flow, second detector means for detecting a rate of said substance when said additive means flows said substance into said conduit means, and control means, responsive to said first detector means and said second detector means, for controlling said additive means, said control means including a unified control panel comprising a channel control sector including first data entry means for manually entering a first data number specifying a first magnitude of an additive substance flow rate determining parameter for use by said control means in controlling said additive means and second data entry means for manually entering a second data number specifying a second magnitude of said additive substance flow rate determining parameter for use by said control means in controlling said additive means, and the unified control panel further comprising means for selectably directing said control means to utilize either said first data number or said second data number in controlling said additive means.

The control means further includes means for selectably directing the control means to utilize either the first data number or the second data number in controlling the additive means.

The second detector means includes means for detecting a speed at which the additive means is operating and means for detecting a flow rate of the substance which is flowed by the additive means. One of these two detecting means is used by the control means for controlling the additive means.

The control means further includes automatic means for automatically controlling the additive means in response to the first detector means, the second detector means and the selected one of the first or second data numbers. The control means also includes manual means for controlling the additive means in response to the first detector means and an electrical signal provided by a variable resistance means. Either the automatic means or the manual means can be selected to control, at any one time, the



additive means.

The apparatus further comprises temperature means for controlling the temperature of the control means and pH detecting means for detecting the pH of a mixture resulting from the addition of the substance to the primary flow.

The method of the present invention for controlling the addition of the substance to the primary flow includes the steps of storing a concentration value in a random access memory, converting a first voltage into a first digitally encoded number indicating the actual flow rate of the primary flow, converting a second voltage into a second digitally encoded number indicating the actual flow rate of the substance, using the concentration value and first digitally encoded number to define a product representing a desired flow rate at which the substance is to be added to the primary flow, using the product and the second digitally encoded number to define a scaled difference representing an error between the actual flow rate of the substance and the desired flow rate of the substance, manually entering a factor having a magnitude less than one, multiplying the error by the factor, and adding the control error to a drive signal for providing an adjusted drive signal to the apparatus which is flowing the substance at an adjusted speed for incrementally adjusting the actual flow rate of the substance toward the desired flow rate.

Therefore, from the foregoing, it is a general object of the present invention to provide a new and improved method and appa-

ratus for mixing a plurality of substances. Other and further objects, features and advantages of the present invention will be readily apparent to those skilled in the art when the following description of the preferred embodiment is read in conjunction with the accompanying drawings.

FIG. 1 is a schematic flow diagram of the preferred embodiment of the present invention shown associated with a water source, a liquid gel concentrate source, a blender, and a well.

FIG. 2 is a top plan view of the preferred embodiment of the apparatus of the present invention.

FIG. 3 is a side elevational view of the apparatus of the present invention shown in FIG. 2.

FIG. 4 is a functional block diagram and flow chart of the preferred embodiment of the control system of the preferred embodiment apparatus of the present invention.

FIG. 5 is a front view of the unified control panel of the preferred embodiment control system of the present invention.

FIG. 6 is a functional block diagram of the bottom assembly associated with the unified control panel shown in FIG. 5.

FIG. 7 is a functional block diagram of the power source assembly associated with the unified control panel shown in FIG. 5.

FIG. 8 is a schematic illustration of the channel 1 input and output signal flow of the preferred embodiment control system.

FIG. 9 is a schematic illustration of the channel 2 input

signal flow of the preferred embodiment control system.

FIG. 10 is a schematic illustration of the input signal flow for one of channels 3, 4, 5, 8, 9 and 10 of the preferred embodiment control system.

FIG. 11 is a schematic illustration of the channel 6 input signal flow of the preferred embodiment control system.

FIG. 12 is a schematic illustration of the channel 7 input and output signal flow of the preferred embodiment control system.

FIG. 13 is a schematic illustration of the channel 2 output signal flow of the preferred embodiment control system.

FIG. 14 is a schematic illustration of the output signal flow for one of the channels 3, 4, 5, 8, 9 and 10 of the preferred embodiment control system.

FIG. 15 is a schematic illustration of the channel 6 output signal flow of the preferred embodiment control system.

FIG. 16 is a schematic illustration of the pH input, UART input/output, and option switchboard input/output signal flows of the preferred embodiment control system.

FIG.S 17A-D are schematic circuit diagrams of the dual flow rate digital interface circuitry for the preferred embodiment control system.

FIG.S 18A-B are schematic circuit diagrams of the liquid crystal display panel meter decoder and displays for the preferred embodiment control system.

FIG. 19 is a flow chart of the main loop program of the pre-

ferred embodiment control system.

FIG. 20 is a flow chart of the subroutine SERV2 shown in FIG. 19.

With reference to the drawings, the preferred embodiment of the present invention will be described. FIG. 1 shows that the preferred embodiment includes an apparatus 2 which receives water from a water source 4 and a liquid gel concentrate from a liquid gel concentrate source 6. The apparatus 2 provides a mixture and additives to a blender apparatus 8 from which the completed fracturing fluid is pumped into a well 10 by a pump 12, such as a Halliburton HT-400 pump.

The apparatus 2 includes a main pump 14, such as a 10x10 Gorman-Rupp centrifugal pump, for pumping water and additives into a holding tank 16. The additives which are added into the flow established by the pump 14 include the liquid gel concentrate, a buffering agent, a clay stabilizing agent, and a surfactant of types known to the art. Examples of these substances include formic acid, BA-1, CLA-STA II, and FRACFLO. All these additives, other than the liquid gel concentrate, are maintained on the apparatus 2 in suitable containers.

The mixture pumped into the holding tank 16 is held in the holding tank for a suitable period to enable the mixture to react, such as by hydration of the gelling agent in the liquid gel concentrate, to provide a suitably yielded fracturing gel. After being held for the appropriate time, the mixture is then

pumped from the holding tank 16 into a blender tub 18 of the blender apparatus 8. Sand is added to this mixture in the blender tub 18, and the resultant sand-laden mixture is pumped from the blender tub 18 for injection into the well 10. The sand-laden mixture can have additional additives added from the apparatus 2 as indicated in FIG. 1. These additional additives are shown in FIG. 1 to be a cross-linking agent and a breaker. These are retained in suitable containers on the apparatus 2. Examples of these substances include CL-11 and MYF-3C. As known to the art, it is important that the cross-linking agent and the breaker not be added to the mixture until the mixture is pumped into the well 10.

The water source 4 includes any suitable water supply which can be connected to the apparatus 2. For example, the water source 4 can include a plurality of frac tanks. For one type of job on which the apparatus can be used, it is contemplated that ten frac tanks be used to provide a 200,000 gallon reservoir of water suitable for fracturing fluid flow rates of fifteen to sixty-three barrels per minute.

The liquid gel concentrate source 6 is an appropriate source of a suitable liquid gel concentrate which can be connected to the apparatus 2. For example, liquid gel concentrate transports of types known to the art can be used.

The blender apparatus 8 illustrated in FIG. 1 is a standard blender trailer known to the art. As shown in FIG. 1, the blender apparatus 8 includes the blender tub 18 into which the

mixture from the holding tank 16 is pumped by a pump 20 through an inlet line 21. The sand-laden mixture prepared in the blender tub 18 is pumped to the pump 12 by another pump 22, through an outlet line 23, also contained on the blender apparatus 8.

The apparatus 2 and the method by which the fracturing fluid is produced by the preferred embodiment of the present invention will be more fully described with reference to FIGS. 2-12.

With reference to FIGS. 2 and 3, the broad structural aspects of the preferred embodiment of the present invention will be described. FIGS. 2 and 3 disclose that the apparatus 2 includes a portable support means comprising a trailer 24 having a platform 26 mounted on a plurality of wheels 28 at the rear and on a support member 30 at the front of the trailer. The trailer 24 can be transported by suitable means as known to the art.

Mounted on the trailer 24 is the pump 14. The pump 14 is part of an inlet conduit means for providing a flow path to the holding tank 16 which is also mounted on the trailer 24. The inlet conduit means of the preferred embodiment extends from a suction header 32 to which the water source 4 is connectible by suitable means. The suction header 32 is connected to a holding tank inlet manifold 34 through which the mixture comprising the water and additives is input into the holding tank 16.

Once in the holding tank 16, the mixture, after a suitable reacting time, is flowed out of the holding tank 16 through a tank outlet manifold 36 shown in FIG. 3. The tank outlet manifold 36 connects to a discharge header 38 shown in FIG. 2. A

flow meter 40 is disposed in the outlet conduit means provided by the tank outlet manifold 36 and the discharge header 38. The blender apparatus 8 is connectible to the discharge header 38 as known to the art.

A flow meter 42 is disposed in the inlet conduit means defined by the suction header 32, the pump 14, and the holding tank inlet manifold 34.

Also mounted on the trailer 24 are the plurality of containers for holding the various liquid additives. In the preferred embodiment shown in FIGS. 2 and 3, the containers include two 293-gallon vertical rectangular liquid additive tanks 44 and 46, a 500-gallon horizontal cylindrical liquid additive tank 48, and two 549-gallon vertical rectangular liquid additive tanks 50 and 52. These containers are mounted on the rear of the trailer 24 as shown in FIGS. 2 and 3.

Mounted just forward of the tank bank comprising the tanks 44-52, is an operator's platform 54 on which a unified control panel of a control system is mounted in a single housing 56. The control system will be more particularly described hereinbelow with reference to FIGS. 4-20.

Also shown in FIGS. 2 and 3 to be mounted on the trailer 24 are a fuel tank 58 which contains fuel for powering a diesel engine 60. Also mounted on the trailer 24 are a hydraulic reservoir 62 and a blower primer 64.

With reference to FIG. 4, the fluid flow and control interrelationships of various elements of the apparatus 2 will be

described. FIG. 4 discloses that the control system includes ten channels of additive means for flowing the additives into a water flow to create, in the preferred embodiment, the fracturing fluid or gel to be pumped downhole into the well 10.

Channel one is the channel which supervises the flow of water from a plurality of frac tanks 66. The flow from the frac tanks 66 is effected by means of the pump 14. The flow of the water is detected by the flow meter 42.

Channel two supervises the addition of the liquid gel concentrate from the liquid gel concentrate source 6. In the illustrated preferred embodiment, channel two includes three subchannels through which the liquid gel concentrate can be flowed into the flowing water established by the pump 14. Each subchannel of channel two includes an additive means comprising a chemical positive displacement pump 68 driven by a hydraulic motor 70 whose operation is regulated by an electro-hydraulic control valve 72 (the specific elements for the channel two subchannels are designated with the letters "a," "b," or "c"). Each set of these elements constitutes an additive pump means by which the additive can be flowed into the inlet conduit means through which the water is flowed.

To detect the speed at which one of the motors 70 drives the associated pump 68, the control system also includes a tachometer 74 associated with the drive shaft coupling the motor 70 and the pump 68. The control system also includes a flow meter 76 in each channel or subchannel for detecting a flow of the additive

pumped by the pump 68 into the inlet conduit means. The pump means is constructed of elements as known to the art.

Channels three through ten are constructed similarly to each subchannel of the channel two (i.e., each includes a pump 68, a motor 70, a valve 72, a tachometer 74 and a flow meter 76). It is to be noted that in the preferred embodiment shown in FIG. 4, channels three and four provide a buffering agent, whereas channels five and six provide other additives, such as surfactants and clay stabilizing agents. These additives are of types as known to the art, such as formic acid, FRAC-FLO, and CLA-STA II. In channel six there are two subchannels as shown in FIG. 4.

Channel seven monitors the flow of the mixture from the holding tank 16 to the blender apparatus 8. Channels eight, nine and ten are used for adding substances to the mixture pumped from the blender tub 18 by means of the pumps 12 and 22. Examples of these substances are MYF-3C, CL-11, and a suitable breaker as known to the art.

FIG. 4 also discloses that a means for detecting the pH of the mixture flowing into the holding tank 16 is disposed in the discharge line of the pump 14. In the preferred embodiment, this detector means includes a suitable pH probe 78 of the type known to the art, such as a sensor used with the TBI Series 540A pH indicator.

It is to be noted that all of the elements shown in FIG. 4, except for the sources 4 and 6, are mounted on the trailer 24 by suitable means as known to the art. It is also to be noted that

the individual elements (e.g., pump 68, tachometers 74) shown in FIG. 4 are of suitable types as known to the art.

As shown in FIG. 5, the control system for the apparatus 2 has a unified control panel 80, contained within the single housing 56, for providing the interface with the operator of the apparatus 2. The front panel 80 has a plurality of channel control sectors 82-100, each control sector being associated with a respective one of the ten channels described with reference to FIG. 4.

The channel control sector 82 is related to the first channel shown in FIG. 4. The channel control sector 82 includes a six-digit digital display 102 for displaying a selectable one of the volumetric flow of the water, flow rate of the water, the total volumetric flow or the total rate computed by the control system. The number which is shown in display 102 is determined by the control system at least in part in response to the flow meter 42. Which number is to be displayed is selected manually by appropriate actuation of a rotary switch 104 forming another part of the channel control sector 82. Another rotary switch 106 of the channel control sector 82 is used for directing the control system to use the water flow rate, the liquid gel concentrate flow rate, or a simulated flow rate as the primary flow against which the additive flows are to be determined. If a simulated flow rate is to be used, the simulated flow rate is developed by manual operation of a potentiometer having a control knob 108 associated therewith. The channel control sector 82 also includes

a match meter indicator 110 having associated calibration switch means 112 associated therewith as known to the art. The calibration switch means 112 includes a toggle switch 112a for placing the channel in either a run or calibrate mode. The calibration switch means 112 also includes a potentiometer control 112b for calibrating the meter 110.

The channel control sector 84 is associated with channel two, the liquid gel concentrate channel. The channel control sector 84 includes a six-digit liquid crystal display 114 by means of which the flow rate, volumetric flow or concentration ratio of the liquid gel concentrate can be visually indicated. Which one of these numbers is displayed is selected by a rotary switch 116. The channel control sector 84 also includes first and second data entry means comprising two thumbwheel switches 118 and 120. By manual manipulation of the thumbwheel switches 118 and 120, two different numbers representing an additive flow rate determining parameter can be entered into the control system. In the preferred embodiment this parameter is the concentration of the additive in the mixture. These concentration values instruct the control system as to how much of the liquid gel concentrate is to be added to the primary flow in response to the detected flow rate of the water or other flow to which the additives are slaved.

The two switches 118 and 120 are not both used by the control system at one time so that one switch can be used to control the current operation of the apparatus while the other switch can be set up for future control in the event a quick change is needed,

for example. The changeover between utilization of either the switch 118 or the switch 120 is controlled by a toggle switch 122. It is to be noted that the toggle switch 122 is used to control which stage of each channel control sector is being used by the control system. For example, when the switch 122 is in the stage one position as shown in FIG. 5, the control system is operating from the thumbwheel switch 118 and those directly below it in FIG. 5. When the switch 122 is in the stage two position, the thumbwheel switch 120 and those directly below it are used by the control system.

Disposed between the thumbwheel switches 118 and 120 are label means 121 for indicating which chemical the channel control sector is associated with and label means 123 for indicating the units of concentration for that chemical.

Because each additive channel includes a tachometer 74 and a flow meter 76, the control system can operate off either one of them to control the addition of the respective additive to the primary flow. Which of the two signals is used is selected by proper actuation of a toggle switch 124 included within the channel control sector 84. When a channel includes a plurality of pumps 68, such as in channel two, the channel control sector includes a plurality of switches 126 for selecting which of the pumps is to be used; when a channel has only one pump 68, then only one switch 126 is used.

In response to the selected positions of the switches 124 and 126, an appropriate indicator is illuminated when a minimum flow

is detected. As illustrated in FIG. 5, the indicators for the channel control sector 84 include six light-emitting diodes 128 which indicate whether the tachometer or flow meter signal of the pump 68a, 68b, or 68c is indicating a minimum flow.

The aforementioned elements of the channel control sector 84 are used in an automatic mode of the control system whereby the speed at which the pumps 68 pump the liquid gel concentrate into the primary flow is controlled. If it is desired that automatic control is not to be maintained or if there is a malfunction in the automatic mode, the control of channel two can be switched from automatic to manual by means of a toggle switch 130 which is manually positionable in either of two actuation states, one defining an automatic mode of operation and the other defining a manual mode of operation. When the toggle switch 130 is in the automatic mode position, the aforementioned elements are used to control the addition of the liquid gel concentrate to the primary flow. When the switch 130 is in the manual position, a manual mode is entered whereby a manual potentiometer control knob 132, a match meter indicator 134 and match meter calibration control means 136 are used. The calibration control means 136 includes a toggle switch 136a for placing the channel in either a run mode or a calibrate mode. The control means 136 also includes a potentiometer control knob 136b which functions similarly to the control 112b. These elements are used to control the operation of the operative pump or pumps selected by the switches 126. The operation in the manual mode is similar to the operation main-

tained with the Halliburton Services 79BI control system known to the art.

Each of the remaining channel control sectors is constructed similarly to either the channel control sector 82 or the channel control sector 84. In particular, channel control sectors 86, 88, 90, 92, 96, 98 and 100 are constructed similarly to the channel control sector 84 (except for the number of pumps utilized), and the channel control sector 94 is similar to the channel control sector 82.

The channel control sector 94 is similar to the channel control sector 82 because the channel control sector 94 is associated with the flow from the holding tank 16 into the blender tub 18. This is analogous to the channel one primary flow from the water source 4 into the holding tank 16. As shown in FIG. 5, the channel control sector 94 has a toggle switch 135, instead of the rotary switch 104, for displaying the rate of the mixture flowing from the holding tank 16 to the blender tub 18. The channel control sector 94 also includes a switch 137, analogous to the switch 106, by means of which various inputs (e.g., actual flow or simulated flow) can be used as the master flow which controls the additives associated with channels eight, nine and ten blended with the sand-laden mixture flowing from the blender tub 18 into the well 10.

FIG. 5 discloses that the unified control panel 80 also includes test means 138 for testing the apparatus 2 in a manner which does not form a part of the claimed present invention.

FIG. 5 still further discloses that the unified control panel 80 includes a connector 139 through which serial communications can be conducted with an external device.

The panel 80 also includes a rotary switch 140 by means of which various frequencies can be selected for calibrating the match meters as known to the art when the switches 112a and 136a are in their calibrate positions. An external output of this frequency signal is provided by means of a suitable connector 142.

A flow meter connector 144 is also provided on the unified control panel 80. This is the input where the signal from the flow meter 40 is connected.

Because the control system of the present invention is contemplated for use in environments where temperature extremes may be encountered, the control system also includes a thermostatically controlled heating and cooling means for controlling the temperature of the electronic components of the control system. The heating or cooling mode of the thermostatically controlled temperature means is made by means of actuation of a switch 146 mounted on the unified control panel 80. When a predetermined temperature has been exceeded within the control system, a light-emitting diode 148 is illuminated and if the temperature extreme is sufficiently great, a light-emitting diode 150 is illuminated indicating that the system has shut down.

Because one of the purposes of the present invention is to provide a control means by which consistent, more reliable frac-

turing gels can be produced, it is important that the present invention also include a means for detecting the acidity or alkalinity of the mixture. This is achieved by using the pH probe 78 of the pH detector means which also includes a pH indicator meter 149 mounted on the unified control panel 80. The pH meter 149 of the preferred embodiment is an analog meter.

Energization of the control system is effected by proper actuation of a power switch 151, which when properly actuated, applies power to the control system as indicated by an illuminated light-emitting diode 152. To reset the electronic controls of the control system, a master reset switch 154 is also provided on the unified control panel 80.

By means of the construction of the control panel 80 as shown in FIG. 5, there is achieved in the present invention a compact and yet versatile operator interface through which suitable control of the apparatus 2 can be maintained. This control is maintained primarily by entering the various concentration values in the thumbwheel switches 118, 120 for each channel control sector and by appropriately setting the manual controls via the potentiometer control knobs 132. Once these have been set and the remaining switches have been set in their selected positions, the control system controls the rate at which the pump or pumps of each channel flow their respective additives into the flows of either the water or mixture. The circuits by means of which this control is achieved are shown in FIGS. 8-16 and FIGS. 17A-D and 18A-B as will be discussed subsequently. Prior to such discus-

sion, however, the remaining structure of the control system portion contained in the housing 56 will be described with reference to FIGS. 6 and 7.

In FIG. 6 there is disclosed the second level of the housing 56 which is found immediately behind the unified control panel 80. The second level includes a thermal enclosure 156 in which a microcomputer 158 of the present invention is contained. A fan 160 is used in association with the thermal enclosure to control the temperature at which the microcomputer 158 is maintained.

The second level also includes a power section 162 further illustrated in FIG. 7.

The second level also includes the printed circuit cards containing the input conditioning circuits 164 and the output conditioning circuits 166 which interface with the mechanical elements of the additive control means of each channel. The elements 164 and 166 are schematically shown in FIGS. 8-18. The second level also includes a control portion 168 of the pH detector means.

FIG. 8 discloses a functional block and schematic circuit diagram of the input circuitry for the channel control sector 82. The electrical output of the flow meter 42 is received by a dual flow circuit schematically shown in FIGS. 17A-D, which FIGS. 17A-D are believed to be self-explanatory to those having skill in the pertinent art and will not be specifically discussed. However, broadly, the dual flow circuit includes an amplify and square circuit 170 (FIG. 17A or 17C) which receives an input from a flow meter or a tachometer (e.g., flow meter 42 as illustrated

in FIG. 8) and provides an output to a percent multiplier circuit 172 (FIG. 17B or 17D) and to a frequency-to-voltage circuit 174 (FIG. 17A or 17C). The output of the amplify and square circuit 170 is switchably connectible to the frequency-to-voltage converter circuit 174 by means of the run/calibration switch 112a shown in FIG. 5 as a part of the calibration switch means 112.

The output from the multiplier circuit 172 is provided to a counter circuit including, in the preferred embodiment, a pulse rate board of a type as known to the art. The pulse rate board includes a plurality of counters for accumulating pulses representing the total volume detected by the flow meter 42. The output of the counter 176 is accessed over an STD bus 178 by the microcomputer 158 of the preferred embodiment.

The output from the frequency-to-voltage converter circuit 174 is provided both to the match meter 110 shown in FIG. 5 and to an analog-to-digital converter 180 which provides a digital signal to the microcomputer 158 via the STD bus 178. In the preferred embodiment the analog-to-digital converter 180 is a Data Translation DT 2742 series analog input board.

Also connected to the STD bus 178 via another analog-to-digital converter 182 is the manual control signal provided by a potentiometer 184 whose setting is controlled by the positioning of the knob 108 on the front panel 80.

The inputs from each of the switches 104, 106 and 122 of the channel control sector 82 are provided to the STD bus 178 via a parallel input circuit 186. In the preferred embodiment the

parallel input circuit 186 is provided by an Intersil ISB-3310 parallel input card.

Outputs for the channel control sector 82 are provided over the STD bus 178 to the six-digit display 102. The display is driven through a 32-channel input/output board. The display means of the preferred embodiment is shown in FIGS. 18A-B.

An LED driver 190 is actuated by a suitable command from the microcomputer 158 over the STD bus 178 to illuminate a light-emitting diode 192 included in the channel control sector 82 for indicating when a flow rate has been detected by the flow meter 42.

The channel control sector 94 of channel seven, which is associated with the flow of gel from the holding tank 16 to the blender tub 18, is constructed similarly to the channel control sector 82 as illustrated in FIG. 12; therefore, channel control sector 94 will not be further described with reference to FIG. 12.

FIGS. 9, 10 and 11 disclose the input circuitry for the channel control sectors 84, 86, 88, 90, 92, 96, 98 and 100. More particularly, FIG. 9 is a functional block and schematic circuit diagram of the inputs for the channel control sector 84; FIG. 10 is a functional block and schematic circuit diagram for one of the channel control sectors 86, 88, 90, 96, 98 and 100; FIG. 11 is a functional block and schematic circuit diagram of the inputs for the channel control sector 92. Each of these channel control sector inputs is constructed substantially the same; therefore,

only the circuitry shown in FIG. 10 will be described. The similar circuits are appropriately labeled in each of the other drawings. However, it is to be noted that the channel control sectors 84 and 92 additionally include combinator circuits 194 and 196, respectively, for combining the signals representing the flows from each of the subchannels in the respective channels. The combinators 194 and 196 are of types known to the art. For example, one type of combinator has an analog section which sums analog signals for display or recording and a digital section which sums the output from scaling circuits. An oscillator clock controls the digital signals by gating and resetting an input storage flip-flop memory to provide an output pulse to a counter which is the sum of the input pulses.

FIG. 10 discloses that each of these additive channels includes a pump input circuit 198 and a flow meter input circuit 200, each of which is constructed similarly to the input circuitry previously described with reference to FIG. 8. The pump input circuit 198 operates in response to the electrical signal provided by the tachometer 74 of the respective channel, and the flow meter input circuit 200 operates in response to the electrical signal provided by the flow meter 76 of the respective additive channel. Each of the additive channel control sectors also includes an operator input portion which includes a parallel input circuit such as described with reference to FIG. 8, for receiving inputs from the display mode switch 116 and the pump/flow meter select switch 124 of the respective channel control

sector. FIG. 10 further shows the operator input portion includes means for interfacing the data from the thumbwheel switches 118 and 120 with the data bus 178. Because duplicate elements described in FIG. 8 are found in the additive channel control sectors as shown in FIGS. 9-11, a further description of these channel control sectors will not be given.

FIGS. 13, 14 and 15 are functional block and schematic circuit diagrams of the outputs of the various additive channels. FIG. 13 illustrates the output drive to each of the valves 72a, 72b and 72c associated with respective ones of the three pumps of the liquid gel concentrate channel. FIG. 15 discloses the output drive circuits for the two subchannels of the channel control sector 92 of channel six. Each subchannel illustrated in FIGS. 13 and 15 includes the elements more particularly shown in FIG. 14 which illustrates a representative one of the output circuits for the channel control sectors 86, 88, 90, 96, 98 and 100.

FIG. 14 shows the STD bus 178 communicates with the six-digit liquid crystal displays 114 of each channel control sector.

FIG. 14 discloses that the STD bus 178 also communicates with a light-emitting diode driver 202 and a light-emitting diode driver 204 for activating a respective one of the light-emitting diodes 128 when the selected pump signal or flow meter signal is indicating a minimum flow. The drivers 202 and 204 form part of the channel control sector drive portion.

The STD bus 178 also communicates with a digital-to-analog

converter 206 in the drive portion of the control sector. In the preferred embodiment the D/A converter is a Data Translation DT 2726 four channel D/A converter. The D/A converter 206 provides an output which is used when the automatic/manual switch 130 is in the automatic position. When the automatic/manual switch 130 is in the manual position, it connects a potentiometer 208 which is set in response to the respective control knob 132 shown in FIG. 5. The automatic/manual switch 130 connects the selected signal to an output converter circuit 210 of a type as known to the art. In the preferred embodiment, the output converter circuit 210 converts the voltage provided through the automatic/manual switch into a zero to 60-milliampere current signal for driving the preferred embodiment Bertea valve 72 associated with the hydraulic motor 70 of the respective additive channel. This output drive signal is provided to the valve 72 only when the pump on/off switch 126 is appropriately set.

FIG. 16 discloses that the control system also includes a dual universal asynchronous receiver/transmitter circuit, such as a Prolog 7304 dual UART card for the preferred embodiment, for providing serial communications over the STD bus 178 through the connector 139 shown in FIG. 5.

There is also shown in FIG. 16 that option switchboards 214, 216 can be connected to the STD bus 178. FIG. 16 also shows the connection of the pH probe 78, the pH electronics 168, and the pH meter 148 to the STD bus 178 via an analog-to-digital circuit as known to the art.

It is to be noted that the individual elements shown in FIGS. 9-16 are of types known to the art, other than those which are specifically shown in FIGS. 17 and 18.

The preferred embodiment microcomputer 158 which controls the handling of the input and output circuits shown in FIGS. 8-18 includes a Prolog 7801 central processing unit (CPU) and associated EPROM board which contains the operating program. Also associated with the CPU via the STD bus 178 are a random access memory of a type known to the art and an arithmetic card for enabling computations to be performed in floating point manner. In the preferred embodiment, the arithmetic card is an Intersil ISB-3600 arithmetic card. These elements are constructed and interconnected in a manner as known to the art for communicating over the STD bus 178 with each other and with the various elements previously described.

With reference to FIGS. 19 and 20, the preferred embodiment program contained in the EPROM board for controlling the operation of the CPU will be described. FIG. 19 discloses the flow chart of the main loop program for controlling the operation of each channel.

The main loop program first calls an initialization subroutine which zeros all of the random access memories, displays and drives and which otherwise initializes the system as known to the art.

Next, the main loop program enters a subroutine LEDLIT which lights the front panel light-emitting diodes 128 for each channel

having a detected flow rate above a preset "no-flow" value. This illumination notifies an operator that a flow below a minimum value has been detected by the flow meter of that channal which is a check against the digital display that might be indicating a flow rate in response to the tachometer signal, which tachometer signal might indicate a flow because the associated pump is operating even though no fluid may be being pumped by the pump.

The next subroutine of the main loop program is the subroutine LDRR. This subroutine loads the concentration ratios entered in the thumbwheel switches 118 and 120. Only those concentration values of the stage of thumbwheel switches which has been selected by the switch 122 are entered.

The next subroutine is a subroutine GRATE which is used to compute the actual rate calculations for each channel. This is done by accessing the digital voltages from each of the analog-to-digital converters, such as the analog-to-digital converter 180 shown in FIG. 8. The subroutine GRATE also retrieves the accumulated digitized pulse counts from the counters 176 of each of the channels. Utilizing the raw voltage data from the analog-to-digital converters, the control means of the present invention can determine the rate of flow in each channel; utilizing the accumulated pulses from each of the counters, the control means can determine the total volume of additive which has flowed. These determinations are made by the microcomputer 158 in a manner as known to the art.

After the subroutine GRATE, the main program loop enters the

subroutine SERV1 which services channel one, the primary flow channel with which the channel control sector 82 is associated. The subroutine SERV1 checks the front panel switch 104 to determine which display mode has been selected. If the total rate display mode has been selected, the subroutine controls the microcomputer to correct the computed actual total rate for proper units. If the total volume is to be displayed, the microcomputer checks to determine if the master reset switch 154 has been actuated thereby indicating that the volumetric measurements are to be reset to zero. If the base fluid rate has been selected, the microcomputer corrects for the proper units. If the base fluid volume has been selected for display, the reset switch is checked. Whichever type of information is to be displayed, the binary representation thereof obtained in the microcomputer is converted to binary coded decimal and displayed in the digital display 102.

Upon completion of the subroutine SERV1, the main loop enters the subroutine SERV2 which has a flow chart disclosed in FIG. 20. From the flow chart, it is apparent that the subroutine SERV2 is the portion of the main loop program which provides the output drive signal to the Bertea valves 72a, 72b and 72c of channel two. This is done by obtaining the concentration ratio for channel two as entered in the selected thumbwheel switch 118 or 120. The concentration ratio is converted from BCD to binary to floating point for use by the Intersil arithmetic card. Next, the stored signal representative of the actual flow rate of chan-

nel one, which signal is the one to which each of the additives is slaved in the preferred embodiment, is obtained. This actual flow rate is multiplied by the entered concentration ratio to yield a product which is then divided by a ratio unit to get the desired flow rate. A feedback signal representing the actual flow rate of the additive of channel two is obtained and subtracted from the desired flow rate to derive a flow error. The flow error is scaled for proper units and then multiplied by a K scaling factor to obtain a control error. The control error is converted to binary and added to the accumulated output drive signal which has been used to previously drive the pumps of channel two. This sum is output through the digital-to-analog converter and the output converter to the appropriate valve as illustrated in FIG. 13. The subroutine then checks the display mode switch 116 to determine which display mode has been selected. If rate is to be displayed, it is corrected for units; if volume is to be displayed, a check for a master reset is made; and if the ratio is to be displayed, the rate signal is divided by the slave signal (e.g., the actual flow rate of channel one) to which the additive is slaved and corrected for units. The appropriate number to be displayed is then converted to BCD and output to the digital display 114.

The subroutines SERV3, 4, 5, 6, 8, 9 and 10 are similar to the subroutine SERV2; however, they are used to control the operation of channels three, four, five, six, eight, nine and ten, respectively.

The algorithm for the preferred embodiment control provided by each of the subroutines SERV2-6, 8-10 can be mathematically defined by the following equation:

new drive output signal =

old drive control signal + [typ x K (RR/RRU x slave - feedback)]

where: "new drive output" = the corrected output drive signal;

"old drive control signal" = the previous output drive signal which is to be corrected if the desired flow rate does not equal the actual flow rate;

"typ" = a conversion factor to change gallons per minute to a pure binary number;

"K" = the K factor which is manually entered by a switch to achieve a stable system (it is a number that has a value of 0.1 to 1.0 in 0.1 increments for the preferred embodiment);

"RR" = the desired concentration ratio in gallons which has been entered in the front panel thumbwheel switches;

"RRU" = the units of the concentration ratio (e.g., 1, 10, 100, 1,000 or 10,000 gallons);

"slave" = the signal to which the additive control is slaved, which is usually either the base fluid or total flow rate in gallons per minute; and

"feedback" = the signal from the feedback source in gallons per minute, usually the actual flow rate of the additive.

Utilizing this algorithm, the system can become over or underdamped by picking a K value either too small or too large. If the K value is too large, the response will be underdamped. This makes the response of the system much faster, but a system that has a non-linear response could go into oscillations and never attain adequate control. If the K factor is picked too small, the system could be overdamped. This would mean that the response is so slow that control is never adequately attained. The specific value of this factor is determined based on the particular mechanical system with which the control means is used.

Additionally, with this algorithm, the actual flow cannot be sampled any faster than the control system response time. If faster sampling occurred, the response would be repeatedly changed before it would have time to respond to a prior change.

The subroutine SERV7 is similar to the subroutine SERV1; however, the subroutine SERV7 is used to monitor the other master flow from the holding tank 16 to the blender tub 18 which is used to control the additives of channels eight, nine and ten.

After the subroutine SERV10 is completed, the main loop enters the subroutine DAMP. This subroutine gives the system the ability to variably set a time delay in the main loop. The delay is used to insure that the actual flow rate of a channel is not sampled at a faster rate than the control means can respond to correct the output drive signal. This insures that the correction for the output drive is not changed before the prior output drive has had time to function.

The last subroutine of the main loop is the subroutine MSTRST which checks for actuation of the master reset switch 154 on the front panel 80. If the switch is actuated, the random access memories are zeroed.

To utilize the preferred embodiment, the trailer 24 is moved to a well site where it is connected to the water source 4, the liquid gel concentrate source 6, and the blender apparatus 8. The concentration values are entered in the appropriate thumbwheel switches 118 and/or 120, the manual control (if desired) is set via the control knobs 132, and the automatic/manual switch 130 placed in the appropriate position for each channel. The pumps 68 which are to be utilized are connected to the control system by appropriate actuation of the pump select switches 126 at the right-hand portion of the control panel 80. The display mode is also selected by the appropriate switch 116. Power is applied via the power switch 150 so that the control means commences control of the various additive channels. Control is achieved as described hereinabove.

CLAIMS

1. An apparatus for controlling the addition of a substance to a primary flow, the apparatus being characterised by conduit means (32,14,34) for providing a path for said primary flow, additive means (e.g. 68) for flowing said substance into said conduit means, first detector means (42) for detecting a rate of said primary flow, second detector means (e.g. 74,76) for detecting a rate of said substance when said additive means flows said substance into said conduit means, and control means, responsive to said first detector means and said second detector means, for controlling said additive means, said control means including a unified control panel (80) comprising a channel control sector including first data entry means (118) for manually entering a first data number specifying a first magnitude of an additive substance flow rate determining parameter for use by said control means in controlling said additive means and second data entry means (120) for manually entering a second data number specifying a second magnitude of said additive substance flow rate determining parameter for use by said control means in controlling said additive means, and the unified control panel further comprising means (122) for selectably directing said control means to utilize either said first data number or said second data number in controlling said additive means.

2. An apparatus as claimed in claim 1, characterised in that said second detector means includes speed detector means (e.g. 74) for detecting a speed rate at which said additive means is operating and flow detector

means (76) for detecting a flow rate of said substance, and said channel control sector further includes means (124) for directing said control means to use either said speed rate or said flow rate for controlling said additive means.

3. An apparatus as claimed in claim 1 or 2, characterised in that said channel control sector further includes variable resistance means (132) for manually controlling an electrical signal usable by said control means in controlling said additive means, said control means further includes automatic means for controlling said additive means in response to said first detector means, said second detector means and the selected one of said first or second data numbers, and manual means (132,134,136) for controlling said additive means in response to said first detector means and said variable resistance means, and said channel control sector further includes means (130) for electrically connecting either said automatic means or said manual means to said additive means.

4. An apparatus as claimed in any preceding claim, characterised in that said apparatus further comprises temperature means for controlling the temperature of said control means and said unified control panel further includes means (146) for selectably operating said temperature means in either a heating mode or a cooling mode.

5. An apparatus as claimed in any preceding claim, characterised in that said apparatus further comprises pH detecting means (78) for detecting the pH of a mixture

resulting from the addition of said substance of said primary flow, and said unified control panel further includes indicator means (149) responsive to said pH detecting means, for visually indicating the pH of said mixture.

6. An apparatus for adding substances to a first flow of a fluid and to a second flow of a mixture, said apparatus being characterised by first conduit means (32,14,34) for providing a flow path for said first flow, first detector means (42) for detecting a rate of said first flow, first additive means (e.g. 68) for flowing a first one of said substances into said first conduit means, second detector means (e.g. 74,76) for detecting a rate associated with said first additive means, second additive means for flowing a second one of said substances into said first conduit means, third detector means for detecting a rate associated with said second additive means, second conduit means, associated with said first conduit means, for providing a flow path for said mixture, said mixture including said fluid, said first substance and said second substance, fourth detector means (40) for detecting a rate of said mixture when said mixture flows along said flow path provided by said second conduit means, third additive means for flowing a third one of said substances into said second conduit means, fifth detector means for detecting a rate associated with said third additive means,and control means for controlling, in response to said first detector means, said second detector means, and said third detector means, said first additive means and said second additive means, and for controlling, in response to said fourth detector means and said fifth detector means, said third additive means, said control means including: a single control panel (80) which includes a first channel control

sector (82) comprising first display means (102) for displaying said detected rate of said first flow, a second channel control sector (84) comprising first data entry means (118) for entering first numerical data pertaining to the control of said first additive means and first variable means (132) for adjustably setting a first electrical signal, a third channel control sector (86) comprising second data entry means for entering second numerical data pertaining to the control of said second additive means and second variable means for adjustably setting a second electrical signal, a fourth channel control sector (94) comprising second display means for displaying said detected rate of said mixture and a fifth channel control sector (96) comprising third data entry means for entering third numerical data pertaining to the control of said third additive means and third variable means for adjustably setting a third electrical signal, said control panel (80) further comprising automatic means, responsive to said first numerical data, said second numerical data, and said third numerical data, for providing first, second and third automatic control signals for controlling said first additive means, said second additive means, and said third additive means, respectively, and manual means, responsive to said first electrical signal, said second electrical signal, and said third electrical signal, for providing first, second and third manual control signals for controlling said first additive means, said second additive means, and said third additive means, respectively, said second channel control sector (84) further comprising first switch means (130) for electrically connecting said first automatic control signal to said first additive means when said first switch means is in a first actuation state

and for electrically connecting said first manual control signal to said first additive means when said first switch means is in a second actuation state, said third channel control sector (86) further comprising second switch means for electrically connecting said second automatic control signal to said second additive means when said second switch means is in a first actuation state and for electrically connecting said second manual control signal to said second additive means when said second switch means is in a second actuation state, and said fifth channel control sector (96) further comprising third switch means for electrically connecting said third automatic control to said third additive means when said third switch means is in a first actuation state and for connecting said third manual control signal to said third additive means when said third switch means is in a second actuation state.

7. An apparatus as claimed in claim 6, characterised in that said second channel control sector further includes fourth data entry means (120) for entering fourth numerical data pertaining to the control of said first additive means, said third channel control sector further includes fifth data entry means for entering fifth numerical data pertaining to the control of said second additive means, said fifth channel control sector further includes sixth data entry means for entering sixth numerical data pertaining to the control of said third additive means, and said single control panel further includes fourth switch means (122) for electrically connecting said first data entry means, said second data entry means and said third data entry means to said automatic means when said fourth switch means is in a first actuation state and for electrically connecting said fourth data entry means, said fifth data entry means

and said sixth data entry means to said automatic means when said fourth switch means is in a second actuation state.

8. An apparatus as claimed in claim 6 or 7, characterised in that said first additive means includes first pump means (68a) for flowing said first substance and second pump means (68b) for flowing said first substance, said second detector means includes first speed detector means (74a) for detecting the speed of said first pump means, second speed detector means (74b) for detecting the speed of said second pump means, first flow meter means (76a) for detecting the flow rate of said flow of said first substance provided by said first pump means, and second flow meter means (76b) for detecting the flow rate of said flow of said first substance provided by said second pump means, said second channel control sector further comprising fifth switch means for controlling whether said first pump means is to be used to pump said first substance into said first conduit means, sixth switch means for controlling whether said second pump means is to be used to pump said first substance to said first conduit means, and seventh switch means for indicating to said automatic means whether said first and second speed detector means or said first and second flow meter means are to be used in computing said first automatic control signal.

9. An apparatus as claimed in claim 6, 7 or 8, wherein each of said second, third and fifth channel control sectors includes means (121) for indicating the name of the substance whose flow is controlled by the respective channel control sector, and means for indicating the units of the numerical data entered in said data entry means of the respective channel control sector.

10. A method for controlling an additive means, being driven by a drive signal, for adding an additive to a flowing fluid utilizing control means having a front panel, said front panel including a numerical entry switch having an additive concentration value entered therein, said control means also having first voltage means for providing a first voltage corresponding to the flow rate of said fluid, and said control means also having second voltage means for providing a second voltage corresponding to the flow rate of said additive, said method being characterised by the steps of storing said concentration value in a random access memory, converting said first voltage into a first digitally encoded number indicating the actual flow rate of said fluid, storing said first digitally encoded number in said random access memory, converting said second voltage into a second digitally encoded number indicating the actual flow rate of said additive, storing said second digitally encoded number in said random access memory, using said concentration value and said first digitally encoded number from said random access memory to define a product representing a desired flow rate at which said additive is to be added to said fluid, using said product and said second digitally encoded number to define a scaled difference representing an error between said actual flow rate of said additive and said desired flow rate of said additive, manually entering data to define a factor having a magnitude less than one, multiplying said error by said factor, and adding said control error to said drive signal for providing an adjusted drive signal to drive said additive means at an adjusted speed for incrementally adjusting said actual flow rate of said additive toward said desired flow rate.

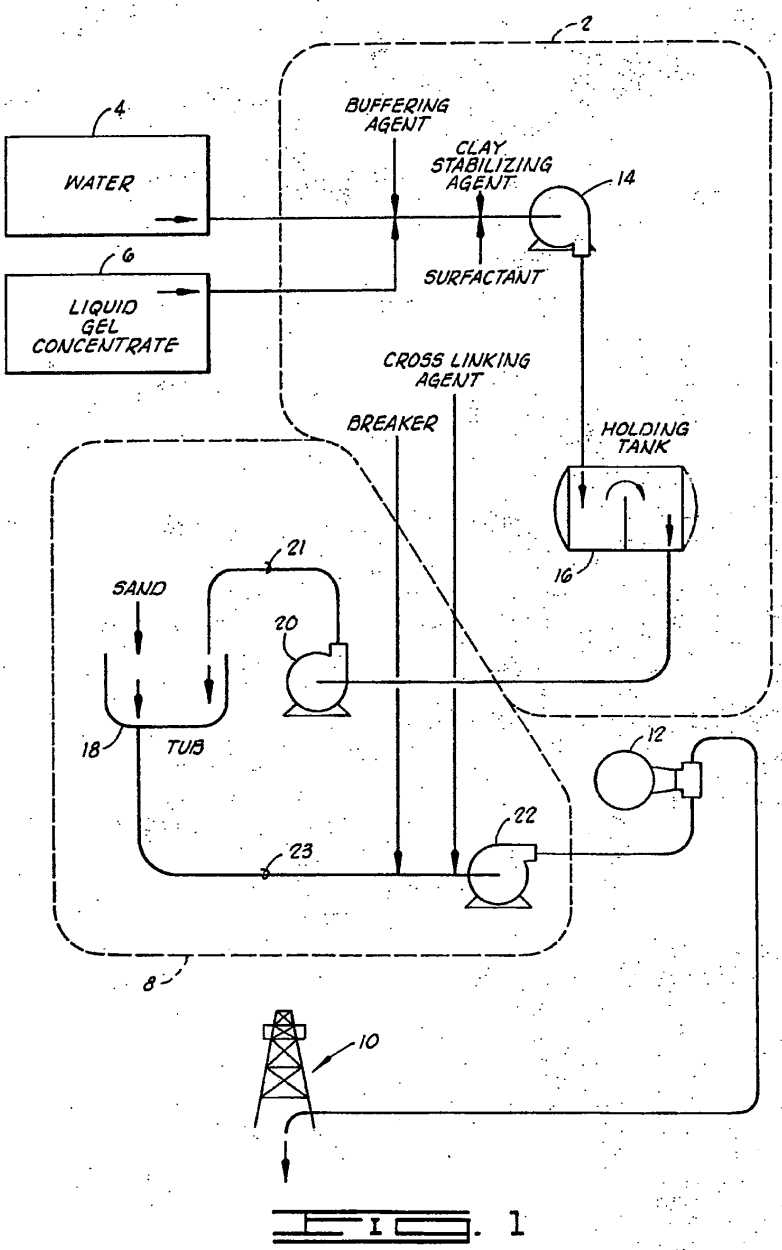

2
4
WATER
6
LIQUID GEL CONCENTRATE
BUFFERING AGENT
CLAY STABILIZING AGENT
14
SURFACTANT
CROSS LINKING AGENT
BREAKER
HOLDING TANK
16
21
SAND
20
18
TUB
12
22
23
8
10

FIG. 1

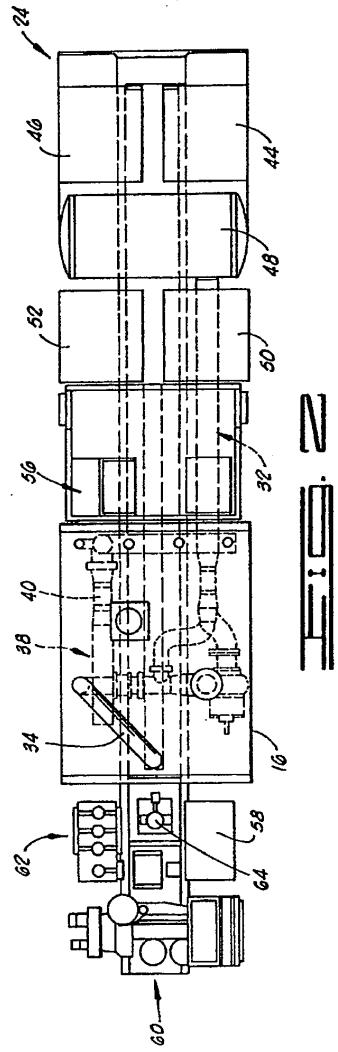

24
46
44
48
52
50
56
32
40
38
34
16
58
62
64
60

FIG. 2

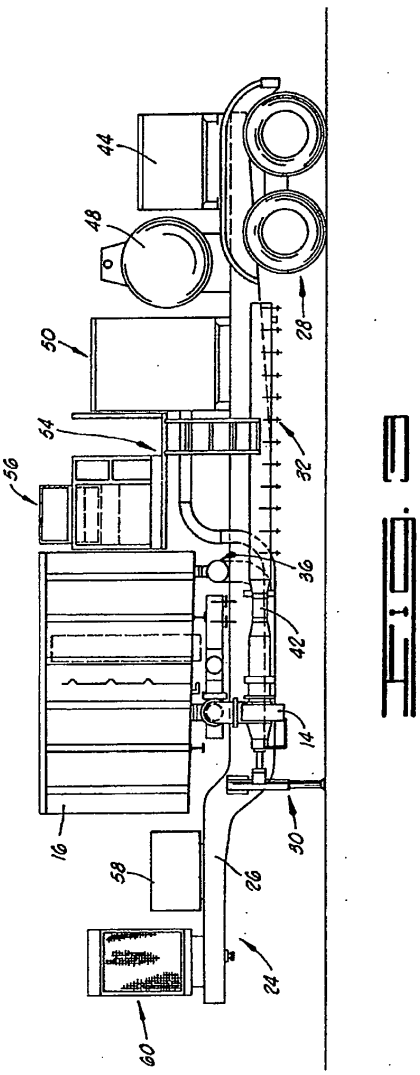

44
48
28
50
54
32
56
36
42
14
16
58
26
30
24
60

FIG. 1

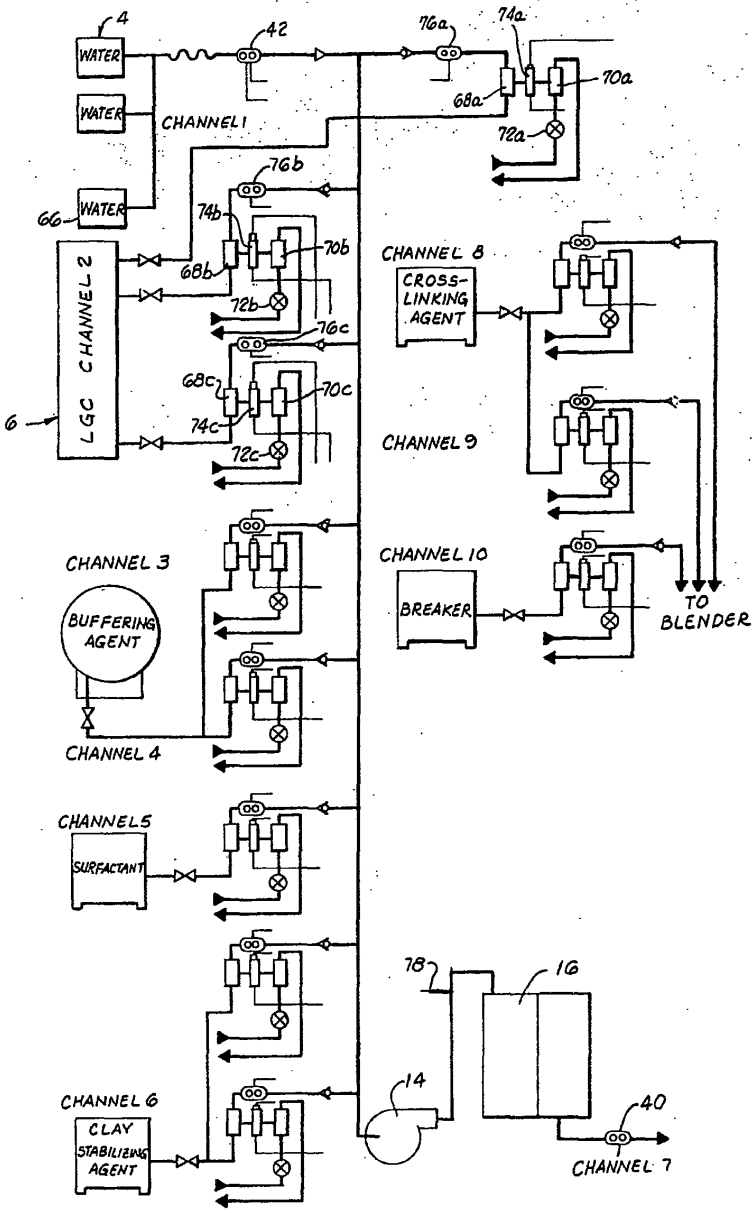

4
WATER
WATER
WATER
66
42
CHANNEL 1
76a
74a
70a
68a
72a
76b
74b
70b
68b
72b
76c
68c
70c
74c
72c
6
LGC CHANNEL 2
CHANNEL 8
CROSS-LINKING AGENT
CHANNEL 9
CHANNEL 10
BREAKER
TO BLENDER
CHANNEL 3
BUFFERING AGENT
CHANNEL 4
CHANNEL 5
SURFACTANT
78
16
14
40
CHANNEL 7
CHANNEL 6
CLAY STABILIZING AGENT

FIG. 4

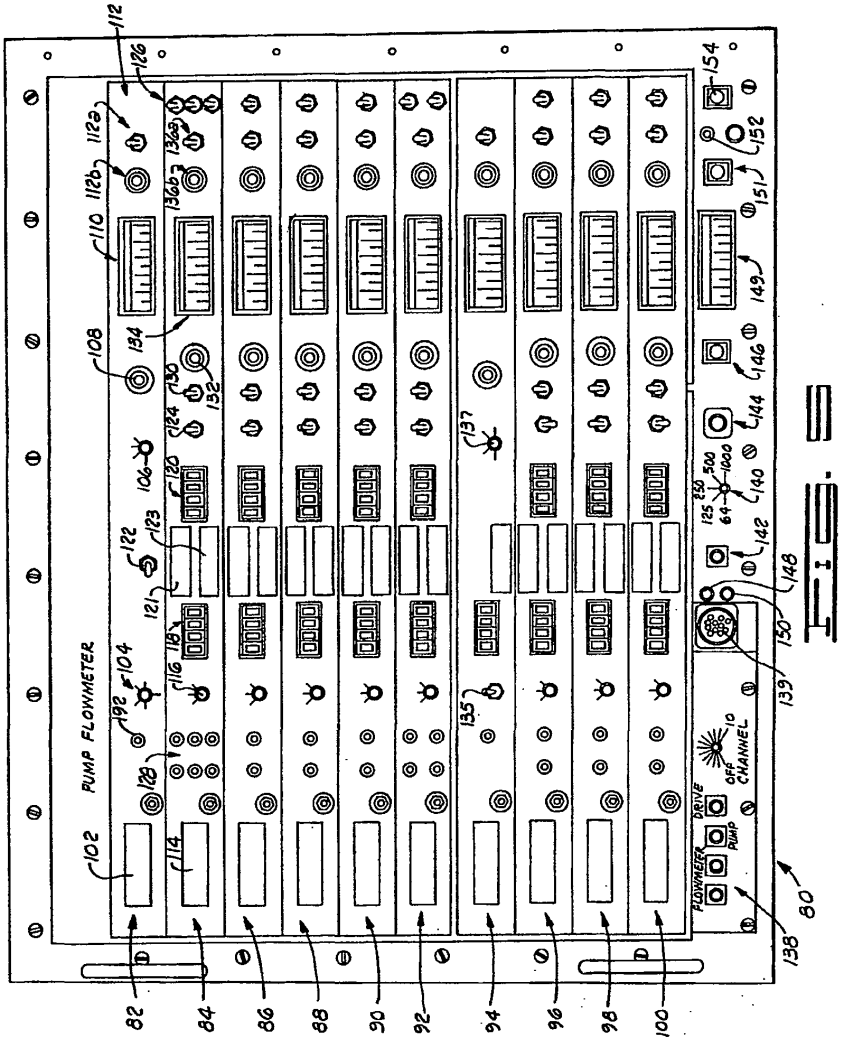

PUMP FLOWMETER
FLOWMETER DRIVE PUMP
OFF CHANNEL
10
125 250 500 1000 64
82 84 86 88 90 92 94 96 98 100
80
102 104 106 108 110 112 112a 112b 114 116 118 120 121 122 123 124 126 128 130 132 134 135 136a 136b 137 138 139 140 142 144 146 148 149 150 151 152 154

FIG. 1

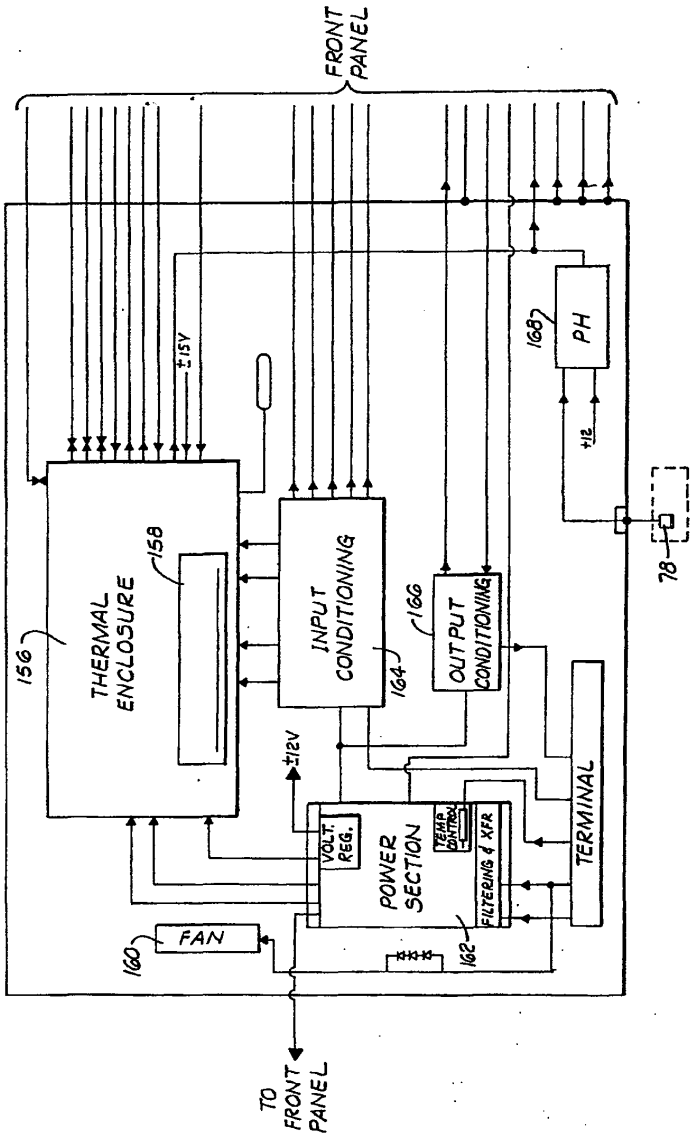

FRONT PANEL
±15V
168
PH
+12
78
156
THERMAL ENCLOSURE
158
INPUT CONDITIONING
164
166
OUT PUT CONDITIONING
±12V
VOLT. REG.
POWER SECTION
TERMINAL
FILTERING & XFR
160
FAN
162
TO FRONT PANEL

FIG. 1

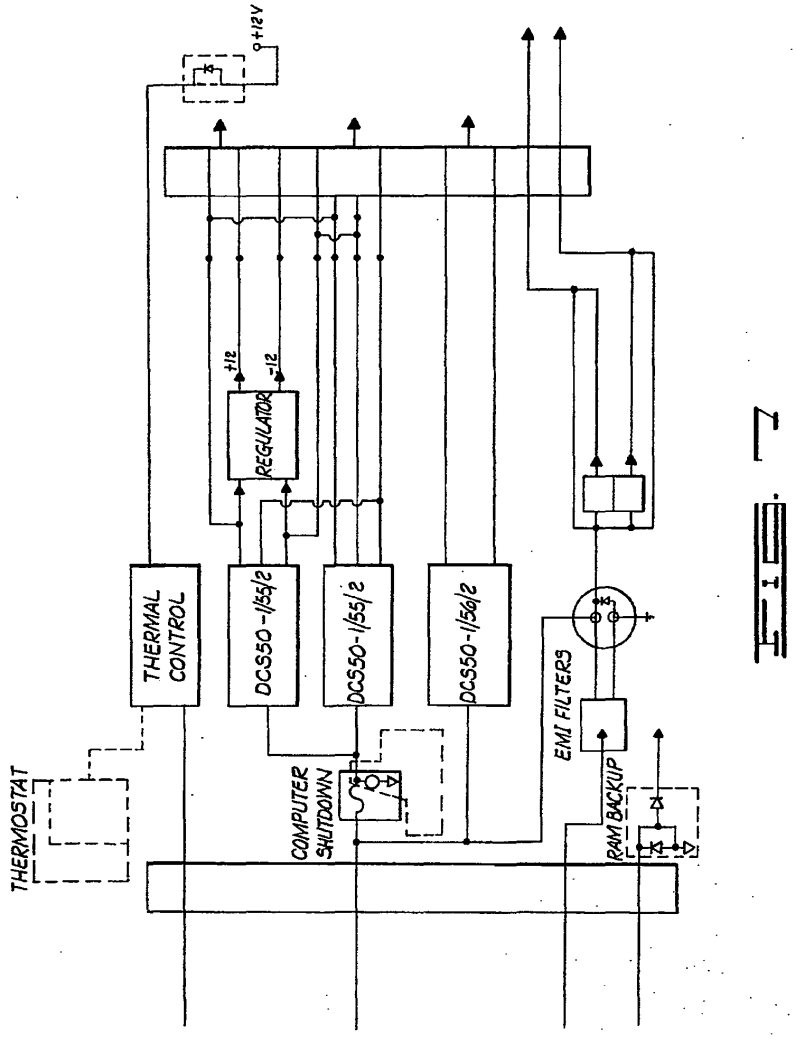

+12V
+12
-12
REGULATOR
THERMAL CONTROL
DC550-1/55/2
DC550-1/55/2
DC550-1/56/2
EMI FILTERS
COMPUTER SHUTDOWN
RAM BACKUP
THERMOSTAT

Fig. 7

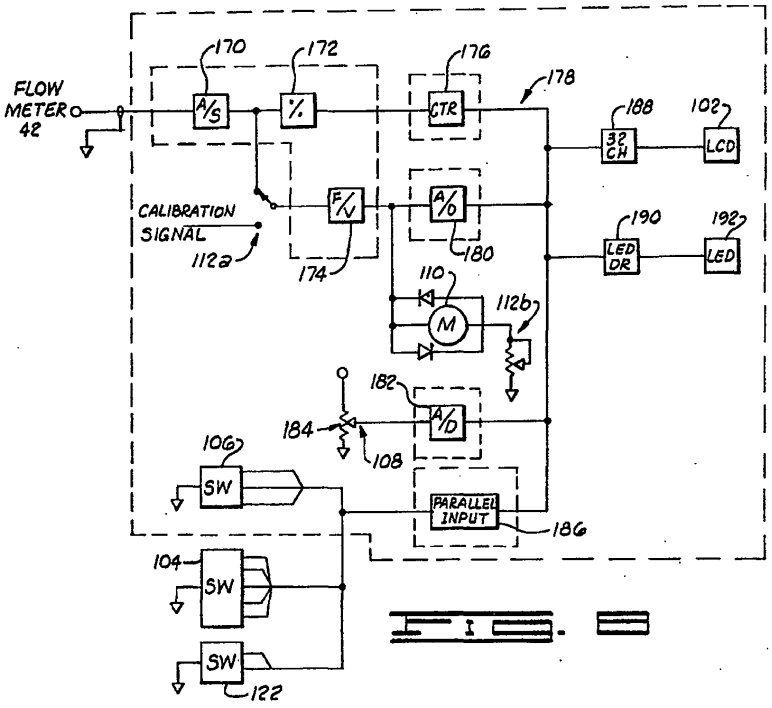

FLOW METER 42
A/S
%
CTR
170
172
176
178
188
102
32 CH
LCD
F/V
A/D
CALIBRATION SIGNAL
112a
174
180
190
192
LED DR
LED
110
M
112b
182
184
108
106
SW
PARALLEL INPUT
186
104
SW
SW
122

FIG. 1

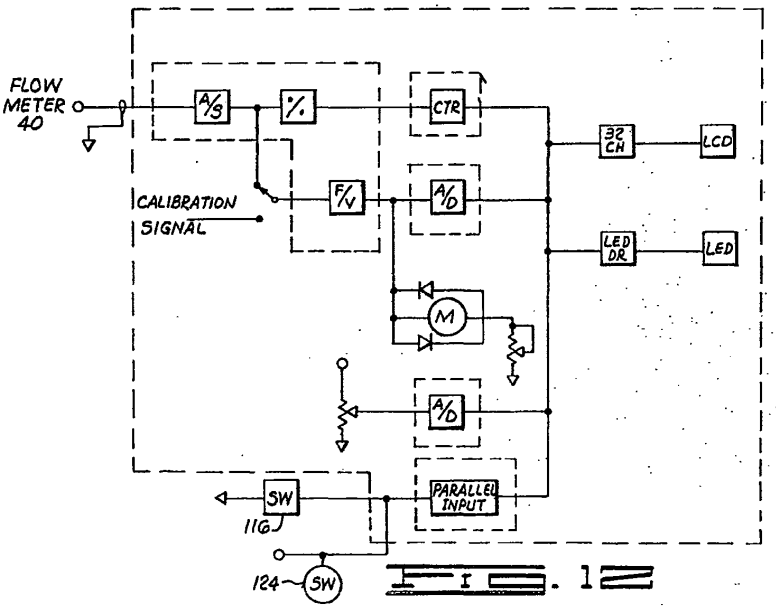

FLOW METER 40
A/S
%
CTR
32 CH
LCD
CALIBRATION SIGNAL
F/V
A/D
LED DR
LED
M
A/D
SW
PARALLEL INPUT
116
124
SW

FIG. 12

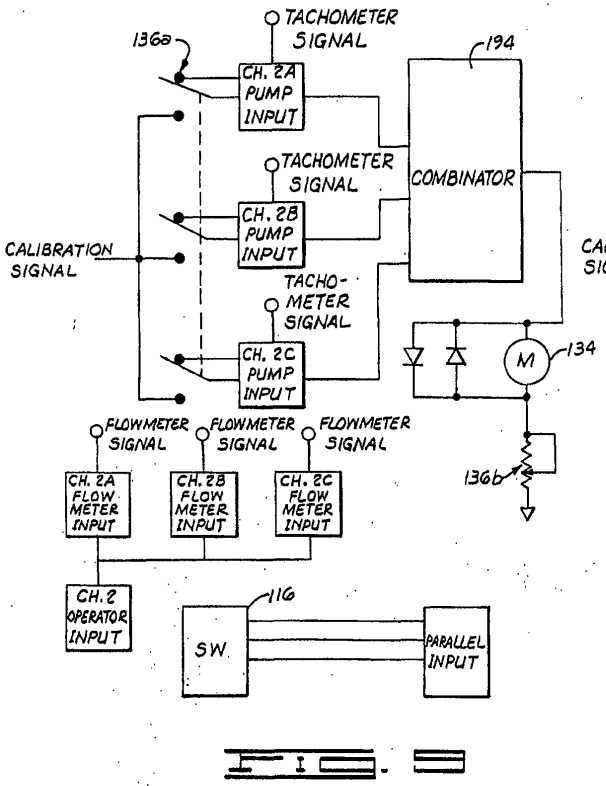


FIG. 10

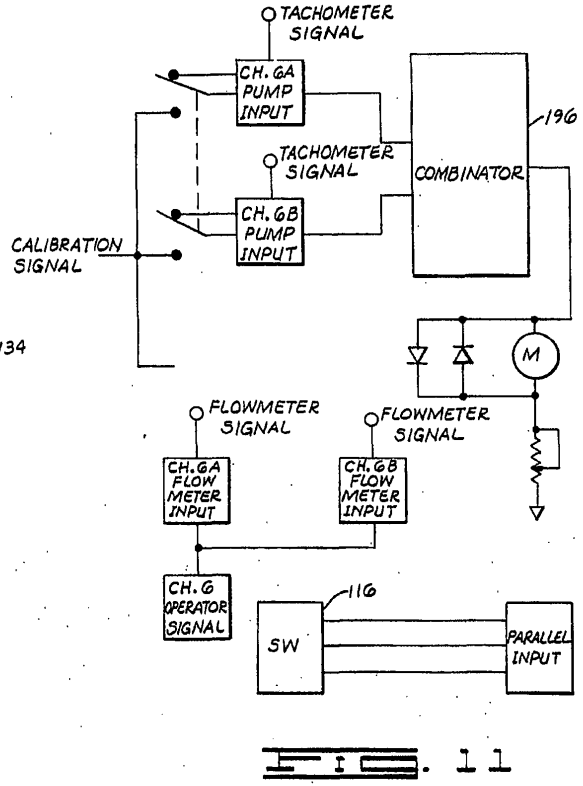


FIG. 11

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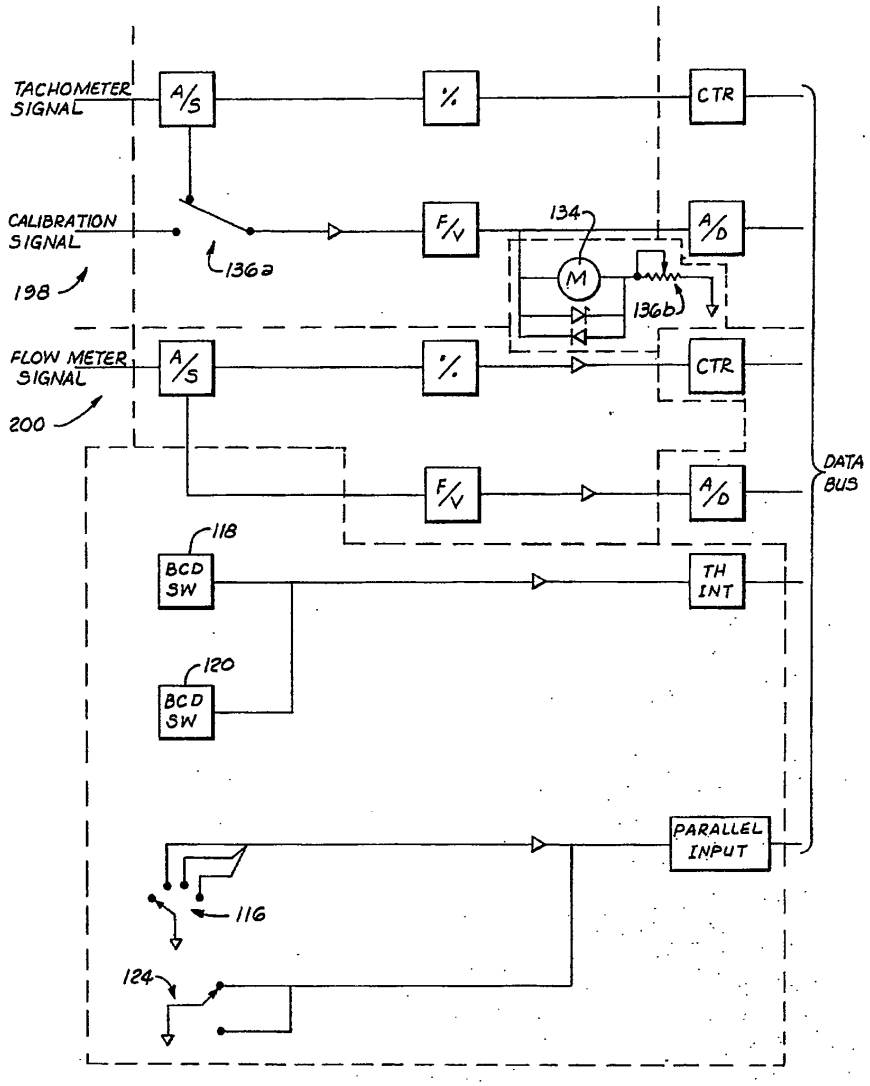

TACHOMETER SIGNAL
A/S
%
CTR
CALIBRATION SIGNAL
198
136a
F/V
134
A/D
M
136b
FLOW METER SIGNAL
200
A/S
%
CTR
F/V
A/D
DATA BUS
118
BCD SW
TH INT
120
BCD SW
PARALLEL INPUT
116
124

FIG. 10

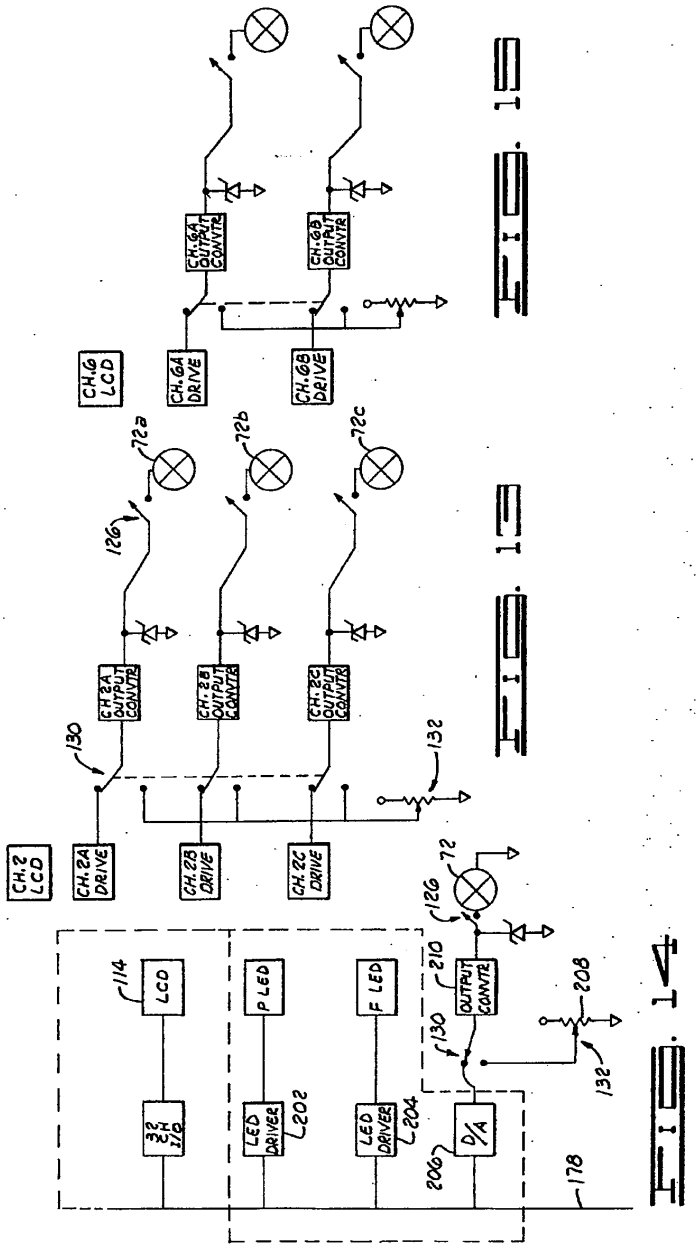


FIG. 15

FIG. 16

FIG. 17

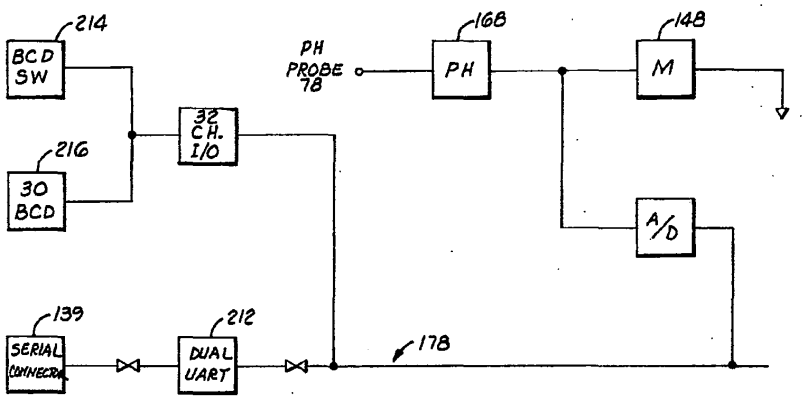
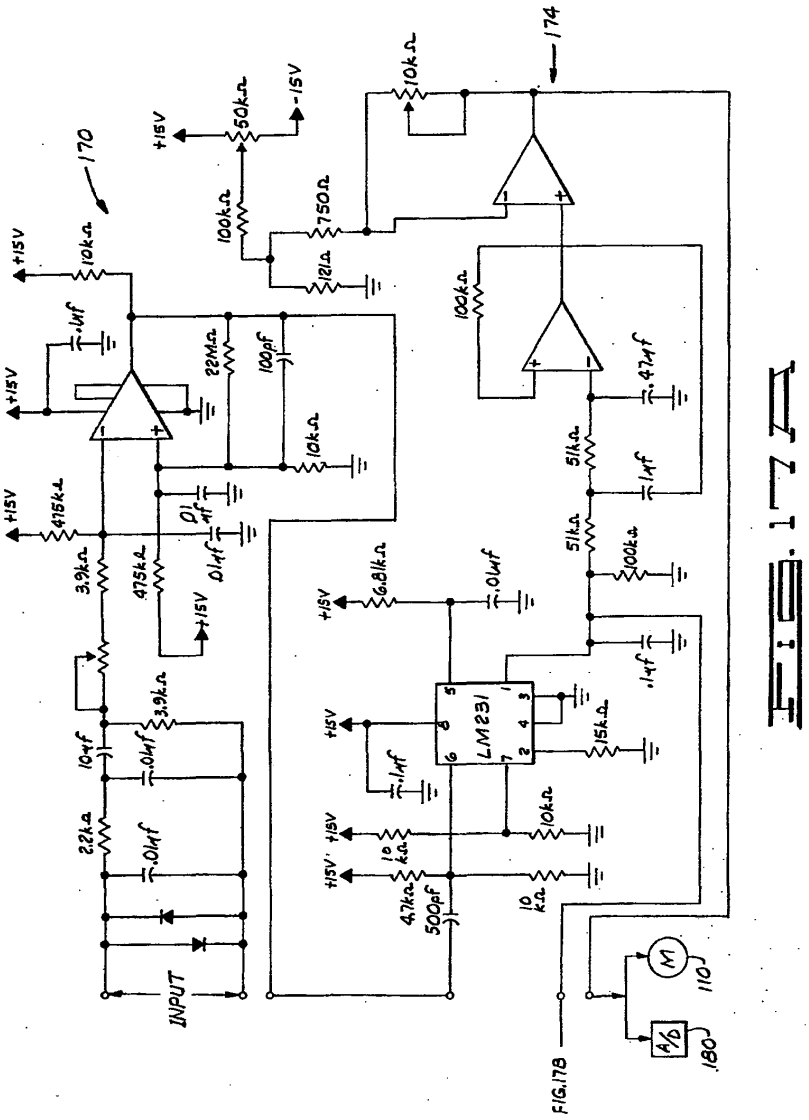

214
BCD SW
216
30 BCD
32 CH. I/O
PH PROBE 78
168
PH
148
M
A/D
139
SERIAL CONNECTOR
212
DUAL UART
178

FIG. 1B


170
174
+15V
-15V
50k.Ω
100k.Ω
750Ω
121Ω
10k.Ω
.1μf
22MΩ
100pF
.01μf
415kΩ
3.9kΩ
475kΩ
3.9kΩ
.1μf
.01μf
2.2kΩ
.01μf
INPUT
16.8kΩ
.01μf
LM231
.1μf
15kΩ
10kΩ
10 kΩ
4.7kΩ
500pF
10 kΩ
100kΩ
51kΩ
51kΩ
100kΩ
.47μf
.1μf
.1μf
M
110
A/D
180
FIG.17B

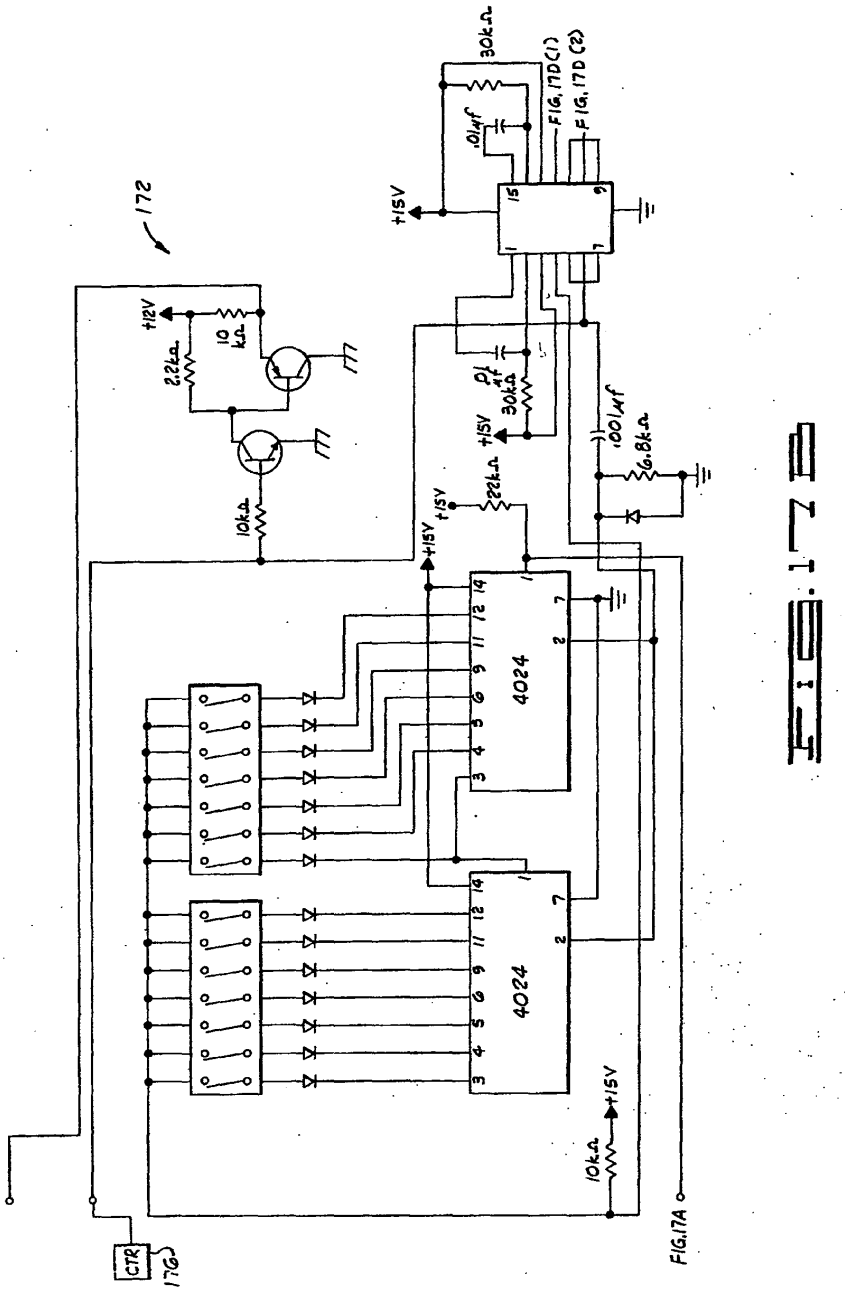

172
+12V
10 kΩ
2.2kΩ
10kΩ
+15V
30kΩ
.01μf
FIG. 17D (1)
FIG. 17D (2)
.01μf
30kΩ
22kΩ
.001μf
6.8kΩ
4024
4024
10kΩ
CTR
17G
FIG. 17A

FIG. 17

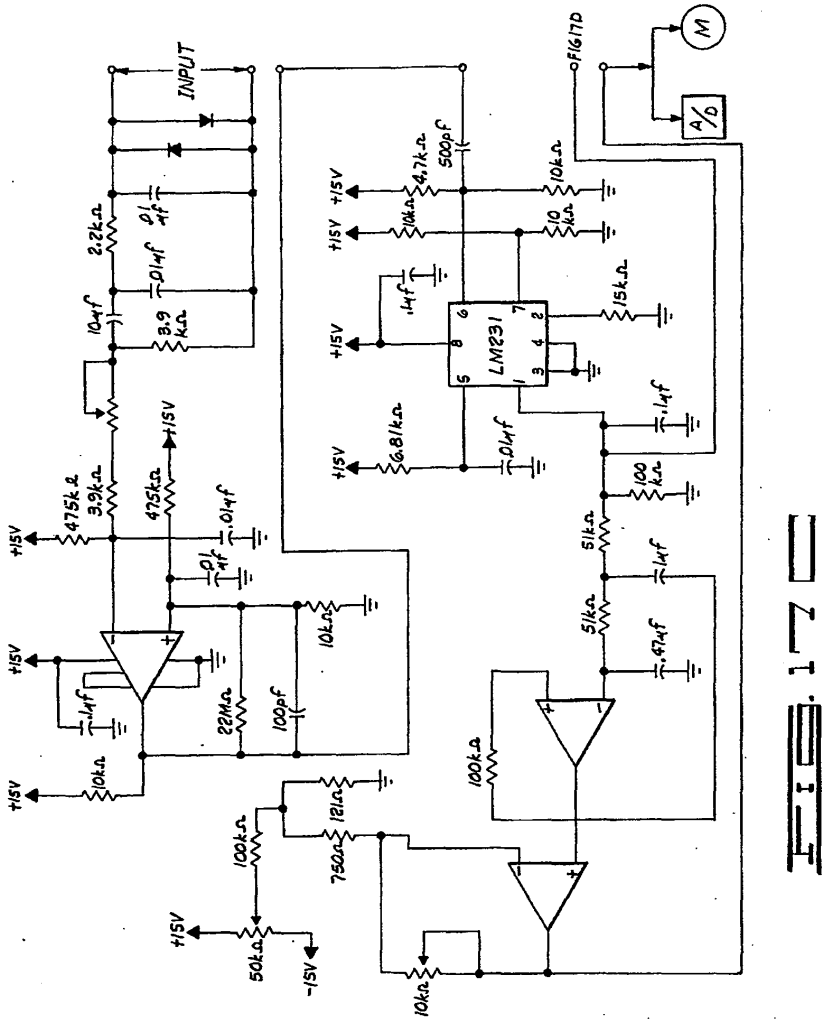

INPUT
FIG17D
M
A/D
LM231
+15V
-15V
2.2k.n
.01μf
.1μf
3.9 kΩ
475k.n
3.9k.n
.01μf
22MΩ
100pF
10k.n
4.7k.n
500pF
10kΩ
15k.n
6.81k.n
51k.n
100 k.n
.47μf
100k.n
121Ω
750Ω
50kΩ
10kΩ

FIG 17

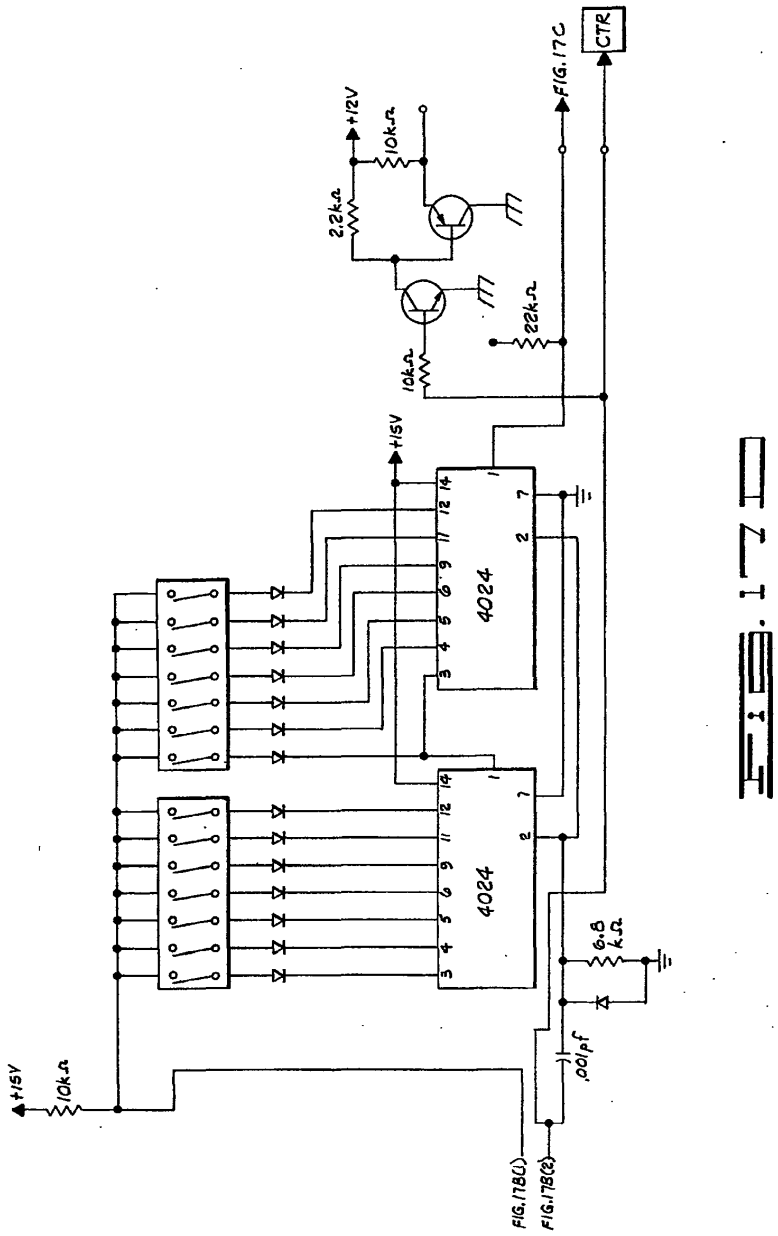

+12V
10k.Ω
2.2k.Ω
22k.Ω
10k.Ω
FIG.17C
CTR
+15V
4024
4024
6.8 k.Ω
.001μf
+15V
10k.Ω
FIG.17B(1)
FIG.17B(2)

Fig. 17

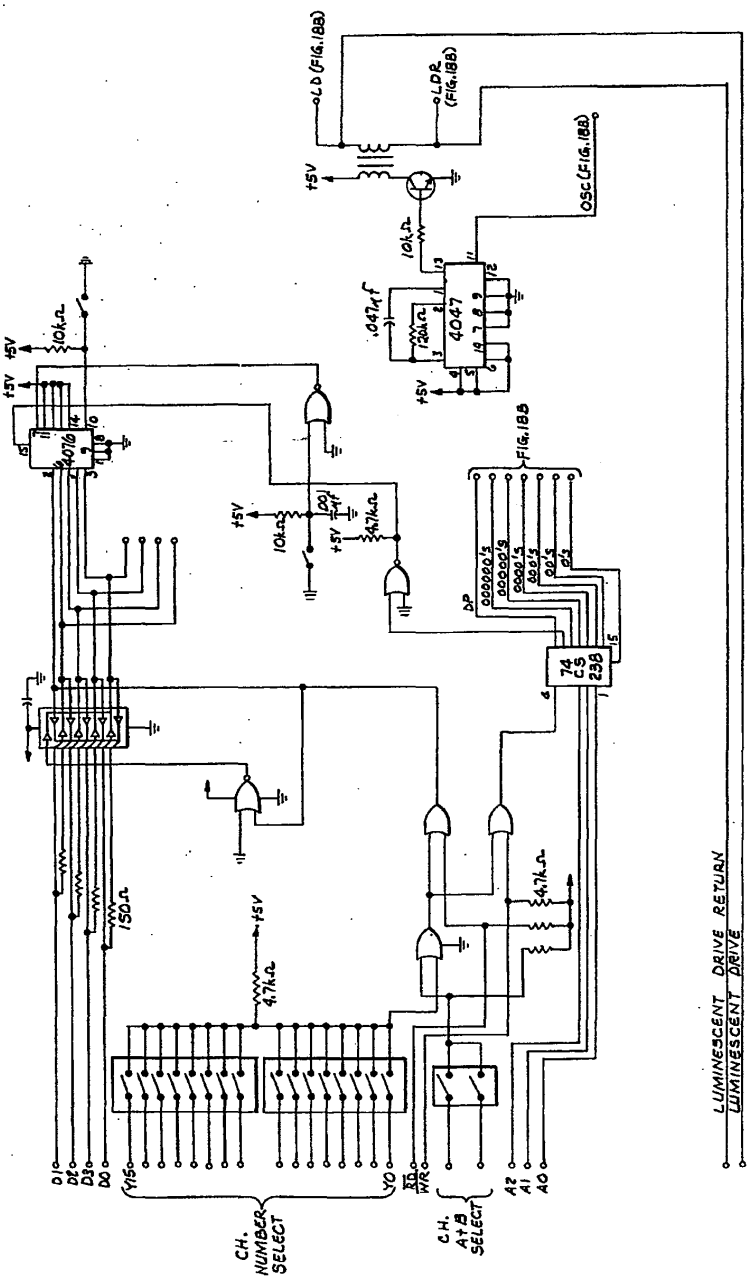

LCD (FIG.18B)
LDR (FIG.18B)
OSC (FIG.18B)
+5V
10kΩ
4047
.047μF
FIG.18B
74 CS 238
4.7kΩ
150Ω
LUMINESCENT DRIVE RETURN
LUMINESCENT DRIVE
CH. NUMBER SELECT
CH. A+B SELECT

FIG. 18A

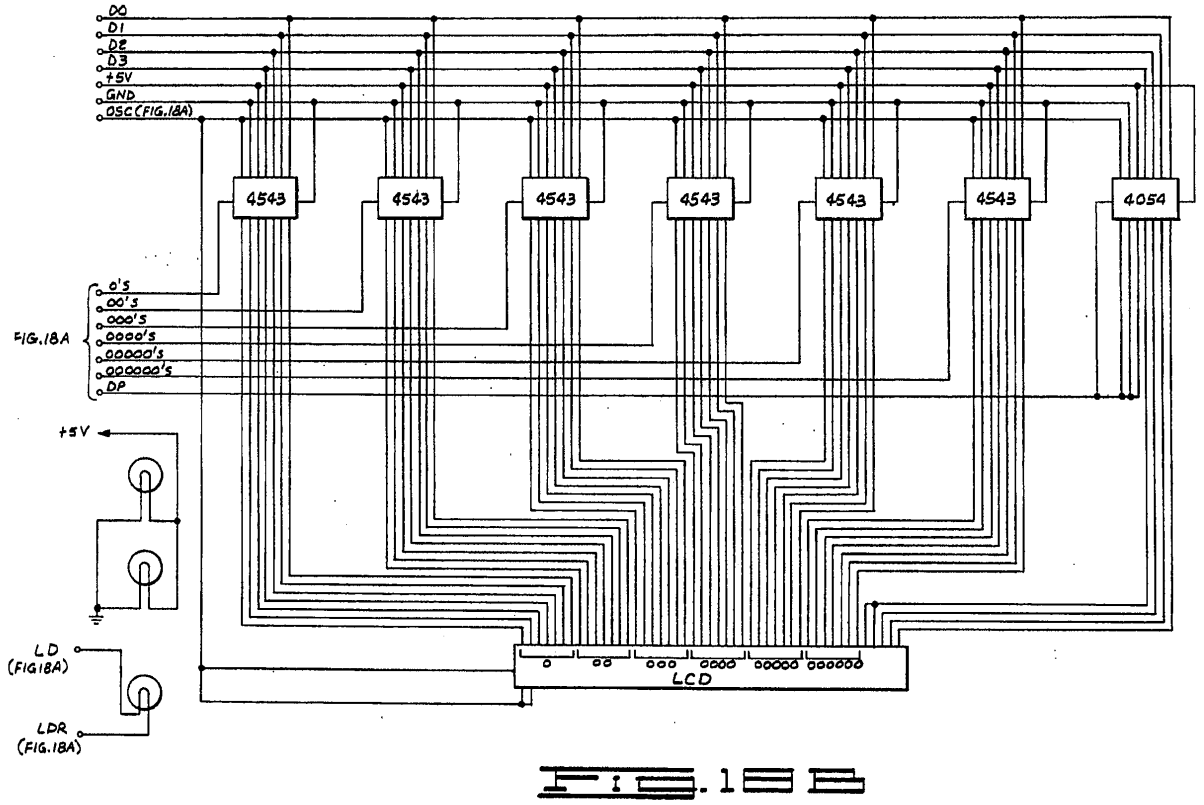


FIG. 1

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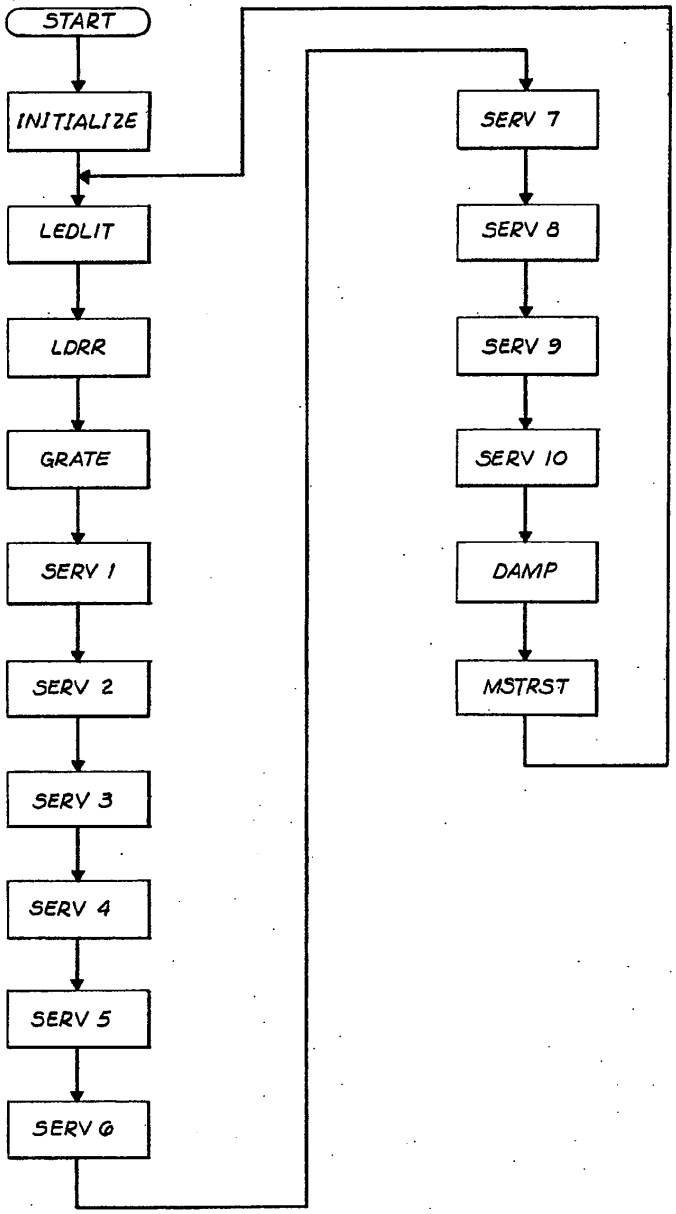

START
INITIALIZE
LEDLIT
LDRR
GRATE
SERV 1
SERV 2
SERV 3
SERV 4
SERV 5
SERV 6
SERV 7
SERV 8
SERV 9
SERV 10
DAMP
MSTRST

FIG. 19

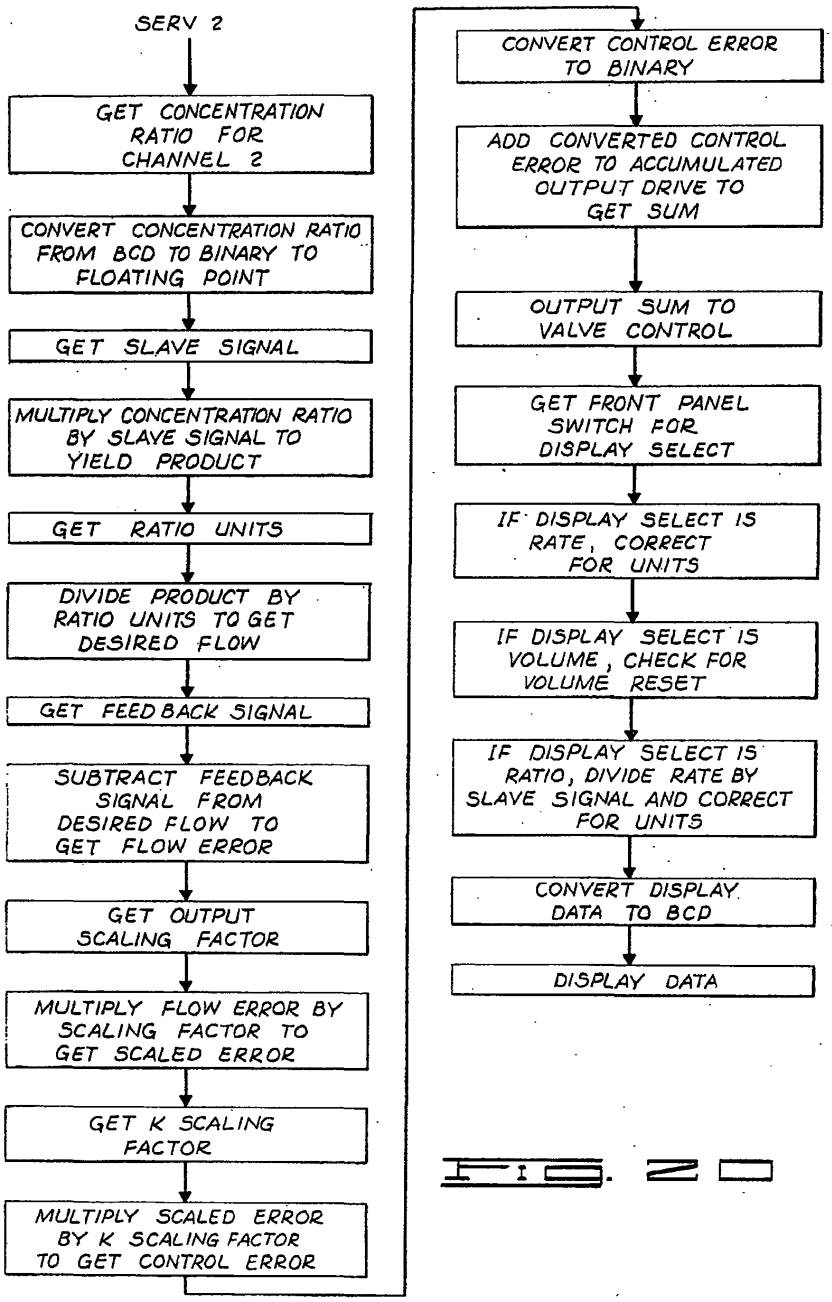

SERV 2
GET CONCENTRATION RATIO FOR CHANNEL 2
CONVERT CONCENTRATION RATIO FROM BCD TO BINARY TO FLOATING POINT
GET SLAVE SIGNAL
MULTIPLY CONCENTRATION RATIO BY SLAVE SIGNAL TO YIELD PRODUCT
GET RATIO UNITS
DIVIDE PRODUCT BY RATIO UNITS TO GET DESIRED FLOW
GET FEEDBACK SIGNAL
SUBTRACT FEEDBACK SIGNAL FROM DESIRED FLOW TO GET FLOW ERROR
GET OUTPUT SCALING FACTOR
MULTIPLY FLOW ERROR BY SCALING FACTOR TO GET SCALED ERROR
GET K SCALING FACTOR
MULTIPLY SCALED ERROR BY K SCALING FACTOR TO GET CONTROL ERROR
CONVERT CONTROL ERROR TO BINARY
ADD CONVERTED CONTROL ERROR TO ACCUMULATED OUTPUT DRIVE TO GET SUM
OUTPUT SUM TO VALVE CONTROL
GET FRONT PANEL SWITCH FOR DISPLAY SELECT
IF DISPLAY SELECT IS RATE, CORRECT FOR UNITS
IF DISPLAY SELECT IS VOLUME, CHECK FOR VOLUME RESET
IF DISPLAY SELECT IS RATIO, DIVIDE RATE BY SLAVE SIGNAL AND CORRECT FOR UNITS
CONVERT DISPLAY DATA TO BCD
DISPLAY DATA

FIG. 2

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(54) Vessel agitator for early hydration of concentrated liquid gelling agent.

(57) A system is provided for mixing of concentrated liquid gelling agent and water to form a fracturing fluid for fracturing of a subterranean formation. High shear rotary mixers (54) are utilized in a blender tub (20) to provide efficient hydration of the concentrated liquid gelling agent and water mixture.

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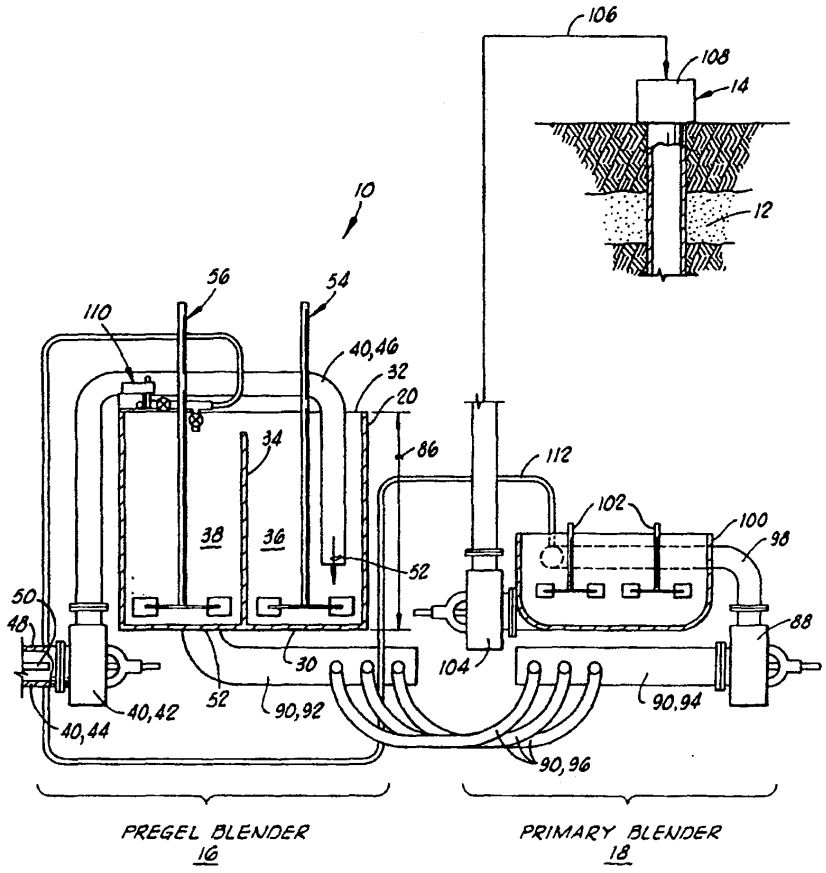

106
108
14
12
10
56
54
110
40,46
32
20
86
34
112
102
100
98
38
36
52
50
48
88
30
104
52
90,92
90,94
40,42
40,44
90,96
PREGEL BLENDER
16
PRIMARY BLENDER
18

FIG. 1

Background Of The Invention

1. Field Of The Invention

The present invention relates generally to the fracturing of wells, and more particularly to a mixer system for mixing concentrated liquid gelling agent and water in an efficient manner to provide rapid and efficient hydration of the concentrated liquid gelling agent.

2. Description Of The Prior Art

It is well known in the oil industry to fracture wells using gelled fracturing fluids to carry sand and other particulate materials into the subterranean formation of the well.

Originally, such gelled fracturing fluids were mixed from dry polymer materials. More recently, it has become common to utilize a concentrated liquid gelling agent which carries the polymer phase dispersed in an oil based fluid. That concentrated liquid gelling agent is mixed with water shortly before the sand or other particulate material is added. Then the sand laden gel is pumped into the well. In order for the gelled fracturing fluid to develop its full viscosity and thus its full sand carrying capacity, it is necessary for the polymer material contained in the concentrated liquid gelling agent to be hydrated, i.e., to absorb water. In the absence of intense shear complete hydration of the gel does not occur for fifteen minutes or more after the guar based polymer is mixed with water. Therefore, continuous mixing of concentrated liquid gelling agent can require holding vessels of very large volumes so that sufficient hydration for proppant support will have occurred before the fluid enters the fracturing blender tub or sand tub.

The time required for the hydration of the gel can be reduced by subjecting the gel to high shear.

The prior art approach to increasing the rate of hydration is represented by U. S. Patent No. 4,828,034 to Constien et al. which discloses a system utilizing a high shear pump to pump the gel through a static mixer to impart shear energy to the gel. Systems like that of the Constien et al. patent, however, as actually used in the field, still typically require a blender tub operating volume on the order of 200 barrels in order to provide sufficient residence time. A 200-barrel blender tub makes an extremely large unit which is difficult to transport to the field.

Thus, there is still a need for an efficient compact system for mixing of concentrated liquid gelling agents and water to form fracturing fluids.

Summary Of The Invention

The present invention provides a system for mixing of concentrated liquid gelling agent and water to form a fracturing fluid for fracturing of a subterranean formation. The system relies upon a high shear rotary mixing means disposed in the blender tub.

Preferably, the blender tub is divided into first and second zones. First and second rotary mixers are disposed in the first and second zones. The plurality of rotary mixers provides a total circulation flow rate at least an order of magnitude greater than the mixture flow rate through the tub so that an average fluid particle of the mixture passes through the mixers a total of at least ten times while passing through the blender tub.

A total mixer specific energy input from the mixers into the mixture is greater than a total pump specific energy input into the mixture from the various pumps associated with the system. This provides a relatively much more efficient viscosity enhancement of the mixture than would be provided for an equivalent combined total mixer and pump specific energy input wherein the total pump specific energy input exceeded the total mixture specific energy input.

Numerous objects, features and advantages of the present invention will be readily apparent to those skilled in the art upon a reading of the following disclosure when taken in conjunction with the accompanying drawings.

Brief Description Of The Drawings

FIG. 1 is a schematic illustration of the mixing system of the present invention.

FIG. 2 is an elevation view of one of the rotary mixers utilized with the present invention.

FIG. 3 is an elevation sectioned view of the rotor of the mixer of FIG. 2.

FIG. 4 is a plan view of the rotor of FIG. 3.

FIG. 5 is a plan view of the blender tub which is approximately to scale and shows the relationship of the two rotary mixers as placed within the two zones of the blender tub.

Detailed Description Of The Preferred Embodiments

Referring now to the drawings, and particularly to FIG. 1, a system 10 is thereshown for the mixing of concentrated liquid gelling agent and water to form a fracturing fluid for fracturing of a subterranean formation 12 of a well 14.

The system 10 basically is comprised of a pre-gel blender portion 16 and a primary blender portion 18.

The pregel blender portion 16 includes a blender tub 20 which is generally rectangular parallelpiped in shape having four sides 22, 24, 26 and 28 (see FIG. 5), a closed bottom 30 and an open top 32.

A weir 34 which may be generally referred to as a divider means 34 divides the tub 20 into first and second zones 36 and 38, respectively.

A supply means 40 comprised of a supply pump 42, a mixing manifold 44 and a supply conduit 46 introduces a concentrated liquid gelling agent and water mixture into the open upper end 32 of blender tub 20 at a mixture throughput flow rate. The open upper end 32 of blender tub 20 may also be described as an inlet 32 of the blender tub 20.

The mixing manifold 44 includes a large diameter outer pipe 48 through which an annular water stream flows, and a concentric axially located inner pipe 50 which brings a stream of concentrated liquid gelling agent into contact with the water just prior to the entry of the mixture of those fluids into the suction of the supply pump 42.

The general makeup of typical concentrated liquid gelling agents is described in detail in U. S. Patent No. 4,772,646 to Harms et al., and U. S. Patent No. 4,828,034 to Constien et al., the details of which are incorporated herein by reference.

The mixture of concentrated liquid gelling agent and water is introduced by the supply conduit 46 through the open upper end 32 of blender tub 20 into first zone 36. The mixture is directed downwardly as indicated by arrow 52 toward the closed bottom 30 of blender tub 20. The mixture will then flow up through first zone 36, over weir 34, into the second zone 38 of blender tub 20. An outlet 52 defined in the closed bottom 30 within the second zone 38 allows the mixture to be withdrawn from the second zone 38.

First and second rotary mixers schematically illustrated as 54 and 56 in FIG. 1 are disposed in the first and second zones 36 and 38, respectively. It is noted that the mixers 54 and 56 are only schematically illustrated in FIG. 1 and their size is very much exaggerated in relation to the size of the blender tub 20. The preferred relative dimensions of the mixer and tub are further described below with regard to FIG. 5.

FIG. 2 is an elevation view of the first rotary mixer 54, and FIG. 5 shows in plan view the location of the first rotary mixer 54 within the first zone 36 of blender tub 20.

The rotary mixer 54 is a high shear rotary mixer and includes a rotor generally designated by the numeral 58 and a stator generally designated by the numeral 60 (see FIG. 5). The rotor 58 as best seen in FIGS. 3 and 4 includes a shaft 62 carrying a disc 64 near its lower end upon which are mounted a plurality of flat non-pitched rotor blades 66. In the illustrated embodiment, there are eight rotor blades 66 on the rotor 58. The stator 60 has sixteen flat non-pitched stator blades 68 as best seen in FIG. 5. There is a relatively small clearance of approximately ¼-inch between the rotor blades 66 and stator blades 68 as the rotor blades 66 rotate within the stator blades 68. This small clearance provides a region of intense shear of the fluid mixture being circulated within the blender tub 20 by the mixers 54 and 56.

The rotor 58 is mounted within a framework 70 having a lower shaft bearing 72 and an upper shaft bearing 74. A motor 76 drives the shaft 62 through a gear box 78 and a flexible roller chain coupling 80.

As best seen in FIG. 5, the rotary mixer 54 is located generally centrally within the first zone 36 of blender tub 20.

The blender tub 20 in a preferred embodiment has a length 82 of approximately 108 inches, a width 84 of approximately 94 inches, a height 86 of approximately 79 inches, and the weir 34 has a height of approximately six feet. This gives the blender tub 20 an operating capacity, that is the volume therein up to height of the weir 34, of approximately 70 barrels. More generally, the blender tub 20 preferably has an operating volume of no greater than 100 barrels, thus providing a relatively compact unit for transport to the field.

The mixer 54 as best seen in FIG. 5 has a framework length 88 and a framework width 90 each of approximately 21½ inches. Rotor 66 has a diameter of approximately eighteen inches across the rotor blades 66. Each of the rotor blades 66 has a radial length of 4.5 inches and a height of 3.6 inches.

The supply pump 42 preferably is a centrifugal pump which can supply the concentrated liquid gelling agent and water mixture to the system 10 at a mixture throughput flow rate ranging from 10 to 100 barrels per minute.

Each of the mixers 54 and 56 in the preferred embodiment has a 107 horsepower motor 76 operating at 550 rpm which provides a circulation rate of approximately 1200 barrels per minute in each of the zones 36 and 38.

The zone volume, approximately 35 barrels for each of the zones 36 and 38, divided by the agitator flow

rate of approximately 1200 barrels per minute yields the average time required by a fluid particle to complete a circulation loop through the impeller of one of the mixers. In the case just described, that time is 1.7 seconds per loop. Thus, for an example mixture throughput flow rate from the pump 42 of 70 barrels per minute, a fluid particle would spin an average time of one minute in the 70 barrel holding tank. During that one minute at 1.7 seconds per loop, an average fluid particle would circulate through the impeller of either mixer 54 or mixer 56 a total of approximately 35 times. Thus, the shear history of an average fluid particle in this example is one of 35 extremely short periods of intense shear separated by longer periods of low shear occurring over a time duration of sixty seconds. As further discussed below, this shear history is significantly different than that provided by an enclosed device such as a static mixer which provides a probably higher frequency of intense shear for a much shorter time duration.

Stated in another way, the rotary mixers 54 and 56 can be described as providing a total circulation flow rate (i.e., 2 x 1200 = 2400 BPM in the above example) at least an order of magnitude greater than the mixture throughput flow rate (70 BPM in the above example) so that an average fluid particle of the mixture passes through the mixers 54 or 56 a total of at least ten times while passing through the blender tub 20. More preferably the total circulation flow rate is at least twenty times greater than the mixture throughput flow rate, and even more preferably the total circulation flow rate is at least thirty times greater than the mixture throughput flow rate. In the example given the average particle would pass through the mixers 34.29 times (i.e., 2400/70).

Referring again to FIG. 1, the primary blender portion 18 of system 10 includes a primary blender suction pump 88 for pumping mixture away from the outlet 52 of the blender tub 20. The mixture is drawn from the outlet 52 of the blender tub 20 by an outlet conduit 90 comprised of a first manifold portion 92 connected to outlet 52, a second manifold portion 94 connected to the suction inlet of primary blender suction pump 88 and a plurality of flexible hoses 96 connecting the first and second manifold portions 92 and 94. The pregel blender portion 16 and primary blender portion 18 of blender system 10 are typically mounted on separate trailers, and the flexible hoses 96 are utilized to interconnect the components located on the two separate trailers.

The primary blender suction pump 88 discharges the mixture through conduit 98 into a relatively small sand tub 100 having a volume on the order of ten barrels, which is utilized to mix sand or other particulate material with the gelled mixture. Conventional rotary mixers 102 may be used in sand tub 100 to insure thorough mixture of the sand with the gelled fracturing fluid. A blender discharge pump 104 takes the sand laden fracturing fluid from sand tub 100 and pumps it through conduit 106 to positive displacement high pressure pumps (not shown) which discharge to wellhead 108 of the well 14.

A viscometer 110 may be mounted on the blender tub 20 for measuring the viscosity of the mixture entering the sand tub 100. That mixture is supplied to the viscometer 110 through a viscometer feed hose 112.

As previously mentioned, the blender tub 20 in a preferred embodiment has an operating volume of approximately 70 barrels. The sand tub 100 has an operating volume of approxi- mately ten barrels. The various conduits interconnecting all of the components between supply pump 42 and blender discharge pump 104 have a further volume of approximately ten barrels, thus defining an overall system 10 having a volume on the order of ninety barrels. The various locations where shear energy is input into the mixture are primarily the pumps 42, 88 and 104, and the high shear mixers 54 and 56.

We have discovered, as further explained below, that for a given specific energy input into a gelled fracturing fluid, the energy is much more efficiently used to increase hydration of the fluid if the energy is input at lower levels over a longer period of time rather than an intense burst over a very short period of time. Thus, large agitated tanks have been determined to be much more energy efficient viscosity producers than are small volume devices such as centrifugal pumps, static mixers and the like which are inefficient viscosity producers. Thus, it is preferred that a total mixer specific energy input from mixers 54 and 56 into the mixture be greater than the total pump specific energy input from pumps 42, 88 and 104 into the mixture. This provides a relatively more efficient viscosity enhancement of the mixture than would be provided for an equivalent combined total mixer and pump specific energy input wherein the total pump specific energy input exceeded the total mixer specific energy input.

For example, in a laboratory comparison of a high shear rotary mixer with a centrifugal pump the following data was obtained. A Waring blender utilizing a rotor and stator arrangement similar to that of mixer 54 was compared to a laboratory scale centrifugal pump. For equal energy inputs per unit mass of 0.50 calories per gram, the Waring blender produced an initial hydration rate of 17 centipoise per minute while the centrifugal pump's initial hydration rate was only 7.5 centipoise per minute.

As used herein, the term "specific energy input" means mechanical energy input per unit mass of the mixture, which may for example be measured in calories per gram.

The system 10 provides a very compact system. The system 10 has a total system volumetric capacity from the suction of pump 42 which may be considered to be the initial point of combination of the concentrated liquid gelling agent and water, to the discharge of blender discharge pump 104 of no greater than about 100

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barrels. The range of mixture throughput flow rates provided by supply pump 42 ranges from a minimum of about ten barrels per minute to a maximum of about 100 barrels per minute. Thus at the minimum flow rate of ten barrels per minute, the system 10 provides a maximum residence time of no greater than about ten minutes for the mixture. For the maximum flow rate of 100 barrels per minute, the system 10 provides a minimum residence time of at least one minute for the mixture.

Theoretical Comparison Of Hydration

Efficiencies Of Various Shear Input Devices

The following mathematical model of the hydration rate of gels in various shear input devices supports the conclusions stated above for the preference of high shear mixers in a blender tub as contrasted to devices such as high shear pumps with static mixers in line.

Several things are known about the initial hydration rate of any mixing device:

(1) Gel will hydrate in the absence of mixing energy given an initial dispersion.

(2) For a given mixing system, the initial hydration rate is an increasing function of specific mixing power. "Specific mixing power" means the rate at which energy is input to the mixture per gram of mixture.

(3) Some mixing systems produce greater hydration rates than other systems at equivalent specific mixing powers.

(4) Given constant conditions, viscosity develops in an exponential fashion. Mathematically,

$$\mu = \mu_\infty (1 - e^{-f(t)}), \quad \text{EQUATION 1}$$

where f is some positive function of time and μ_∞ is the ultimate viscosity. The constant conditions include temperature, pH, mixing system geometry, specific mixing power, gel concentration, and chemistry. For the above relationship;

$$\frac{d\mu}{dt} \sim \mu_\infty \quad \text{EQUATION 2}$$

A relatively simply model for initial hydration rate that exhibits all of the above behavior is:

$$\frac{d\mu}{dt}\Big|_o = \mu_\infty (C + kp^n) \quad \text{EQUATION 3}$$

where:

μ_∞ = ultimate apparent viscosity
C = static hydration constant
k = mixing system efficiency coefficient
p = specific mixing power
n = mixing power exponent.

Using the developed model of EQUATION 3 for initial hydration rate, a relationship can be written for initial viscosity development as follows:

$$\mu = \mu_o + \frac{d\mu}{dt}\Delta t \quad \text{EQUATION 4}$$

$$\mu = 1 + \mu_\infty (C + kp^{0.55})\,\Delta t_p + \mu_\infty C \Delta t_s \quad \text{EQUATION 5}$$

where:

Δt_p = duration of applied mixing power
Δt_s = duration of static condition

For an example where:

μ_∞ = 38 cp and
C = 0.0947 min^{-1}

Then:

$$\mu = 1 + 3.6\,(\Delta t_p + \Delta t_s) + 38k\,p^{0.55}\,\Delta t_p \quad \text{EQUATION 6}$$

When K = 0.458 $(g^n\ min^{n-1})/Cal^n$ (polytron impeller), then:

$$\mu = 1 + 3.6\,(\Delta t_p + \Delta t_s) + 17.4\,p^{0.55}\,\Delta t_p \quad \text{EQUATION 7}$$

Equation 6 is only valid for the early stages of hydration when the plot of viscosity vs. time is approximately a straight line. Equation 6 should probably not be applied for total hydration developments of more than approximately 70% or 80%.

Equation 6 is useful in answering an important question when designing a mixing system. If a given amount of specific mixing energy and hydration time are available, at what specific mixing power level is this available energy most efficiently applied? For example, if 0.5 Cal/g specific mixing energy and one minute of hydration time were available then:

$$p\,\Delta t_p = 0.5$$

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and the question is: What values of p and Δt_p whose product is 0.5 produce the maximum viscosity in one minute? For example when:

e = 0.5 cal/g
p = 0.5 cal/g min
Δt_p = 1 min and
Δt_e = 0
Equation 7 results in:
μ = 16.5 cp (after one minute)
When:
e = 0.5 Cal/g
p = 2 Cal/g min,
Δt_p = 0.25 min, and
Δt_e = 0.75 min
Then Equation 7 results in

$$\mu = 11.0 \text{ cp (after one minute)}$$

Clearly, equivalent amounts of specific mixing energy do not produce equivalent average hydration rates. For any given conditions of specific mixing energy e and available hydration time $\Delta t_p + \Delta t_e$, Equation 6 maximizes when Δt_p is maximum and p is minimum since the first two terms are constant. This result is due solely to the value of the specific mixing power exponent n. If n were greater than one, then minimizing Δt_p would maximize viscosity for a given specific mixing energy e and hydration time $\Delta t_p + \Delta t_e$. Even though the exact value of n is not known, it is known that $0.40 < n < 0.70$ and the above conclusions only require that $n < 1$.

The above conclusions are significant when designing or recommending mixing procedures for the purpose of producing maximum viscosity in a hydrating gel. The duration of applied mixing power Δt_p can be written in terms of volume and flow rate as:

$$\Delta t_p = \frac{V}{Q} \quad \text{EQUATION 8}$$

where
V = volume of fluid being sheared
Q = flow rate of produced gel.

Since the flow rate in continuous operations is fixed by the job requirements, then Δt_p must be maximized by maximizing the volume of fluid being sheared. This result indicates that large agitated tanks are energy-efficient viscosity producers while small-volume devices such as centrifugal pumps, static mixers, etc., are inefficient viscosity producers.

Thus it is seen that the apparatus and methods of the present invention readily achieve the ends and advantages mentioned as well as those inherent therein. While certain preferred embodiments have been illustrated and described for purposes of the present disclosure, numerous changes in the arrangement and construction of the invention may be made by those skilled in the art which changes are encompassed within the scope and spirit of the invention as defined by the appended claims.

Claims

1. A system for mixing of concentrated liquid gelling agent and water to form a fracturing fluid for fracturing of a subterranean formation, comprising:

   a blender tub having an inlet and outlet, and having a divider means for dividing said tub into a plurality of zones including at least a first zone and a second zone arranged so that fluid flowing into said inlet must flow through said first zone and then through said second zone to said outlet;

   supply means for introducing a concentrated liquid gelling agent and water mixture to said inlet at a mixture throughput flow rate; and

   a plurality of rotary mixers including at least first and second rotary mixers disposed in said first and second zones, respectively, said plurality of rotary mixers providing a total circulation flow rate at least an order of magnitude greater than said mixture throughput flow rate so that an average fluid particle of said mixture passes through said mixers a total of at least ten times while passing through said blender tub.

2. The system of claim 1, wherein:

   said first zone is in direct communication with said inlet so that fluid flowing through said inlet flows immediately into said first zone.

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3. The system of claim 1, wherein:
said second zone is in direct communication with said outlet so that said second zone is a final zone of said plurality of zones.

4. The system of claim 1, wherein:
said divider means includes an overflow weir dividing said first and second zones.

5. The system of claim 1, wherein:
said rotary mixers provide a total circulation flow rate at least twenty times greater than said mixture throughput flow rate so that said average fluid particle passes through said mixers a total of at least twenty times while passing through said blender tub.

6. The system of claim 1, wherein:
said rotary mixers provide a total circulation flow rate at least thirty times greater than said mixture throughput flow rate so that said average fluid particle passes through said mixers a total of at least thirty times while passing through said blender tub.

7. The system of claim 1, wherein:
said blender tub has a capacity of no greater than about one hundred barrels thus providing a relatively compact mixing system.

8. The system of claim 1, wherein:
said supply means includes supply pump means for pumping said mixture to said inlet of said blender tub after said concentrated liquid gelling agent and water are first combined;
said system further includes discharge pump means for pumping said mixture away from said outlet of said blender tub; and
a total mixer specific energy input from said mixers into said mixture is greater than a total pump specific energy input from said supply pump means and said discharge pump means into said mixture, thus providing a relatively more efficient viscosity enhancement of said mixture than would be provided for an equivalent combined total mixer and pump specific energy input wherein the total pump specific energy input exceeded the total mixer specific energy input.

9. The system of claim 8, wherein: said rotary mixers are high shear rotary mixers each including a rotor having a plurality of rotor blades and a stator having a plurality of stator blades, said rotor blades and stator blades having a relatively small clearance therebetween for providing a region of intense shear of said mixture as said mixture is circulated within said tub zones by said mixers, said rotor blades and stator blades preferably being flat non-pitched blades.

10. The system of claim 9, wherein: said system has a total system volumetric capacity from an initial point of combination of said concentrated liquid gelling agent and water to a point of discharge of said mixture from said system of no greater than about one hundred barrels thus providing a maximum residence time of no greater than about ten minutes at mixture throughput flow rates of at least ten barrels per minute.

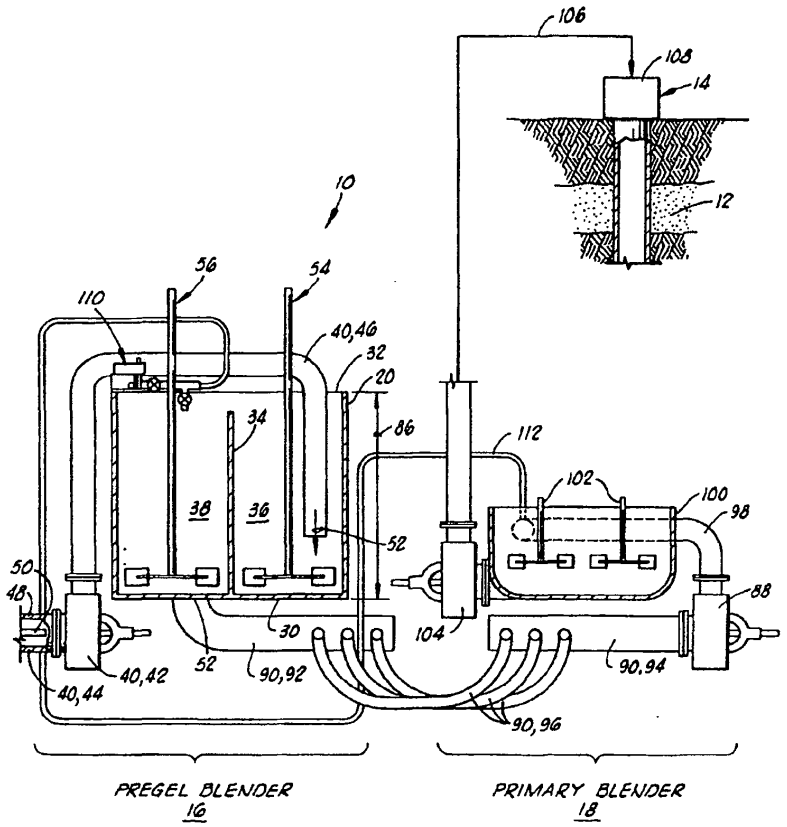

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Fig. 1

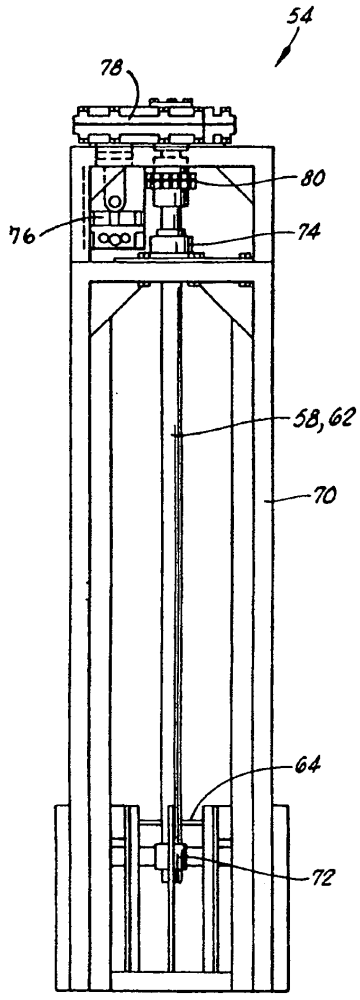


FIG. 2

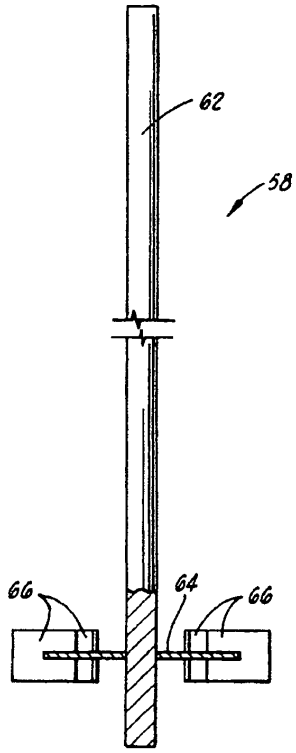


FIG. 3

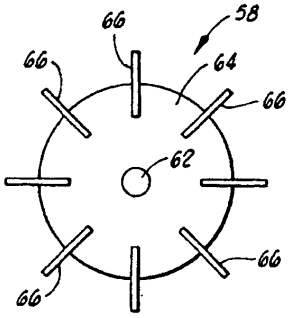


FIG. 4

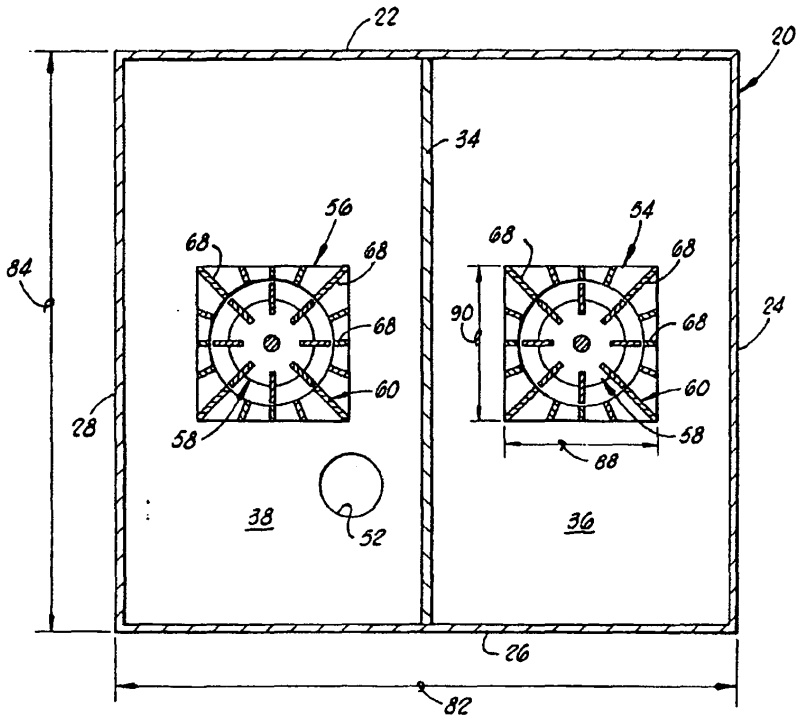

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FIG. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 30 3233

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US-A-2 128 447 (WRIGHT)	1-10	B01F13/10
A	FR-A-1 349 863 (UNILEVER)	9	
A	US-A-4 217 145 (GADDIS) * abstract *	1	
A	FR-A-2 050 199 (GRIFFON)		
A	DE-A-3 930 152 (SCHMIDT)		
A	US-A-2 324 988 (GREENUP)		
P,X	US-A-5 046 856 (MCINTIRE)	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B01F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28 JULY 1992	PEETERS S.

EPO FORM 1503 03.82 (P0401)

CATEGORY OF CITED DOCUMENTS

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(54) Title: APPARATUS AND METHOD FOR ACCELERATING HYDRATION OF PARTICULATE POLYMER

(57) Abstract: Disclosed is an apparatus and method for hydrating particulate polymer. In the presently preferred embodiment, the apparatus includes a storage assembly, a hydration assembly and a delivery assembly that connects the storage assembly to the hydration assembly. The hydration assembly preferably includes a pre-wetter, a high- energy mixer and a blender. The preferred method for hydrating the particulate polymer includes transferring the polymer from the storage assembly to the hydration assembly. The method further includes pre-wetting the particulate polymer with a hydration fluid to form a gel, mixing the gel with additional hydration fluid in a high-energy mixer and blending the gel in a blender. The method may also include removing any air entrained in the gel in a weir tank.

APPARATUS AND METHOD FOR ACCELERATING HYDRATION OF PARTICULATE POLYMER

Related Applications

This application claims the benefit of United States Provisional Patent Application No. 60/395,084 filed July 11, 2002, which is herein incorporated by reference.

Field of the Invention

The present invention generally relates to the preparation of substances useable as well treatment fluids. More particularly, the present invention relates to the accelerated hydration of a polymer gel agent. Once hydrated, the polymer gel can be combined with suitable particulate matter ("proppant") or other chemicals to yield well treatment fluids. Well treatment fluids are commonly used in fracturing, acidizing, completion and other wellbore operations.

Background of the Invention

High viscosity water based well treatment fluids, such as fracturing fluids, acidizing fluids, and high density completion fluids, are commonly used in the oil industry in treating oil and gas wells. These fluids are normally made by suspending proppant material with a carrier gel at the well site. Typically, the carrier gel is produced using dry polymer additives or agents, which are mixed with water or other fluids at the well site or at a remote location.

The mixing procedures used in the past have inherent problems. The earliest batch mixing procedures involved mixing sacks of the polymer in tanks at the job site.

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This method produced inaccurate mixing and lumping of the powder into insoluble "gel balls" or "fisheyes" which obstructed the flow of the gel and generated chemical dust hazards.

To achieve better mixing, it is known to delay hydration long enough for the individual polymer particles to disperse and become surrounded by water so that no dry particles are trapped inside a gelled coating to form a gel ball. This delay can be achieved by coating the polymer with material such as borate salts, glyoxal, non-lumping HEC, sulfosuccinate, metallic soaps, surfactants, or other materials of opposite surface charge to the polymer. Another known way to improve the efficiency of polymer addition to water and derive the maximum yield from the polymer is to prepare a stabilized polymer slurry ("SPS"), also referred to as a liquid gel concentrate ("LGC"). The liquid gel concentrate is premixed and then later added to the water.

Although aqueous-based liquid gel concentrates have worked well at eliminating gel balls, aqueous concentrates can suspend only a limited quantity of polymer due to the physical swelling and viscosification that occurs in a water-based medium. Typically, about 0.8 pounds of polymer can be suspended per gallon of the concentrate. By using a hydrocarbon carrier fluid, rather than water, higher quantities of solids can be suspended. Hydrocarbon-based liquid gel concentrates can be later mixed with water in a manner similar to that for aqueous-based liquid gel concentrates.

In environmentally sensitive locations, however, governmental regulations restrict the use of hydrocarbon-based liquid gel concentrates. There are numerous environmental problems associated with the clean-up and disposal of both hydrocarbon-based concentrates and well treatment gels containing hydrocarbons; as

well as with the clean-up of the tanks, piping, and other handling equipment which have been contaminated by the hydrocarbon-based gel.

In addition to prior art homogenization and capacity limitations, transporting premixed liquid gel concentrate in bulk to offshore and remote locations is cost prohibitive. Service vehicles utilized to supply offshore and remote locations have a limited storage capacity and are often forced to make multiple trips between the production facility and the remote location, particularly when the liquid gel concentrate is water-based.

Because it is easier and more cost effective to transport the polymer and hydrating fluid separately, it is desirable to continuously mix a well treatment gel "on-the-fly" during the actual treatment of the subterranean formation from dry ingredients. Such on-line systems could satisfy the fluid flow requirements for large hydraulic fracturing jobs during the actual fracturing of the subterranean formation by continuously mixing the fracturing gel.

One method and apparatus for continuously mixing a fracturing gel is disclosed in United States Patent No. 4,828,034 to Constien et al., in which a fracturing fluid slurry concentrate is mixed through a static mixer device on a real time basis with a hydrocarbon-based solvent, such as diesel. The slurry is then pushed through baffled tanks in a first-in, first-out flow pattern to produce a hydrated fracturing fluid during the actual fracturing operation. Because hydrocarbon-based fluids are used to prepare the gel, this technology has limited application under modern regulatory programs.

United States Patent No. 5,190,374 to Harms et al., discloses a method and apparatus for continuously producing a carrier gel, by feeding dry polymer into an axial flow mixer which uses a convergent fluid mixing energy to wet the polymer

during its initial contact with water. During use, however, the dry polymer splatters tends to stick to the walls of the mixer, accumulate and eventually choke the flow through the mixer.

Accordingly, there is a need for a process to produce a carrier gel in which relatively higher amounts of polymer per unit volume can be utilized while eliminating the environmental problems and objections related to hydrocarbon-based concentrates. There is also a need for apparatus and method for producing carrier gels on a substantially continuous basis during the well treatment operation to alleviate the problems of storing and transporting pre-mixed carrier gels.

Summary of the Invention

The present invention includes an apparatus and method for hydrating particulate polymer. In the presently preferred embodiment, the apparatus includes a delivery assembly that connects a storage assembly to a hydration assembly. The hydration assembly preferably includes a pre-wetter, a high-energy mixer and a blender.

The preferred method for hydrating the particulate polymer includes transferring the polymer from the storage assembly to the hydration assembly. The method further includes pre-wetting the particulate polymer with a hydration fluid to form a gel, mixing the gel with additional hydration fluid in a high-energy mixer and blending the gel in a blender. The method may also include removing any air entrained in the gel in a weir tank.

Brief Description of the Drawings

FIG. 1 is a side elevational view of an apparatus capable of hydrating particulate polymer constructed in accordance with a presently preferred embodiment of the present invention.

FIG. 2 is a side elevational view of a preferred embodiment of the hydration assembly of the apparatus of claim 1.

FIG. 3 is a side view of an alternate embodiment of the mixer of FIG. 2.

FIG. 4 is a flowchart of a preferred method for hydrating particular polymer.

Detailed Description of the Preferred Embodiment

As disclosed herein, a carrier gel ("gel") is prepared through the combination of a substantially dry polymer and a hydration fluid, such as water. The gel can be subsequently diluted or blended with proppant material or chemicals to produce a well treatment fluid. Although the present invention is not so limited, a particularly suitable polymer is disclosed in United States Patent Application No. 10/146,326, filed by White. As used herein, the term "particulate" broadly designates solids capable of movement through augers or similar devices and includes solids otherwise referred to as "granular," "pulverized," "powder" or by related terms. Although the term "polymer" typically refers to synthetic materials, as used herein, the term "polymer" also includes naturally occurring materials, such as guars and gums

Referring first to FIG. 1, shown therein is a side elevational view of a hydration apparatus 100 constructed in accordance with a preferred embodiment of the present invention for preparing a carrier gel from a substantially dry particulate polymer and a hydrating fluid. The hydration apparatus 100 preferably includes a polymer storage assembly 102, a delivery assembly 104, a hydration assembly 106

and a power assembly 108. In the preferred embodiment, a trailer 110 supports the storage, delivery, hydration and power assemblies 102, 104, 106 and 108, respectively. The trailer 110 is configured for attachment to common trucks or semi-tractors. It will be understood that each of the separate components of the apparatus 100 could also be supported by other fixed or mobile structures, such as skids, boats or concrete pads.

The power assembly 108 preferably includes an engine 112 that directly or indirectly drives one or more hydraulic pumps, electric generators and pneumatic compressors (not shown). In the preferred embodiment, the hydraulic pumps, electric generators and pneumatic compressors are used to provide power to the various other components within the apparatus 100. The construction of power systems for service equipment is well known in the art.

The storage assembly 102 is configured to contain substantially dry polymer prior to hydration. In the presently preferred embodiment, the storage assembly 102 includes a plurality of removable tote tanks 114 and a receiving rack 116 configured to support the tote tanks 114. In the preferred embodiment, the receiving rack 116 is designed to receive the legs on each of the tote tanks 114 and is equipped with double locking pins. The receiving rack 116 preferably includes one or more pneumatic vibrators 118 that generate gentle harmonics that aid the flow of the dry polymer from the tote tanks 114.

Each tote tank 114 preferably includes an anti-bridging discharge cone 120 equipped with a shut-off knife valve 122. The operation of the knife valves 120 control the flow of dry particulate polymer from each tote tank 114. In a particularly preferred embodiment, the storage assembly 102 includes four tote tanks 114, each with separate discharge cones 118, shut-off valves 122 and pneumatic vibrators 118.

During use of the apparatus 100, one or more of the tote tanks 114 can be simultaneously used to supply the necessary dry polymer. In this way, empty tote tanks 114 can be advantageously replaced with full tote tanks 114 without interrupting a continuous delivery of polymer to the hydration assembly 106. Furthermore, unlike conventional bulk polymer storage designs, the tote tanks 114 can be substantially sealed to prevent the hydrophilic polymer from prematurely hydrating with ambient moisture.

The delivery system 104 preferably includes a metering auger 124, a collection chamber 126, a transfer auger 128, a discharge chamber 130 and related controls (not shown). In the presently preferred embodiment, gravity moves the dry particulate polymer from the tote tanks 114 to the metering auger 124. Each of the components in the delivery system 104 is preferably sealed to reduce the exposure of the dry polymer to ambient or environmental moisture. Although not shown in FIG. 1, an additional intermediate sealed hopper can be used to connect the discharge cones 118 with the metering auger 124 to increase the flow of polymer from the tote tanks 114 and further prevent the introduction of ambient moisture to the system.

The metering auger 124 moves the particulate polymer at a selected volumetric rate from the tote tanks 114 to the collection chamber 126. The polymer is then moved from the collection chamber 126 to the hydration assembly 106 with the transfer auger 128. The collection chamber 126 is preferably equipped with a 45° angled inlet and provides an area for the transfer of material from the metering auger 124 to the transfer auger 128. In the preferred embodiment, the transfer auger 128 is flexible to permit bending from the 45° inlet of the collection chamber 126 to a nearly vertical position. In this way, polymer is carried up the transfer auger 128 from the collection chamber 126 to the discharge chamber 130. The discharge chamber 130

provides a sealed conduit between the delivery assembly 104 and the hydration unit 106.

In the presently preferred embodiment, the metering auger 124 and transfer auger 128 include high-torque hydraulic motors 132 and 134, respectively, that are controlled electronically over hydraulic proportional valves (not shown) with manual control valves as redundant backups (not shown). In the preferred embodiment, the proportional control valves receive a signal from a programmable logic circuit that is pre-programmed with the desired ratio of polymer to water. As such, the programmable logic circuit can automatically control the delivery rates of polymer to the hydration assembly 106 through the metering auger 124 and transfer auger 128 in response to the volumetric flowrate of water being drawn into the apparatus 100. This control system permits the apparatus 100 to be programmed to track the operational characteristics of downstream equipment, such as gel/proppant blenders and pumper units. It will be understood that these and other control systems for the apparatus 100 can be located in a control station on the trailer 110 or at a remote location.

Turning next to FIG. 2, shown therein is a side elevational view of the hydration assembly 106. The hydration assembly 106 preferably includes a pre-wetter 136, a high-energy mixer 138, a blender 140 and a weir tank 142. The hydration assembly 106 further includes an intake manifold 144, at least one pump 146 and a discharge manifold 148.

In the presently preferred embodiment, the pump 146 is a mission-style centrifugal pump. The intake manifold 144 is preferably configured for connection with conventional fluid piping or hoses (not shown) to bring hydration fluid into the apparatus 100 from a hydration fluid source. The hydration assembly 106 further includes an intake valve 150 that manually or automatically controls the flow of

pressurized hydration fluid from the pump 146 to the hydration assembly 106. High-pressure fluid supply lines (not numerically designated) connect the pump 146 to the pre-wetter 136 and high-energy mixer 138.

The pre-wetter 136 is preferably a venturi-cyclone type mixer in which high pressure hydration fluid creates a high-velocity, rapidly spinning funnel as it passes through the pre-wetter 136. To achieve the cyclonic flow pattern, high-pressure fluid is introduced at one side of the cylindrical pre-wetter 136. In the presently preferred embodiment, the pre-wetter 136 includes an internal "throat" that encourages the cyclonic flow pattern and accelerates fluids passing through the pre-wetter 136.

A pre-wetter valve 152 is used to adjust the flow of high-pressure fluid into the pre-wetter 136. The pre-wetter 136 is also connected to the discharge chamber 130 of the delivery assembly 104. In this way, dry polymer moves into the pre-wetter 136 where it initially contacts the high-pressure hydration fluid to form gel. The converging geometry of the cyclonic flow pattern, axial vortices and centrifugal forces in the pre-wetter 136 enhance the interfacial contact of the individual polymer particles.

The outlet of the pre-wetter 136 is connected to the high-energy mixer 138. The high-energy mixer 138 includes a closed housing 154, an impeller 156 and a motor 158. The impeller 156 is driven by the motor 158, which in turn is powered by pressurized hydraulic fluid. The impeller 156 includes a plurality of vanes 160 that are configured to transfer rotational energy and shearing action into the gel to further accelerate hydration and homogenize the consistency of the gel. In a particularly preferred embodiment, the vanes 160 include "cupped" surfaces that increase the transfer of energy to the gel. In an alternate embodiment, each of the vanes 160 includes one or more holes that augment the shearing action created by the impeller

156. The energy imparted to the gel by the high-energy mixer 138 is partially translated to velocity as the gel exits the high-energy mixer 138.

In an alternate embodiment, the high-energy mixer 138 is replaced or used in conjunction with an eductor mixer 162, shown in FIG. 3. As shown in FIG. 3, the eductor mixer 162 can be connected to the output of the pre-wetter 136 and to a high-pressure line from the pump 146. The eductor mixer 162 preferably includes one or more nozzles 164 and throats 166 to accelerate the pressurized hydration fluid. The acceleration of the hydration fluid lowers the pressure of the hydration fluid and draws the gel output of the pre-wetter 136 into the eductor mixer 162 for additional mixing and hydration. It will be noted that the eductor mixer 162 is particularly useful in lower volume hydration applications.

Turning back to FIG. 2, the blender 140 receives the accelerated gel output by the high-energy mixer 138. In the preferred embodiment, the blender 140 includes a discharge pipe 168 that introduces the gel from the high-energy mixer 138 below the surface of the gel contained in the blender 140. To prevent the potential backflow of gel from the blender 140 to the high-energy mixer 138, the hydration assembly 106 preferably includes a check valve 170.

The blender 140 preferably includes a motor 172, and one or more agitators that are driven by the motor 172 via a shaft 174. In the particularly preferred embodiment shown in FIG. 2, the agitators are three blender discs 176 that include holes in the top two discs and fins on the bottom of the lowest disc that collectively produce a smooth, rolling turbulence in the blender 140. The downward suction produced by the spinning blender discs 176 creates a vortex to and through the discs. Fins on the bottom of the blender discs force product off the tank bottom back up the sidewalls and into the downward suction vortex. Suitable discs are available from J.

May Equipment Group of Arlington, TX under the MAXY-DISC trademark. Although blender discs 176 are presently preferred, the paddles, screws or propellers can also be employed alone or in combination with the preferred blender discs 176.

The blender 140 can also include one or more baffles 178 positioned at various positions that are configured to further refine the rolling turbulence created by the blender 140. The blender 140 also includes a drain valve 180 that can be used to drain the contents of the blender 140 to either the intake manifold 144 or discharge manifold 148.

The blender 140 includes an overflow conduit 182 that directs gel into the weir tank 142. Discounting changes in the density of the gel that occur within the blender 140, the same volumetric flowrate of gel entering the blender 140 exits the blender 140 to the weir tank 142 through the overflow conduit 182 during steady-state operation. Although the overflow conduit 182 is depicted near the top of the blender 140, it will be understood that the overflow conduit 182 could be positioned at different depths within the blender 140.

The weir tank 142 preferably contains one or more steps 184 that reduce the velocity of the gel and allow entrained air to escape. The weir tank 142 includes a drain 186 that can be used to deliver the gel to either the intake manifold 144 or the discharge manifold 148. In the preferred embodiment, the static head pressure created by the elevational difference between the weir tank 142 and the discharge manifold 148 is sufficient to feed gel to downstream storage facilities or equipment. In an alternate preferred embodiment, a second pump (not shown) can be used to deliver the gel from the weir tank 142 to downstream equipment.

The hydration assembly 106 includes discharge plumbing 188 and diverter valves 190 that connect the blender drain 174 and the weir tank drain 186 to the intake

and discharge manifolds 144, 148. The diverter valves 190 can be used to divert output from the blender drain 174 and weir tank drain 186 to the discharge manifold 148 for delivery to downstream devices. It will be noted that, for some applications, it may not be necessary to use the weir tank 142. Additionally, the intake manifold 144 can alternatively be used to direct gel from the hydration assembly 106 to downstream equipment.

The diverter valves 190 can also be used to divert the output from the blender 140 and the weir tank 142 to the intake manifold 144 for recirculation within the hydration assembly 106. Recirculating the gel within the hydration assembly 106 can be used to adjust or maintain the consistency of the gel during the operation of apparatus 100.

Turning now to FIG. 4, shown therein is a flowchart for a preferred method 192 for the accelerated hydration of polymer. Beginning at step 194, substantially dry polymer is transferred from the storage assembly 102 to the hydration assembly 106 with the delivery assembly 104. At step 196, the polymer is pre-wetted with a selected hydration fluid, preferably water, in the pre-wetter 136 to form a gel. Next, at step 198, the gel from the pre-wetter 136 is mixed and energized in the high-energy mixer 138. The gel is next blended in the blender 140 at step 200. Finally, at step 202, air entrained in the gel is removed in the weir tank 142. The order of the steps listed above in the preferred method 192 can be re-arranged to meet the needs of specific applications. Those skilled in the art will also recognize that one or more of the steps on the method 192 can be omitted without altering the successful hydration of particulate polymer as contemplated by the present invention.

It is to be understood that even though numerous characteristics and advantages of various embodiments of the present invention have been set forth in the

foregoing description, appended claims and drawings, together with details of the structure and functions of various embodiments of the invention, this disclosure is illustrative only, and changes may be made in detail, especially in matters of structure and arrangement of parts within the principles of the present invention to the full extent indicated by the broad general meaning of the terms expressed above.

It is claimed:

1. A method for hydrating particulate polymer in a hydration apparatus, the method comprising:

transferring substantially dry particulate polymer from a storage assembly to a hydration unit;

pre-wetting the substantially dry particulate polymer with a hydration fluid in a pre-wetter to form a gel;

mixing the gel with additional hydration fluid in a high-energy mixer;

blending the gel in a blender; and

removing entrained air from the gel in a weir tank.

2. The method of claim 1, wherein the step of transferring substantially dry particulate polymer further comprises:

metering the particulate polymer from a tote tank to a collection chamber with a metering augur; and

transferring the particulate polymer from the collection chamber to a discharge chamber with a transfer auger.

3. The method of claim 2, wherein the metering auger and the transfer auger are automatically controlled in response to the amount of hydrating fluid being drawn into the apparatus.

4. The method of claim 1, wherein the step of pre-wetting the substantially dry particulate polymer further comprises:

inducing a cyclonic flow pattern of the hydration fluid in the pre-wetter; and

introducing the substantially dry particulate polymer into the hydration fluid having a cyclonic flow pattern.

5. The method of claim 1, wherein the step of mixing the gel further comprises imparting energy to the gel with an impeller inside the high-energy mixer.

6. The method of claim 1, wherein the step of mixing the gel further comprises:

introducing the gel into an eductor mixer; and

combining the gel with accelerated hydration fluid in the eductor mixer.

7. The method of claim 1, wherein the step of blending the gel further comprises producing a rolling turbulence in the gel with one or more agitators.

8. The method of claim 7, wherein the step of producing a rolling turbulence further comprises contacting the gel with one or more blender discs.

9. An apparatus for hydrating particulate polymer, the apparatus comprising:

a storage assembly;

a delivery assembly connected to the storage assembly; and

a hydration assembly connected to the delivery assembly, wherein the hydration unit comprises:

a pre-wetter;

a high-energy mixer; and

a blender.

10. The apparatus of claim 9, wherein the storage assembly further comprises:

at least one tote tank; and

a receiving rack configured to support the at least one tote tank.

11. The apparatus of claim 10, wherein the at least one tote tank further comprises:

an anti-bridging cone; and

a knife shut-off valve.

12. The apparatus of claim 10, wherein the receiving rack further comprises one or more pneumatic vibrators.

13. The apparatus of claim 9, wherein the delivery assembly further comprises:

a metering auger;

a collection chamber;

a transfer auger; and

a discharge chamber.

14. The apparatus of claim 13, wherein the transfer auger is flexible.

15. The apparatus of claim 9, wherein the pre-wetter is configured to induce a cyclonic flow pattern as hydration fluid enters the pre-wetter.

16. The apparatus of claim 9, wherein the high-energy mixer further comprises:

a housing; and

a rotating impeller.

17. The apparatus of claim 16, wherein the impeller includes a plurality of vanes that have cupped surfaces.

18. The apparatus of claim 16, wherein the impeller includes a plurality of vanes that include one or more holes.

19. The apparatus of claim 9, wherein the blender further comprises one or more blender discs that create a rolling turbulence when rotated in the presence of the gel.

20. The apparatus of claim 9, further comprising a weir tank having one or more steps.

21. The apparatus of claim 9, further comprising:

an intake manifold configured to draw hydration fluid into the apparatus;

a pump connected to the intake manifold; and

a discharge manifold configured to discharge gel to downstream equipment or storage facilities.

22. An apparatus for hydrating particulate polymer, the apparatus comprising:

a storage assembly, wherein the storage assembly includes one or more tote tanks supported by a receiving rack;

a delivery assembly connected to the storage assembly; and

a hydration assembly connected to the delivery assembly, wherein the hydration unit includes an eductor mixer.

23. An apparatus for hydrating particulate polymer, the apparatus comprising:

means for storing the particulate polymer;

means for hydrating the particulate polymer; and

means for delivering the particulate polymer from the means for storing the particulate polymer to the means for hydrating the particulate polymer.

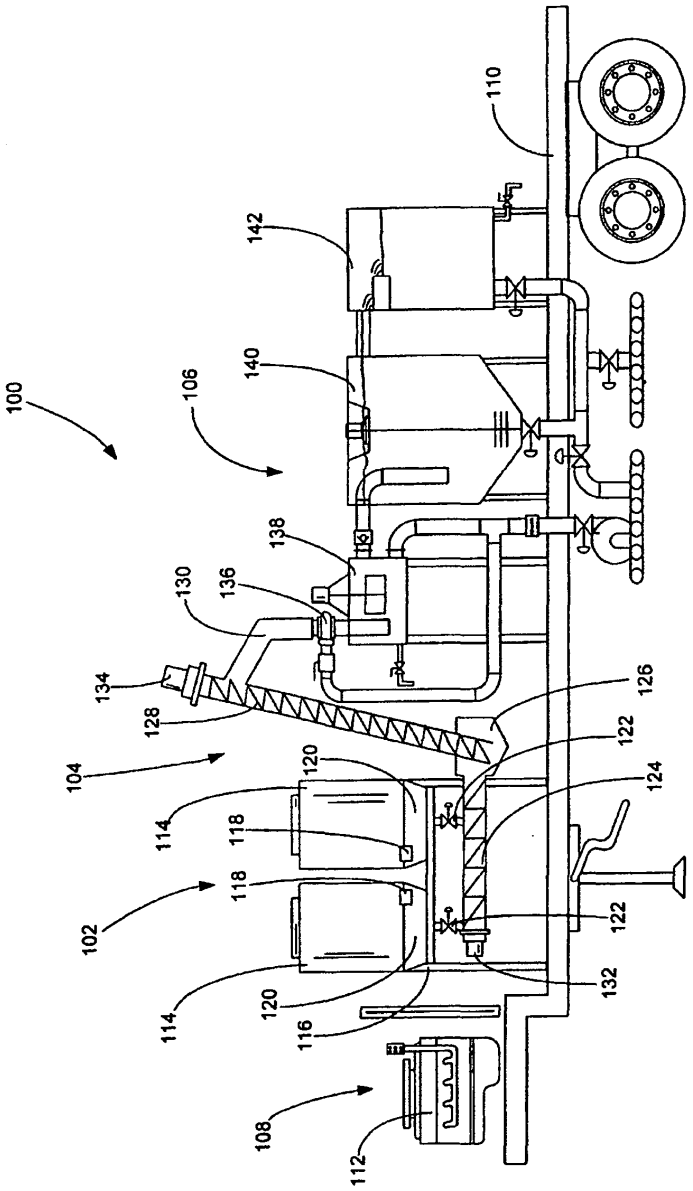

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FIG. 1

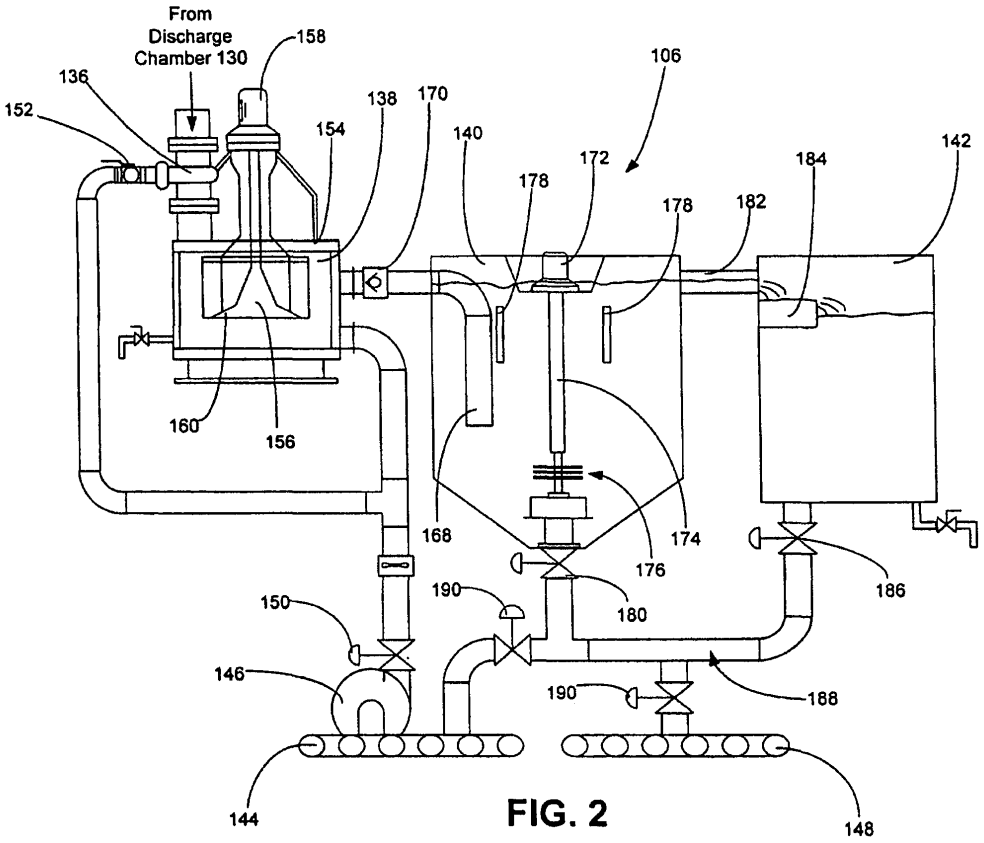

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FIG. 2

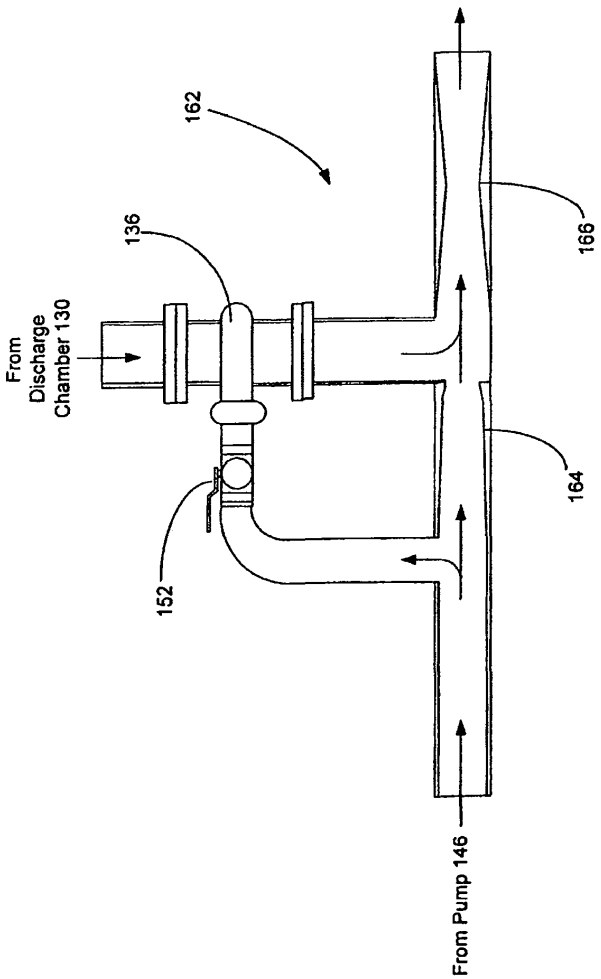


FIG. 3

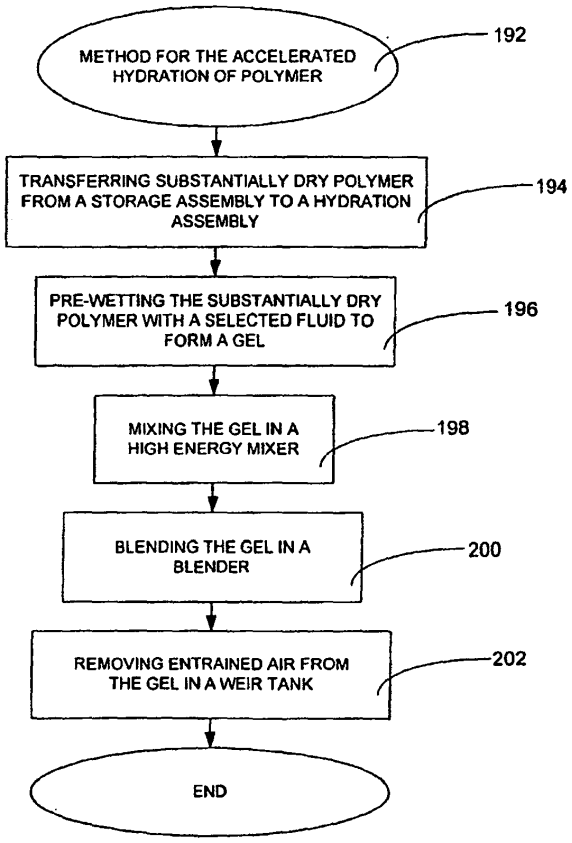

METHOD FOR THE ACCELERATED HYDRATION OF POLYMER
192
TRANSFERRING SUBSTANTIALLY DRY POLYMER FROM A STORAGE ASSEMBLY TO A HYDRATION ASSEMBLY
194
PRE-WETTING THE SUBSTANTIALLY DRY POLYMER WITH A SELECTED FLUID TO FORM A GEL
196
MIXING THE GEL IN A HIGH ENERGY MIXER
198
BLENDING THE GEL IN A BLENDER
200
REMOVING ENTRAINED AIR FROM THE GEL IN A WEIR TANK
202
END

FIG. 4

Electronic Acknowledgement Receipt	
EFS ID:	2848975
Application Number:	11291496
International Application Number:	
Confirmation Number:	7986
Title of Invention:	Method and apparatus for centralized well treatment
First Named Inventor/Applicant Name:	William Lloyd McNeel
Customer Number:	29920
Filer:	Paul N. Katz/Debbie Allen
Filer Authorized By:	Paul N. Katz
Attorney Docket Number:	2005-IP-018647U1
Receipt Date:	12-FEB-2008
Filing Date:	01-DEC-2005
Time Stamp:	16:02:45
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)
1	Claims	0637180930NotNonComp.PDF	366483 26ca4abb7d07085510d7d0ee2cbe87b39b38172b	no	11
Warnings:					
Information:					

2		0637180930IDS.PDF	5014775 7203c9f3a9d825bc080da8c66f6df0942742c88f	yes	152

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Information Disclosure Statement Letter	1	2
Information Disclosure Statement (IDS) Filed	3	3
Foreign Reference	4	65
Foreign Reference	66	77
Foreign Reference	78	102
Foreign Reference	103	119
Foreign Reference	120	138
NPL Documents	139	152

Warnings:	
Information:	
Total Files Size (in bytes):	5381258

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:		§	
	McNeel *et al.*	§	Group Art Unit: **3676**
		§	
Serial No.:	**11/291,496**	§	
		§	Examiner: **Leonard, Kerry W**
Filed:	**December 1, 2005**	§	
		§	
Title:	**"Method and Apparatus for Centralized Well Treatment"**	§	
		§	Atty. Docket No: **HES 2005-IP-018647U1**
		§	

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P.O. Box 1450
Alexandria, VA 22313-1450

CERTIFICATE OF FILING ELECTRONICALLY VIA EFS
MPEP 503

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Debbie Allen
DEBBIE ALLEN

DATE OF SUBMISSION: FEBRUARY 12, 2008
ELECTRONIC FILING (EFS)

RESPONSE TO NOTICE OF NON-COMPLIANT AMENDMENT UNDER 37 C.F.R. § 1.121

In response to the Notice of Non-Compliant Amendment mailed January 28, 2008 ("Notice"), Applicants herein respectfully submit the following:

- **Revised Listing and Amendments to the Claims**, which are reflected beginning on page 2 of this paper; and
- **Remarks**, which begin on page 10 of this paper.

Applicants had previously submitted a Request for Continued Examination under 37 C.F.R. § 1.114 ("RCE") in response to the Final Office Action mailed October 16, 2007. This response is being submitted within one month of the Notice and corrects the non-compliant section of the RCE, in compliance with 37 C.F.R. § 1.121.

REVISED LISTING AND AMENDMENTS TO THE CLAIMS

Please amend the claims as shown directly below. This complete listing of claims will replace all prior versions and listings of claims for this application.

1. (Withdrawn) A method of stimulating multiple wells from a central location, comprising the steps of:

stimulating a first well from the central location using a first stimulation fluid through a first fluid line; and

simultaneously stimulating a second well from the central location using a second stimulation fluid through a second fluid line.

2. (Withdrawn-Currently Amended) The method of claim 1 wherein the first stimulation fluid comprises at least one [[a]] compound selected from the group consisting of: a proppant, a fracturing fluid, a gelling agent[[s]], a friction reducer[[s]], an acid, and ~~combinations~~ a derivative thereof.

3. (Withdrawn-Currently Amended) The method of claim 1 wherein the second stimulation fluid comprises at least one [[a]] compound selected from the group consisting of: a proppant, a fracturing fluid, a gelling agent[[s]], a friction reducer[[s]], an acid, and ~~combinations~~ a derivative thereof.

4. (Withdrawn) The method of claim 1 wherein the first stimulation fluid and the second stimulation fluid have the same composition.

5. (Withdrawn) A method of stimulating multiple wells comprising the steps of:

stimulating a first well location through a first stimulation fluid from a central manifold; and

simultaneously stimulating a second well location through a second stimulation fluid from the central manifold.

6. (Withdrawn-Currently Amended) The method of claim 5 wherein the first stimulation fluid comprises at least one [[a]] compound selected from the group consisting of: a proppant, a fracturing fluid, a gelling agent[[s]], a friction reducer[[s]], an acid, and ~~combinations~~ a derivative thereof.

7. (Withdrawn-Currently Amended) The method of claim 5 wherein the second stimulation fluid comprises at least one [[a]] compound selected from the group consisting of: a proppant, a fracturing fluid, a gelling agent[[s]], a friction reducer[[s]], an acid, and ~~combinations~~ a derivative thereof.

8. (Withdrawn) The method according to claim 5 wherein the first well location and the second well location are at the same pad.

9. (Withdrawn) The method according to claim 5 wherein the first well location and the second well location are at different pads.

10. (Withdrawn) The method of claim 5 wherein the first stimulation fluid and the second stimulation fluid have the same composition.

11. (Currently Amended) A[[n]] system for centralized well operations comprising:

a well treatment operations factory which manufactures and pumps a well stimulation fluid;

a first connection between a first well location and the well operations factory;

a second connection between a second well location and the well operations factory; and

means for simultaneously flowing a first stimulation fluid only to the first well location and a second stimulation fluid only to [[a]] the second well location.

12. (Original) The system of claim 11 wherein the means for simultaneously flowing treatment fluid comprises a manifold.

13. (Original) The system of claim 12 wherein the well operations factory comprises a pumping grid wherein the pumping grid is operable to connect to the manifold.

14. (Original) The system of claim 13 wherein the well operations factory comprises a blending unit wherein the blending unit is operable to connect to the pumping grid.

15. (Currently Amended) The system of claim 14 wherein the well operations factory comprises a proppant storage system wherein the proppant storage system is operable to ~~connect~~ deliver proppant to the blending unit.

16. (Original) The system of claim 14 wherein the well operations factory comprises a chemical storage system wherein the chemical storage system is operable to connect to the blending unit.

17. (Original) The system of claim 15 wherein the well operations factory comprises a power unit operable to connect to the manifold, pumping grid, blending unit, the proppant storage system, the first well location, and the second well location.

18. (Original) The system of claim 16 wherein the well operations factory comprises a power unit operable to connect to the manifold, pumping grid, blending unit, chemical storage system, the first well location, and the second well location.

19. (Original) The system of claim 17 wherein the well operations factory is enclosed in a structure selected from the group consisting of: a supported fabric structure, a collapsible structure, a prefabricated structure, a retractable structure, a composite structure, a temporary structure, a prefabricated wall and roof structure, a deployable structure, a modular structure, a preformed structure, a mobile accommodation structure, and combinations thereof.

20. (Original) The system of claim 12 wherein the first connection is operable to deliver a fluid from the first well location to the manifold.

21. (Original) The system of claim 12 wherein the second connection is operable to deliver a fluid from the second well location to the manifold.

22. (Original) The system of claim 20 wherein the fluid comprises a stimulation fluid.

23. (Original) The system of claim 21 wherein the fluid comprises a stimulation fluid.

24. (Original) The system of claim 12 wherein the manifold is connected to a second manifold.

25. (Original) The system of claim 24 wherein the second manifold is operable to simultaneously flow a first stimulation fluid to a first well location and a second stimulation fluid to a second well location.

26. (Original) The system of claim 12 comprising a third connection between the manifold and the first well location.

27. (Original) The system of claim 26 wherein the third connection is operable to deliver a fluid from the first well location to the manifold.

28. (Original) The system of claim 27 comprising a fourth connection between the manifold and the second well location.

29. (Original) The system of claim 28 wherein the fourth connection is operable to deliver a fluid from the second well location to the manifold.

30. (Original) The system of claim 11 wherein the well operations factory and means for simultaneously flowing treatment fluid are located on a boat.

31. (Currently Amended) The system of claim 11 wherein the first fluid comprises at least one [[a]] compound selected from the group consisting of: a proppant, a fracturing fluid, a gelling agent[[s]], a friction reducer[[s]], an acid, and ~~combinations~~ a derivative thereof.

32. (Currently Amended) The system of claim 11 wherein the second stimulation fluid comprises at least one [[a]] compound selected from the group consisting of: a proppant, a fracturing fluid, a gelling agent[[s]], a friction reducer[[s]], an acid, and ~~combinations~~ a derivative thereof.

33. (Original) The system of claim 11 wherein the first stimulation fluid and the second stimulation fluid have the same composition.

34. (Withdrawn) An apparatus for directing stimulation fluid comprising:

a first input for accepting pressurized stimulation fluid;

a first line connected to said first input, said first line comprising:

a first valve connected to a first pressure sensor, said first pressure sensor further connected to a second valve;

said first line connected to a first wellhead;

a second line connected to said first input, said second line comprising

a third valve connected to a second pressure sensor, said second pressure sensor further connected to a fourth valve;

said second line connected to a second wellhead.

35. (Withdrawn) An apparatus for directing stimulation fluid comprising:

a first input for accepting a first pressurized stimulation fluid;

a second input for accepting a second pressurized stimulation fluid;

a first line connected to said first input, said first line comprising a first valve;

a second line connected to said second input, said second line comprising a second valve;

said first line and said second line connected together at a first junction, said first junction further connected to a first wellhead;

a third line connected to said first input, said third line comprising a third valve;

a fourth line connected to said second input, said fourth line comprising a fourth valve; and

said third line and said fourth line connected together at a second junction, said second junction further connected to a second wellhead.

36. (Withdrawn) The apparatus according to claim 35 wherein

said first line further comprises a fifth valve and a first pressure sensor, said first pressure sensor located between said first valve and said fifth valve.

37. (Withdrawn) The apparatus according to claim 36 wherein

said second line further comprises a sixth valve and a second pressure sensor, said second pressure sensor located between said second valve and said sixth valve.

38. (Withdrawn) The apparatus according to claim 37 wherein

said third line further comprises a seventh valve and a third pressure sensor, said third pressure sensor located between said third valve and said seventh valve.

39. (Withdrawn) The apparatus according to claim 38 wherein

said fourth line further comprises an eighth valve and a fourth pressure sensor, said fourth pressure sensor located between said fourth valve and said eighth valve.

40. (New) A system for centralized well operations comprising:

a well treatment operations factory which manufactures and pumps a well stimulation fluid;

a first connection between a first pad and the well operations factory;

a second connection between a second pad and the well operations factory; and

means for simultaneously flowing a first stimulation fluid to the first pad and a second stimulation fluid to the second pad.

41. (New) A system for centralized well operations comprising:

a well treatment operations factory which dynamically manufactures and pumps a well stimulation fluid;

a first connection between a first well location and the well operations factory;

a second connection between a second well location and the well operations factory; and

means for simultaneously flowing a first stimulation fluid to the first well location and a second stimulation fluid to the second well location.

42. (New) The system of claim 11, wherein the well locations are pads and wherein the well treatment operations factory dynamically manufactures and pumps a well stimulation fluid.

REMARKS

I. General Remarks

Please consider the application in view of the following remarks and the previously submitted RCE. Applicants thank the Examiner for his careful consideration of this application and the references that Applicants have submitted.

II. Disposition of Claims

Claims 1-39 are pending in this application.

Claims 1-10 and 34-39 are withdrawn from further consideration. Of these, claims 2, 3, 6, and 7 have been amended herein. These amendments are supported by the specification as filed. It should not be assumed that these amendments were made for reasons relating to patentability.

Claims 11-16, 20-29, and 31-33 are rejected.

Claims 19 and 30 are objected to as depending from a rejected base claim.

Claims 11, 15, 31, and 32 have been amended herein. These amendments are supported by the specification as filed. It should not be assumed that these amendments were made for reasons relating to patentability.

New claims 40-42 have been added to recite aspects of the invention. The new claims are supported by the specification as filed and do not introduce new matter.

Applicants reserve the right to subsequently take up prosecution on the claims as originally filed in this or appropriate continuation, continuation-in-part and/or divisional applications.

Profrac Holding Corporation
U.S. Well Services, LLC
IPR2023-01319
Ex. 1002, p. 362 of 988

SUMMARY

In light of the above remarks, supplemental to those made in the RCE, Applicants respectfully request reconsideration and withdrawal of the outstanding rejections. Applicants further submit that the application is now in condition for allowance, and solicit timely notice of the same. Should the Examiner have any questions, comments, or suggestions in furtherance of the prosecution of this application, the Examiner is invited to contact the attorney of record.

Applicants have previously submitted payment of $810.00 for the RCE fee under 37 C.F.R. § 1.117(e). Applicants believe that there are no other fees due in association with the filing of this Response. However, should the Commissioner deem that any fees are due, the Commissioner is authorized to debit Baker Botts L.L.P. Deposit Account No. 02-0383, Order Number 063718.0930, for any payment of associated fees, underpayment of fees, or to credit same with any overpayment of fees that may occur in association with this filing.

Respectfully submitted,

BAKER BOTTS L.L.P. (023640)

Date: February 12, 2008

By: _____
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ATTORNEY FOR APPLICANTS

Profrac Holding Corporation
U.S. Well Services, LLC
IPR2023-01319
Ex. 1002, p. 363 of 988

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	§		
McNeel *et al.*	§	Group Art Unit:	**3676**
	§		
Serial No.: **11/291,496**	§	Examiner:	**Leonard, Kerry W.**
	§		
Filed: **December 1, 2005**	§	Atty. Docket No.:	**HES 2005-IP-018647U1**
	§		
Title: **"Method and apparatus for centralized well treatment"**	§		
	§		
	§		
	§		
	§		

MAIL STOP AMENDMENT
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P. O. Box 1450
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Debbie Allen

DEBBIE ALLEN — MARCH 6, 2008

DATE OF SUBMISSION: 3-6-08
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SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

Dear Honorable Commissioner:

Applicants respectfully request, pursuant to 37 C.F.R. §§ 1.56, 1.97 and 1.98, that the art listed on the attached PTO-1449 form be considered and cited in the examination of the above-identified application.

Furthermore, pursuant to 37 C.F.R. §§1.97(g) and (h), no representation is made that these references are material to the patentability of the present application.

Applicants believe there are no fees due in association with the filing of this Supplemental Information Disclosure Statement. Should the Commissioner deem that any fees are due, Applicants respectfully request that the Commissioner accept this as a Petition Therefor

Profrac Holding Corporation
U.S. Well Services, LLC
IPR2023-01319
Ex. 1002, p. 364 of 988

and direct that any fees be charged to Baker Botts, L.L.P. Deposit Account No. 02-0383, Order Number 063718.0930.

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Date: March 6, 2008

Information Disclosure Citation in an Application	Application No. 11/291,496	Applicant(s) McNeel et al.	
	Docket Number HES 2005-IP-018647U1	Group Art Unit 3676	Filing Date December 1, 2005

U.S. PATENT DOCUMENTS

		DOCUMENT NO.	ISSUE/ PUB. DATE	NAME	CLASS	SUBCLASS	FILING DATE
		4,137,970	02/06/79	Laflin et al.			04/20/77
		4,724,905	02/16/88	Uhri			09/15/86
		4,830,106	05/16/89	Uhri			12/29/87
		5,659,480	08/19/97	Anderson et al.			06/27/95
		7,036,587	02/02/06	Munoz, Jr. et al.			06/27/03
		2007/0153622	07/05/07	Dykstra et al.			12/30/05
		2007/0153624	07/05/07	Dykstra et al.			12/30/05
		2007/0171765	07/26/07	Dykstra et al.			12/30/05
		2007/0153623	07/05/07	Dykstra et al.			12/30/05
		11/545,749		Surjaatmadja			10/10/06
		11/753,314		Surjaatmadja			05/24/07
		7,143,842	12/05/06	Freyer			06/16/03
		2006/0161358	07/20/06	Dykstra et al.			01/04/05

FOREIGN PATENT DOCUMENTS

		DOCUMENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION Yes	TRANSLATION No
		EP 0474350	03/11/92	Europe	E21B	43/26		
		NO 20042134	11/28/05	Norway	E21B	33/12		

NON-PATENT DOCUMENTS

		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	
		Warpinski, Nonnan R and Branagan, Paul T., "Altered Stress Fracturing", JPT, 990-97, 473-476.	09/1989
		Surjaatmadja, "Single Point of Initiation, Dual-Fracture Placement for Maximizing Well Production," 2007 Society of Petroleum Engineers, SPE 107718	
		Surjaatmadja, "The Important Second Fracture and its Operational Placement for Maximizing Production," Society of Petroleum Engineers SPE 107059	
		Surjaatmadja, "The Mythical Second Fracture and its Operational Placement for Maximizing Production," Society of Petroleum Engineers SPE 106046	

EXAMINER	DATE CONSIDERED
EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP § 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.	

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 474 350 A1**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number : **91306562.9**

(51) Int. Cl.[5] : **E21B 43/26**

(22) Date of filing : **18.07.91**

(30) Priority : **07.09.90 US 579126**

(43) Date of publication of application :
11.03.92 Bulletin 92/11

(84) Designated Contracting States :
DE FR GB IT NL

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(54) **Control of subterranean fracture orientation.**

(57) Fracture orientation in underground formations is controlled to increase well productivity, by perforating or notching the wellbore in a first direction to the anticipated fracture orientation, and in a second direction at 60° to 120° to the anticipated fracture orientation, and then hydraulically fracturing in the first direction and, while injection is proceeding, fracturing in the second direction.

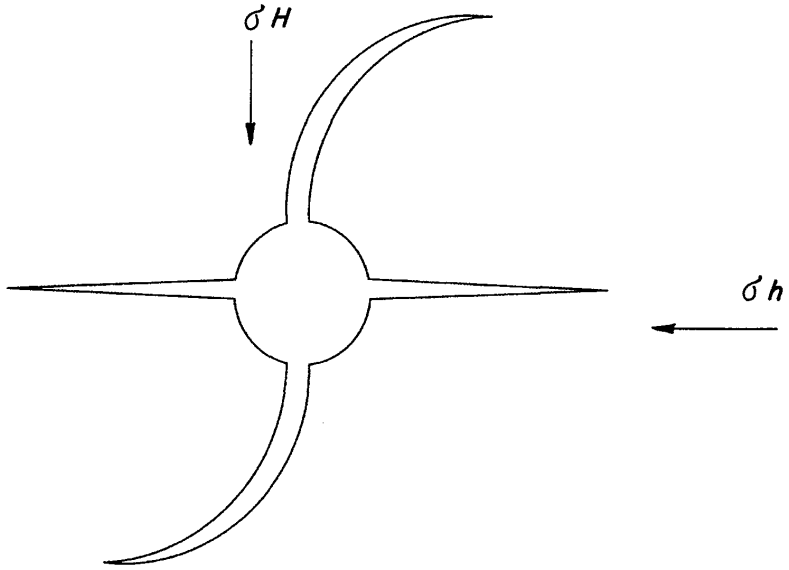


FIG. 2

EP 0 474 350 A1

Jouve, 18, rue Saint-Denis, 75001 PARIS

This invention relates to a method of controlling the fracture orientation of hydraulic fractures in underground formations to increase well productivity.

Hydraulic fracturing is a well established method used in the oil and gas industry for reservoir stimulation. The general technique is to inject fluid under high pressure into a well bore and perforated formation to create fractures in the hydrocarbon bearing formation. It was first applied in the oil industry in 1948 to stimulate productivity from low permeability oil bearing formations.

A problem frequently encountered with hydraulic fracturing is that the fracture orientation is not optimal for maximum well productivity. The orientation of a fracture in an underground formation is generally controlled by the in-situ stress of the formation. The formation is subjected to three principal stresses, one vertical and two horizontal. When a formation is hydraulically fractured the created fracture should propagate in the path of least resistance or, in other words, the fracture will be perpendicular to the least principal stress.

In deeper formations (generally below 610m), one of the horizontal stresses is usually the smallest stress because of the high weight of the rock. Consequently, a vertical fracture is created. The above is also generally true for any natural fracturing which may be present in the formation. It is a common experience that augmenting either natural or man-made hydraulic fractures with further hydraulic fracturing results in parallel fractures which do not significantly increase the productivity of the well.

Warpinski et al. (SPE 17533, SPE Rocky Mountain Regional Meeting, Casper, Wyoming, May 11-13, 1988) suggests that the technique of altered stress fracturing may be used to overcome the problem of hydraulic fracturing paralleling permeable natural fractures. Warpinski et al. discusses the concept of using an offset well to create hydraulic fractures that alter a stress field around a production well. It states that if the stress difference is not too large, the wells are relatively close together and the treatment pressures and fracture sizes in the offset wells are sufficiently large, enough stress can be added to the virgin minimum horizontal in-situ stress to make it the maximum horizontal stress. Warpinski speculates that a possible application of the stress alteration concept is for the alteration of the vertical distribution of the minimum horizontal in-situ stress in a single vertical hole. This could be used to advantage if hydraulic fractures are propagating into undesirable zones.

U.S. Patent No. 4,724,905 discloses the use of hydraulic fracturing in one well to control the direction of propagation of a second hydraulic fracture in a second well located nearby. The first well is fractured and the fractures will generally form parallel to the fractures in the natural fracture system. The hydraulic pressure is maintained in the first well and another hydraulic fracturing operation is conducted at a second well within the zone of in-situ stress alteration caused by the first hydraulic fracture. This patent states that the second hydraulic fracture initiates at an angle, often perpendicular, to the first hydraulic fracture.

U.S. Patent No. 4,830,106 discloses the use of simultaneous hydraulic fracturing in at least two spaced apart wells to control the direction of propagation of the fractures. This simultaneous pressure causes the fractures to curve away from each well or towards each well depending on the relative position and spacing of the wells in this stress field and the magnitude of the applied far field stresses. These generated fractures may than intercept at least one natural hydrocarbon bearing fracture.

U.S. Patent No. 4,834,181 discloses the alteration of in-situ stress conditions using sequential hydraulic fracturing. The well formation is hydraulically fractured causing at least one vertical fracture to form. Thereafter a plugging material is directed into the created fracture and the material is allowed to solidify. A second hydraulic fracture is formed which should divert around the plugged fracture. The steps of plugging, hydraulically fracturing and diverting the subsequently created fracture are continued until branched or dendritic fractures are caused to emanate into the formation from the wellbore. U.S. Patent No. 4,687,061 teaches the simultaneous fracturing of a borehole at two different levels in a deviated well.

None of the above methods are totally satisfactory. The methods using two wells are complex and hard to control. Additionally, these methods typically are not practical in fields with well spacing requirements. In the method disclosed in U.S. Patent No. 4,834,181, the direction of the sequential fracturing is not controlled from the wellbore and it is merely a matter of chance as to whether the branch fractures will run perpendicular to either the natural fractures in the formation of the earlier induced hydraulic fractures. U.S. Patent No. 4,687,061 does not disclose a method to control the direction of the propagation of the fracture from the wellbore, nor does it disclose using the method in a vertical hole. The industry is still in need of a method which can with some predictability control the orientation of hydraulic fracturing from a single wellbore.

The present invention provides a method of controlling hydraulic fracture orientation in hydrocarbon bearing formations by first determining the anticipated fracture orientation of the hydrocarbon bearing formation.

According to the present invention, there is provided a method of controlling hydraulic fracture orientation in hydrocarbon bearing formations penetrated by a wellbore comprising the steps of determining the anticipated fracture orientation of the hydrocarbon bearing formation; perforating or notching the wellbore within the formation in a direction parallel to the anticipated fracture orientation; perforating or notching the wellbore within the formation in a second direction of 60° to 120° to the anticipated fracture orientation; first fracturing the for-

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mation in the direction parallel to the anticipated fracture orientation by injecting a fluid through said wellbore and into said formation; and while injection is proceeding in the first fracture, fracturing the formation in said second direction.

In the present invention, the simultaneous fracturing is used. Thus, the anticipated fracture orientation of the hydrocarbon bearing formation is determined. The formation is then perforated or notched in a direction parallel to the anticipated fracture orientation and perforated or notched in a direction perpendicular to the anticipated fracture orientation. The formation is then first fractured in the direction parallel to the anticipated fracture orientation and, while injection is proceeding in the first fracture, the formation is fractured in the direction perpendicular to the anticipated fracture orientation.

This method of simultaneous fracturing can also be performed by perforating or notching the formation parallel to the anticipated fracture orientation at one level in the hydrocarbon bearing formation and perforating or notching the formation perpendicular to the anticipated fracture orientation at another level in the hydrocarbon bearing formation. For both methods of simultaneous fracturing it can be first determined whether the stress around a first hydraulic fracture will be altered to allow a reversal of the stresses. Additionally, in a preferred embodiment the first fracture is allowed to extend 5 to 25 minutes before the second fracture is initiated.

In order that the invention may be more fully understood, reference is made to the accompanying drawings, wherein:

Fig. 1 is a schematic drawing depicting the minimum and maximum horizontal stresses and the normal fracture orientation of a wellbore and formation; and

Fig. 2 is a schematic drawing depicting the orientation of a second hydraulic fracture in accordance with the present invention.

The methods of the present invention allow for the control of the orientation of hydraulic fracturing of a well to promote greater productivity from the hydrocarbon bearing formation. This is accomplished by hydraulically fracturing the formation and propping and plugging the fractures which result. The formation is then perforated or notched in a direction angularly disposed relative to the anticipated fracture direction of the first hydraulic fracture. Preferably, this perforation will be within the range of 60° to 120° relative to the anticipated fracture direction of the first hydraulic fracture, and most preferably be at approximately 90° to the anticipated direction of the first hydraulic fracture. The presence of the first fracture will force the second fracture to propagate in a direction away from that of the first fracture. Several variations on this basic concept are also disclosed in this invention.

The most advantageous use of this method is in naturally fractured formations. In using this method the chance to intersect natural formations will be enhanced. This is especially important if the natural fractures have a similar orientation to the normally induced hydraulic fractures. This method is also useful in high permeability systems where greater fracture conductivity is desired. This system will produce fractures that will be at least equal to a fracture with double the fracture conductivity if the fractures become parallel after a short distance or with superior flow patterns if they become parallel after a long distance. The method is useful, however, even in low permeability formations because the formation will be more efficiently depleted using the two fracture configuration.

Hydraulic fracturing is well known in the industry. During a typical hydraulic fracturing operation, a slurry, including a viscous base fluid and a solid particulate material particularly referred to as a "proppant", is pumped down the well at sufficient pressure to fracture open the producing formation surrounding the well. Once a fracture has been created the pumping of the slurry is typically continued until a sufficient volume of the proppant has been carried by the slurry into the fracture. After a suitable time the pumping operation is stopped at which time the proppant residue will prop open the fracture in the formation, preventing it from closing. As a result of the fracture the flow from the producing formation is increased thereby increasing the wells production.

The three principal stresses in an underground formation are designated by σ_v, σ_H and σ_h (one vertical and two horizontal). The minimum horizontal stress is given the symbol σ_h while the higher horizontal stress is given the symbol σ_H. In relatively deep formations, for example those below 2,000 ft. (610m), one of the horizontal stresses is usually the smallest of these three formation stresses. When the formation is hydraulically fractured the created fracture will typically propagate in the path of least resistance which, in most such situations, means a vertical fracture will result.

When a vertical well is drilled the stress distribution in the vicinity of the wellbore is altered. Stress distribution around a wellbore may be determined experimentally or analytically by the use of such techniques as microfrac testing or strain relaxation. As a first hydraulic fracture is created the state of stress may be further altered. If the difference between the minimum horizontal stress and the maximum horizontal stress is not too large, the stress around the wellbore may be reversed by the effect of the first hydraulic fracture such that the stress parallel the first hydraulic fracture is not the smallest any longer. If the stresses are reversed, a second hydraulic fracture will typically propagate in a direction perpendicular to the first hydraulic fracture.

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The preferred method to measure these stresses is microfrac testing. A microfrac test is basically a small scale or microhydraulic fracturing operation utilizing a small quantity of fracturing fluid, without proppant, to create a test fracture. Typically, one or two barrels (159 to 318dm³) of fracturing fluid are injected into the subsurface formation at an injection rate of between two and twenty gallons (7.6 to 75.8dm³) per minute. As is well known to those skilled in the art, the injection rate and and fracturing fluid volume necessary to initiate and propagate a fracture for 10 to 20 ft (3.0 to 6.1m) depend upon the subsurface formation and fracturing fluid properties. (Kuhlman, Microfrac Tests Optimize Frac Jobs, Oil and Gas Journal, 45-49 (Jan. 1990).) (Incorporated herein by reference.)

After fracturing, the injection of the fluid is typically stopped and the well is shut in or the fracturing fluid is allowed to flow back at a prescribed rate. The newly created fracture begins to close upon itself since fluid injection has ceased. In either situation test pressure versus time data is acquired. Fracture theory predicts that the fluid pressure at the instant of fracture closure is a measure of minimum principal stress of the formation. (Daneshy et al., In-situ Stress Measurements During Drilling, Journal of Petroleum Technology, 891-898 (August 1986)) (Incorporated herein by reference).

Methods for estimating the maximum horizontal stress from microfrac testing have also been developed. Usually several microfrac cycles are performed, meaning that the fracture is reopened several times. The reopening pressure is a function of both minimum and maximum horizontal stress. Since minimum horizontal stress is determined independently, reopening pressure is used to calculate maximum horizontal stress. The horizontal stresses also may be calculated using known strain relaxation techniques (Teufel L.W., Determination of In-Situ Stress from Anelastic Strain Recovery Measurements of Oriented Core, *SPE/DOE* 11649) (Incorporated herein by reference).

Using the above-measured stress values it can be determined whether the stress field around a first hydraulic fracture will be altered enough to allow a reversal of the stresses. It has been shown that creating a fracture alters a state of stress. This can be calculated using equations given by Sneddon. (Sneddon and Elliott, The Opening of A Griffith Crack Under Internal Pressure, *Quarterly of Applied Mathematics*, Vol. 4, No. 3, p. 262 (1946). Green and Sneddon, Distribution of Stress in the Neighborhood of A Flat Elliptical Crack of An Elastic Solid, *Proceedings Cambridge Phil. Soc.*, pp. 159-163 (January, 1949)) (Incorporated herein by reference) Snedden gives the stress field around an infinitely long 2D crack in a homogenous, isotropic elastic body having Poisson's ratio and the geometry shown as follows:

$$\frac{1}{2}(\sigma_x + \sigma_y) = P\left\{\frac{r}{\sqrt{r_1 r_2}}\cos\left[\Theta - \frac{1}{2}(\Theta_1 + \Theta_2)\right] - 1\right\} \quad \text{(eq. 1)}$$

$$\frac{1}{2}(\sigma_y + \sigma_x) = P\left\{\frac{r\sin\theta}{c}\left(\frac{c}{r_1 r_2}\right)^{3/2}\sin\frac{3}{2}(\theta_1 + \theta_2)\right\} \quad \text{eq. 2}$$

$$\tau_{xy} = P\left\{\frac{r\sin\theta}{c}\left(\frac{c^2}{r_1 r_2}\right)^{3/2}\cos\frac{3}{2}(\theta_1 + \theta_2)\right\} \text{ and} \quad \text{eq. 3}$$

$$\sigma_z = v(\sigma_x + \sigma_y). \quad \text{(eq. 4)}$$

Where:

σ_x,

σ_y,

and

σ_z represent stresses induced by fracture in cartesian coordinate directions.

In Eqs. 1-4, P is the internal pressure, c is the crack half height (H/2), and the geometric relations are given by:

$$r = \sqrt{x^2 + y^2} \qquad \theta = \tan^{-1}(x/y)$$

$$r_1 = \sqrt{x^2 + (y + c)^2} \qquad \theta_1 = \tan^{-1}(x/(-y - c))$$

$$r_2 = \sqrt{x^2 + (y - c)^2} \qquad \theta_2 = \tan^{-1}(x/(c - y))$$

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Negative values of Θ, Θ_1, and Θ_2, should be replaced by $\pi + \Theta$, $\pi + \Theta_1$, and Θ_2, respectively. Examination of Eqs. 1-4 also suggests that all stresses can be normalized by the pressure, P, and all lengths can be normalized by the half height, c = H/2.

Equations 1-4 may be used to calculate the decay of the stress field with distance away from the fracture. It also can be predicted whether reversal of stresses will occur. This reversal will take place when $\sigma_h + \sigma_x > \sigma_H + \sigma_z$, where σ_h and σ_H are the minimum and maximum horizontal principal stresses. This calculation assumes that the fracture is long enough relative to the wellbore radius that it can be considered infinite, a good approximation in the practical application of this technique.

If the calculation shows that the stress field is altered, then another hydraulic fracture, assuming the first one is temporarily plugged, should propagate in a direction different from the original one. This reoriented propagation is enhanced by preferential perforation or notching as disclosed below. In the most preferred method the above measurements and calculations are performed. It is not, however, necessary to perform the above steps. As a general rule the difference between the two horizontal stresses in a given formation will not be large enough to prevent the reversal of the stress field. Therefore this invention also includes embodiments in which the initial calculations are not performed.

There are several different possible applications of this method. The most preferred method is as follows. The natural fracture orientation of the reservoir is determined. This may be done by several analytical or experimental methods including, but not limited to, microfracture, strain relaxation analysis which measures the time dependent swelling of a core sample as soon as it reaches the surface and borehole televiewing which can be used in an open hole to view natural fracture orientation. After the fracture orientation of the reservoir has been determined, the formation is perforated in the direction of the expected fracture orientation. For example, if the direction of the minimum horizontal stress indicates that the formation will fracture in an east/west direction, the formation should be perforated in an east/west direction.

The methods of perforating are well known by those skilled in the art and are extremely numerous. Any method of perforating which allows for directionally orienting the perforations can be used in this invention. The formation could also be notched in the appropriate direction. Any controlled notching technique can also be used, for example, but not limited to, hydraulic notching using hydraulic jets to notch the formation.

The formation is then fractured with appropriate fracture pressure and fracturing fluids. These parameters may be determined by various methods which are known to those skilled in the art. The fluid must contain an appropriate proppant to hold the formation open once the hydraulic pressure in the fracture is reduced. After the fracture has closed onto the proppant some type of substance which will plug the fracture is injected into the fracture and allowed to harden.

The plugging material which is used should only be temporary. This material could be a breakable gel or some type of a fluid which will harden once it is injected into the formation. The temporary plugging material may be any one of a number of commonly used materials provided it is compatible with the overall treating system. Examples of such materials include polysaccharides, such as guar gums, derivatized guar gum, and derivatized cellulose which may be crosslinked to form rigid gels, or polymerizable materials such as acrylamide, styrene or silicates which also can form rigid gels. Additives may be included in the plugging materials which will cause the gels to break up subsequent to the treatment. Alternatively, subsequent treatments may be performed which will break the gels. These treatments may include enzymes, oxidizers, reducers and acids. One example of an appropriate compound is Temblok™. (Halliburton Services, Inc., Duncan, Oklahoma). The plugging material must remain hard long enough to allow for the second hydraulic fracturing procedure to be completed.

After the plugging material hardens the formation is perforated or notched as described above in a direction perpendicular to the original fracture. For example, if it was determined that the original fracture should propagate in an east/west direction then the formation should be notched or perforated in a north/south direction. The borehole should be perforated or notched at a depth which is approximately in the middle of the hydrocarbon bearing formation. The formation is then again hydraulically fractured with the appropriate fracturing fluid and proppant. The presence of the first fracture together with the directional perforating or notching will force the second fracture to propagate in a direction away from the first fracture.

A variation of this method may also be employed. Again the orientation of the hydraulically induced fracture is determined as described above. It is determined, if desired, whether the stress field around a first hydraulic fracture can be altered to allow a reversal of the stresses. The formation is then perforated or notched in both a parallel and perpendicular direction to the expected fracture orientation. A tool is then set that will allow injection of fracturing fluids and proppant in either direction and with which the direction of injection may be controlled. A selective injection packer or pin-point injection packer tool can be used in this method. This tool comprises opposing cups or packer types that isolate the perforations to be treated. The spacing between the cups can be adjusted as necessary. Same means, such as a ball and seat or ball valve must be used to close off the

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center opening below the tool and force the treating or washing fluid through ports between the cups.

A concentric bypass can be built into the selective injection packer tool to allow pressure to equalize from the top to below the bottom cup. This concentric bypass also provides a means of reversing around the bottom of the tool to remove the ball from the seat allowing the fluid to reverse out of the tubing. Other types of tools that could be utilized include sliding sleeves or selective crossover tools.

The formation is first hydraulically fractured using the perforations or notches which run in a direction parallel to the anticipated fracture orientation. The fracture should be extended about 5 to 25 minutes, the preferred time being about ten minutes. Preferably the fracture should extend at least 50 feet. As injection is proceeding in the direction parallel to the expected fracture orientation the formation is hydraulically fractured using the perforations or notches which are perpendicular to the fraction orientation direction. It is believed that the effect of the first fracture will orient the second fracture in a direction perpendicular to the original fracture direction.

A second method of simultaneously fracturing the formation may also be utilized. In this method the perforations or notches are not created at the same level but at different levels in the formation. The distance between the levels depends on the formation thickness and properties. The optimum distance between levels should range from about 5 to 10 ft. (1.5 to 3.0m). Again, the first step is to determine the fracture orientation in the formation.

Fracturing at different levels can be done in a variety of ways known to those skilled in the art. One way to perform this operation is to utilize a sand plug. In this case, the lower fracture is fully created and the wellbore is filled with sand up to the bottom of the upper perforations. This will prevent fluid flow into the lower fracture. Alternatively, a fluid such as Temblock™ could be utilized.

In a preferred method of practicing the invention, the first fracture is created by the injection at the lower level of an appropriate fracturing fluid and proppant through the tubing. The fracture is allowed to extend for 5 to 25 minutes preferably about ten minutes. As injection is proceeding the second fracture is created using the perforating or notching in the higher level by injecting the appropriate fracturing fluid and proppant through the annulus. Again it is believed that the stresses created by the first fracture as well as the preferential directional notching or perforating will cause the second fracture to start propagating in a direction away from the first fracture.

While the invention has been described in terms of certain embodiments those skilled in the art will readily appreciate that various modifications, changes, substitutions and omissions may be made.

Claims

1. A method of controlling hydraulic fracture orientation in hydrocarbon bearing formations penetrated by a wellbore comprising the steps of determining the anticipated fracture orientation of the hydrocarbon bearing formation; perforating or notching the wellbore within the formation in a direction parallel to the anticipated fracture orientation; perforating or notching the wellbore within the formation in a second direction of 60° to 120° to the anticipated fracture orientation; first fracturing the formation in the direction parallel to the anticipated fracture orientation by injecting a fluid through said wellbore and into said formation; and while injection is proceeding in the first fracture, fracturing the formation in said second direction.

2. A method according to claim 1, wherein said second direction is approximately 90° to the anticipated fracture orientation.

3. A method according to claim 1 or 2, including the further step of determining whether the stress field around a first hydraulic fracture will be altered to allow a reversal of the stresses.

4. A method according to claim 1,2 or 3, wherein the first fracture is allowed to extend for 5 to 25 minutes, before the second fracture is initiated.

5. A method according to claim 1,2,3 or 4, wherein the perforating or notching parallel to the anticipated fracture orientation in the wellbore is done at one level in the hydrocarbon bearing formation, and the perforating or notching perpendicular to the anticipated fracture orientation in the wellbore is done at another level in the hydrocarbon bearing formation.

6. A method according to claim 5, wherein the levels of the perforations or notches in the wellbore are spaced from about 5 to about 10 feet (1.5 to 3.0m) apart.

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7. A method according to any of claims 1 to 6, wherein a first fracturing fluid is introduced through the wellbore under conditions sufficient to fracture the formation in the direction substantially parallel to the anticipated fracture orientation; and while the first fracture is maintained in an at least partially open condition by the presence of said fracturing fluid, the formation is fractured in said second direction by injection of a second fracturing fluid.

8. A method according to claim 7, wherein said first and second fracturing fluids have substantially the same composition.

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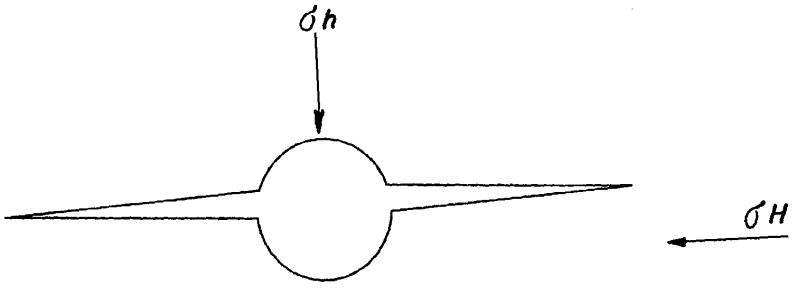


FIG. 1

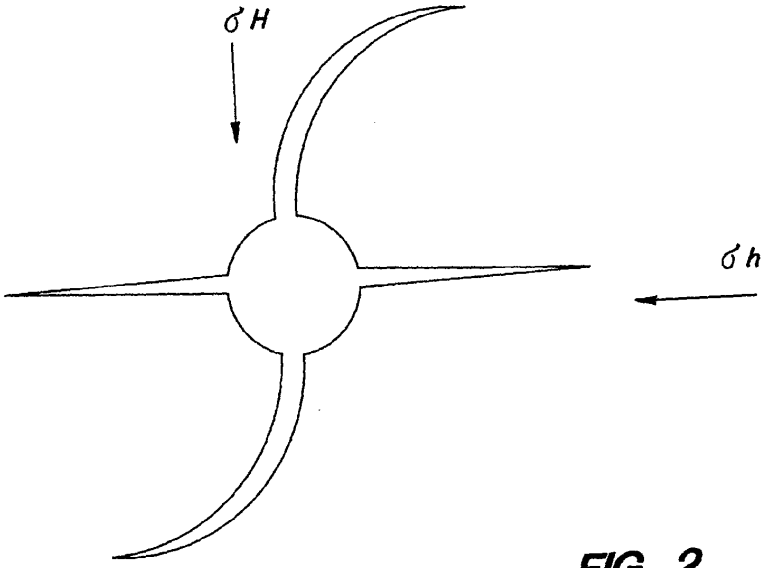


FIG. 2

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European Patent Office

EUROPEAN SEARCH REPORT

Application Number

DOCUMENTS CONSIDERED TO BE RELEVANT

EP 91306562.9

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	GB - A - 1 460 647 (INTERCOMP RESOURCE DEVELOPMENT & ENGINEERING INC.) * Totality * ----	1	E 21 B 43/26

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

E 21 B 43/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	14-11-1991	BENCZE

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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No 20042134

A METHOD AND A DEVICE FOR EXPANDING A BODY UNDER OVERPRESSURE

This invention relates to a method for expanding a body under overpressure. More particularly, it concerns the expansion of a body which is made of an elastic material having a considerable portion of closed cavities, the material allowing the diffusion of a fluid through the material and into the cavities. The method is particularly suitable for operations in the ground, in which a body of this kind, when it is being lowered to the desired position, is compressed by the prevailing overpressure, after which a fluid diffuses, over some time, through the material and into the cavities. Alternatively, the cavities are open and are held in compression during insertion into an area of elevated pressure. The invention also includes a device for practicing the method.

Bodies of this kind may have a number of applications, for example as an annular packer in an underground well. In this description, to illustrate the operation, such an application has been taken as the starting-point. The example does not in any way limit the use of the body to this example.

Completing a petroleum well by means of a sand screen in an open hole is a simple and reliable method for completing a reservoir section. A petroleum well normally penetrates formations of varying production properties. These different properties may lead to undesired well fluid of an area flowing in through the sand screen and further into the production pipe.

It may thus be desirable to close off an area to the inflow of fluid. This closing off must take place in the annulus between the sand screen and the well hole.

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According to the prior art, such closing off is effected for example by means of inflatable annular packers which are placed at a desirable location, and which are then activated by means of relatively complicated equipment. It has sometimes turned out to be difficult to achieve pressure tightness by the use of packers of this kind.

NO patent 312478 discloses a packer which is made of a swellable material. After the packer has been placed at a desired location, the material of the packer absorbs a fluid and thereby swells until it seals the annulus. In some wells, for example when dry gas is produced, it can be difficult to achieve sufficient swelling of the packer material.

The invention has as its object to remedy the drawbacks of the prior art.

The object is realized in accordance with the invention through the features specified in the description below and in the following Claims.

By placing a body which is made of an elastic material with a considerable portion of closed cavities, the material allowing the diffusion of a fluid through the material into the cavities, in an area where overpressure is prevailing, the material will be compressed, in particular through reduction of the volume of the cavities and thereby that of the material.

Over time a surrounding fluid diffuses through the material into the cavities, whereby the body expands into its essentially original dimension, possibly until it is prevented from further expansion by adjacent bodies.

Alternatively, the elastic material may be formed with many open cavities, the material being kept in compression, for example by means of a compressing material, so that the

cavities are at least partially compressed during insertion of the material into an area of elevated pressure. After the material has been placed in the area in question, the material is released from its compressed state, whereby fluid flows into the cavities of the material. The material thereby expands to its essentially original size.

Bodies of this kind are suitable for application also in water wells and dry gas wells, in which swelling materials are usable only to a limited degree.

In what follows is described a non-limiting example of a preferred method and embodiment which are visualized in the accompanying drawings, in which:

Figure 1 shows a production pipe with a sand screen in an underground well, in which there are arranged annular packers according to the invention to limit the admission area of the sand screen;

Figure 2 shows, on a larger scale, a section of Figure 1;

Figure 3 shows an expandable pipe which is provided externally with a sleeve of compressed expandable material before expansion has taken place; and

Figure 4 shows the same pipe as Figure 3 after the expansion of the expandable pipe and material has taken place.

In the drawings the reference numeral 1 identifies an underground well in a reservoir formation 2. A production pipe 4 including a sand screen 6 is placed in the underground well 1. Well fluid, indicated in Figure 1 by arrows 8, flows from the reservoir formation 2 into the production pipe 4 through the sand screen 6. The underground well 1 forms an area of overpressure due to the height of the fluid column of the well.

In order to shut off the inflow of fluid into the production pipe 4 from adjacent areas, annular packers 10 have been set.

The annular packers 10, see Figure 2, are made of an elastic material 12 with a considerable portion of closed cavities 14, the material allowing the diffusion of a fluid through the material 12 into the cavities 14. The material 12 may be nitrile rubber, for example. The material 12 may be provided with one or more reinforcements 16, for example in the form of fibre cloth.

The annular packer 10 is formed with a somewhat larger transverse dimension than the transverse dimension of the opening which it is to fill. When the annular packer 10 is run into the underground well 1, the cavities 14 of the material are compressed due to an increasing static pressure. Thereby, the annular packer 10 can easily be moved forward into the desired position.

The diffusion of fluid through the material 12 into the cavities 14 of the material 12 will start immediately. The cavities 14 are thereby filled, so that the pressure within the cavities 14 will be approximately equal to the prevailing pressure at the annular packer 10. Thereby, the annular packer 10 will attempt to adopt its original shape. If the diameter of the underground well is smaller than the original diameter of the annular packer 10, the annular packer 10 will tighten against the formation wall 18 of the underground well 1, alternatively against a casing, not shown, if the underground well 1 is cased.

In an alternative embodiment, see Figures 3 and 4, an expandable pipe 20 is provided with an encircling sleeve 22 of a material 24 which has open pore-like cavities. Before insertion into the underground well 1, the material 24 of

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the sleeve 22 is compressed by means of an encircling preloading material 26. The preloading material 26 may be formed by, for example, a fibre cloth.

After the expandable pipe 20 has been placed in a desired position, the expandable pipe 20 is expanded, whereby the preloading material 26 bursts.

The expansion of the sleeve 22 then takes place by fluid flowing into the cavities of the material 24, whereby the sleeve 22 is expanded into its original shape.

C L A I M S

1. A method for expanding a body (10, 22) under overpressure, c h a r a c t e r i z e d i n that the body (10, 22) which is formed of a material (12, 24) with a considerable portion of cavities, and which is compressed when being placed in an area of overpressure, is expanded by the cavities filling with fluid.

2. A method in accordance with claim 1, c h a r a c - t e r i z e d i n that the body (10, 22) which is made of an elastic material (12) with a considerable portion of closed cavities (14), the material (12) allowing the diffusion of a fluid through the material (12) into the cavities (14), is placed in an area of overpressure (1), after which a fluid present at the body (10, 22) diffuses through the elastic material (12) into the cavities (14).

3. A method in accordance with claim 1, c h a r a c - t e r i z e d i n that the body (10, 22) which is made of a material (24) with a considerable portion of open openings, is compressed by means of a preloading material (26) before the body (10, 22) is placed in an area (1) of overpressure, after which the preloading

material (26) is released from the material (24) as the open cavities of the material (24) are filling with fluid.

4. A device of an expandable body (10, 22), characterized in that the body (10, 22) which is formed of a material (12, 24) with a considerable portion of cavities, and which is placed, in the compressed form, in an area of overpressure, is arranged to expand by the openings filling with fluid.

5. A device in accordance with claim 4, characterized in that the body (10, 22) is made of an elastic material (12) with a considerable portion of closed cavities (14), the material (12) allowing the diffusion of a fluid through the material (12) into the cavities (14), and the body (10, 22) is arranged to be placed in an area of overpressure (1) and then be expanded by a fluid present at the body (10, 22) diffusing through the elastic material (12) into the cavities (14).

6. A device in accordance with claim 3, characterized in that the body (10, 22) which is made of an elastic material (24) with a considerable portion of open cavities, is compressed by means of a preloading material (26) before it is to be placed in an area of overpressure.

A B S T R A C T

A method and a device for expanding a body (10, 22) under overpressure, in which the body (10, 22) which is formed of a material (12, 24) with a considerable portion of cavities, and which is compressed when being placed in an area of overpressure, is expanded by the cavities filling with fluid.

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(Figure 2)

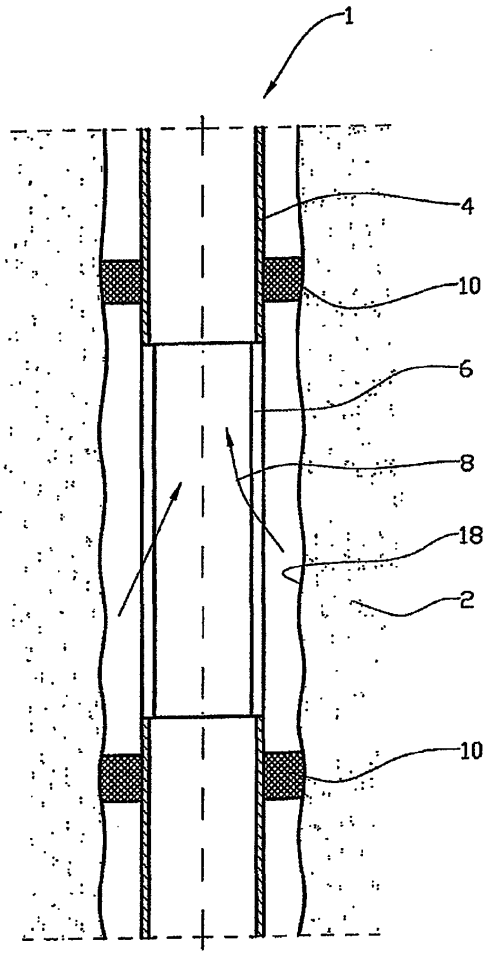


Fig. 1

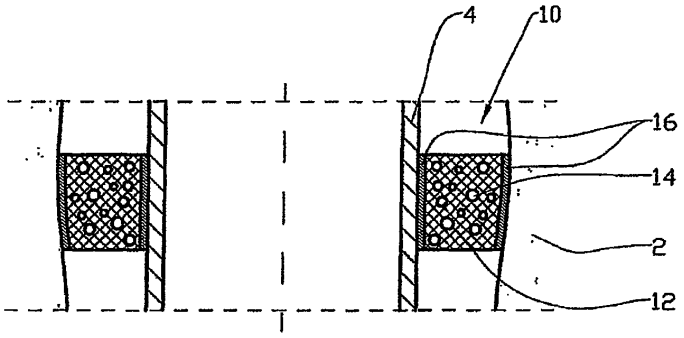


Fig. 2

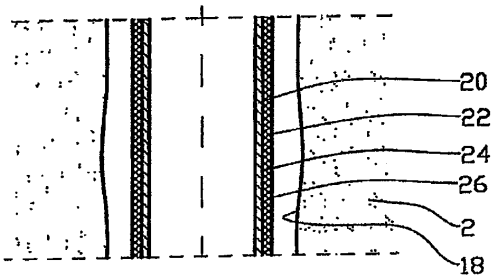


Fig. 3

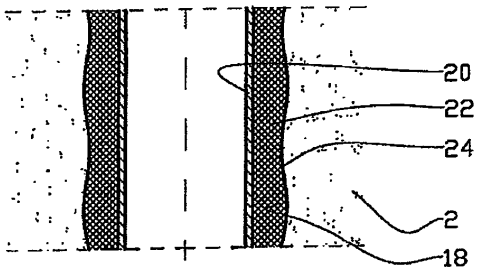


Fig. 4

No 20042134

A METHOD AND A DEVICE FOR EXPANDING A BODY UNDER OVERPRESSURE

This invention relates to a method for expanding a body under overpressure. More particularly, it concerns the expansion of a body which is made of an elastic material having a considerable portion of closed cavities, the material allowing the diffusion of a fluid through the material and into the cavities. The method is particularly suitable for operations in the ground, in which a body of this kind, when it is being lowered to the desired position, is compressed by the prevailing overpressure, after which a fluid diffuses, over some time, through the material and into the cavities. Alternatively, the cavities are open and are held in compression during insertion into an area of elevated pressure. The invention also includes a device for practicing the method.

Bodies of this kind may have a number of applications, for example as an annular packer in an underground well. In this description, to illustrate the operation, such an application has been taken as the starting-point. The example does not in any way limit the use of the body to this example.

Completing a petroleum well by means of a sand screen in an open hole is a simple and reliable method for completing a reservoir section. A petroleum well normally penetrates formations of varying production properties. These different properties may lead to undesired well fluid of an area flowing in through the sand screen and further into the production pipe.

It may thus be desirable to close off an area to the inflow of fluid. This closing off must take place in the annulus between the sand screen and the well hole.

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According to the prior art, such closing off is effected for example by means of inflatable annular packers which are placed at a desirable location, and which are then activated by means of relatively complicated equipment. It has sometimes turned out to be difficult to achieve pressure tightness by the use of packers of this kind.

NO patent 312478 discloses a packer which is made of a swellable material. After the packer has been placed at a desired location, the material of the packer absorbs a fluid and thereby swells until it seals the annulus. In some wells, for example when dry gas is produced, it can be difficult to achieve sufficient swelling of the packer material.

The invention has as its object to remedy the drawbacks of the prior art.

The object is realized in accordance with the invention through the features specified in the description below and in the following Claims.

By placing a body which is made of an elastic material with a considerable portion of closed cavities, the material allowing the diffusion of a fluid through the material into the cavities, in an area where overpressure is prevailing, the material will be compressed, in particular through reduction of the volume of the cavities and thereby that of the material.

Over time a surrounding fluid diffuses through the material into the cavities, whereby the body expands into its essentially original dimension, possibly until it is prevented from further expansion by adjacent bodies.

Alternatively, the elastic material may be formed with many open cavities, the material being kept in compression, for example by means of a compressing material, so that the

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cavities are at least partially compressed during insertion of the material into an area of elevated pressure. After the material has been placed in the area in question, the material is released from its compressed state, whereby fluid flows into the cavities of the material. The material thereby expands to its essentially original size.

Bodies of this kind are suitable for application also in water wells and dry gas wells, in which swelling materials are usable only to a limited degree.

In what follows is described a non-limiting example of a preferred method and embodiment which are visualized in the accompanying drawings, in which:

Figure 1 shows a production pipe with a sand screen in an underground well, in which there are arranged annular packers according to the invention to limit the admission area of the sand screen;

Figure 2 shows, on a larger scale, a section of Figure 1;

Figure 3 shows an expandable pipe which is provided externally with a sleeve of compressed expandable material before expansion has taken place; and

Figure 4 shows the same pipe as Figure 3 after the expansion of the expandable pipe and material has taken place.

In the drawings the reference numeral 1 identifies an underground well in a reservoir formation 2. A production pipe 4 including a sand screen 6 is placed in the underground well 1. Well fluid, indicated in Figure 1 by arrows 8, flows from the reservoir formation 2 into the production pipe 4 through the sand screen 6. The underground well 1 forms an area of overpressure due to the height of the fluid column of the well.

In order to shut off the inflow of fluid into the production pipe 4 from adjacent areas, annular packers 10 have been set.

The annular packers 10, see Figure 2, are made of an elastic material 12 with a considerable portion of closed cavities 14, the material allowing the diffusion of a fluid through the material 12 into the cavities 14. The material 12 may be nitrile rubber, for example. The material 12 may be provided with one or more reinforcements 16, for example in the form of fibre cloth.

The annular packer 10 is formed with a somewhat larger transverse dimension than the transverse dimension of the opening which it is to fill. When the annular packer 10 is run into the underground well 1, the cavities 14 of the material are compressed due to an increasing static pressure. Thereby, the annular packer 10 can easily be moved forward into the desired position.

The diffusion of fluid through the material 12 into the cavities 14 of the material 12 will start immediately. The cavities 14 are thereby filled, so that the pressure within the cavities 14 will be approximately equal to the prevailing pressure at the annular packer 10. Thereby, the annular packer 10 will attempt to adopt its original shape. If the diameter of the underground well is smaller than the original diameter of the annular packer 10, the annular packer 10 will tighten against the formation wall 18 of the underground well 1, alternatively against a casing, not shown, if the underground well 1 is cased.

In an alternative embodiment, see Figures 3 and 4, an expandable pipe 20 is provided with an encircling sleeve 22 of a material 24 which has open pore-like cavities. Before insertion into the underground well 1, the material 24 of

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the sleeve 22 is compressed by means of an encircling preloading material 26. The preloading material 26 may be formed by, for example, a fibre cloth.

After the expandable pipe 20 has been placed in a desired position, the expandable pipe 20 is expanded, whereby the preloading material 26 bursts.

The expansion of the sleeve 22 then takes place by fluid flowing into the cavities of the material 24, whereby the sleeve 22 is expanded into its original shape.

C L A I M S

1. A method for expanding a body (10, 22) under overpressure, c h a r a c t e r i z e d i n that the body (10, 22) which is formed of a material (12, 24) with a considerable portion of cavities, and which is compressed when being placed in an area of overpressure, is expanded by the cavities filling with fluid.

2. A method in accordance with claim 1, c h a r a c - t e r i z e d i n that the body (10, 22) which is made of an elastic material (12) with a considerable portion of closed cavities (14), the material (12) allowing the diffusion of a fluid through the material (12) into the cavities (14), is placed in an area of overpressure (1), after which a fluid present at the body (10, 22) diffuses through the elastic material (12) into the cavities (14).

3. A method in accordance with claim 1, c h a r a c - t e r i z e d i n that the body (10, 22) which is made of a material (24) with a considerable portion of open openings, is compressed by means of a preloading material (26) before the body (10, 22) is placed in an area (1) of overpressure, after which the preloading

material (26) is released from the material (24) as the open cavities of the material (24) are filling with fluid.

4. A device of an expandable body (10, 22), characterized in that the body (10, 22) which is formed of a material (12, 24) with a considerable portion of cavities, and which is placed, in the compressed form, in an area of overpressure, is arranged to expand by the openings filling with fluid.

5. A device in accordance with claim 4, characterized in that the body (10, 22) is made of an elastic material (12) with a considerable portion of closed cavities (14), the material (12) allowing the diffusion of a fluid through the material (12) into the cavities (14), and the body (10, 22) is arranged to be placed in an area of overpressure (1) and then be expanded by a fluid present at the body (10, 22) diffusing through the elastic material (12) into the cavities (14).

6. A device in accordance with claim 3, characterized in that the body (10, 22) which is made of an elastic material (24) with a considerable portion of open cavities, is compressed by means of a preloading material (26) before it is to be placed in an area of overpressure.

A B S T R A C T

A method and a device for expanding a body (10, 22) under overpressure, in which the body (10, 22) which is formed of a material (12, 24) with a considerable portion of cavities, and which is compressed when being placed in an area of overpressure, is expanded by the cavities filling with fluid.

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(Figure 2)

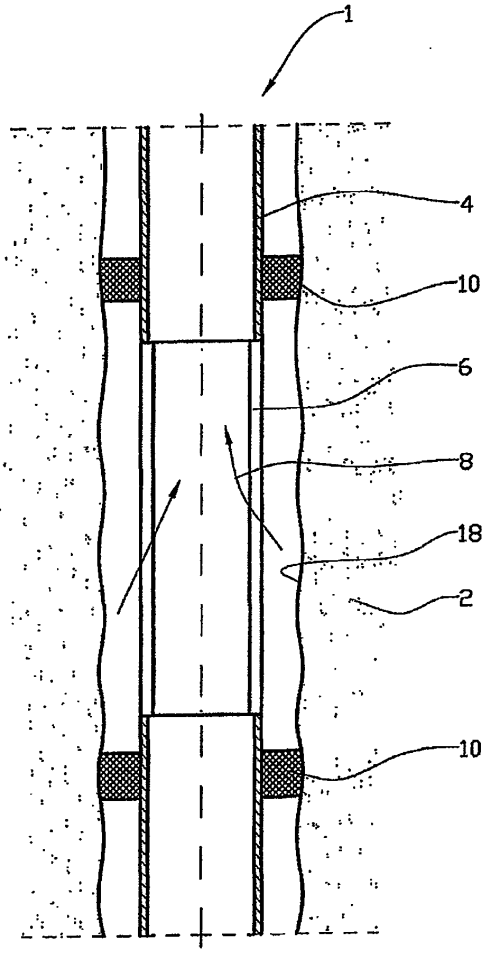


Fig. 1

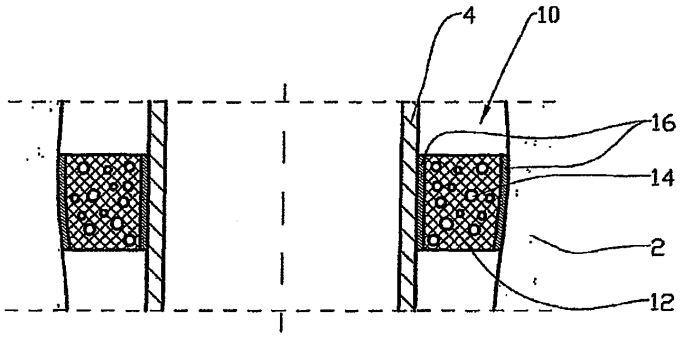


Fig. 2

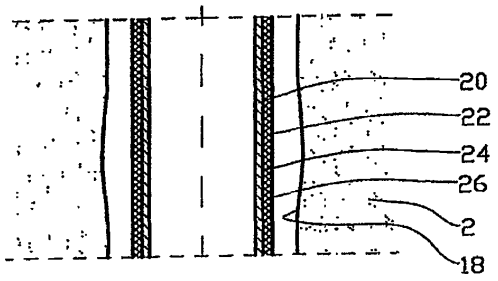


Fig. 3

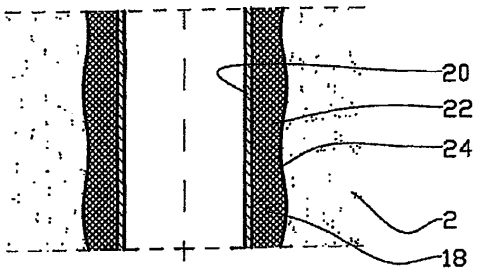


Fig. 4

Electronic Acknowledgement Receipt	
EFS ID:	2958217
Application Number:	11291496
International Application Number:	
Confirmation Number:	7986
Title of Invention:	Method and apparatus for centralized well treatment
First Named Inventor/Applicant Name:	William Lloyd McNeel
Customer Number:	29920
Filer:	Paul N. Katz/Debbie Allen
Filer Authorized By:	Paul N. Katz
Attorney Docket Number:	2005-IP-018647U1
Receipt Date:	06-MAR-2008
Filing Date:	01-DEC-2005
Time Stamp:	12:58:35
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)
1		0637180930SuppIDS.PDF	5059365 2dd399675ba198d1ce5f2501044e251e49b9ece3	yes	67

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Information Disclosure Statement Letter	1	2
	Information Disclosure Statement (IDS) Filed	3	3
	Foreign Reference	4	12
	Foreign Reference	13	32
	NPL Documents	33	44
	NPL Documents	45	54
	NPL Documents	55	59
	NPL Documents	60	67

Warnings:	
Information:	
Total Files Size (in bytes):	5059365

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/08a (03-08)
Approved for use through 04/30/2008. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11291496
Filing Date	2005-12-01
First Named Inventor	McNeel et al.
Art Unit	3676
Examiner Name	Leonard, Kerry W.
Attorney Docket Number	HES 2005-IP-018647U1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

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NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11291496
	Filing Date	2005-12-01
	First Named Inventor	McNeel et al.
	Art Unit	3676
	Examiner Name	Leonard, Kerry W.
	Attorney Docket Number	HES 2005-IP-018647U1

	1	Notice of Publication dated 04/10/08 from Application Serial No. 11/753,314	☐

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

EFS Web 2.1.0

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11291496
	Filing Date	2005-12-01
	First Named Inventor	McNeel et al.
	Art Unit	3676
	Examiner Name	Leonard, Kerry W.
	Attorney Docket Number	HES 2005-IP-018647U1

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature		Date (YYYY-MM-DD)	2008-05-27
Name/Print	Corey Tumey	Registration Number	57,709

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Electronic Acknowledgement Receipt	
EFS ID:	3357448
Application Number:	11291496
International Application Number:	
Confirmation Number:	7986
Title of Invention:	Method and apparatus for centralized well treatment
First Named Inventor/Applicant Name:	William Lloyd McNeel
Customer Number:	29920
Filer:	Corey S. Tumey/Debbie Allen
Filer Authorized By:	Corey S. Tumey
Attorney Docket Number:	2005-IP-018647U1
Receipt Date:	27-MAY-2008
Filing Date:	01-DEC-2005
Time Stamp:	13:14:47
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)
1		0637180930IDS.PDF	179705 c205227dee71c43dde53c115856ade3a5ff1b93a	yes	4

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Information Disclosure Statement (IDS) Filed	1	3
	NPL Documents	4	4
Warnings:			
Information:			
	Total Files Size (in bytes):	179705	

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National Stage of an International Application under 35 U.S.C. 371
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New International Application Filed with the USPTO as a Receiving Office
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/291,496	12/01/2005	William Lloyd McNeel	2005-IP-018647U1	7986

29920 7590 08/21/2008

JOHN W. WUSTENBERG
P.O. BOX 1431
DUNCAN, OK 73536

EXAMINER	
LEONARD, KERRY W	
ART UNIT	PAPER NUMBER
3676	
MAIL DATE	DELIVERY MODE
08/21/2008	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

PTOL-90A (Rev. 04/07)

Office Action Summary	Application No.	Applicant(s)	
	11/291,496	MCNEEL ET AL.	
	Examiner	Art Unit	
	KERRY W. LEONARD	3676	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *2/12/08*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *11-33 and 40-42* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *11-33 and 40-42* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 11-13, 20-29, 31-33, and 40-42 are rejected under 35 U.S.C. 102(b) as being anticipated by ZAKIEWICZ (US 4,305,463).

With respect to claim 11, ZAKIEWICZ discloses a system for centralized well operations comprising a well treatment operations factory which manufactures and pumps a well stimulation fluid, a first connection between a first well location and the well operations factory, a second connection between a second well location and the well operations factory and means for simultaneously flowing a first stimulation fluid to the first well location and a second stimulation fluid to a second well location (column 4, lines 12-68 and Figure 1). With respect to the depending claims, the reference discloses that the means for simultaneously flowing treatment fluid comprises a manifold (Figure 1, items 9, 10, 11, 12, 13, 14, 21 wherein item 9 represents the first connection and location and item 10 represents the second connection and location), that the well operations factory comprises a pumping grid wherein the pumping grid is operable to connect to the manifold, that the fist connection is operable to deliver a fluid from the first well location to the manifold, that the second connection is operable to deliver a fluid from the second well location to the manifold, that the fluid comprises a

stimulation fluid, that the manifold is connected to a second manifold, that the second manifold is operable to simultaneously flow a first stimulation fluid to a first well location and a second stimulation fluid to a second well location, a third connection between the manifold and the first well location, that the third connection is operable to deliver a fluid from the first well location to the manifold, that there is a fourth connection between the manifold and the second well location, wherein the fourth connection is operable to deliver a fluid from the second well location to the manifold, that the first fluid comprises a compound selected from the group of claims 31 and 32, and that the first simulation fluid and the second stimulation fluid have the same composition. With respect to claims 40-42, the reference discloses a system for centralized well operations comprising a well treatment operations factory which manufactures and pumps a well stimulation fluid, connections between the first pad and second pad and the well operations factory, and means for simultaneously flowing a first stimulation fluid to the first pad and second stimulation fluid to the second pad.

3. Claims 11-16, 20-25, 31-32, and 40-42 are rejected under 35 U.S.C. 102(b) as being anticipated by LUK et al. (US 5,515,920).

With respect to claim 11, LUK discloses a system for centralized well operations comprising a well treatment operations factory which manufactures and pumps a well stimulation fluid, a first connection between a first well location and the well operations factory, a second connection between a second well location and the well operations factory and means for simultaneously flowing a first stimulation fluid to

the first well location and a second stimulation fluid to a second well location (abstract, Figure 6, column 6, lines 26-47). With respect to the depending claims, the reference discloses that the means for simultaneously flowing treatment fluid comprises a manifold (column 4, lines 51-59 and #5), that the factory comprises a pumping grid wherein the grid is operable to connect to the manifold, that the factory comprises a blending unit wherein the blending unit is operable to connect to the pumping grid (#20 and #30 and #70), wherein the factory comprises a proppant storage system wherein the storage system is operable to deliver proppant to the blending unit (column 6, lines 42-47 and #80 which is the proppant storage which delivers proppant to the system), wherein the first connection is operable to deliver a fluid from the first well location to the manifold, wherein the second connection is operable to deliver a fluid from the second well location to the manifold, wherein the fluid comprises a stimulation fluid, wherein the manifold is connected to a second manifold (#40 and #5), wherein the second manifold is operable to simultaneously flow a first stimulation fluid to a first well location and a second stimulation fluid to a second well location, and wherein the first fluid comprises a compound selected from the groups of claims 31 and 32 (column 7, lines 21-26). With respect to claims 40-42, the reference discloses a system for centralized well operations comprising a well treatment operations factory which manufactures and pumps a well stimulation fluid, connections between the first pad and second pad and the well operations factory, and means for simultaneously flowing a first stimulation fluid to the first pad and second stimulation fluid to the second pad.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 17-19 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over LUK alone.

LUK discloses a system as described above. However the reference does not explicitly state that the well operations factory comprises a power unit or that the factory is enclosed. However, it would be obvious to one of ordinary skill in the art that the system of LUK would require some type of power unit in order to operate the system. In addition, the structures described in claim 19 are very well known in the art and it would be obvious to one of ordinary skill in the art to enclose some or all of the components in the well operations factory in order to protect them from the elements. It would also be considered obvious to provide the well operations factory on a vessel in order to produce hydrocarbons from undersea reservoirs.

6. Claim 30 is rejected under 35 U.S.C. 103(a) as being unpatentable over ZAKIEWICZ alone.

ZAKIEWICZ discloses a system as described above. The reference does not explicitly state that the well operations factory is located on a boat, however, it would be

considered obvious to one having ordinary skill in the art at the time the invention was made to provide the well operations factory on a vessel in order to produce hydrocarbons from undersea reservoirs.

Response to Arguments

7. Applicant's arguments filed 2/12/08 have been fully considered but they are not persuasive. The amendments to the claims have not placed them in condition for allowance and the rejections are presented in detail in the paragraphs above.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kerry W. Leonard whose telephone number is 571-272-8133. The examiner can normally be reached on Monday-Friday, 10:00am-6:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jennifer H. Gay can be reached on 571-272-7029. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Jennifer H Gay/
Supervisory Patent Examiner, Art Unit 3676

KWL
8/18/08

Notice of References Cited	Application/Control No. 11/291,496	Applicant(s)/Patent Under Reexamination MCNEEL ET AL.	
	Examiner KERRY W. LEONARD	Art Unit 3676	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-4,305,463	12-1981	Zakiewicz, Bohdan	166/245
*	B	US-5,515,920	05-1996	Luk et al.	166/280.1
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11291496	MCNEEL ET AL.
	Examiner	**Art Unit**
	Leonard, Kerry W	3676

SEARCHED			
Class	**Subclass**	**Date**	**Examiner**

SEARCH NOTES		
Search Notes	**Date**	**Examiner**
Search in EAST and Google Patents (see search history)		KWL
Consulted primary examiners G Suchfield and H Dang and SPE J Gay		KWL

INTERFERENCE SEARCH			
Class	**Subclass**	**Date**	**Examiner**

PTO/SB/08a (03-08)
Approved for use through 04/30/2008. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11291496
Filing Date	2005-12-01
First Named Inventor	McNeel et al.
Art Unit	3676
Examiner Name	Leonard, Kerry W.
Attorney Docket Number	HES 2005-IP-018647U1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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	1							☐

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NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11291496
	Filing Date	2005-12-01
	First Named Inventor	McNeel et al.
	Art Unit	3676
	Examiner Name	Leonard, Kerry W.
	Attorney Docket Number	HES 2005-IP-018647U1

/KL/	1	Notice of Publication dated 04/10/08 from Application Serial No. 11/753,314	☐

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature	/Kerry Leonard/	Date Considered	08/18/2008

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[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

EFS Web 2.1.0

PTO-1449 Information Disclosure Citation in an Application	Application No. 11/291,496	Applicant(s) MCNEEL ET AL.	
	Docket Number HES 2005-IP-018647U1	Group Art Unit 3676	Filing Date DECEMBER 1, 2005

U.S. PATENT DOCUMENTS

		DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS	FILING DATE
/KL/	1	6,394,184	05/28/2002	Tolman et al.	166	281	02/12/2001
	2	2007/0125544	07/07/2007	Robinson et al.	166	308.3	04/03/2006

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		DOCUMENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION YES	TRANSLATION NO
/KL/	1	WO 2007/024383 A2	07/24/2006	PCT	E21B	43/16	X	

NON-PATENT DOCUMENTS

		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	DATE
/KL/	1	Office Action from Application Serial No. 11/396,918	05/03/2007

EXAMINER /Kerry Leonard/	DATE CONSIDERED 08/18/2008

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Information Disclosure Citation in an Application	Application No. 11/291,496	Applicant(s) MCNEEL ET AL.	
	Docket Number HES 2005-IP-018647U1	Group Art Unit 3676	Filing Date December 1, 2005

U.S. PATENT DOCUMENTS

/KL/

	CITE NO.	DOCUMENT NO.	PUB/ISSUE DATE	NAME	CLASS	SUBCLASS	FILING DATE
	1	4,209,278	6/24/1980	Cooper *et al.*			
	2	4,265,266	5/4/1981	Kierbow *et al.*			
	3	4,353,482	10/22/1982	Tomlinson *et al.*			
	4	4,409,927	10/18/1983	Loesch *et al.*			
	5	5,014,218	5/7/1991	Crain *et al.*			
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	7	2007/0201305	8/30/2007	Heilman *et al.*			

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	F1	EP 0124251	11/7/1984	Crain				
	F2	EP 0508817	10/14/1992	Stromberg				
	F3	WO 2004/007894	1/22/2004	Coody *et al.*				

NON-PATENT DOCUMENTS

	CITE NO.	DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	DATE
	N1	Foreign communication related to a counter part application	6/11/2007
	N2	Foreign communication related to a counter part application	9/5/2007
	N3	Final rejection of US Patent Application Serial No. 11/396,918	1/25/2008

EXAMINER	/Kerry Leonard/	DATE CONSIDERED	08/18/2008

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Information Disclosure Citation in an Application	Application No. 11/291,496	Applicant(s) McNeel et al.	
	Docket Number HES 2005-IP-018647U1	Group Art Unit 3676	Filing Date December 1, 2005

U.S. PATENT DOCUMENTS

/KL/

		DOCUMENT NO.	ISSUE/ PUB. DATE	NAME	CLASS	SUBCLASS	FILING DATE
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		4,724,905	02/16/88	Uhri			09/15/86
		4,830,106	05/16/89	Uhri			12/29/87
		5,659,480	08/19/97	Anderson et al.			06/27/95
		7,036,587	02/02/06	Munoz, Jr. et al.			06/27/03
		2007/0153622	07/05/07	Dykstra et al.			12/30/05
		2007/0153624	07/05/07	Dykstra et al.			12/30/05
		2007/0171765	07/26/07	Dykstra et al.			12/30/05
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		11/753,314		Surjaatmadja			05/24/07
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		2006/0161358	07/20/06	Dykstra et al.			01/04/05

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		DOCUMENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION Yes	TRANSLATION No
		EP 0474350	03/11/92	Europe	E21B	43/26		
		NO 20042134	11/28/05	Norway	E21B	33/12		

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		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	
		Warpinski, Nonnan R and Branagan, Paul T., "Altered Stress Fracturing", JPT, 990-97, 473-476.	09/1989
		Surjaatmadja, "Single Point of Initiation, Dual-Fracture Placement for Maximizing Well Production," 2007 Society of Petroleum Engineers, SPE 107718	
		Surjaatmadja, "The Important Second Fracture and its Operational Placement for Maximizing Production," Society of Petroleum Engineers SPE 107059	
		Surjaatmadja, "The Mythical Second Fracture and its Operational Placement for Maximizing Production," Society of Petroleum Engineers SPE 106046	

EXAMINER /Kerry Leonard/	DATE CONSIDERED 08/18/2008

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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11291496	MCNEEL ET AL.
	Examiner	**Art Unit**
	Leonard, Kerry W	3676

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	04/27/2007	10/15/2007	08/18/2008						
	1	N	N	N						
	2	N	N	N						
	3	N	N	N						
	4	N	N	N						
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	7	N	N	N						
	8	N	N	N						
	9	N	N	N						
	10	N	N	N						
	11	✓	✓	✓						
	12	✓	✓	✓						
	13	✓	✓	✓						
	14	✓	✓	✓						
	15	✓	✓	✓						
	16	✓	✓	✓						
	17	✓	✓	✓						
	18	✓	✓	✓						
	19	O	O	✓						
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	32	✓	✓	✓						
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	34	N	N	N						
	35	N	N	N						
	36	N	N	N						

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CLAIM		DATE								
Final	Original	04/27/2007	10/15/2007	08/18/2008						
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	38	N	N	N						
	39	N	N	N						
	40			✓						
	41			✓						
	42			✓						

PTO/SB/08a (03-08)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11291496
Filing Date	2005-12-01
First Named Inventor	Lloyd McNeel
Art Unit	3676
Examiner Name	Kerry W. Leonard
Attorney Docket Number	HES 2005-IP-018647U1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20080236818	A1	2008-10-02	Dykstra	

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FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11291496
	Filing Date	2005-12-01
	First Named Inventor	Lloyd McNeel
	Art Unit	3676
	Examiner Name	Kerry W. Leonard
	Attorney Docket Number	HES 2005-IP-018647U1

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Examiner Signature		Date Considered	

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	Filing Date	2005-12-01
	First Named Inventor	Lloyd McNeel
	Art Unit	3676
	Examiner Name	Kerry W. Leonard
	Attorney Docket Number	HES 2005-IP-018647U1

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☒ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	Melody Wirz	Date (YYYY-MM-DD)	2008-10-06
Name/Print	Melody Wirz	Registration Number	53,783

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Electronic Acknowledgement Receipt	
EFS ID:	4065269
Application Number:	11291496
International Application Number:	
Confirmation Number:	7986
Title of Invention:	Method and apparatus for centralized well treatment
First Named Inventor/Applicant Name:	William Lloyd McNeel
Customer Number:	29920
Filer:	Paul N. Katz/Debbie Allen
Filer Authorized By:	Paul N. Katz
Attorney Docket Number:	2005-IP-018647U1
Receipt Date:	06-OCT-2008
Filing Date:	01-DEC-2005
Time Stamp:	15:44:35
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Filed (SB/08)	0637180930IDS.PDF	124032 322b175803774ae4ff5bc23e45b4cbec93a2e7cc	no	3
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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:		§	
	McNeel et al.	§	Group Art Unit: **3676**
		§	
Serial No.:	**11/291,496**	§	
		§	Examiner: **Leonard, Kerry W.**
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Title:	**"Method and Apparatus for Centralized Well Treatment"**	§	Atty. Docket No: **HES 2005-IP-018647U1** (063718.0930)

MAIL STOP AMENDMENT
Honorable Commissioner of Patents
P. O. Box 1450
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DATE OF SUBMISSION: OCTOBER 15, 2008
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SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

Dear Honorable Commissioner:

Applicants respectfully request, pursuant to 37 C.F.R. §§ 1.56, 1.97 and 1.98, that the art listed on the attached PTO-1449 form be considered and cited in the examination of the above-identified application.

Furthermore, pursuant to 37 C.F.R. §§1.97(g) and (h), no representation is made that these references are material to the patentability of the present application.

The Commissioner is hereby authorized to debit Baker Botts L.L.P.'s Deposit Account No. 02-0383, Order Number 063718.0930, in the amount of $180.00 for the Supplemental Information Disclosure Statement under 37 C.F.R. § 1.97(c). Applicants believe that no additional fees are due in

association with the filing of this Response. However, should the Commissioner deem that any additional fees are due, including any fees for extensions of time, the Commissioner is authorized to debit the Deposit Account of Baker Botts L.L.P., No. 02-0383, order number 063718.0930, for any underpayment of fees that may be due in association with this filing.

Respectfully submitted,

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Date: October 15, 2008

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U.S. PATENT DOCUMENTS

		DOCUMENT NO.	ISSUE/ PUB. DATE	NAME	CLASS	SUBCLASS	FILING DATE
	1	US 5,281,023	01-25-94	CEDILLO ET AL.	366	17	08-02-89
	2	US 5,365,435	11-15-94	STEPHENSON	700	265	02-19-93
	3	US 4,305,463	12-15-81	ZAKIEWICZ	166	245	10-31-70
	4	US 5,515,920	05-14-96	LUK ET AL.	166	280.1	10-27-94
	5	2007/0125543	06-07-07	MCNEEL ET AL.	166	308.3	12-01-05
	6	2004/0020662	02-05-04	FREYER	166	387	06-29-01
	7	2008/0083532	04-10-08	SURJAATMADJA	166	250.1	05-24-07

FOREIGN PATENT DOCUMENTS

		DOCUMENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION YES	TRANSLATION NO
	1	WO 2006/109035 A	10-19-06		G05D	11/13		

NON-PATENT DOCUMENTS

		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	DATE
	1	Information Disclosure Statement for Application Serial No. 11/396,918	10-15-07
	2	Information Disclosure Statement for Application Serial No. 11/873,160	10-16-07
	3	Information Disclosure Statement for Application Serial No. 11/873,186	10-16-07
	4	Office Action for Application Serial No. 11,753,314	06-12-08
	5	International Search Report for International Application No. PCT/GB2008/001044	08-13-08
	6	Office Action for Application Serial No. 11,873,186	09-24-08
	7	Notice of Publication for Application Serial No. 11/691,623	10-02-08

EXAMINER	DATE CONSIDERED

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP § 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.

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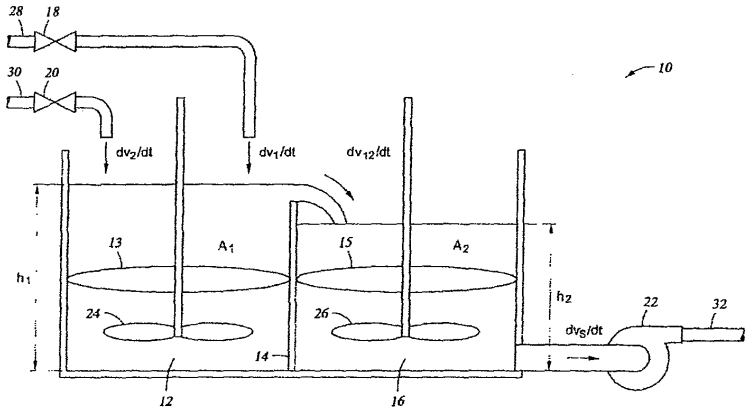
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(54) Title: CONTROL SYSTEM DESIGN FOR A MIXING SYSTEM WITH MULTIPLE INPUTS



(57) Abstract: A control system for mixing at least two materials in a physical system, for example cement and water for a well bore, having two or more tanks comprises at least two actuators, each actuator being operable to introduce a material into a first tank to form a first mixture, the first mixture flowing into a second tank to form a second mixture and a controller operable, based on a commanded input, to control the at least two actuators to obtain a density of either the first mixture or the second mixture and a volume flow rate of the second mixture out of the second tank, wherein the density is controlled independently from the volume flow rate, and wherein the commanded input comprises a commanded combined volume flow rate and a commanded combined mass flow rate of the materials passing through the actuators into the first tank.

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Control System Design for a Mixing System with Multiple Inputs

FIELD OF THE INVENTION

The present disclosure is directed to a control system design for a mixing system having multiple inputs, and more particularly, but not by way of limitation, to a control system design for a cement mixing system used in well bore servicing applications.

BACKGROUND OF THE INVENTION

A control system typically comprises one or more physical system components under some form of automated control that cooperate to achieve a set of common objectives. The control system may be designed to reliably control the physical system components in the presence of external disturbances, variations among physical components due to manufacturing tolerances, and changes in commanded input values for controlled output values, such as a cement mixture density, for example. The control system may also be designed to remain stable and avoid oscillations within a range of specific operating conditions.

In a well bore environment, a control system may be used when mixing materials to achieve a desired mixture output. For example, when drilling an oil or gas well, it is common to install a tubular casing into the well bore and cement the casing in place against the well bore wall. A cement mixing system that supports well bore servicing operations, such as cementing casing into a well bore, may be designed with a control system configured to provide a desired volumetric flow rate of mixed cement having a desired density. In particular, the cement mixing control system may control valves that allow the in-flow of dry cement material and water to obtain the desired cement mixture density and desired cement mixture volumetric flow rate. The control system may operate, for example, by monitoring the cement mixture flow rate and density, and by regulating an in-flow water valve and an in-flow dry cement material valve. However, because such systems conventionally control the output parameters, such as cement mixture flow rate and density, dependently, these systems tend to have long lag times in the response of one valve to changes in the position of the other valve. This can lead to unacceptable oscillations in the monitored parameters, and difficulty in stabilizing the system. Therefore, to make the system more stable, it

would be desirable to control output parameters, such as a mixture flow rate and a mixture density, for example, independently of each other. Accordingly, a need exists for a mixing control system with multiple inputs that decouples the effects of changes in the commanded outputs.

SUMMARY OF THE INVENTION

Disclosed herein is a control system for mixing at least two materials in a physical system having two or more tanks comprising at least two actuators, each actuator being operable to introduce a material into a first tank to form a first mixture, the first mixture flowing into a second tank to form a second mixture and a controller operable, based on a commanded input, to control the at least two actuators to obtain a density of either the first mixture or the second mixture and a volume flow rate of the second mixture out of the second tank, wherein the density is controlled independently from the volume flow rate.

Further disclosed herein is a control system for mixing at least two materials in a tank comprising at least two actuators, each actuator being operable to introduce a material into the tank to form a mixture and a controller operable, based on a commanded input, to control the at least two actuators to obtain a density of the mixture and a volume flow rate of the mixture out of the tank, wherein the density is controlled independently from the volume flow rate.

Further disclosed herein is a control system for mixing at least two materials comprising a controller operable to control a physical system comprising a plurality of actuators, each actuator being operable to introduce a material into a first tank to form a first mixture, wherein the controller operates the actuators to control a desired characteristic of the first mixture.

Further disclosed herein is a method for mixing at least two materials comprising introducing the at least two materials into a physical system, combining the at least two materials to form a mixture thereof, and independently controlling a desired characteristic of the mixture of the at least two materials and a desired parameter of the physical system.

Further disclosed herein is a method for mixing at least two materials comprising determining a commanded combined mass flow rate of the at least two materials into a first tank [commanded dm_{in}/dt], determining a commanded combined

volume flow rate of the at least two materials into the first tank [commanded dv_{in}/dt], and independently controlling, based on the commanded dm_{in}/dt and the commanded dv_{in}/dt, a density of a mixture of the at least two materials in the first tank [ρ_{12}]and a volume flow rate of the mixture out of the first tank [dv_{12}/dt].

These and other features and advantages will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present disclosure and the advantages thereof, reference is now made to the following brief description, taken in connection with the accompanying drawings and detailed description, wherein like reference numerals represent like parts.

Figure 1 is a diagram of one embodiment of a physical plant within which a control system for a mixing system may be implemented;

Figure 2 is a block diagram of one embodiment of a control system;

Figure 3 is a block diagram of one embodiment of a flow modulator component of the control system of Figure 2;

Figure 4 is a block diagram of one embodiment of a flow regulator component of the control system of Figure 2;

Figure 5A is a block diagram of two embodiments of a state feedback controller with command feed forward component of the control system of Figure 2;

Figure 5B is a block diagram of the first embodiment of the state feedback controller with command feed forward component of Figure 5A;

Figure 5C is a block diagram of the second embodiment of the state feedback controller with command feed forward component of Figure 5A;

Figure 6 is a block diagram of the components of the control system of Figure 2 in the context of the physical plant;

Figure 7 is a flow diagram illustrating an exemplary use of the control system of Figure 2;

Figure 8A is a block diagram of one embodiment of a height observer component;

Figure 8B is a block diagram of one embodiment of a control system comprising first and second height observer components;

Figure 9A is a block diagram of one embodiment of a density observer component;

Figure 9B is a block diagram of one embodiment of a control system comprising first and second density observer components;

Figure 10A is a block diagram of a first portion of an embodiment of a control system for a physical plant having a single tank, the first portion including a height controller;

Figure 10B is a block diagram of a second portion of the embodiment of the control system for a physical plant having a single tank, the second portion including a density controller;

Figure 11 is a block diagram of one embodiment of a control system having a density observer associated with a first tank and no automated height control;

Figure 12 is a block diagram of one embodiment of a control system having a density observer associated with the first tank and a height observer associated with a second tank; and

Figure 13 illustrates one example of a general purpose computer system suitable for implementing the several embodiments of the control system and its various components.

DETAILED DESCRIPTION

It should be understood at the outset that the present disclosure describes various implementations of different embodiments of a control system having one or more inputs. However, the present control system may also be implemented using any number of other techniques, whether currently known or in existence. The present disclosure should in no way be limited to the descriptions, drawings, and techniques illustrated below, including the design and implementation illustrated and described herein.

In an embodiment shown in Figure 1, a physical plant 10 to be controlled comprises a first tank 12 joined by a weir 14 to a second tank 16, a first actuator 18 dispensing a first material to be mixed, a second actuator 20 dispensing a second material to be mixed, and an outflow pump 22. A first mixture 13 is formed from the in-

flow of the first material from the first actuator 18 and the second material from the second actuator 20 into the first tank 12. When the first mixture 13 fills the first tank 12 to the height of the weir 14, the first mixture 13 overflows into the second tank 16. The mixture in the second tank 16 is referred to as a second mixture 15. A first stirrer 24 and a second stirrer 26 may be provided to promote homogeneity of the first mixture 13 in the first tank 12 and the second mixture 15 in the second tank 16, respectively. The second mixture 15 exits the second tank 16 via an outflow pump 22 and a discharge line 32. In other embodiments, additional actuators may feed additional materials into the first tank 12. In other embodiments, a single tank or three or more tanks may be used.

In an embodiment, the physical plant 10 is a well bore servicing fluid mixing system, such as, for example, a cement mixer used to provide a continuous stream of a cement slurry for cementing a tubular casing against a well bore wall. In this embodiment, a dry cement material may be fluidized by the introduction of pressurized air, which promotes fluid flow of the dry cement through a first feed line 28, to be dispensed into the first tank 12 through the first actuator 18, for example, and a carrier fluid, such as water, for example, may flow through a second feed line 30 to be dispensed into the first tank 12 through the second actuator 20. In this embodiment, the first and second actuators 18, 20 may be valves, for example. These two materials, the dry cement material and the carrier fluid, are mixed by the first stirrer 24 to obtain the first mixture 13. Non-fluidized sand or other particulate matter may be dispensed through a third actuator (not shown), such as a screw feeder, for example, into the first tank 12 to mix with the cement slurry. In various embodiments, any of the actuators may comprise a valve, a screw feeder, an augur, an elevator, or other type of actuator known to those skilled in the art. The first mixture 13 is preferably substantially homogenous. The physical plant 10 should provide the cement slurry via the outflow pump 22 and the discharge line 32 at a volumetric flow rate sufficient to support the well bore servicing operation, and should mix the dry concrete material, the carrier fluid, and any particulate material in appropriate proportions so that the cement slurry dispensed thereby achieves a desired density. The physical plant 10 in other embodiments may support other mixing operations of other materials. For example, in another embodiment, proppants and a carrier fluid may be dispensed

through the first and second actuators 18, 20 into the first tank 10 to form a portion of a fracturing fluid.

Figure 1 also identifies several parameters of a control system, *e.g.*, a first control system 100 depicted in Figure 2, coupled to the physical plant 10 and functional to control the operation thereof. The first tank 12 has a cross-sectional area represented by the constant A_1, and the second tank 16 has a cross-sectional area represented by the constant A_2. The height of the first mixture 13 in the first tank 12 is represented by the variable h_1, and the height of the second mixture 15 in the second tank 16 is represented by the variable h_2. The volumetric flow rate of the first material, for example dry cement, through the first actuator 18 into the first tank 12 is represented by dv_1/dt. The volumetric flow rate of the second material, for example water, through the second actuator 20 into the first tank 12 is represented by dv_2/dt. The volumetric flow rate of the first mixture 13, for example a cement slurry, over the weir 14 into the second tank 16 is represented by dv_{12}/dt. The volumetric flow rate of the second mixture 15 out of the second tank 16 and through the outflow pump 22 is represented by dv_s/dt.

The first control system 100 disclosed hereinafter is expected to reduce control oscillations due to system time lags and to promote independent control of a mixture density and a mixture flow rate.

Turning now to Figure 2, a first control system 100 is depicted that is coupled to the physical plant 10 of Figure 1 and controls the first actuator 18 and the second actuator 20. In an embodiment, the first control system 100 controls the actuators 18, 20 to obtain sensed parameter values that approach or equal the following input parameter values that are input into the first control system 100 by an operator through an interface with the first control system 100: a height h_2 of the second mixture 15 in the second tank 16, a volumetric flow rate dv_s/dt of the second mixture 15 out of the second tank 16, and a density ρ_s of the second mixture 15 out of the second tank 16. In other embodiments, the first control system 100 may control the first actuator 18 and the second actuator 20 to obtain sensed parameter values that approach or equal other input parameter values. For example, the first control system 100 may be said to control the volumetric flow rate of the first mixture 13 over the weir 14 into the second tank 16, represented by dv_{12}/dt, and the density of the second mixture 15 as it

leaves the second tank 16, represented by ρ_s. However, the first control system 100 actually controls the first actuator 18 and the second actuator 20, for example, by adjusting a valve position or by modifying a rotation rate of a screw feeder.

The first control system 100 comprises a controller 102 that receives input parameter values from an operator through an interface with the first control system 100, and also receives sensed parameter values from sensors coupled to or integral with the physical plant 10. The controller 102 distributes as output parameter values commands to the first actuator 18 and the second actuator 20. An input parameter value 104 for h_2 provides to the controller 102 the desired height h_2 of the second mixture 15 in the second tank 16, an input parameter value 106 for dv_s/dt provides the desired volumetric flow rate dv_s/dt of the second mixture 15 out of the second tank 16, and an input parameter value 108 for ρ_s provides the desired density ρ_s of the second mixture 15 out of the second tank 16. A h_1 sensor 110 provides an indication of the height h_1 of the first mixture 13 in the first tank 12, a h_2 sensor 112 provides an indication of the height h_2 of the second mixture 15 in the second tank 16, a ρ_{12} sensor 114 provides an indication of the density ρ_{12} of the first mixture 13, and a ρ_s sensor 116 provides an indication of the density ρ_s of the second mixture 15. These indications may be referred to as sensed parameter values.

In an embodiment, the first control system 100 controls the actuators 18, 20 to achieve a desired volumetric flow rate dv_{12}/dt of the first mixture 13 over the weir 14 into the second tank 16, and a density ρ_s of the second mixture 15 out of the second tank 16, independently of each other. For example, changing the dv_s/dt input parameter value 106 causes the controller 102 to control the actuators 18, 20 so that the actual volumetric flow rate dv_{12}/dt of the first mixture 13 over the weir 14 into the second tank 16 changes until it substantially equals the dv_s/dt input parameter value 106. Actual values may also be referred to as nominal values in some contexts by those skilled in the control systems art. However, the density ρ_s of the second mixture 15 as it leaves the second tank 16 remains substantially unchanged because the density and flow rate parameters are controlled independently. Similarly, changing the ρ_s input parameter value 108 causes the controller 102 to alter the control signals to actuators 18, 20 until the sensed density ρ_s of the second mixture 15 as read by the ρ_s sensor 116 substantially equals the ρ_s input parameter value 108. However, the

volumetric flow rate dv_{12}/dt of the first mixture 13 over the weir 14 into the second tank 16 remains substantially unchanged because the flow rate and density parameters are controlled independently.

Turning now to Figure 3, a flow modulator 150 for use with one or more embodiments of the first control system 100 is depicted. The flow modulator 150 comprises a first flow modulator 152 and a second flow modulator 154 to modulate the first actuator 18 and the second actuator 20, respectively. In some embodiments, the first flow modulator 152 and the second flow modulator 154 may be combined in an integrated modulator unit 155 or combined in a single functional block, such as, for example, within a computer programmed to modulate the first actuator 18 and the second actuator 20. The first and second flow modulator 152, 154 provide a mechanism for modulating or converting between the preferred control parameters, for example volumetric rate and mass flow rate, and the physical controls of the physical system, for example control signals to the first actuator 18 and the second actuator 20. Both the first flow modulator 152 and the second flow modulator 154 receive from another component of the controller 102 a commanded first volume flow rate signal 151 for dv_{in}/dt and a commanded first mass flow rate signal 153 for dm_{in}/dt. For example, the commanded first volume flow rate dv_{in}/dt signal 151 and the commanded first mass flow rate dm_{in}/dt signal 153 may be received from a flow regulator 200 to be discussed hereinafter, or from some other component of the controller 102. The commanded first volume flow rate dv_{in}/dt signal 151 corresponds to a desired combined volumetric in-flow rate of materials, for example dry cement and carrier fluid, from the first actuator 18 and the second actuator 20 into the first tank 12. The commanded first mass flow rate dm_{in}/dt signal 153 represents a desired combined mass in-flow rate of these materials from the first actuator 18 and the second actuator 20 into the first tank 12.

In an embodiment, the flow modulator 150 generates an $actuator_1$ signal to control the first actuator 18, and this $actuator_1$ signal may be expressed mathematically as proportional to a function f_1 as follows:

$$\text{actuator}_1 \text{ signal} \propto f_1 = [dm_{in}/dt - (dv_{in}/dt)\rho_{m2}]/(\rho_{m1} - \rho_{m2}) \quad (1)$$

Similarly, the flow modulator 150 generates an actuator$_2$ signal to control the second actuator 20, and the actuator$_2$ signal may be expressed mathematically as proportional to a function f_2 as follows:

$$\text{actuator}_2 \text{ signal} \propto f_2 = [(dv_{in}/dt)\rho_{m1} - dm_{in}/dt]/(\rho_{m1} - \rho_{m2}) \quad (2)$$

where dm_{in}/dt is the combined mass flow rate entering the tank, dv_{in}/dt is the combined volume flow rate entering the tank, ρ_{m1} is the density of the first material, for example dry cement, flowing into the first tank 12 from the first actuator 18, and where ρ_{m2} is the density of the second material, for example water, flowing into the first tank 12 from the second actuator 20. One skilled in the art will readily be able to determine a suitable first constant of proportionality for equation (1) to drive the first actuator 18 and a suitable second constant of proportionality for equation (2) to drive the second actuator 20 in a particular embodiment. In an embodiment, the actuator$_1$ and actuator$_2$ signals may be conditioned by one or more components (not shown) between the flow modulator 150 and the actuators 18, 20 to conform the actuator$_1$ and actuator$_2$ signals to a non-linear response of one or more of the actuators 18, 20.

Turning now to Figure 4, a flow regulator 200 for use with one or more embodiments of the first control system 100 is depicted. The flow regulator 200 comprises a first flow regulator 202 and a second flow regulator 204. In some embodiments, the first flow regulator 202 and the second flow regulator 204 may be combined in an integrated unit 205 or combined in a single functional block, such as, for example, within a computer programmed to perform flow regulation. The first flow regulator 202 receives from another component of the controller 102 a commanded volumetric flow rate signal 201 for dv_{12}/dt of the first mixture 13 over the weir 14 into the second tank 16, and a sensed height h_1 of the first mixture 13 in the first tank 12 from the h_1 sensor 110. The first flow regulator 202 may receive the commanded volumetric flow rate dv_{12}/dt signal 201, for example, from a flow$_1$ state feedback controller with command feed forward 250, to be discussed hereinafter, or from some other component of the controller 102. The first flow regulator 202 generates the commanded first volumetric flow rate dv_{in}/dt signal 151 that is received as a commanded value by the flow modulator 150 or by the first and second flow modulators 152, 154 as described above with reference to Figure 3.

The second flow regulator 204 receives from another component of the controller 102 a commanded mass flow rate signal 203 for dm_{12}/dt of the first mixture 13 over the weir 14 into the second tank 16, a sensed height h_1 of the first mixture 13 in the first tank 12 from the h_1 sensor 110, and a sensed density ρ_{12} of the first mixture 13 from sensor 114. The second flow regulator 202 may receive the commanded mass flow rate dm_{12}/dt signal 203, for example, from a $flow_2$ state feedback controller with command feed forward 252, to be discussed hereinafter, or from some other component of the controller 102. The second flow regulator 204 generates the commanded first mass flow rate dm_{in}/dt signal 153 that is received as a commanded value by the flow modulator 150 or by the first and second flow modulators 152, 154 described above with reference to Figure 3.

In an embodiment, the function of the first flow regulator 202 may be expressed mathematically as:

$$\text{commanded } dv_{in}/dt = F(h_1)(1 - K_v) + K_v(\text{commanded } dv_{12}/dt) \quad (3)$$

and the function of the second flow regulator 204 may be expressed mathematically as:

$$\text{commanded } dm_{in}/dt = F(h_1)\rho_{12}(1 - K_m) + K_m(\text{commanded } dm_{12}/dt) \quad (4)$$

where $F(h_1)$ is a non-linear function of the height h_1 of the first mixture 13 in the first tank 12 and provides an estimate of a volumetric flow rate dv_{12}/dt of the first mixture 13 over the weir 14 into the second tank 16; where commanded dv_{12}/dt is the commanded volumetric flow rate dv_{12}/dt signal 201; where commanded dm_{12}/dt is the commanded mass flow rate dm_{12}/dt signal 203; where ρ_{12} is an indication of density of the first mixture 13 in the first tank 12 based on the input from the ρ_{12} sensor 114; and where K_v and K_m are constants of proportionality that are greater than zero. The values for K_v and K_m may be chosen through a closed form solution and/or iteratively so as to minimize overall response time while maintaining stability and desired flow rate and density trajectories during transition phases. An exemplary non-linear function $F(h_1)$ for volumetric flow rate over a rectangular weir is given in *Engineering Fluid Mechanics*, 5th Edition, by Roberson and Crowe, published by Houghton Mifflin, 1993, and may be represented as:

$$dv_{12}/dt = F(h_1) = KL(h_1 - h_w)^{(3/2)} \quad (5)$$

where L is the length of the weir 14 dividing the tanks 12, 16, K is a flow coefficient that may be empirically determined over a set of operating conditions for a specific weir geometry, and h_w is a constant representing the height of the weir.

The volumetric outflow of the first mixture 13 dv_{12}/dt and the mass outflow of the first mixture 13 dm_{12}/dt from the first tank 12 to the second tank 16 may be modeled as negative state feedbacks in the physical plant 10. In equation (3), the effect of the $1xF(h_1)$ term is to cancel or decouple the negative state feedback associated with dv_{12}/dt, and in equation **(4)**, the effect of the $1x\rho_{12}F(h_1)$ term is to decouple the negative state feedback associated with dm_{12}/dt. The control system 102 may be more robust as a result of the state feedback decoupling in the first and second flow regulators 202, 204 because the control system 102 only has to correct for errors between desired and actual mass rate and desired and actual volumetric flow rate without having to also compensate for the first mixture 13 leaving the first tank 12.

Turning now to Figure 5A, a $flow_1$ state feedback controller with command feed forward 250 and a $flow_2$ state feedback controller with command feed forward 252 for use with one or more embodiments of the first control system 100 are depicted. The $flow_1$ state feedback controller with command feed forward 250 receives the h_2 input parameter value 104 and the dv_s/dt input parameter value 106 from an operator interfacing with the first control system 100, and also receives an indication of the height h_2 of the second mixture 15 in the second tank 16 from the h_2 sensor 112. Based on these inputs, the $flow_1$ state feedback controller with command feed forward 250 produces the commanded volumetric flow rate dv_{12}/dt signal 201 that is received as a commanded value by the first flow regulator 202 described above with reference to Figure 4. The $flow_1$ state feedback controller with command feed forward 250 may also be referred to as a height controller with command feed forward.

The $flow_2$ state feedback controller with command feed forward 252 receives the dv_s/dt input parameter value 106 and the ρ_s input parameter value 108, from an operator interfacing with the first control system 100, and also receives an indication of the density ρ_s of the second mixture 15 in the second tank 16 from the ρ_s sensor 116. Based on these inputs, the $flow_2$ state feedback controller with command feed forward 252 produces the commanded mass flow rate dm_{12}/dt signal 203 that is received as a

commanded value by the second flow regulator 204 described above with reference to Figure 4. The $flow_2$ state feedback controller with command feed forward 252 may also be referred to as a density controller with command feed forward. The flow state feedback controllers with command feed forward 250, 252 receive different inputs but serve the same purpose of providing a commanded value signal to a flow regulator 202, 204. In some embodiments, the $flow_1$ state feedback controller with command feed forward 250 and the $flow_2$ state feedback controller with command feed forward 252 may be combined in an integrated unit 251 or combined in a single functional block, such as, for example, within a computer programmed to perform the indicated functions.

Turning now to Figure 5B, a block diagram shows processing details of one embodiment of the $flow_1$ state feedback controller with command feed forward 250. A first summation component 253, represented by the Σ symbol within a circle as is conventional in mathematical notation, determines a first error term $e_1(t)$ by negatively summing the indication of the height h_2 of the second mixture 15 in the second tank 16 from the h_2 sensor 112 with the h_2 input parameter value 104. The inputs to any summation component, for example the first summation component 253, are positively or negatively summed together to determine the output of the summation component. Specifically, the inputs associated with a "+" (plus) sign are positively summed, while the inputs associated with a "–" (minus) sign are negatively summed. The output of the first summation component 253, namely the first error term $e_1(t)$, is then processed by a first proportional-integral (PI) controller 255 having a gain K_{p1} for a first proportional component 254 and an integral gain K_{i1} for a first integral component 256 associated with a first integration factor 258, as represented by 1/S inside the box, as is conventional in control system art to suggest integration. The proportional and integral operations on the first error term $e_1(t)$ are positively summed by a second summation component 259. A twenty-fifth summation component 257 sums the output of the second summation component 259 with the dv_s/dt input parameter value 106 of the second mixture 15 out of the second tank 16. The output of the twenty-fifth summation component 257 is the commanded volumetric flow rate dv_{12}/dt signal 201 that is received as a commanded value by the first flow regulator 202 described above with reference to Figure 4. The temporal response of the $flow_1$ state feedback

controller with command feed forward 250, represented as a function $u_1(t)$, may be expressed mathematically as:

$$\text{commanded } dv_{12}/dt = u_1(t) = dv_s/dt + K_{p1}e_1(t) + K_{i1}\int e_1(t)dt \qquad (6)$$

The outflow of the second mixture 15 from the second tank 16 may be modeled as negative state feedback in the physical plant 10. In equation (6), the effect of the dv_s/dt term, which is the command feed forward term, is to decouple the negative state feedback associated with the outflow of the second mixture 15 from the second tank 16. While this may not be strict state feedback decoupling, the same benefits of robustness may be at least partially obtained using this technique.

Turning now to Figure 5C, a block diagram shows processing details of one embodiment of the $flow_2$ state feedback controller with command feed forward 252. A third summation component 261 determines a second error term $e_2(t)$ by negatively summing the indication of the density ρ_s of the second mixture 15 in the second tank 16 from the ρ_s sensor 116 with the ρ_s input parameter value 108. The second error term $e_2(t)$ is then processed by a second PI controller 263 having a gain K_{p2} for a second proportional component 260 and an integral gain K_{i2} for a second integral component 262 associated with a second integration factor 264. The proportional and integral operations on the second error term $e_2(t)$ are positively summed by a fourth summation component 265. A twenty-sixth summation component 287 sums the output of the fourth summation component 265 with the output of a first multiplier component 266 and the output of a second multiplier component 267. The first multiplier component 266 output equals the ρ_s input parameter value 108 multiplied by $(dh_2/dt)A_2$, where A_2 is the cross-sectional area of the second tank 16 and dh_2/dt is the height rate of change of the second mixture 15 in the second tank 16. In an embodiment, the first multiplier component 266 may be omitted, as for example when the parameter dh_2/dt is not readily available. The second multiplier component 267 outputs the product of the ρ_s input parameter value 108 multiplied by the input parameter value 106 of dv_s/dt of the second mixture 15 out of the second tank 16. The output of the twenty-sixth summation component 287 is the commanded mass flow rate dm_{12}/dt signal 203 that is received as a commanded value by the second flow regulator 204 described above with reference to Figure 4. Thus, the temporal

response of the $flow_2$ state feedback controller with command feed forward 252, represented as a function $u_2(t)$, may be expressed mathematically as:

commanded $dm_{12}/dt = u_2(t) = input\rho_s\{(dh_2/dt)A_2 + dv_s/dt\} + K_{P2}e_2(t) + K_{I2}\int e_2(t)dt$ (7)

The outflow of mass from the second tank 16 may be modeled as negative state feedback in the physical plant 10. In equation (7), the effect of the $\rho_s(dv_s/dt)$ term, the command feed forward term, is to decouple the negative state feedback associated with the outflow of mass from the second tank 16. While this may not be strict state feedback decoupling, the same benefits of robustness may be at least partially obtained using this technique. An additional refinement of this relaxed state feedback decoupling technique may be obtained by decoupling the effect of a loss of mass associated with changes of height of the second mixture 15 in the second tank 16. In equation (7), the $\rho_s(dh_2/dt)A_2$ term also contributes to decoupling the negative state feedback associated with the outflow of mass from the second tank 16. The dh_2/dt factor may be determined from a series of indications of the height of the second mixture 15 in the second tank 16 or by other means such as an estimate of dh_2/dt produced by a height observer as discussed below.

One skilled in the art will recognize that the results of the analysis of the $flow_1$ state feedback controller with command feed forward 250 and the $flow_2$ state feedback controller with command feed forward 252 above may be applied to digital signals as well as analog signals. For example, analog parameters such as the indication of density ρ_s of the second mixture 15 in the second tank 16 from the ρ_s sensor 116 may be converted by an analog-to-digital converter (D/A converter) to a digital signal. Similarly, analog outputs may be produced by a digital-to-analog converter (A/D converter), optionally combined with an amplifier to provide sufficient power to drive an electromechanical device, converting a digital control signal to an analog control signal suitable for controlling the first actuator 18 and the second actuator 20.

Turning now to Figure 6, the major components of the first control system 100 are depicted coupled together and to the actuators 18, 20 of the physical plant 10 described above with reference to Figure 1. In particular, Figure 6 depicts an embodiment of the first control system 100 of Figure 2, showing the various components that may comprise the controller 102.

Referring to the right side of the drawing, the first and second flow modulators 152, 154, as described above with reference to Figure 3, are shown cross-coupled and connected to control the first and second actuators 18, 20. The first flow modulator 152 receives the commanded first volume flow rate dv_{in}/dt signal 151 from the first flow regulator 202 and the commanded first mass flow rate dm_{in}/dt signal 153 from the second flow regulator 204 to generate an $actuator_1$ control signal to control the first actuator 18. The second flow modulator 154 receives the commanded first volume flow rate dv_{in}/dt 151 signal from the first flow regulator 202 and the commanded first mass flow rate dm_{in}/dt 153 signal from the second flow regulator 204 to generate an $actuator_2$ control signal to control the second actuator 20. Thus, the first and second flow modulators 152, 154 may be said to control the actuators 18, 20 based on the dv_{in}/dt and dm_{in}/dt system parameters, which are not the parameters desired to be controlled. Instead, these system parameters dv_{in}/dt and dm_{in}/dt are associated closely with the operation of the first and second actuators 18, 20 by the flow modulators 152, 154. However, it is desired to control other system parameters, namely the input parameter values, which are derived from the states of the first and second actuators 18, 20 and the characteristics of the physical plant 10, for example the cross-sectional area of the first and second tanks 12, 16, and are time lagged with respect to the the states of the actuators 18, 20. The possible states of the actuators 18, 20 depend on the actuator type. For example, a valve opens or closes, whereas a screw feeder turns at different speeds. The various other components of the controller 102, which will be discussed herein, enable control of the desired system parameters by bridging between the states of the actuators 18, 20 and those parameters desired to be controlled.

The first flow regulator 202 receives the commanded volumetric flow rate dv_{12}/dt signal 201 from the $flow_1$ state feedback controller with command feed forward 250 and the h_1 indication from the h_1 sensor 110 to generate the commanded first volume flow rate dv_{in}/dt signal 151 that feeds into the flow modulators 152,154. As discussed above with reference to Figure 4, the first flow regulator 202 uses the indication of h_1 to decouple the negative state feedback associated with the flow of the first mixture 13 out of the first tank 12. For example, the volumetric outflow can be

determined from $F(h_1)$, as discussed above, and then the volumetric outflow can be decoupled.

The second flow regulator 204 receives the commanded mass flow rate dm_{12}/dt signal 203 from the $flow_2$ state feedback controller with command feed forward 252, the indication from the h_1 sensor 110, and the ρ_{12} indication from the ρ_{12} sensor 114 to generate the commanded first mass flow rate dm_{in}/dt signal 153 that feeds into the flow modulators 152, 154. As discussed above with reference to Figure 4, the second flow regulator 204 uses the indications of h_1 and of ρ_{12} to decouple the negative state feedback associated with the flow of the first mixture 13 out of the first tank 12. For example, the mass outflow can be calculated from the product of the indication of ρ_{12} and the volumetric outflow dv_{12}/dt, where the volumetric outflow dv_{12}/dt is determined from $F(h_1)$, and the mass outflow then can be decoupled. The first and second flow regulators 202, 204 may be said to provide one level of removal from the system parameters dv_{in}/dt and dm_{in}/dt directly associated with the states of the first and second actuators 18, 20.

The $flow_1$ state feedback controller with command feed forward 250 receives the h_2 input parameter value 104 and the dv_s/dt input parameter value 106 from an operator interfacing with the first control system 100, and also receives the indication of h_2 from the h_2 sensor 112 to generate the commanded volumetric flow rate dv_{12}/dt signal 201 that feeds into the first flow regulator 202. As discussed above, the $flow_1$ state feedback controller with command feed forward 250 may be referred to as a height controller, because it controls the height h_2 of the second mixture 15 in the second tank 16. The command feed forward term, namely the dv_s/dt input parameter value 106, may be considered to decouple the negative state feedback of volumetric flow out of the second tank 16 as discussed above with reference to Figure 5B.

The $flow_2$ state feedback controller with command feed forward 252 receives the dv_s/dt input parameter value 106 and the ρ_s input parameter value 108 from an operator interfacing with the first control system 100, and also receives the indication of ρ_s from the ρ_s sensor 116 to generate the commanded mass flow rate dm_{12}/dt signal 203 that feeds into the second flow regulator 204. As discussed above, the $flow_2$ state feedback controller with command feed forward 252 may be referred to as a density controller, because it controls the density ρ_s of the second mixture 15 in the second

tank 16. The command feed forward term, formed by the product of the ρ_s input parameter value 108 multiplied by the dv_s/dt input parameter value 106, may be considered to decouple the negative state feedback of mass flow out of the second tank 16 as discussed above with reference to Figure 5C.

The $flow_1$ and $flow_2$ state feedback controller with command feed forward 250, 252 may be said to provide yet another level of removal from the system parameters dv_{in}/dt and dm_{in}/dt directly associated with the states of the first and second actuators 18, 20, and provide the desired responsiveness to the parameters desired to be controlled.

It will be readily appreciated by one skilled in the art that portions of the control components described above may be combined, for example within a computer program implementing the functional blocks of the control components.

In operation, as set out in the logic flow diagram of Figure 7, the first control system 100 disclosed herein may, for example, be used to control a physical plant 10 comprising a cement slurry mixing system that provides cement slurry for cementing a tubular casing into a well bore. During such an operation, the operator may want the first control system 100 to provide a cement slurry having a desired density ρ_s, while pumping the cement slurry out of the second tank 16 at a desired volumetric flow rate dv_s/dt, and while maintaining the height of the cement slurry in the second tank 16 at a desired height h_2.

The process begins at block 400 in which the well bore servicing equipment, including the physical plant 10 and the first control system 100, is brought to the well bore site and assembled. The discharge line 32 of Figure 1 is coupled to the well bore, for example, using connected lengths of pipe, one end of which connects to a manifold or header at the well bore. Vessels containing blended dry cement and water in sufficient quantities are positioned to continuously supply the first feed line 28 and the second feed line 30 of Figure 1.

Once the equipment has been set up at the well site, the process proceeds to block 402 where an operator provides input parameter values to the controller 102, for example through a console or lap top computer coupled to the controller 102, for example via a serial cable or a wireless link. The input parameter values may include the h_2 input 104, the dv_s/dt input 106, and the ρ_s input 108. In operation, the controller

102 will act to control the first and second actuators 18, 20, for example valves, such that the corresponding actual quantities of ρ_s, dv_s/dt, and h_2 approach or equal the input parameter values.

The process proceeds to block 404 where the operator engages the controller 102. The process continues hereinafter along two independent but at least partially coupled paths. Proceeding to block 406, the controller 102 actively controls the first and second actuators 18, 20 in accordance with the input parameter values and the sensed conditions of the physical plant 10. When the controller 102 is first engaged, it is likely that the first and second tanks 12, 16 will be empty. In this case, the controller 102 may open one of the first or second actuators 18, 20 fully open and then open the other of the first or the second actuators 18, 20 so as to achieve the desired cement slurry density as indicated by the ρ_s input parameter value 108. The controller 102 continually determines and updates the actuator control signals that are output to the first and second actuators 18, 20, and the controller 102 may be said to be operating within a control loop represented by blocks 406 and 408. The controller 102 remains in this control loop 406, 408 while compensating for changes of indications returned from the physical plant 10, for example the sensed density ρ_s of the cement slurry in the second tank 16 according to sensor 116, and for changes of input values, for example the h_2 input parameter value 104.

The process also concurrently proceeds along a second branch to block 410 where the physical plant 10 begins to pump cement slurry via the outflow pump 22, through the discharge line 32, through the coupled pipes, and downhole into the well bore. As the flow rate dv_s/dt of the cement slurry exiting the second tank 16 via the outflow pump 22 changes, for example due to fluctuations in electrical power driving the outflow pump 22 or due to fluctuations in well bore back pressure, the controller 102 adjusts and maintains the actual physical parameters of the physical plant 10 to approach or equal the input parameter values.

The process proceeds to block 412 where the operator may modify an input parameter value, for example the ρ_s input 108. This change causes the controller 102 to change the control signals that are output to the first and second actuators 18, 20 in the control loop 406, 408, for example by further opening the first actuator 18 and further closing the second actuator 20. The coupling between this action of modifying