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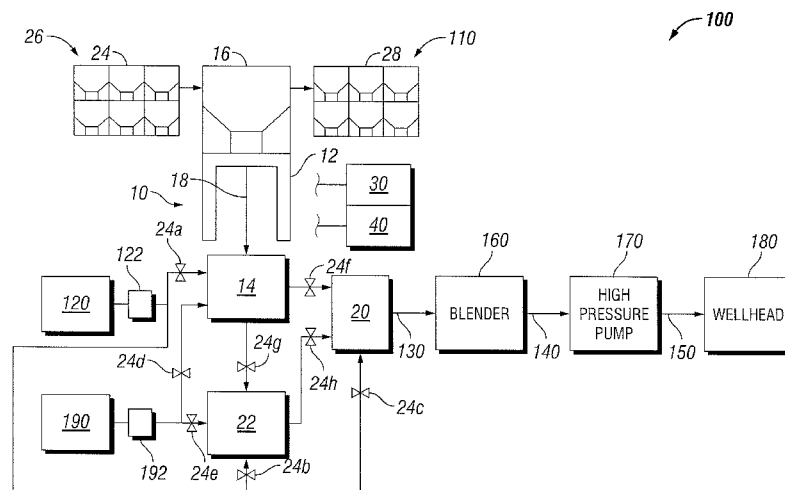
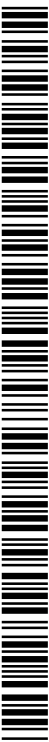


FIG. 1

(57) Abstract: An example fluid management system for generating a fluid for a treatment operation may include a mixer and a first portable container disposed proximate to and elevated above the mixer. The first portable container may hold dry chemical additives. A feeder may be positioned below the first portable container to direct dry chemical additives from the first portable container to the mixer. The system may also include a first pump to provide fluid to the mixer from a fluid source.



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## FLUID MANAGEMENT SYSTEM FOR PRODUCING TREATMENT FLUID USING CONTAINERIZED FLUID ADDITIVES

### TECHNICAL FIELD

5           The present disclosure relates generally to treatment operations for hydrocarbon wells, and more particularly, to a fluid management system for producing treatment fluid using containerized fluid additives.

### BACKGROUND

10           During the drilling and completion of oil and gas wells, various wellbore treatment fluids are used for a number of purposes. For example, high viscosity gels are used to create fractures in oil and gas bearing formations to increase production, and maintain positive hydrostatic pressure in the well while limiting flow of well fluids into earth formations during installation of completion equipment. High viscosity gels and fluids also are used to flow sand into wells during gravel packing operations and as proppant during a hydraulic  
15           fracturing operation.

          High viscosity gels and fluids and other treatment fluids are normally produced by mixing dry powder and/or granular materials and agents with water in stages. For instance, a first stage may include incorporating one or more chemical fluid additives into a source of water to produce a treatment fluid with pre-determined fluid properties, e.g., viscosity,  
20           density, etc. The treatment fluid can then be blended with sand or other granular materials before being pumped into a wellbore.

          The chemical fluid additives are normally transported to a well site in a commercial or common carrier tank truck. Once the tank truck is at the well site, the fluid additives must be transferred or conveyed from the tank truck into a supply tank. The fluid additives are usually  
25           blown pneumatically from the tank truck into an on-location storage/delivery system (e.g., silo). The storage/delivery system may then deliver the fluid additives onto a conveyor or into a hopper connected to a mixing apparatus. This process can be time-consuming and difficult in practice, however, as well as lead to large amounts of dust and noise generation due to the turbulent nature to pneumatic transfer.

## BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present disclosure and its features and advantages, reference is now made to the following description, taken in conjunction with the accompanying drawings, in which:

5           FIG. 1 is a diagram illustrating an example system for treatment operations, according to aspects of the present disclosure;

          FIG. 2 is a diagram illustrating an example fluid management unit for producing treatment fluids during a treatment operation, according to aspects of the present disclosure;

10           FIG. 3 is a diagram illustrating another example fluid management unit for producing treatment fluids during a treatment operation, according to aspects of the present disclosure;

          FIG. 4 is a diagram illustrating an example site layout for a treatment operation, according to aspects of the present disclosure;

          FIG. 5 is a diagram illustrating an example platform, according to aspects of the present disclosure;

15           FIG. 6 is a diagram illustrating another example site layout for a treatment operation, according to aspects of the present disclosure; and

          FIG. 7 is a diagram illustrating a blender unit, according to aspects of the present disclosure.

## DETAILED DESCRIPTION

Illustrative embodiments of the present disclosure are described in detail herein. In the interest of clarity, not all features of an actual implementation are described in this specification. It will of course be appreciated that in the development of any such actual  
5 embodiment, numerous implementation specific decisions must be made to achieve developers' specific goals, such as compliance with system related and business related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit  
10 of the present disclosure. Furthermore, in no way should the following examples be read to limit, or define, the scope of the disclosure.

To facilitate a better understanding of the present disclosure, the following examples of certain embodiments are given. In no way should the following examples be read to limit, or define, the scope of the invention. Certain embodiments according to the present  
15 disclosure may be directed to systems and methods for efficiently managing fluid additives and the production of treatment fluid. Fluid additive handling systems are used in a wide variety of contexts including, but not limited to, drilling and completion of oil and gas wells, concrete mixing applications, agriculture, and others. The disclosed embodiments are directed to a fluid management system and associated methods for efficiently utilizing fluid  
20 additives for the production of treatment fluid for use in a hydrocarbon-producing well.

The terms "couple" or "couples" as used herein are intended to mean either an indirect or a direct connection. Thus, if a first device couples to a second device, that connection may be through a direct connection, or through an indirect mechanical or electrical connection via other devices and connections. The term "fluidically coupled" or "in  
25 fluid communication" as used herein is intended to mean that there is either a direct or an indirect fluid flow path between two components.

In existing treatment operations, dry chemical fluid additives (e.g., gel powder, diverter material, fluid loss material, and friction reducer material) may be transported to a job site in sacks or tanker trucks, where the dry additives are then transferred directly from  
30 the tanker trucks to fixed on-site storage containers using pneumatic conveyors or other transfer mechanisms. The transfer mechanisms can cause some of the dry additives or particulates from the dry additives to disperse into the air. The present disclosure facilitates

the transfer and use of dry chemical fluid additives within pre-filled, portable containers in a mixing process to produce treatment fluid. For instance, instead of a pneumatic transfer process to move dry additives from a transportation unit to a mixing unit, the transportation unit may deliver one or more containers of dry additives to the well site, where the containers  
5 may then be arranged on a platform (e.g., stand, rack structure) around a fluid management system that performs one stage of the mixing process. The fluid management system may include structures to accommodate one or more containers such that a metered flow of dry additives can be provided directly into a mixer to produce a treatment fluid with pre-determined fluid properties.

10 FIG. 1 is a diagram illustrating an example system 100 for treatment operations, according to aspects of the present disclosure. The system 100 includes a fluid management system 110 in fluid communication with a blender system 160. The blender system 160 may in turn be in fluid communication with one or more high pressure pumps 170, which are in turn in fluid communication with a wellhead 180. In use, the fluid management system 110  
15 may receive water or another fluid from a fluid source 120 (e.g., a ground water source, a pond, one or more frac tanks) mix one or more fluid additives into the received water or fluid produce a treatment fluid with a desired fluid characteristic, and provide the produced treatment fluid 130 to the blender system 160. The blender system 160 may receive the produced treatment fluid 130 from the fluid management system 110 and mix the produced  
20 treatment fluid with a proppant, such as sand, or another granular material to produce a final treatment fluid 140. The high pressure pumps 170 may then pressurize the final treatment fluid 140 to generate pressurized final treatment fluid 150 that is directed into the wellbore 180. The configuration of system 100 is not intended to be limiting, as equipment, devices, systems, or subsystems may be added to or removed from the system 100.

25 The fluid management system 110 may comprise one or more mixing units 10. As depicted, the mixing unit 10 includes a container support frame 12 and a mixer 14. The system 110 also includes a portable fluid additive container 16 elevated on the support frame 12 and holding a quantity of dry chemical fluid additives, such as gel powder, diverter material, fluid loss material, and friction reducer material. Although the support frame 12 is  
30 shown holding only container 16 in Fig. 1, it should be appreciated that the support frame 12 can be configured to hold a plurality of fluid additive containers, containing one or more types of dry additives. In addition to the support frame 12 used for receiving and holding the

container 16, the mixing unit 10 may also include a feeder 18 for directing dry additives from the container 16 to the mixer 14. Example feeders include, but are not limited to, a metering screw and a chute for directing a gravity flow of dry chemical to the mixer 14 in combination with a metering valve. The feeder 18 may provide a controlled flow of dry additives into the  
5 mixer 14.

The mixer 14 may be in fluid communication with and receive fluids from the fluid source 120 and from one or more liquid chemical storage tanks 190 of the fluid management system 100. In certain embodiments, the mixer 14 may be in fluid communication with the fluid source 120 through one or more fluid transfer pumps 122 that may direct a controlled  
10 flow of fluid (e.g., water) into the mixer 14. Similarly, the mixer 14 may be in fluid communication with the liquid chemical storage tanks 190 through one or more fluid transfer pumps 192 that direct a controlled flow of liquid chemicals (e.g., acid) into the mixer 14. The mixer 14 is not required to be in fluid communication with the fluid source 120 and liquid chemical storage tanks 190 through fluid transfer pumps 122/192, however, as  
15 pressurized tanks, gravity, or other transfer configurations can also be used. The received fluid and/or liquid chemicals may then be mixed with the fluid additives from the container 16 to, at least in part, produce treatment fluid 130.

The fluid management system 110 may further comprise at least one pump 20 to transfer the produced treatment fluid 130 from the fluid management system 110 to the  
20 blender 160, or to the high pressure pumps 170. As depicted, the at least one pump 20 is in fluid communication with the mixer 14, so that treatment fluid produced by the mixer 14 may be pumped directly to or around the blender system 160 from the fluid management system 110. In certain embodiments, the at least one pump 20 may comprise a booster pump that increases the pressure of the produced treatment fluid 130 as it leaves the fluid management  
25 system 110. Additionally, although the pump 20 is shown as distinct from the fluid transfer pumps 122 and 192, the pump 20 may be incorporated into a bank of pumps with the transfer pumps 122 and 192 that control the flow of fluid and/or liquid chemicals within the fluid management system 110.

In certain embodiments, the fluid management system 110 may comprise one or more  
30 fluid tanks 22 that may receive mixed treatment fluid from the mixer 14 and store it for a period of time. This may be useful, for instance, with respect to certain gel chemical additives which must rest in fluid for a pre-determined period of time, also referred to as

“hydrating,” before the gel fully incorporates into the treatment fluid. As depicted, the fluid tank 22 is in fluid communication with the mixer 14 to receive “un-hydrated” treatment fluid, and is also in fluid communication within the pump 20 to allow for the “hydrated” treatment fluid, which may comprise produced treatment fluid 130 in certain instances, to be pumped to the blender system 160. In certain embodiments, the fluid tank 22 also may be in fluid communication with the fluid source 120 and the liquid chemical storage tanks 190 through the fluid transfer pumps 122 and 192, respectively, to allow for modifications of fluid within the fluid tanks 22.

As depicted, the fluid management system 110 further comprises a plurality of valves 24a-h that provide for selective fluid communication between the associated elements of the fluid management system 110. Valves 24a-c may provide selective communication between the fluid source 120/pump 122 and the mixer 14, fluid tank 22, and pump 20, respectively. Valves 24d and 24e may provide selective communication between the liquid chemical storage tanks 190/pump 192 and the mixer 14 and fluid tank 22, respectively. Valves 24f and 24g may provide selective communication between the mixer 14 and the pump 20 and fluid tank 22, respectively. Valve 24h may provide selective communication between the fluid tank 22 and the pump 20. It should be appreciated that the configuration of valves 24a-h and the selective fluid communication they provide are not intended to be limiting. For instance, some may be omitted, extra valves may be included, or the configuration may be changed entirely depending on the configuration of the fluid management system 110. Additionally, in certain embodiments, some or all of the valves 24a-h may comprise actuatable valves that open or close in response to commands issued from a control system 40 of the fluid management system 110, which will be described in detail below.

In certain embodiments, the fluid management system 110 may further comprise a power unit 30 electrically coupled to one or more elements of the fluid management system 110, including, but not limited to the mixer 14, the pumps 20/122/192, the feeder 18, and the control system 40. Example power units include, but are not limited to, engines that supply at least one of hydraulic, mechanical, or electrical power to one or more elements of the fluid management system 110. Example engines include, but are not limited to, diesel-powered, natural-gas-powered, or dual fuel engines. In certain embodiments, one or more turbine generators may be used to generate and supply electrical power to one or more elements of the fluid management system 110.

The control unit 40 may be operatively associated with or otherwise control one or more elements of the fluid management system 110, including, but not limited to the mixer 14, the pumps 20/122/192, and the valves 24a-h, and the feeder 18. The control unit 40 may be operatively associated with the one or more elements of the fluid management system 110 through electrical, mechanical, and/or hydraulic means. For instance, to the extent the feeder 18 and pumps 122/192/20 are driven by electric motors (not shown), the control unit 40 may issue electrical control signals for one or more variable speed drives (not shown) associated with the electric motors (not shown) to control when and how the feeder 18 and pumps 122/192/20 operate. Additionally, to the extent the valves 24a-h comprise electrically actuable valves, the control system 40 may issue individual voltage or current signals to the valves 24a-h to cause them to open or close.

In certain embodiments, the control unit 40 may include a computing unit that automatically controls or otherwise facilitates control of the fluid management system 110. As used herein, a computing system may comprise any device with a processor and an associated memory device containing processor-executable instructions (e.g., software or firmware) that cause the control unit 40 to perform certain actions. Example computing units include, but are not limited to, desktop computers, laptop computers, and/or tablets. In certain embodiments, the computing unit may be incorporated or otherwise included with hydraulic or mechanical control mechanisms to control the operation of the fluid management system 110.

During treatment operations, one or more full containers 24 may be selectively moved onto the support frame 12 from a staging area 26. The one or more full containers 24 may be selected based, at least in part, on the type of chemical fluid additive it contains. Once the one or more containers 24 are in place, the control unit 40 may issue one or more commands to the pump 122 to cause fluid from the fluid source 120 to enter the mixer 14 at a known rate. Simultaneously, the control unit 40 may trigger the feeder 18 of the mixing unit 10 to introduce chemical fluid additive from the container 16 into the mixer 14 at a rate necessary to produce a fluid with a desired fluid characteristic one mixed in the mixer. The control unit 40 may open the valve 24g to allow un-hydrated fluid from the mixer 14 to enter the fluid tank 22 to hydrate appropriately. Also, the control unit 40 may issue one or more commands to the pump 192 to cause liquid chemicals to be introduced into the treatment fluid. Once hydration has occurred, valve 24h may be opened, allowing the produced treatment fluid 130

to be pumped by pump 20 to the blender system 160. It should be appreciated that the above process is but one of many potential processes that can be performed with the fluid management system 110 to produce treatment fluid.

As the treatment operation progresses, the chemical fluid additive in the container 16  
5 may be wholly or partially consumed over time by the mixing unit 10 to produce a treatment fluid with the desired fluid characteristics. Once the necessary treatment fluid is produced, the one or more containers may be removed from the frame 12 and placed in the staging area 26 or in a discard area 28, and other containers 24 may be placed on the frame, depending on the type of treatment fluid that is to be produced. In certain embodiments, the containers on  
10 the frame 12 may be interchanged while the treatment fluid is being mixed, to ensure that the correct chemical additives are introduced.

The above system may avoid the need to pneumatically transfer the chemical additives by facilitating transfer of the chemicals within a container. Specifically, the system 110 may allow for containers with chemical additives to be delivered directly to a wellsite  
15 and used directly from the container without the need to transfer the chemicals to an intermediary storage tanks. As will be described in detail below, the feeder 18 may only need to move the chemicals a short distance from the container to a mixer in order to produce the required treatment fluid, reducing the opportunity for chemical particulates from being released into the air.

20 In certain embodiments, some or all of the elements of the fluid management system 110 may be incorporated into a mobile fluid management unit that can be deployed on-site at a treatment operation. FIG. 2 is a diagram illustrating an example fluid management unit 200 for producing treatment fluids during a treatment operation, according to aspects of the present disclosure. As depicted, the fluid management unit 200 comprises a mixer unit 240,  
25 pump 204, fluid tank 206, power unit 208, and control unit 210 deployed on a movable trailer 212. The mixer unit 240 comprises a mixer 202 and a fluid additive container 214 placed on a support frame 216 coupled to the trailer 212. One or more chemical pumps 220 is positioned alongside the fluid tanks 206. Although the system 212 is shown deployed on a trailer 212, it should be appreciated that other movable structures, such as skids, can also be  
30 used. Additionally, a plurality of valves, pipes, and other fluid conduits (not shown) may be used to connect the elements of the fluid management unit 200 in a manner similar to the fluid management system described above with respect to Fig. 1.

In the embodiment shown, the pump 204 is positioned at one end of the trailer 212 at least partially within the support frame 216 and under the container 214. Specifically, the mixer 202 is positioned under an output port of a feeder 218 coupled to the support frame 216 and operatively associated with the container 214. By positioning the feeder 218 under the container 214, the system may rely on gravity to move the dry chemical additives from the containers 214 to the feeder 218, where they can be moved to the mixer 202 in a controlled manner. As depicted, the feeder 218 comprises a screw feeder with a hopper 218a that receives dry chemical additives from the container 214 before the screw feeder moves the dry chemical additives from the hopper 218a to the mixer 202. In this manner, the flow of dry chemical additives from the container 214 may be self-regulating, with additional material only being let out of the container 214 when material is moved from the hopper 218a. It should be appreciated, however, that other feeder configurations are possible within the scope of the present disclosure.

As depicted, the mixer 202 comprises a growler mixer that receives dry chemical additives from the feeder 218 through an opening in the top of the mixer 202, and receives fluid from the fluid transfer pump 204 through a fluid port in the side of the mixer 202. Although not shown, the mixer 202 may comprise other fluid inlet and outlet ports that facilitates movement of mixed treatment fluid from the mixer 202 to the fluid tank 206 for hydration, or to a pump (not shown) for pumping produced treatment fluid to a blender system. Although a growler mixer 202 is shown, other types of mixers may be used within the scope of the present disclosure.

As depicted, the power unit 208 and fluid tank 206 are positioned at an opposite end of the trailer 212 from the frame 216, pump 204, and mixer 202. The control unit 210 is positioned between the fluid tank 206 and the pump 202, enclosed within a housing accessible by on-site personnel. The connections between the power unit 208 and the control unit 210 to the equipment located on the trailer 212 are not shown, but can be located at any suitable location on the unit 200.

It should be appreciated that the configuration of the unit 200 may be altered from the depicted configuration depending on the types of equipment used, and still fall within the scope of the present disclosure. For instance, Fig. 3 is a diagram illustrating another example fluid management unit 300 that can accommodate more than one container. As depicted, the unit 300 includes many of the same elements as the unit 200, including, but not limited to, a

power unit 308 and fluid tanks 306 at one end of a trailer 312, a pump 304 located at an opposite end of the trailer 312, and a control unit 310 located between the fluid tanks 306 and the pump 304. The unit 300 differs, however, in that a mixer unit 340 includes two frames 316a and b that accommodate two containers 314a and b. Although two frames 316a and b are depicted, it should be appreciated that one larger frame that accommodates multiple containers may be implemented within the scope of this disclosure. Additionally, the unit 300 is not limited to only two containers/frames.

As depicted, each of the frames 316a/b include associated feeders 318a/b that direct dry chemical fluid additives from the containers 314a/b into a shared mixer 202. In this manner, treatment fluids may be mixed using multiple dry chemical fluid additives simultaneously, reducing the number of mixing stages and the time it takes or generate a treatment fluid with the necessary fluid characteristics. The feeders 318a/b may, but are not required to, include screw feeders/hoppers similar to the ones described above with respect to Fig. 2, which can provide a metered flow of each additive into the mixer 302. Additionally, although one mixer 302 is shown, multiple mixers may be used.

In certain embodiments, one or more fluid management systems and units similar to the ones described above may be incorporated into a treatment operation that further utilizes the containerization of the dry chemical fluid additives. FIG. 4 is a diagram illustrating an example site layout 400 for a treatment operation, according to aspects of the present disclosure. As depicted, the layout 400 comprises a container staging area 402 around which a fluid treatment unit 404 and a blender unit 406 are positioned. The fluid treatment unit 404 may be in fluid communication with one or more liquid chemical tanks 408 positioned adjacent to the unit 404, as well as a plurality of frac tanks 410 that comprise a fluid source for the treatment operation. The output of the fluid treatment unit 404 may be in fluid communication with the input of the blender unit 406. The output of the blender unit 406 may be in fluid communication with one or more high pressure pumps 412 through a manifold trailer 414, with the one or more high pressure pumps 412 being fluidly connected to a wellbore (not shown).

As depicted, the container staging area 402 may comprise a pad, platform or any other type of structure on which one or more containers 420 of materials for use in the treatment operation are staged. The containers 420 may comprise a plurality of chemical fluid additive containers for use with the fluid management unit, similar to the fluid additive containers

described above with respect to Figs. 1-3. In certain embodiments, the containers 420 also may comprise bulk material containers of sand, proppant, or other granular material for use with the blender unit 406. The container staging area 402 may include devoted areas for each type of container 420 disposed thereon, as well as designated areas for full, empty, and partially used containers.

In the embodiment shown, the layout 400 further comprises a device 422 positioned on the staging area 402 for manipulating the containers 420. Manipulating the containers 420 may include, but is not limited to, loading one or more containers on the fluid management unit 404 and blender unit 406, unloading one or more containers 420 from the fluid management unit 404 and blender unit 406, receiving one or more shipments of containers 420 at the staging area 402, and moving one or more empty containers 420 from the staging area 402. In the embodiment shown, the device 422 comprises a forklift, although other devices, including cranes, hoists, etc. can be used.

As depicted, the fluid management unit 404 and blender unit 406 are accessible from the staging area 402 by the device 422. This may facilitate placement and removal of containers from the fluid management unit 404 and blender unit 406. In certain embodiments, the staging area 402 may also provide access to one or more transportation pathways 440 through which one or more of the containers 420 may be delivered to or removed from the staging area 402. Example transportation pathways include roads, whether paved or unpaved, or other areas dedicated or otherwise intended for use by motorized vehicles, whether permanently, temporarily, or intermittently. As depicted, the transportation pathway 440 provides access to the staging area 402 by a trailer 450. The trailer 450 may transport to the site a load of full containers containing different types of materials, e.g., chemical fluid additives, sand, etc., as well as transport empty containers away from the site.

In use, the trailer 450 may deliver one or more containers to the job site, which are unloaded from the trailer 450 and positioned in the staging area 402 by the device 422. The device 422 may then, for example, retrieve a chemical fluid additive container 460 from the staging area 402 and position it on the fluid management unit 404. The device 422 may also retrieve one or more sand containers 470 from the staging area 402 and position the on the blender unit 406. With the treatment operation underway, the device 422 may load/unload containers from the fluid management unit 404/blender unit 406/truck 450 as is necessary to produce the treatment fluid at the flow rate required by the treatment operation. It should be

appreciated, however, that the order in which the containers are loaded and unloaded, and the process generally can be adapted to suit the requirements of a particular treatment operation and still fall within the scope of the present disclosure.

5 The above described layout 400 may facilitate the transportation and use of containerized materials, including chemical additives, sand, etc., for an entire treatment operation. Specifically, none of the dry materials needed to generate treatment fluid on-site needs to be pneumatically moved to temporary storage tanks. Rather, the materials may be delivered, monitored, and handled in a systematic fashion with the containers. This may reduce particulate matter at the job site as well as lead to a more efficient use of dry  
10 materials. Specifically, the containers may allow for the delivery of more precise amounts of dry materials on site than is possible with typical operations.

In certain embodiments, rather than or in addition deploying the fluid management system on a single movable fluid management unit, similar to the units described above with respect to Figs. 2 and 3, it may be possible to separately deploy parts of the fluid management  
15 system within the scope of this disclosure. For instance, Fig. 5 is a diagram illustrating an example individually-deployed mixing unit 500, according to aspects of the present disclosure. As depicted, the mixing unit 500 comprises platforms 502/504 on which dry chemical containers 502a and 504a are placed respectively. Similar to the mixing unit configuration described with respect to Fig. 3, the mixing unit 500 may, but is not required to,  
20 share a mixer 506 that is fed by feeders 502b and 504b respectively coupled to platforms 502 and 504. The mixing unit 500 also may, but is not required to, couple to fluid sources, fluid tanks, chemical tanks, and fluid transfer pumps in a manner similar to that described above with respect to Fig. 1.

Notably, the use of an individually-deployed mixing unit may provide flexibility with  
25 respect to the design of a fluid management system and any movable fluid management unit including elements of a fluid management system. For instance, Fig. 6 is a diagram illustrating an example site layout 600 similar to the layout illustrated in Fig. 4, except that an individually-deployed mixing unit 602 is positioned between the fluid management unit 604 and the blender unit 606. As depicted, the mixing unit 602 comprises two containers 602a/b  
30 of chemical additives, with the fluid management unit 604 containing one container 604a of chemical additives, providing a total of three potential slots for a dry chemical additive container. As would be appreciated by one of ordinary skill in the art in view of this

disclosure, the number and orientation of potential slots for dry chemical additive containers may be changed with nominal alterations in the individually deployed mixing unit 602 itself. This may provide greater flexibility to scale to operation to accommodate the production of more complex treatment fluids without having to retool a fluid management unit with an integrated mixing unit.

As depicted, the layout 600 further includes a mixing unit incorporated within the blender unit 606, as indicated by the dry chemical container 660 being placed on the blender unit 606 adjacent to sand or proppant containers 606a-c. Fig. 7 illustrates a diagram of the blender unit 606 in which the infrastructure associated with the blender unit 606, including a support frame 610, blender tub 612, and fluid pump 614 are positioned on a trailer 616. The mixing unit 650 is incorporated into the blender unit 606 via an extension of the frame 610 to accommodate the placement of the dry chemical container 660. As depicted, the feeder 652 and mixer 654 are positioned at least partially under the dry chemical container 660 in a vacant space on the trailer 616. By placing the mixing unit 650 on the blender unit 606, the system may provide even greater flexibility to scale to operation to accommodate the production of more complex treatment fluids. It should be appreciated, however, that the blender unit configuration depicted in Fig. 7 is not intended to be limiting, and that mixing units with associated dry chemical additive containers may be incorporated into different types of equipment available on site for a treatment operation.

An example fluid management system for generating a fluid for a treatment operation may include a mixer and a first portable container disposed proximate to and elevated above the mixer. The first portable container may hold dry chemical additives. A feeder may be positioned below the first portable container to direct dry chemical additives from the first portable container to the mixer. The system may also include a first pump to provide fluid to the mixer from a fluid source.

In one or more embodiments described in the preceding paragraph, the system may further include a power unit operatively associated with at least the mixer and the feeder.

In one or more embodiments described in the preceding paragraph, the mixer, the first portable container, and the feeder may be positioned on a movable structure.

In one or more embodiments described in the preceding paragraph, a fluid tank may be in fluid communication with the mixer for receiving un-hydrated fluid from the mixer, wherein the fluid tank is positioned on the movable structure.

In one or more embodiment of the preceding four paragraphs, a second portable container may be disposed on the movable structure proximate to and elevated above the mixer or a second mixer and holding dry chemical additives, and a second feeder may be positioned below the second portable container on the movable structure to direct dry chemical additives from the second portable container to the mixer or the second mixer.

In one or more embodiment of the preceding five paragraphs, a second portable container may be deployed on a frame that is separate from the movable structure. The second portable container may be proximate to and elevated above a second mixer and holding dry chemical additives. A second feeder may be positioned below the second portable container on the movable structure to direct dry chemical additives from the second portable container to the second mixer.

In one or more embodiment of the preceding six paragraphs, the system may include a pump for directing fluid from the fluid management system to a blender system.

In one or more embodiment of the preceding seven paragraphs, the dry chemical additive may be at least one of gel powder, diverter material, fluid loss material, and friction reducer material.

In one or more embodiment of the preceding eight paragraphs, the first portable container may be positioned on a frame that is positioned adjacent to a staging area containing a plurality of portable container holding dry chemical additives.

In one or more embodiment of the preceding nine paragraphs, the feeder may include a hopper positioned below an opening of the first portable container, and a screw feed extending from the hopper toward an opening in the mixer.

An example method may include loading a first portable container onto a support frame, wherein the first portable container holds dry chemical additives. The dry chemical additives may be fed from the first portable container to a mixer positioned at least partially below the first portable container. A treatment fluid may be generated within the mixer by mixing the dry chemical additives with a fluid received from a fluid source. The treatment fluid may be directed to at least one of a blending unit and a fluid tank for hydrating the treatment fluid.

In one or more embodiment of the preceding paragraph, the fluid source may include a frac tank in fluid communication with the mixer through a fluid transfer pump.

In one or more embodiment of the preceding two paragraphs, the support frame, the

mixer, and the fluid tank may be positioned on a movable structure

In one or more embodiment of the preceding three paragraphs, the blending unit and the fluid tank may be deployed on separate structures from the support frame.

5 In one or more embodiment of the preceding four paragraphs, the support frame and mixer may be positioned on the same structure as the blending unit.

In one or more embodiment of the preceding five paragraphs, loading the first portable container onto the support frame may include loading the first portable container onto the support frame from a staging area comprising a plurality of containers holding dry chemical additives.

10 In one or more embodiment of the preceding six paragraphs, a second portable container may be loaded onto the blending unit from the staging area, wherein the second portable container holds proppant.

15 In one or more embodiment of the preceding seven paragraphs, directing the treatment fluid to at least one of the blending unit and the fluid tank for hydrating the treatment fluid may include first directing the treatment fluid to the fluid tank for hydrating the treatment fluid and subsequently directing the hydrated treatment fluid from the fluid tank to the blending unit.

In one or more embodiment of the preceding eight paragraphs, at least one liquid chemical may be received in at least one of the mixer and the fluid tank.

20 In one or more embodiment of the preceding nine paragraphs, loading the first portable container onto the support frame may include loading the first portable container onto the support frame using a forklift.

25 Although the present disclosure and its advantages have been described in detail, it should be understood that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the disclosure as defined by the following claims.

## WHAT IS CLAIMED IS:

1. A fluid management system for generating a fluid for a treatment operation, comprising:
  - a mixer;
  - 5 a first portable container disposed proximate to and elevated above the mixer and holding dry chemical additives;
  - a feeder positioned below the first portable container to direct dry chemical additives from the first portable container to the mixer; and
  - a first pump to provide fluid to the mixer from a fluid source.
- 10 2. The system of claim 1, further comprising a power unit operatively associated with at least the mixer and the feeder.
3. The system of claim 2, wherein the mixer, the first portable container, and the feeder are positioned on a movable structure.
4. The system of claim 3, further comprising a fluid tank in fluid communication with  
15 the mixer for receiving un-hydrated fluid from the mixer, wherein the fluid tank is positioned on the movable structure.
5. The system of claim 2, further comprising
  - a second portable container disposed on the movable structure proximate to and elevated above the mixer or a second mixer and holding dry chemical additives; and
  - 20 a second feeder positioned below the second portable container on the movable structure to direct dry chemical additives from the second portable container to the mixer or the second mixer.
6. The system of claim 2, further comprising
  - a second portable container deployed on a frame that is separate from the movable  
25 structure, wherein the second portable container is proximate to and elevated above a second mixer and holding dry chemical additives; and
  - a second feeder positioned below the second portable container on the movable structure to direct dry chemical additives from the second portable container to the second mixer.
- 30 7. The system of any one of claims 1-6, further comprising a pump for directing fluid from the fluid management system to a blender system.

8. The system of any one of claims 1-6, wherein the dry chemical additive comprises at least one of gel powder, diverter material, fluid loss material, and friction reducer material.
9. The system of claim 1, wherein the first portable container is positioned on a frame that is positioned adjacent to a staging area containing a plurality of portable container  
5 holding dry chemical additives.
10. The system of claim 1, wherein the feeder comprises a hopper positioned below an opening of the first portable container, and a screw feed extending from the hopper toward an opening in the mixer.
11. A method, comprising:  
10 loading a first portable container onto a support frame, wherein the first portable container holds dry chemical additives;  
feeding the dry chemical additives from first portable container to a mixer positioned at least partially below the first portable container;  
generating a treatment fluid within the mixer by mixing the dry chemical additives  
15 with a fluid received from a fluid source; and  
directing the treatment fluid to at least one of a blending unit and a fluid tank for hydrating the treatment fluid.
12. The method of claim 11, wherein the fluid source comprises a frac tank in fluid communication with the mixer through a fluid transfer pump.
- 20 13. The method of claim 11, wherein the support frame, the mixer, and the fluid tank are positioned on a movable structure.
14. The method of claim 11, wherein the blending unit and the fluid tank are deployed on separate structures from the support frame.
15. The method of claim 11, wherein the support frame and mixer are positioned on the  
25 same structure as the blending unit.
16. The method of claim 11, wherein loading the first portable container onto the support frame comprises loading the first portable container onto the support frame from a staging area comprising a plurality of containers holding dry chemical additives.
17. The method of claim 16, further comprising loading a second portable container onto  
30 the blending unit from the staging area, wherein the second portable container holds proppant.

18. The method of claim 11, wherein directing the treatment fluid to at least one of the blending unit and the fluid tank for hydrating the treatment fluid comprises first directing the treatment fluid to the fluid tank for hydrating the treatment fluid and subsequently directing the hydrated treatment fluid from the fluid tank to the blending unit.
- 5 19. The method of claim 11, further comprising receiving at least one liquid chemical in at least one of the mixer and the fluid tank.
20. The method of claim 16, wherein loading the first portable container onto the support frame comprises loading the first portable container onto the support frame using a forklift.

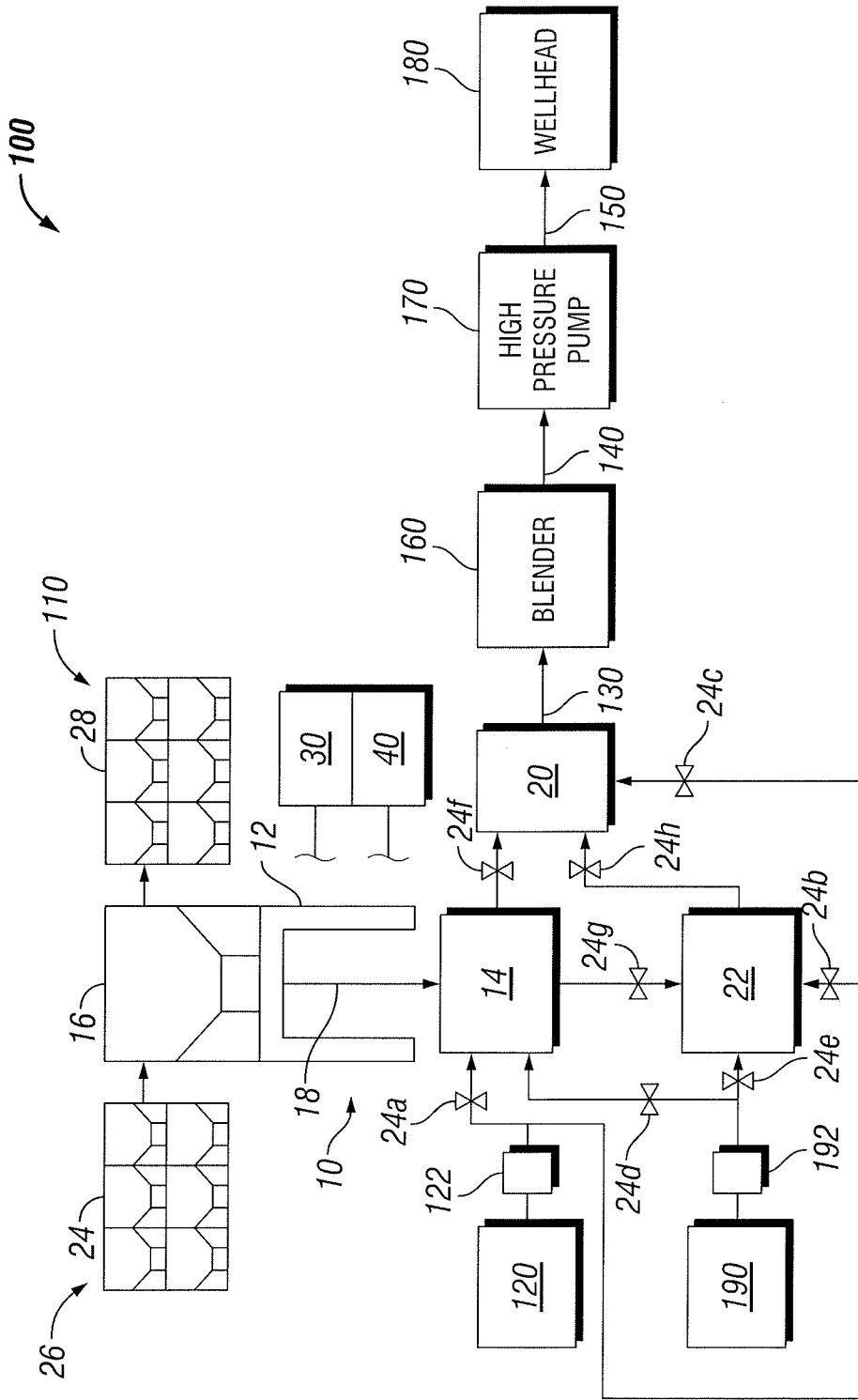


FIG. 1

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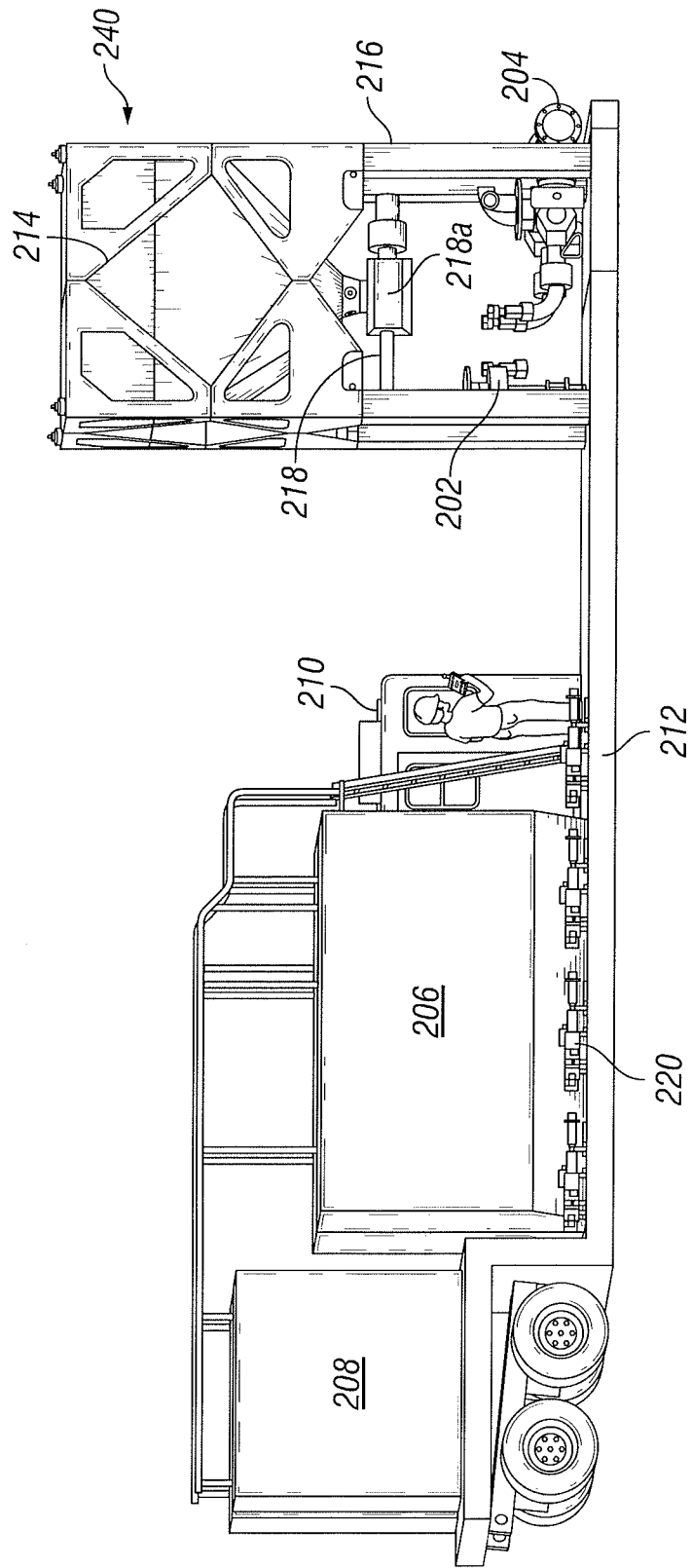
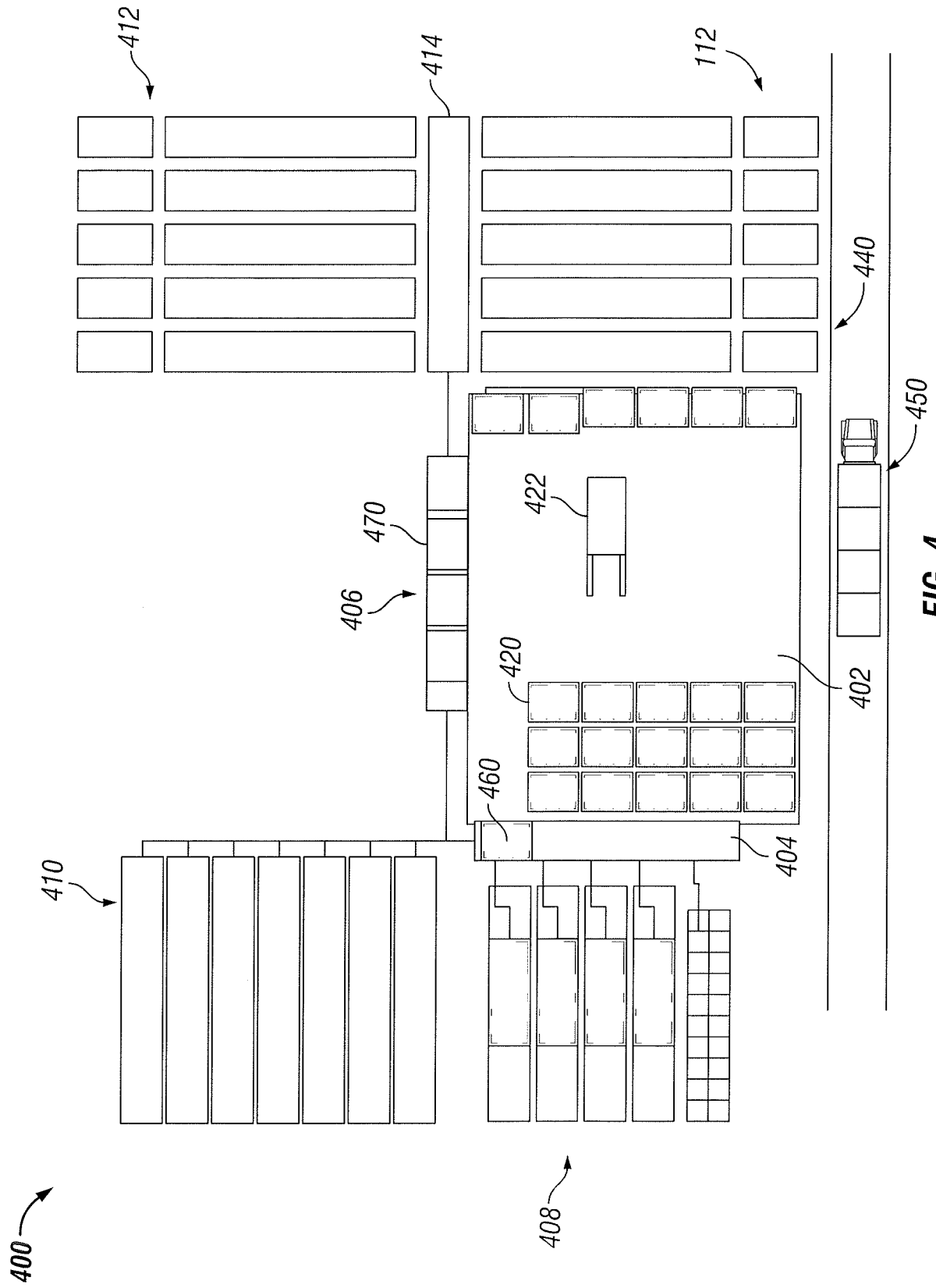


FIG. 2





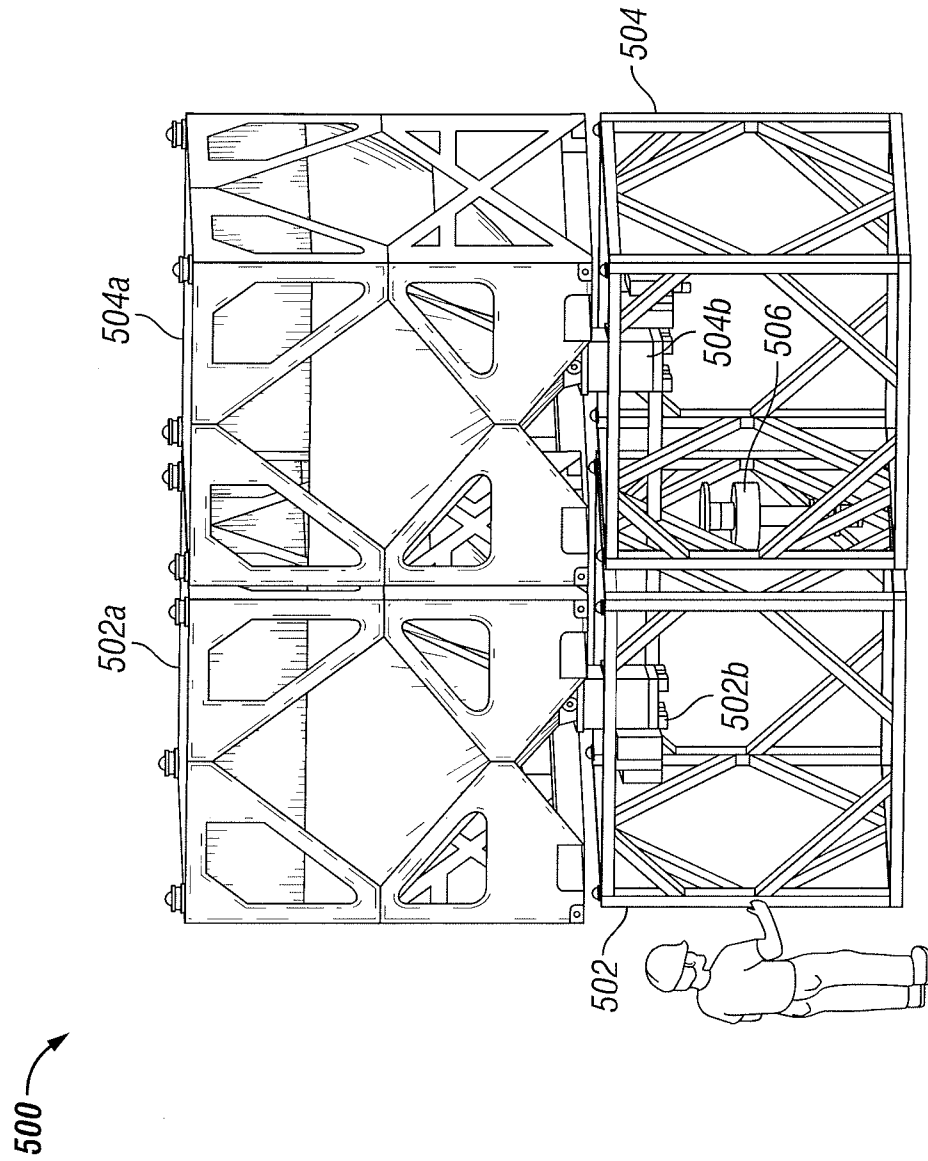


FIG. 5

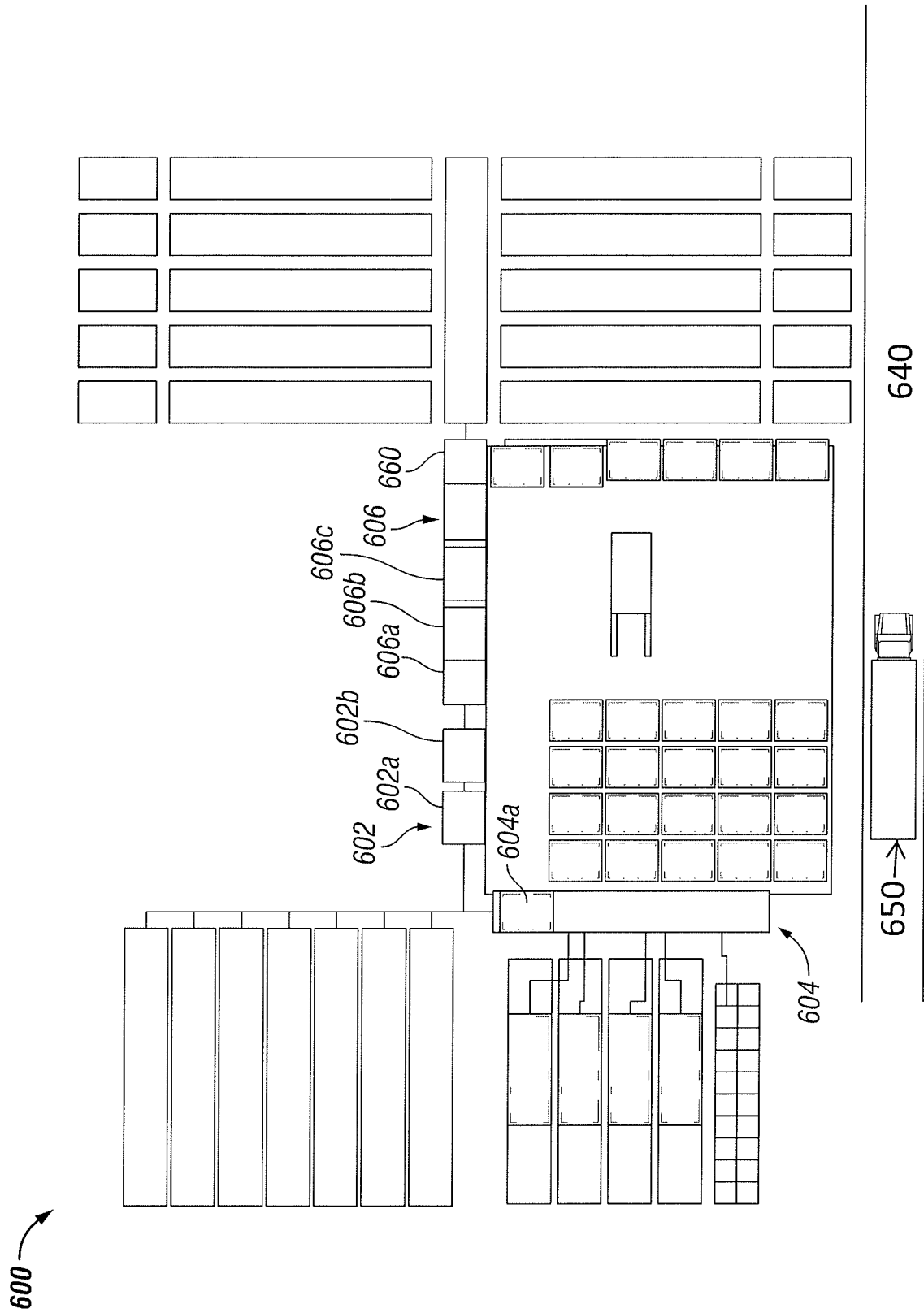


FIG. 6

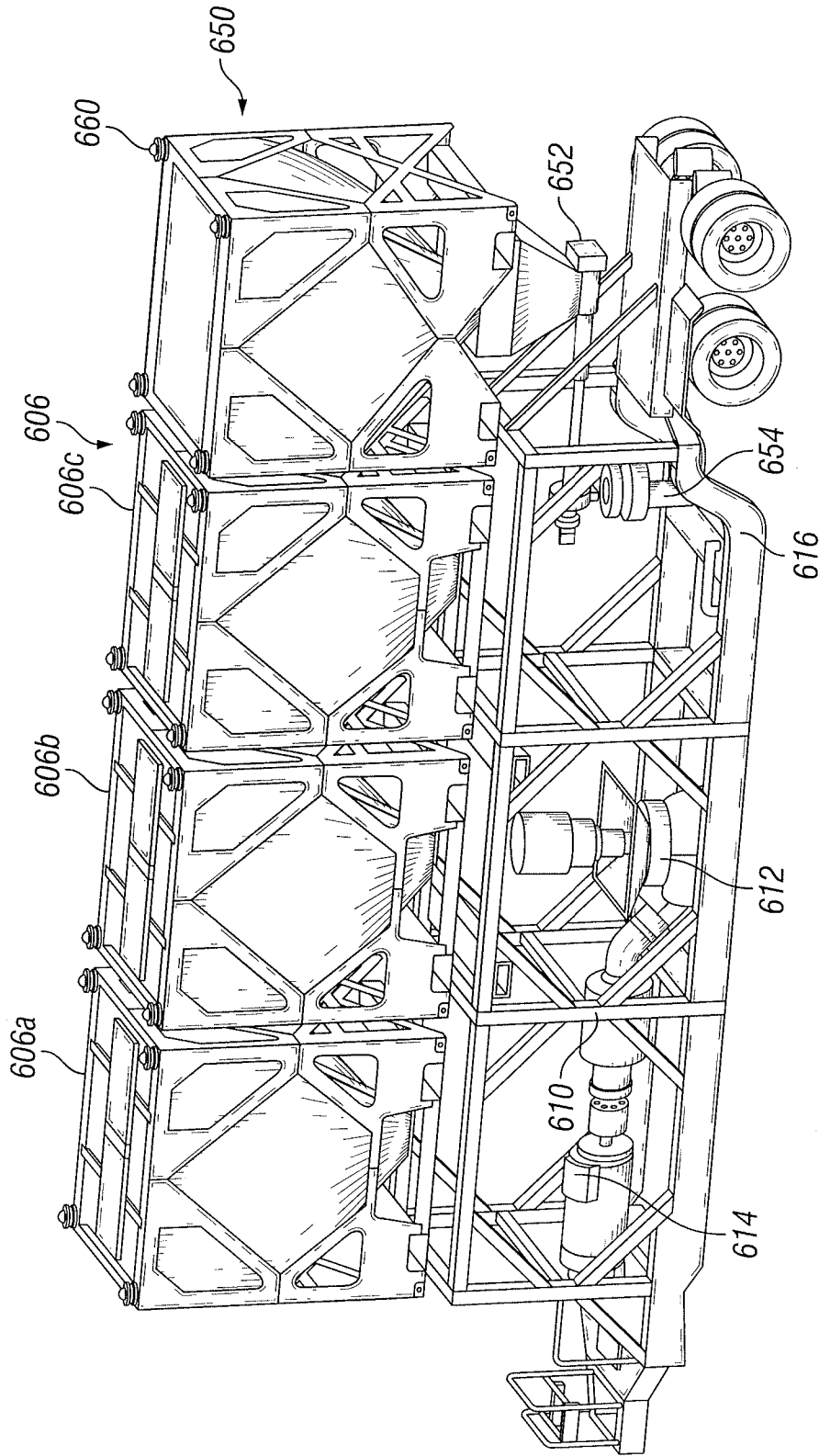


FIG. 7

**A. CLASSIFICATION OF SUBJECT MATTER****E21B 43/17(2006.01)i, E21B 43/26(2006.01)i, E21B 41/00(2006.01)i**

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

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

E21B 43/17; E21B 21/01; E21B 43/267; E21B 43/16; E21B 21/06; E21B 43/26; B01F 15/02; E04H 7/18; E21B 41/00

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) &amp; Keywords: treatment, mixer, portable, container, feeder, pump, dry, additive, blender, hydration, tank, trailer

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No. |
|-----------|---|-----------------------|
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| Y         | WO 2015-160374 A1 (HALLIBURTON ENERGY SERVICES, INC.) 22 October 2015<br>See paragraphs [0017], [0022], [0033], [0047]; and figures 2, 4. | 1-20                  |
| A         | US 2014-0020892 A1 (OREN et al.) 23 January 2014<br>See paragraphs [0066]-[0080]; and figures 1-9.  | 1-20                  |
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| A         | US 5896883 A (KHALATBARI et al.) 27 April 1999<br>See column 1, lines 21-63; column 4, lines 54-58; and figures 1-2.                      | 1-20                  |

 Further documents are listed in the continuation of Box C. See patent family annex.

\* Special categories of cited documents:

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&amp;" document member of the same patent family

Date of the actual completion of the international search

28 November 2016 (28.11.2016)

Date of mailing of the international search report

**28 November 2016 (28.11.2016)**

Name and mailing address of the ISA/KR

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Information on patent family members

International application No.

PCT/US2016/024027

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