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(54) **MULTI-MODE HYDRAULIC CYLINDER CONTROL SYSTEM FOR HYDRAULIC WORKOVER UNIT**

(57) Hydraulic workover system having at least two sets of hydraulic cylinders coupled with a single load. A plurality of control valves transitionable between a closed position and an open position, the plurality of control valves having at least one extend control valve disposed between each set of hydraulic cylinders and an extend supply pump, at least one retract control valve disposed between each set of hydraulic cylinders and a retract supply pump, and at least one float control valve disposed between each set of hydraulic cylinders and a float supply pump. A logic control system coupled with the plurality of control valves and configured to transition the plurality of control valves between the closed and open position, thereby controlling flow between the at least two sets of hydraulic cylinders and the extend supply pump, retract supply pump, and float supply pump.

MULTI-MODE HYDRAULIC CYLINDER CONTROL SYSTEM FOR HYDRAULIC WORKOVER UNIT

FIELD

[0001] The subject matter herein generally relates to a hydraulic workover unit and method of using the same, and in particular, a multi-mode hydraulic cylinder control system for a hydraulic workover unit.

BACKGROUND

[0002] Hydraulic workover units allow for movement of a load by actuating two sets of hydraulic cylinders between an extended and retracted position. Hydraulic workover units have operating modes that can be changed by manually operating valves adjacent to the hydraulic workover unit. Manual operation of valves and/or blocking of ports is a tedious and time consuming process, and prevents real-time control of the hydraulic workover unit.

Further, US 9,133,669 B1 discloses a tubular lift safety system that can include a wellbore tubular removal system for removing tubulars from wellbores, which can have an upper section movable relative to a lower section. The upper section and the lower section can both have gripping members for gripping and releasing the tubulars while the upper section is moved relative to the lower section; thereby removing the tubulars from the wellbore. The upper section can have cutting devices for forming lifting holes and a saw for cutting the tubulars. A fluid source can control extension and retraction of the upper section relative to the lower section, operation of the gripping members, and operation of the saw. A remote control can monitor pressure from the fluid source.

US 6,094,910 discloses an apparatus for a derrick, including hydraulic piston/cylinder arrangements for raising and lowering a yoke

travelling on guide rails attached to the derrick. A hydraulic system having different modes of operation is provided for the operation of the piston/cylinder arrangements. The hydraulic system can operate in a normal mode for raising or lowering the yoke and in other modes by interconnecting upper and lower chambers of the piston/ cylinder arrangements and utilizing a differential surface area of the piston exposed to the two chambers for rapidly raising or lowering the yoke.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] FIG. 1 illustrates a diagrammatic view of an example embodiment of a multi-mode hydraulic cylinder hydraulic workover unit.

[0004] FIG. 2 is a diagrammatic view a multi-mode control system of a hydraulic workover unit; and

[0005] FIG. 3 is a diagrammatic view of a logic controller of a multi-mode control system for a hydraulic workover unit.

DETAILED DESCRIPTION

[0006] It will be appreciated that for simplicity and clarity of illustration, where appropriate, reference numerals have been repeated among the different figures to indicate corresponding or analogous elements. In addition, numerous specific details are set forth in order to provide a thorough understanding of the embodiments described herein. However, it will be understood by those of ordinary skill in the art that the embodiments described herein can be practiced without these specific details. In other instances, methods, procedures and components have not been described in detail so as not to obscure the related relevant feature being described. Also, the description is not to be considered as limiting the scope of the embodiments described herein. The drawings are not necessarily to scale and the proportions of certain parts have been

exaggerated to better illustrate details and features of the present disclosure.

[0007] In the following description, terms such as "upper," "upward," "lower," "downward," "above," "below," "downhole," "uphole," "longitudinal," "lateral," and the like, as used herein, shall mean in relation to the bottom or furthest extent of the surrounding wellbore even though the wellbore or portions of it may be deviated or horizontal. Correspondingly, the transverse, axial, lateral, longitudinal, radial, etc., orientations shall mean orientations relative to the orientation of the wellbore or tool. Unless otherwise specified, any use of any form of the term "couple," or any other term describing an interaction between elements is not meant to limit the interaction to direct interaction between the elements and also may include indirect interaction between the elements described.

[0008] The term "inside" indicate that at least a portion of a region is partially contained within a boundary formed by the object. The term "substantially" is defined to be essentially conforming to the particular dimension, shape or other word that substantially modifies, such that the component need not be exact. For example, substantially cylindrical means that the object resembles a cylinder, but can have one or more deviations from a true cylinder.

[0009] Disclosed herein is a multi-mode control system for a hydraulic workover system that employs multiple hydraulic cylinders to provide force and motion. The hydraulic workover system includes at least two sets of hydraulic cylinders coupled with a single load and transitionable between an extended position and a retracted position. Each set of hydraulic cylinders has an extension port and a retraction port.

[0010] An extend supply pump can be coupled with the extension port to provide hydraulic fluid to extend at least one set of hydraulic cylinders.

A retract supply pump can be coupled with the retraction port to provide hydraulic fluid to retract at least one set of hydraulic cylinders. A float supply pump coupled with the extension port and the retraction port to provide hydraulic fluid to lubricate at least one set of hydraulic cylinders. In at least one embodiment, the retract supply pump and extend supply pump can be combined with a switching valve.

[0011] The hydraulic workover system can also include a plurality of control valves and a logic control system. Each of the control valves is transitionable between a closed position and an open position. The plurality of control valves having at least one extend control valve disposed between each set of hydraulic cylinders and the extend supply pump, at least one retract control valve disposed between each set of hydraulic cylinders and the retract supply pump, and at least one float control valve disposed between each set of hydraulic cylinders and the float supply pump. A logic control system coupled with the plurality of control valves and configured to transition the plurality of control valves between the closed position and the open position. The logic control system controls flow between the at least two sets of hydraulic cylinders and the extend supply pump, retract supply pump, and float supply pump.

[0012] The plurality of control valves can include a regeneration control valve disposed between the extend control valve, retract control valve, and float supply valve. The regeneration control valve allows hydraulic fluid to flow directly from the extension port to the retraction port, or vice versa, without returning to a pump, thereby improving performance of the hydraulic workover system.

[0013] The logic control system controls the hydraulic workover system to switch between a plurality of operating modes. Each operating mode transitions one or more of the plurality of control valves to a predetermined position. The operating modes can include, but are not

limited to, a park mode, a purge mode, a warming mode, a regeneration mode, a high speed mode, a low speed mode, and/or combinations thereof.

[0014] The park mode is defined as each of the plurality of control valves in a closed position and the at least two sets of hydraulic cylinders are hydraulically locked, thus preventing movement of the load.

[0015] The purge mode/warming mode is defined by the plurality of control valves being in the closed position and hydraulic fluid is circulated from the extend and retract supply pump to the counterbalance valves and back to tank, thereby warming the hydraulic fluid and purging any contaminates from the hydraulic workover system.

[0016] The high speed mode is defined by the float supply control valve coupled with one set of hydraulic cylinders in the open position allowing a float supply of hydraulic fluid flow, and the extend control valve and retract control valves coupled with the other set of hydraulic cylinders are open allowing a substantial majority of hydraulic fluid flow, thus allowing the load to move a substantially double a normal operation speed. In an embodiment having two sets of hydraulic cylinders, the high speed mode moves the load with twice as fast as the normal operation speed with half the force output. In an embodiment having three sets of hydraulic cylinders, the high speed mode moves the load three times as fast as the normal operation speed with a third of the force output.

[0017] The low speed mode is defined by the extend control valve and retract control valve coupled with each set of hydraulic cylinders are open and allow hydraulic fluid flow from the extend supply pump and the retract supply pump, thereby moving the load at a normal operation speed. For example, when provided with two sets of hydraulic cylinders, the normal operation speed moves the load with twice the force of the high speed mode.

[0018] The regeneration mode is defined by the regeneration control valve being in the open position. The regeneration mode can be implemented in combination with the high speed or low speed modes, but can only be implemented to extend the cylinders. When in regeneration mode, the hydraulic workover system automatically engages regeneration during extension of the hydraulic cylinder and disengages during retraction.

[0019] While the present disclosure is described in relation to a hydraulic workover unit utilizing hydraulic cylinders, the present disclosure can be implemented with any hydraulic actuator, motor, or cylinder configured to transition a load from one position to another, or an electric motor or electric acuator. While two sets of hydraulic cylinders are shown in relation to the illustrated embodiment, more than two sets of hydraulic cylinders, for example four sets of hydraulic cylinders can be implemented without deviating from the present disclosure.

[0020] The present disclosure is described with respect to a plurality of pilot pressure controlled valves; however, it is within the scope of this disclosure to implement electrical signals operating solenoid operated control valves. In some instances, the electrical signals operating solenoid operated control valves can be computer controlled (having a processor) and include software driven logic.

[0021] FIG. 1 illustrates a well site 100 having a multi-mode hydraulic cylinder hydraulic workover unit 200 in accordance with an example embodiment. The well site 100 has a wellbore 102 formed in the subterranean formation 106. The well site 100 can include a rig 104 disposed above the wellbore 102. The rig 104 can have one or more safety devices 110, such as a blowout preventer, disposed below the hydraulic workover unit 200.

[0022] The hydraulic workover unit 200 can be coupled with a load 108 to be disposed within the wellbore 102. The load 108 can be a drill pipe, drill string, or downhole tool to be disposed within a wellbore 102. The hydraulic workover unit 200 can employ force and motion to move the load 108 into the wellbore 102. As the load extends into the wellbore 102, the required force to dispose the load 108 further into the wellbore 102 typically increases. The hydraulic workover unit 200 can have multiple operating modes to efficiently move the load 108 within the wellbore 102.

[0023] The hydraulic workover unit 200 can include two or more sets of hydraulic cylinders 112 disposed around the load 108 to force the load 108 into or out of the wellbore 102. The sets of hydraulic cylinders 112 can be diagonally disposed on opposing sides of the load 108, such that each set of hydraulic cylinders 112 even applies force to the load 108. This arrangement allows each set of hydraulic cylinders 112 to apply force on the load individually in a perfectly vertical manner.

[0024] Each set of hydraulic cylinders 112 can be configured to apply a predetermined amount of force to the load 108 upon actuation. The hydraulic workover unit 200 can have a load capacity split evenly among each set of cylinders 112. The hydraulic cylinders 112 can be actuated by hydraulic fluid or oil to move the load. The hydraulic workover unit 200 can supply the hydraulic fluid to evenly each set of hydraulic cylinders 112 to provide full load capacity or provide all the hydraulic fluid to a single set of hydraulic cylinders 112 to provide half load capacity, but doubled speed.

[0025] During low load force requirements, the hydraulic workover unit 200 can employ a single set of hydraulic cylinders 112 at half load capacity with double the strokes per minute. During high load force requirements, the hydraulic workover unit 200 can employ both sets of hydraulic cylinders 112 at full load capacity.

[0026] While the present embodiment is shown and described with respect to land based operations, the present embodiment can also be implemented in sea based operations.

[0027] FIG. 2 illustrates a diagrammatic view of the multi-mode hydraulic work unit 200. The hydraulic workover unit 200 has at least two sets of hydraulic cylinders 202, 204 coupled with a single load and transitionable between an extended position and a retracted position. The sets of hydraulic cylinders 202, 204 can have a rod and piston 206 disposed therein. The piston 206 separates the hydraulic cylinder 202, 204 into a rod side 214 and a blind side 212.

[0028] Each set of hydraulic cylinders 202, 204 has an extension port 208 and a retraction port 210. Each extension port 208 is fluidly coupled with each respective set of hydraulic cylinders 202, 204 and receives fluid into the blind side 212 of the hydraulic cylinder 202, 204, thereby extending the piston 206 to the extended position. The extension port 208 can also expel fluid from the blind side 212 when transitioning the piston 206 from the extended position to the retracted position.

[0029] Each retraction port 210 is fluidly coupled with each respective set of hydraulic cylinders 202, 204 and receives fluid into the rod side 214 of the hydraulic cylinders 202, 204, thereby retracting the hydraulic cylinders 202, 204 to the retracted position. The retraction port 210 can also expel fluid from the rod side 214 when transitioning the piston 206 from the retracted position to the extended position.

[0030] The hydraulic cylinders 202, 204 can be coupled to a extend supply pump 216 and a retract supply pump 218. The extend supply pump 216 is fluidly coupled with the extension port 208 to provide hydraulic fluid to the blind side 212 of the hydraulic cylinder 202, 204, thereby extending the piston 206 and transitioning the hydraulic cylinder 202, 204 to the extended position.

[0031] The retract supply pump 218 is fluidly coupled with the retraction port 210 to provide hydraulic fluid to the rod side 214 of the hydraulic cylinder 202, 204, thereby retracting the piston 206 and transitioning the hydraulic cylinder 202, 204 to the retracted position.

[0032] The hydraulic workover unit 200 can also include a float supply pump 220 fluidly coupled with the extension port 208 and the retraction port 210. The float supply pump 220 can provide hydraulic fluid to lubricate the hydraulic cylinder 202, 204. The float supply pump 220 can be coupled to the extension port 208 and the retraction port 210 via a float supply line 222. The float supply line 222 can also be coupled to a tank 224 configured to receive hydraulic fluid flowing away from the hydraulic cylinder 202, 204. The float supply line 222 can be bi-directional allowing fluid flow from the float supply pump 220 in one direction, and fluid flow to the tank 224 in an opposite direction.

[0033] The hydraulic workover unit 200 has a plurality of control valves 226 transitionable between a closed position and an open position. The plurality of control valves 226 includes two extend control valves 228, 229, two retract control valves 230, 231, and two float supply valves 232, 233. Each of the plurality of control valves 226 can be spring biased to the closed position. In the closed position, the control valves 226 prevent fluid flow therethrough. In the open position, the control valves 226 allow fluid to flow therethrough. The plurality of control valves 226 are positive seal, zero leak valves.

[0034] The extend control valves 228, 229 are coupled with the extension port 208 and the extend supply pump 216. The extend control valves 228, 229 are configured to control hydraulic fluid flow between the extend supply pump 216 and each set of hydraulic cylinders 202, 204. Each of the two extend control valves 228, 229 can be transitioned between the closed position and open position independent of the other.

One extend control valve 228 can be coupled with hydraulic cylinder set 202 and the other extend control valve 229 can be coupled with hydraulic cylinder set 204.

[0035] In the closed position, the extend control valves 228 prevent fluid flow from and between the extend supply pump 216 and the extension port 208. In the open position, the extend control valves 228 allow fluid flow from the extend supply pump 216 to the extension port 208, thereby allowing fluid flow to the blind side 212 of the hydraulic cylinders 202, 204.

[0036] The retract control valves 230, 231 are coupled with the retract port 210 and the retract supply pump 218. The retract control valves 230, 231 are configured to control hydraulic fluid flow between the retract supply pump 218 and each set of hydraulic cylinders 202, 204. Each of the two retract control valves 230, 231 can be transitioned between the closed position and the open position independent of the other. One retract control valve 230 can be coupled with hydraulic cylinder set 202 and the other retract control valve 231 can be coupled with hydraulic cylinder set 204.

[0037] In the closed position, the retract control valves 230 prevent fluid flow from and between the retract supply pump 218 and the retraction port 210. In the open position, the retract control valves 230 allow fluid flow from the retract supply pump 218 to the retraction port 210, thereby allowing fluid flow to the rod side 214 of the hydraulic cylinders 202, 204.

[0038] The float supply control valves 232, 233 are coupled with the extension port 208, retraction port 210, and the float supply pump 220. The float supply valves 232, 233 are configured to control hydraulic fluid between the float supply pump 220 and each set of hydraulic cylinders 202, 204. Each of the two float supply control valves 232, 233 can be

transitioned between the closed position and the open position independent of the other. One float supply control valve 232 can be coupled with hydraulic cylinder set 202 and the other float supply control valve 233 can be coupled with hydraulic cylinder set 204.

[0039] In the closed position, the float supply control valves 232, 233 prevent fluid flow from and between the float supply pump 220, the extension port 208 and the retraction port 210. In the open position, the float supply control valves 232, 233 allow fluid flow from the float supply pump 220 to the extension portion 208 and the retraction port 210, thereby allowing fluid flow to the hydraulic cylinder sets 202, 204.

[0040] The plurality of control valves 226 can also include two regeneration control valves 234, 235. Regeneration control valves 234,235 can allow regeneration within each set of hydraulic cylinders 202, 204 increasing speed of the hydraulic workover unit 200.

[0041] The transition of the plurality of control valves 226 allows the hydraulic workover unit 200 to have multiple operating modes. The operating modes can include a low speed, a high speed set 1, a high speed set 2, an automatic regeneration mode, a park mode, and purge/warming mode.

[0042] Low speed allows operation of both sets of hydraulic cylinders 202, 204 simultaneously and maximizing force of the hydraulic workover unit 200. Each of set of hydraulic cylinders 202, 204 extends and retracts as fluid flow is received by the extension port 208 and retraction port 210. The extend control valves 228, 229 retract control valves 230, 231 are all set to the open position and float supply control valves 232, 233 are set to the closed position. The retract 230, 231 and extend 228, 229 control valves being in the open position allows hydraulic fluid flow from the extend supply pump 216 to the blind side 212 of each hydraulic cylinder 202, 204 and from the retract supply pump 218 to the rod side 214 of

each hydraulic cylinder 202, 204. As the hydraulic cylinders 202, 204 actuate between the extended position and retracted position, the hydraulic fluid is expelled through the respective extension port 208 or retraction port 210, through the retract 230, 231 or extend 228, 229 control valves to tank 224 via respective counterbalance valves 236, 238. For example, low speed can allow movement of the hydraulic cylinder sets 202, 204 at 400,000 lbs at 6 strokes per minute.

[0043] High speed allows a single set of hydraulic cylinders 202, 204 to act on the load while the other set of hydraulic cylinders 202, 204 remains floated and inactive. Floated cylinders are still provided with fluid in such a way to provide continuous lubrication to the cylinders and prevent cavitation. Inactive cylinders are not hydraulically coupled to the load, and therefore not supplying a force to move the load. For example, high speed can allow movement of the one of the hydraulic cylinder sets 202, 204 at 200,000 lbs at 12 strokes per minute.

[0044] High speed set 1 implements the set of hydraulic cylinders 202 to carry the load while the cylinders 204 are floated and inactive. The use of hydraulic cylinders 202 to carry the load allows maximum operating speed while only providing power to move the load from a single set of hydraulic cylinders. Extend control valve 228 is open while extend control valve 229 is closed and retract control valve 230 is open while retract control valve 231 is closed, thereby allowing hydraulic cylinders 202 to carry the load.

[0045] Float supply valve 233 and regeneration supply valve 235 are open to provide float charge pressure to hydraulic cylinder set 204 and open the blind side 212 and rod side 214 to the float charge pressure via the extension port 208 and retraction port 210 respectively.

[0046] Similarly, high speed set 2 implements the set of hydraulic cylinders 204 to carry the load while the cylinders 202 are floated and

inactive. The use of hydraulic cylinders 204 to carry the load allows maximum operating speed while only proving power to move the load from a single set of hydraulic cylinders. Extend control valve 229 is open while extend control valve 228 is closed and retract control valve 231 is open while retract control valve 230 is closed, thereby allowing hydraulic cylinders 204 to carry the load.

[0047] Float supply valve 232 and regeneration supply valve 234 are open to provide float charge pressure to hydraulic cylinder set 202 and open the blind side 212 and rod side 214 to the float charge pressure via the extension port 208 and retraction port 210 respectively.

[0048] In high speed sets 1 and 2, the hydraulic workover unit 200 can function at maximum operating speed and half of its maximum load capacity.

[0049] Low speed regeneration operates substantially similar to low speed having both sets of cylinders 202, 204 active and functioning to move the load, but with regeneration valves 234, 235 open. The rod side 214 of all cylinders is open to the blind side 212 as allowing fluid to flow out of the rod side 214 and into the blind side 212 as the rod and piston 206 extends. The increased fluid flow from the rod side 214 increases the speed of the cylinder for a given primary hydraulic flow rate. The increased speed is a caused by the difference in effective areas between the rod 214 and blind side 212 of the cylinders, thus the total available force is reduced in proportion to the ratio of areas. Regeneration is only available with hydraulic cylinders with different rod side 214 and blind side 212 areas and is only available during extension of the sets of cylinders 202, 204.

[0050] High speed set 1 and high speed set 2 can each also be implemented with regeneration. In high speed set 1, float supply valve 234 is open to allow regeneration for set of hydraulic cylinders 202. In

high speed set 2, float supply valve 235 is open to allow regeneration for set of hydraulic cylinders 204. Regeneration for high speed set 1 and high speed set 2 function substantially similar to low speed regeneration, except that one set of hydraulic cylinders 202, 204 is floated and inactive.

[0051] Automatic regeneration can be implemented with any of the low speed regeneration, high speed set 1 regeneration, or high speed set 2 regeneration modes. Automatic regeneration can engage regeneration while the cylinders are extended and disengage regeneration while the cylinders are retracted. Automatic regeneration can be provided by retract pilot supply valve 242 and associated supply lines 243 and 245. Supply line 243 is connected to the retract side of the hydraulic workover unit 200 and supply line 245 is coupled to the extend side of the hydraulic workover unit 200. Retract pilot supply valve 242 provides the source pilot pressure from the regeneration activation controls and is normally set to block pilot pressure from passing through the valve and onto the regeneration controls. When a regeneration mode is engaged, hydraulic power is supplied from the extend supply pump 216 to the extend the cylinders pilot line 245 actuating pilot supply valve 242 against the spring and allowing pressure from supply line 245 through the valve to activate at least one of regeneration control valves 234, 235 depending on which set of cylinders 202, 204 is active or both if both sets of cylinders 202, 204 are active. When hydraulic power is supplied from the retract supply pump 218, the supply line 243 provides pressure to shift the pilot supply valve 242 to block pilot pressure to regeneration control valves 234, 235, thus closing the regeneration control valves 235, 235 and deactivating the regeneration. The spring in the retract supply valve 242 reduces possible chattering by requiring positive pressure on the cylinder extend side before engaging regeneration. The retract CB disable valve 240 is also closed during regeneration to force fluid to move from the cylinder retract

port 210 to the cylinder extend port 208 without escaping through counterbalance valve 236.

[0052] The hydraulic workover unit 200 can be in park mode when the plurality of control valves 226 are closed blocking all hydraulic pressure and flow from reaching the cylinders 202, 204. Each set of hydraulic cylinders 202, 204 is hydraulically locked and cannot move unless one of the plurality of control valves 226 is leaking. Any hydraulic fluid pressure supplied by the extend supply up 216 or retract supply pump 218 is blocked by the plurality of control valves 226. If the pressure exceeds a predetermined value, the hydraulic fluid will flow through counter balance valves 236, 238 and return to tank 224. Park mode can be activated manually, or through a coupling with another system that provides the necessary pilot signals to stop the cylinders at any time. Over pressure relief valves, not shown but fluidly connected between the retract port 206 or extend port 210 to the tank 224, act to relieve any dynamically induce pressure caused by the cylinders 202, 204 being in motion at the time park mode is engaged.

[0053] Warming mode can be engaged any time the hydraulic workover unit 200 is in park mode. In warming mode, any fluid pressure exceeding a predetermined value flows through counter balance valves 236, 238 and back to tank 224. Overpressure allows circulation of fluid through most of the power and return lines to flush, and if filtered, clean the fluid without any chance of the cylinders moving. Filtering the flow of fluid through the hydraulic workover unit 200 can be useful after recent field connections exposing the hydraulic workover unit 200 connections to environmental conditions, such as dirt, sand, and other particulates. The warming mode in this operation can function as a purge mode to flush any possible contamination out of the lines and valves without passing the

hydraulic fluid and contaminates through the plurality of control valves 226 or either set of hydraulic cylinders 202, 204.

[0054] Continued flow through the counter balance valves 236, 238 generates heat within the fluid depending on the amount of fluid flow and the pressure drop through the counter balance valves 236, 238. By controlling the flow rate and the predetermined pressure required to actuate the counter balance valves 236, 238, the heat rate can be controlled to a desired amount. Heating the fluid can be useful for starting the hydraulic workover unit 200 in cold environmental conditions.

[0055] FIG. 3 illustrates an example control system 300 for a multi-mode hydraulic workover unit 200. The control system 300 can be coupled with the multi-mode hydraulic workover unit 200 and configured to actuate the plurality of control valves 226. The control system 300 includes three manual valves 302, 304, 306 for controlling the operating modes of the hydraulic workover unit 200. The cylinder set mode control valve 302 can transition the hydraulic workover unit 200 between low speed, high speed set 1, and high speed set 2. The cylinder set mode control valve 302 can be transitioned to engage either set of cylinders 202, 204 for high speed set 1 and high speed set 2, respectively, or engage both sets of cylinders 202, 204 for low speed mode.

[0056] As described above with respect to FIG. 2, the plurality of control valves 226 are biased to a closed position. A pilot pressure must be applied to signal each individual valve to transition from the closed position to the open position. The valves 226 being biased to a closed position acts as a failsafe, such that loss of control pressure causes the system to enter park mode where the cylinders are hydraulically locked and prevented from moving. The plurality of control valves 226 can also be biased to an open position if desired for a particular application.

[0057] Cylinder set mode control 302 in low speed mode allows pilot pressure to pass through park mode logic valves 308 and 310 to open extend control valves 228, 230 and retract control valves 229, 231. The pilot pressure also closes float mode logic valves 314, 316 to closed, thereby closing float control valves 232, 233. In this operating mode, all cylinders are active and carrying the load and float charge pressure is block by float valves 232, 233.

[0058] Cylinder set mode control 302 in high speed set 1 mode blocks and vents pilot pressure for cylinder set 204. Extend supply valve 231 and retract supply valve 229 are closed, thereby deactivating cylinder set 204. Pilot pressure passes through park mode logic valve 310 to open extend control valve 228 and retract supply valve 230. Pilot pressure also flows through float mode logic valve 314 to open float supply valve 233 and regeneration valve 235 to allow float charge pressure into hydraulic cylinder set 204. The pilot pressure also shifts float mode logic valve 316 to vent and close float supply valve 232 on hydraulic cylinder set 202.

[0059] Cylinder set mode control 302 in high speed set 2 mode blocks and vents pilot pressure for cylinder set 202. Extend supply valve 230 and retract supply valve 228 are closed, thereby deactivating cylinder set 202. Pilot pressure passes through park mode logic valve 308 to open extend control valve 229 and retract supply valve 231. Pilot pressure also flows through float mode logic valve 316 to open float supply valve 232 and regeneration valve 234 to allow float charge pressure into hydraulic cylinder set 202. The pilot pressure also shifts float mode logic valve 314 to vent and close float supply valve 233 on hydraulic cylinder set 204.

[0060] Regeneration mode control 304 is transitionable between on and off to control use of regeneration within the operating modes. When regeneration mode control 304 is on and the cylinders 206 are extended, pilot pressure 244, 245 from extend supply pump 216 passes through park

mode logic valve 312 to shuttle valves 318 and 320 to open regeneration control valves 234, 235. Shuttle valves 318, 320 allow either float mode or regeneration mode to operate the regeneration valves 234, 235 to provide regeneration if the cylinder set is active and carrying the load, or to open both extend and retract sides of the cylinder to the float charge pressure if the set is inactive. During automatic regeneration as described above with respect to FIG. 2, the regeneration pilot source 244, 245 to the regeneration mode control 304 is interrupted by retract pilot supply 242 when the cylinder is retracted disabling regeneration even if regeneration mode control 304 is on.

[0061] Park mode control 306 is set on when pilot pressure shifts valves 308, 310, and 312 which vents pressure to retract control valves 228, 229, extend control valves, 230, 231, float supply valves 232, 233 and regeneration control valves 234, 235 logic valves, thereby closing each valve and isolating the cylinders from hydraulic power. The isolation from hydraulic power hydraulically locks each set of cylinders 202, 204 and prevents movement of the load and the rods and pistons 206.

[0062] It is believed the exemplary embodiment and its advantages will be understood from the foregoing description, and it will be apparent that various changes may be made thereto without departing from the spirit and scope of the disclosure or sacrificing all of its advantages, the examples hereinbefore described merely being preferred or exemplary embodiments of the disclosure.

STATEMENTS OF THE DISCLOSURE INCLUDE:

Statement 1: A hydraulic workover system comprising at least two sets of hydraulic cylinders coupled with a single load and transitionable between an extended position and a retracted position, each set of hydraulic cylinders having an extension port and a retraction port, an extend supply

pump fluidly coupled with the extension port, the extend supply pump providing hydraulic fluid to extend at least one set of the hydraulic cylinders to the extending position, a retract supply pump fluidly coupled with the retraction port, the retract supply pump providing hydraulic fluid to retract at least one set of the hydraulic cylinders to the retracted position, a float supply pump fluidly coupled with the extension port and the retraction port, the float supply pump providing hydraulic fluid to lubricate at least one set of the hydraulic cylinders, a plurality of control valves transitionable between a closed position and an open position, the plurality of control valves having at least one extend control valve disposed between each set of hydraulic cylinders and the extend supply pump, at least one retract control valve disposed between each set of hydraulic cylinders and the retract supply pump, and at least one float control valve disposed between each set of hydraulic cylinders and the float supply pump, and a logic control system communicatively coupled with the plurality of control valves and configured to transition the plurality of control valves between the closed position and the open position, thereby controlling flow between the at least two sets of hydraulic cylinders and the extend supply pump, retract supply pump, and float supply pump.

Statement 2: The hydraulic workover system of Statement 1, wherein the plurality of control valves includes a regeneration control valve disposed between the extend control valve, retract control valve, and float supply valve, the regeneration control valve allowing hydraulic fluid to flow.

Statement 3: The hydraulic workover system of any one of the preceeded Statements 1 or 2, further comprising a plurality of operating modes

wherein the logic control system transitions the plurality of control valves in a predetermined sequence to transition between the plurality of modes.

Statement 4: The hydraulic workover system of Statement 3, wherein the plurality of operating modes includes a park mode, each of the plurality of control valves is closed in the park mode and the at least two sets of hydraulic cylinders are hydraulically locked, thus the load remains stationary.

Statement 5: The hydraulic workover system of Statement 3, wherein the plurality of operating modes includes a high speed mode wherein the float supply control valve coupled with one set of hydraulic cylinders is open allowing a float supply of hydraulic fluid flow and the extend control valve and retract control valve coupled with the one set of hydraulic cylinders are open allowing a substantial majority of hydraulic fluid flow, thus allowing the load to move at substantially double a normal operation speed.

Statement 6: The hydraulic workover system of Statement 3, wherein the plurality of operating modes includes a low speed mode wherein the extend control valve and retract control valve coupled with each set of hydraulic cylinders are open allowing hydraulic fluid flow from the extend supply pump and the retract supply pump, thereby moving the load at a normal operation speed.

Statement 7: The hydraulic workover system of Statement 3, wherein the plurality of operating modes includes a warming mode wherein the plurality of control valves are closed and hydraulic fluid is circulated from

the extend and retract supply pump to the counterbalance valves, thereby warming the hydraulic fluid.

Statement 8: The hydraulic workover system of any one of the preceeding Statements 1-7, wherein the at least two sets of hydraulic cylinders is three sets of hydraulic cylinders attached to a single load and transitionable between the extended position and the retracted position.

Statement 9: The hydraulic workover system of any preceding Statements 1-8, wherein the at least two sets of hydraulic cylinders are configured to dispose pipe into a wellbore.

Statement 10: A hydraulic workover unit comprising at least two sets of hydraulic cylinders coupled with a single load and transitionable between an extended position and a retracted position, each set of hydraulic cylinders having an extension port configured to be coupled to an extend supply pump and a retraction port configured to be coupled with a retract supply pump, a plurality of control valves transitionable between a closed position and an open position, the plurality of control valves having at least one extend control valve, at least one retract control valve, and at least one float control valve, and a logic control system communicatively coupled with the plurality of control valves and configured to transition the plurality of control valves between the closed position and the open position, thereby controlling flow between the at least two sets of hydraulic cylinders and the extend supply pump, retract supply pump, and float supply pump.

Statement 11: The hydraulic workover unit of Statement 10, wherein the plurality of control valves includes a regeneration control valve disposed

between the extend control valve, retract control valve, and float supply valve, the regeneration control valve allowing hydraulic fluid to flow.

Statement 12: The hydraulic workover unit of any one of the preceding Statements 10 or 11, further comprising a plurality of operating modes wherein the logic control system transitions the plurality of control valves in a predetermined sequence to transition between the plurality of modes.

Statement 13: The hydraulic workover unit of Statement 12, wherein the plurality of operating modes includes a park mode, each of the plurality of control valves is closed in the park mode and the at least two sets of hydraulic cylinders are hydraulically locked, thus the load remains stationary.

Statement 14: The hydraulic workover unit of Statement 12, wherein the plurality of operating modes includes a high speed mode wherein the float supply control valve coupled with one set of hydraulic cylinders is open allowing a float supply of hydraulic fluid flow and the extend control valve and retract control valve coupled with the one set of hydraulic cylinders are open allowing a substantial majority of hydraulic fluid flow, thus allowing the load to move at substantially double a normal operation speed.

Statement 15: The hydraulic workover unit of Statement 12, wherein the plurality of operating modes includes a low speed mode wherein the extend control valve and retract control valve coupled with each set of hydraulic cylinders are open allowing hydraulic fluid flow from the extend supply pump and the retract supply pump, thereby moving the load at a normal operation speed.

Statement 16: The hydraulic workover unit of any of the preceding Statements 10-15, wherein the plurality of operating modes includes a warming mode wherein the plurality of control valves are closed and hydraulic fluid is circulated from the extend and retract supply pump to the counterbalance valves, thereby warming the hydraulic fluid.

Statement 17: The hydraulic workover unit of any one of the preceding Statements 10-16, wherein the at least two sets of hydraulic cylinders is three sets of hydraulic cylinders attached to a single load and transitionable between the extended position and the retracted position.

Statement 18: A method for controlling a multi-mode hydraulic workover system comprising operating a multi-mode hydraulic workover unit coupled to a load transitionable between a plurality of operating modes, the multi-mode hydraulic work over unit comprising at least two sets of hydraulic cylinders transitionable between an extended position and a retracted position, a plurality of control valves transitionable between a closed position and an open position, the plurality of control valves having at least one extend control valve, at least one retract control valve, and at least one float control valve, and a logic control system communicatively coupled with the plurality of control valves and configured to transition the plurality of control valves between the closed position and the open position, and transitioning, by the logic control system, the multi-mode hydraulic workover unit from one operating mode to another by transitioning the one or more of the plurality of control between the open and close positions.

Statement 19: The method of Statement 18, wherein transitioning the multi-mode hydraulic workover unit from one operating mode to another includes transitioning from a park mode wherein each of the plurality of control valves is closed to a low speed mode wherein the at least extend control valve and the at least one retract control valve are transitioned to open.

Statement 20: The method of any one of the preceding Statements 18 or 19, wherein transitioning the multi-mode hydraulic workover unit from one operating mode to another includes transitioning to a high speed mode wherein the at least extend control valve and the at least one retract control valve are transitioned to open for one set of hydraulic cylinders and the at least extend control valve and the at least one retract control valve are closed for the other set of hydraulic cylinders.

Statement 21: The method of any one of the preceding Statements 18-20, wherein transititioning the multi-mode hydraulic workover unit from one operating mode to another includes engaging a regeneration mode wherein at least one regeneration control valve is open during extension of at least one of the set of hydraulic cylinders.

Statement 22: The method of any one of the preceding Statements 18-21, wherein the at least two sets of hydraulic cylinders are configured to dispose pipe into a wellbore.

Conclusies:

1. Hydraulisch workoversysteem omvattende:

ten minste twee reeksen hydraulische cilinders (202, 204) die zijn gekoppeld met een enkele lading en kunnen worden getransleerd tussen een uitgetrokken positie en een ingetrokken positie, waarbij elke reeks hydraulische cilinders (202, 204) een uittrekpoort (208) en een intrekpoort (212) heeft;

een uittrektoevoerpomp (216) die via fluïdum is gekoppeld met de uittrekpoort (208), waarbij de uittrektoevoerpomp (216) hydraulisch fluïdum levert voor het uitrekken van ten minste één reeks van de hydraulische cilinders (202, 204) naar de uitgetrokken positie;

een intrektoevoerpomp (218) die via fluïdum is gekoppeld met de intrekpoort (212), waarbij de intrektoevoerpomp (218) hydraulisch fluïdum levert voor het intrekken van ten minste één reeks van de hydraulische cilinders (202, 204) naar de ingetrokken positie;

een drijftoevoerpomp (220) die via fluïdum is gekoppeld met de uittrekpoort (208) en de intrekpoort (212), waarbij de drijftoevoerpomp (220) hydraulisch fluïdum levert voor het smeren van ten minste één reeks van de hydraulische cilinders (202, 204);

een veelvoud van regelkleppen (226) die kunnen worden getransleerd tussen een gesloten positie en een open positie, waarbij het veelvoud van regelkleppen (226) ten minste één uittrekregelklep (228, 229) heeft tussen elke reeks hydraulische cilinders (202, 204) en de uittrektoevoerpomp (216), ten minste één intrekregelklep (230, 231) die is geplaatst tussen elke reeks hydraulische cilinders (202, 204) en de intrektoevoerpomp (218), en ten minste één drijfregelklep (232, 233) die is geplaatst tussen elke reeks

hydraulische cilinders (202, 204) en de drijftoevoerpomp (220); en

een logisch controlesysteem dat communicatief is gekoppeld met het veelvoud van regelkleppen (226) en is geconfigureerd voor overgang van het veelvoud van regelkleppen (226) tussen de gesloten positie en de open positie, waardoor de stroom wordt geregeld tussen de ten minste twee reeksen hydraulische cilinders (202, 204) en de uittrektoevoerpomp (216), intrektoevoerpomp (218) en drijftoevoerpomp (220).

2. Hydraulisch workoversysteem volgens conclusie 1, waarbij het veelvoud van regelkleppen (226) een regeneratieregelklep (234, 235) omvat die is geplaatst tussen de uittrekregelklep (228, 229), intrekregelklep (230, 231), en drijfregelklep (232, 233), waarbij de regeneratieregelklep (234, 235) toelaat dat hydraulisch fluïdum stroomt.

3. Hydraulisch workoversysteem volgens conclusie 1, verder omvattende een veelvoud van werkingsmodi waarbij het logische controlesysteem het veelvoud van regelkleppen (226) overbrengt in een vooraf bepaalde sequentie voor overgang tussen het veelvoud van modi.

4. Hydraulisch workoversysteem volgens conclusie 3, waarbij het veelvoud van werkingsmodi een parkeermodus omvat, waarbij elk van het veelvoud van regelkleppen (226) gesloten is in de parkeermodus en de ten minste twee reeksen hydraulische cilinders (202, 204) hydraulisch vergrendeld zijn, waardoor de lading stationair blijft.

5. Hydraulisch workoversysteem volgens conclusie 3, waarbij het veelvoud van werkingsmodi een hoge snelheidsmodus omvat

waarbij de drijftoevoerregelklep (232, 233) die is gekoppeld met één reeks hydraulische cilinders (202, 204) open is waardoor een drijftoevoer van hydraulische fluïdumstroom toegelaten wordt en de uittrekregelklep (228, 229) en intrekregelklep (230, 231) gekoppeld met de één reeks hydraulische cilinders (202, 204) open zijn om een aanzienlijk merendeel van de hydraulische fluïdumstroom toe te laten, waardoor de lading met in hoofdzaak het dubbele van de normale werkingssnelheid verplaatst kan worden.

6. Hydraulisch workoversysteem volgens conclusie 3, waarbij het veelvoud van werkingsmodi een lage snelheidsmodus omvat waarbij de uittrekregelklep (228, 229) en intrekregelklep (230, 231) gekoppeld met elke reeks hydraulische cilinders (202, 204) open zijn om de hydraulische fluïdumstroom toe te laten vanuit de uittrektoevoerpomp (216) en de intrektoevoerpomp (218), waardoor de lading met een normale werkingssnelheid verplaatst wordt.

7. Hydraulisch workoversysteem volgens conclusie 3, waarbij het veelvoud van werkingsmodi een opwarmingsmodus omvat waarbij het veelvoud van regelkleppen (226) gesloten zijn en hydraulisch fluïdum wordt gecirculeerd van de uittrek- en intrektoevoerpomp naar de tegengewichtkleppen, waardoor het hydraulisch fluïdum opgewarmd wordt.

8. Hydraulisch workoversysteem volgens conclusie 1, waarbij de ten minste twee reeksen hydraulische cilinders (202, 204) drie reeksen hydraulische cilinders zijn die zijn vastgemaakt aan een enkele lading en kunnen worden getransleerd tussen de uitgetrokken positie en de ingetrokken positie.

9. Hydraulisch workoversysteem volgens conclusie 1, waarbij de ten minste twee reeksen hydraulische cilinders (202, 204) geconfigureerd zijn om een leiding in een boorgat te plaatsen.

10. Hydraulische workovereenheid omvattende:

ten minste twee reeksen hydraulische cilinders (202, 204) die zijn gekoppeld met een enkele lading en kunnen worden getransleerd tussen een uitgetrokken positie en een ingetrokken positie, waarbij elke reeks hydraulische cilinders (202, 204) een uittrekpoort (208) geconfigureerd om gekoppeld te worden met een uittrektoevoerpomp (216) en een intrekpoort (212) geconfigureerd om gekoppeld te worden met een intrektoevoerpomp (218) heeft;

een veelvoud van regelkleppen (226) die kunnen worden getransleerd tussen een gesloten positie en een open positie, waarbij het veelvoud van regelkleppen (226) ten minste één uittrekregelklep (228, 229), ten minste één intrekregelklep (230, 231), en ten minste één drijfregelklep (232, 233) heeft; en

een logisch controlesysteem dat communicatief is gekoppeld met het veelvoud van regelkleppen (226) en is geconfigureerd voor overgang van het veelvoud van regelkleppen (226) tussen de gesloten positie en de open positie, waardoor de stroom wordt geregeld tussen de ten minste twee reeksen hydraulische cilinders (202, 204) en de uittrektoevoerpomp (216), intrektoevoerpomp (218) en drijftoevoerpomp (220).

11. Hydraulische workovereenheid volgens conclusie 10, waarbij het veelvoud van regelkleppen (226) een regeneratieregelklep (234, 235) omvat die is geplaatst tussen de uittrekregelklep (228, 229), intrekregelklep (230, 231),

en drijfregelklep (232, 233), waarbij de regeneratieregelklep (234, 235) toelaat dat hydraulisch fluïdum stroomt.

12. Hydraulische workovereenheid volgens conclusie 10, verder omvattende een veelvoud van werkingsmodi waarbij het logische controlesysteem het veelvoud van regelkleppen (226) overbrengt in een vooraf bepaalde sequentie voor overgang tussen het veelvoud van modi.

13. Hydraulische workovereenheid volgens conclusie 12, waarbij het veelvoud van werkingsmodi een parkeermodus omvat, waarbij elk van het veelvoud van regelkleppen (226) gesloten is in de parkeermodus en de ten minste twee reeksen hydraulische cilinders (202, 204) hydraulisch vergrendeld zijn, waardoor de lading stationair blijft.

14. Hydraulische workovereenheid volgens conclusie 12, waarbij het veelvoud van werkingsmodi een hoge snelheidsmodus omvat waarbij de drijftoevoerregelklep (232, 233) die is gekoppeld met één reeks hydraulische cilinders (202, 204) open is waardoor een drijftoevoer van hydraulische fluïdumstroom toegelaten wordt en de uittrekregelklep (228, 229) en intrekregelklep (230, 231) gekoppeld met de één reeks hydraulische cilinders (202, 204) open zijn om een aanzienlijk merendeel van de hydraulische fluïdumstroom toe te laten, waardoor de lading met in hoofdzaak het dubbele van de normale werkingssnelheid verplaatst kan worden.

15. Hydraulische workovereenheid volgens conclusie 12, waarbij het veelvoud van werkingsmodi een lage snelheidsmodus omvat waarbij de uittrekregelklep (228, 229) en intrekregelklep (230, 231) gekoppeld met elke reeks hydraulische cilinders (202, 204) open zijn om de

hydraulische fluïdumstroom toe te laten vanuit de uittrektoevoerpomp (216) en de intrektoevoerpomp (218), waardoor de lading met een normale werkingssnelheid verplaatst wordt.

16. Hydraulische workovereenheid volgens conclusie 10, waarbij het veelvoud van werkingsmodi een opwarmingsmodus omvat waarbij het veelvoud van regelkleppen (226) gesloten zijn en hydraulisch fluïdum wordt gecirculeerd van de uittrek- en intrektoevoerpomp naar de tegengewichtkleppen, waardoor het hydraulisch fluïdum opgewarmd wordt.

17. Hydraulische workovereenheid volgens conclusie 10, waarbij de ten minste twee reeksen hydraulische cilinders (202, 204) drie reeksen hydraulische cilinders zijn die zijn vastgemaakt aan een enkele lading en kunnen worden getransleerd tussen de uitgetrokken positie en de ingetrokken positie.

18. Werkwijze voor het controleren van een multi-modi hydraulisch workoversysteem omvattende:

het bedienen van een multi-modi hydraulische workovereenheid , waarbij de multi-modi hydraulische workovereenheid omvat: ten minste twee reeksen hydraulische cilinders (202, 204) die gekoppeld zijn met een enkele lading en kunnen worden getransleerd tussen een uitgetrokken positie en een ingetrokken positie;

een veelvoud van regelkleppen (226) die kunnen worden getransleerd tussen een gesloten positie en een open positie, waarbij het veelvoud van regelkleppen (226) ten minste één uittrekregelklep (228, 229), ten minste één intrekregelklep (230, 231), en ten minste één drijfregelklep (232, 233) heeft; en

een logisch controlesysteem dat communicatief is gekoppeld met het veelvoud van regelkleppen (226) en is geconfigureerd voor overgang van het veelvoud van regelkleppen (226) tussen de gesloten positie en de open positie;

het overgaan van de een of meerdere van het veelvoud van regelkleppen (226) tussen de open en gesloten posities.

19. Werkwijze volgens conclusie 18, waarbij de multi-mode hydraulische workovereenheid kan overgaan tussen een veelvoud van werkingsmodi, waarbij het overgaan van de multi-modi hydraulische workovereenheid van één werkingsmodus naar een andere het overgaan omvat van een parkeermodus waarbij elk van het veelvoud van regelkleppen (226) gesloten is naar een lage snelheidsmodus waarin de ten minste uittrekregelklep (228, 229) en de ten minste één intrekregelklep (230, 231) overgegaan zijn om te openen.

20. Werkwijze volgens conclusie 18, waarbij de multi-mode hydraulische workovereenheid kan overgan tussen een veelvoud van werkingsmodi, waarbij het overgaan van de multi-modi hydraulische workovereenheid van één werkingsmodus naar een andere het overgaan omvat naar een hoge snelheidsmodus waarbij de ten minste uittrekregelklep (228, 229) en de ten minste één intrekregelklep (230, 231_) overgegaan zijn om te openen voor één reeks hydraulische cilinders (202, 204) en de ten minste uittrekregelklep (228, 229) en de ten minste één intrekregelklep (230, 231) gesloten zijn voor de andere reeks hydraulische cilinders (202, 204).

21. Werkwijze volgens conclusie 18, waarbij de multi-mode hydraulische workovereenheid kan overgaan tussen een veelvoud van werkingsmodi, waarbij het overgaan van de multi-modi

hydraulische workovereenheid van één werkingsmodus naar een andere het activeren omvat van een regeneratiemodus waarbij ten minste één regeneratieregelklep (234, 235) open is tijdens het uittrekken van ten minste één van de reeks hydraulische cilinders (202, 204).

22. Werkwijze volgens conclusie 18, waarbij de ten minste twee reeksen hydraulische cilinders (202, 204) geconfigureerd zijn om een leiding in een boorgat te plaatsen.

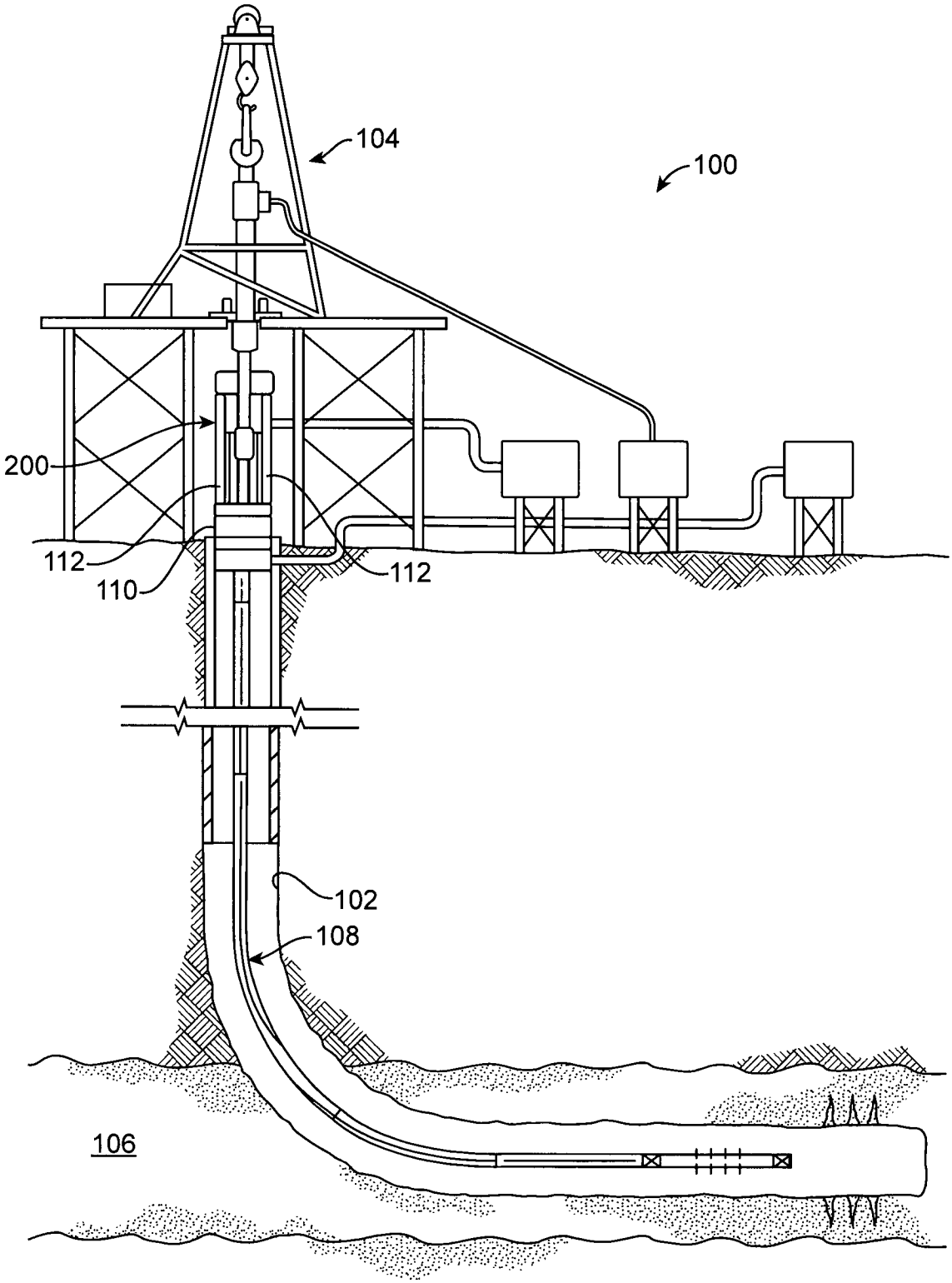

FIG. 1

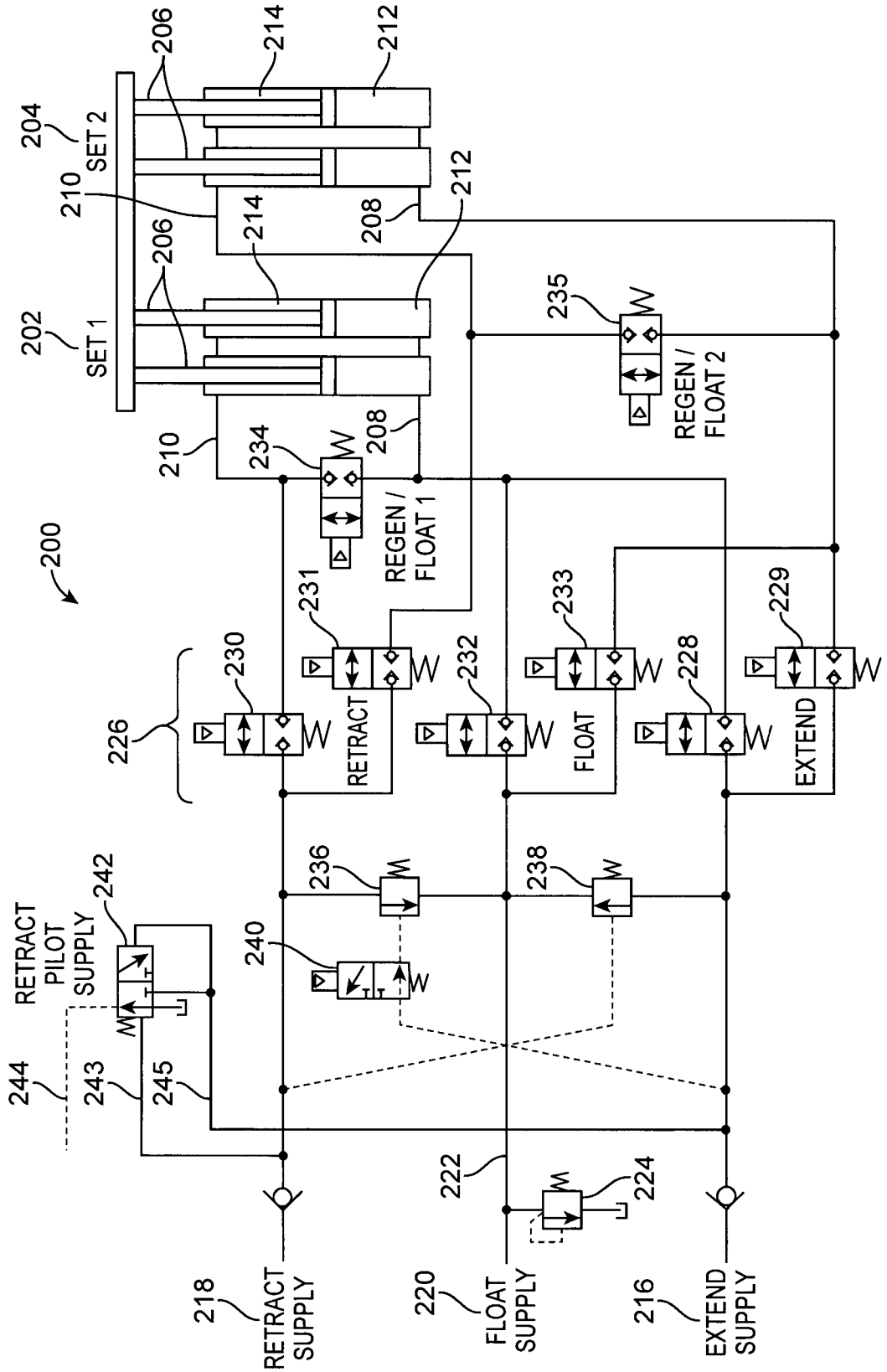
200
202
SET 1
204
SET 2
206
208
210
212
214
216
EXTEND SUPPLY
218
RETRACT SUPPLY
220
FLOAT SUPPLY
222
224
226
228
EXTEND
229
230
231
RETRACT
232
FLOAT
233
234
REGEN / FLOAT 1
235
REGEN / FLOAT 2
236
238
240
242
RETRACT PILOT SUPPLY
243
244
245

FIG. 2

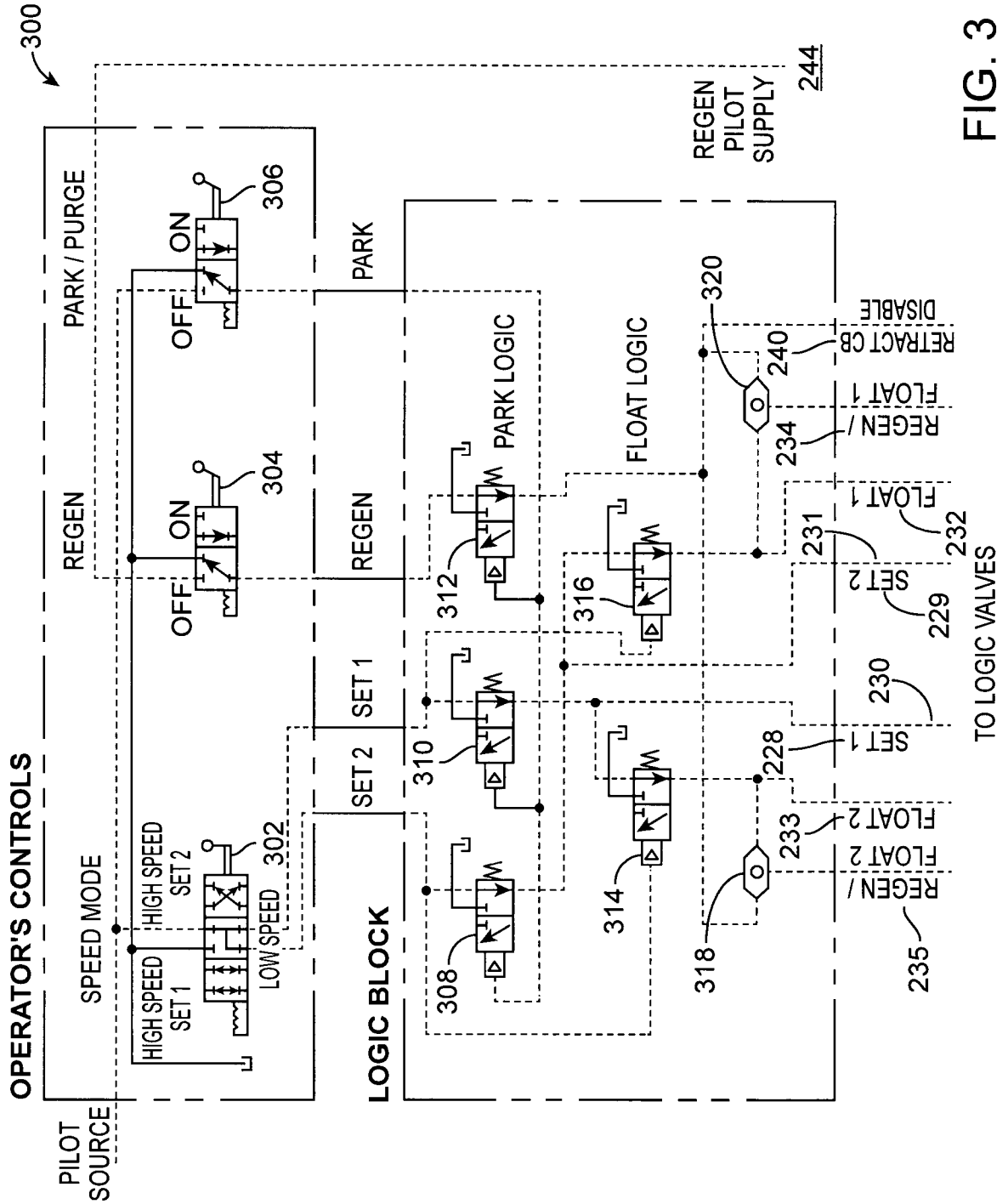
300
OPERATOR'S CONTROLS
PILOT SOURCE
SPEED MODE
HIGH SPEED SET 1
HIGH SPEED SET 2
LOW SPEED
302
PARK / PURGE
REGEN
OFF
ON
304
306
LOGIC BLOCK
SET 1
SET 2
PARK
REGEN
PARK LOGIC
FLOAT LOGIC
308
310
312
314
316
318
320
REGEN PILOT SUPPLY
244
RETRACT CB
DISABLE
240
FLOAT 1
REGEN / FLOAT 1
234
231
FLOAT 1
232
SET 2
229
230
SET 1
228
FLOAT 2
233
REGEN / FLOAT 2
235
TO LOGIC VALVES

FIG. 3

ABSTRACT

Hydraulic workover system having at least two sets of hydraulic cylinders coupled with a single load. A plurality of control valves transitionable between a closed position and an open position, the plurality of control valves having at least one extend control valve disposed between each set of hydraulic cylinders and an extend supply pump, at least one retract control valve disposed between each set of hydraulic cylinders and a retract supply pump, and at least one float control valve disposed between each set of hydraulic cylinders and a float supply pump. A logic control system coupled with the plurality of control valves and configured to transition the plurality of control valves between the closed and open position, thereby controlling flow between the at least two sets of hydraulic cylinders and the extend supply pump, retract supply pump, and float supply pump.

Rijksdienst voor Ondernemend Nederland

OCTROOIAANVRAAG NR.:
NO 139776
NL 1042220

ONDERZOEKSRAPPORT

BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK

RELEVANTE LITERATUUR

Categorie[1]	Literatuur met, voor zover nodig, aanduiding van speciaal van belang zijnde tekstgedeelten of figuren	Van belang voor conclusie(s) nr:	Classificatie (IPC)
A	US 9 133 669 B1 (STREETY JIMMY DUANE [US] ET AL) 15 september 2015 (2015-09-15) * kolommen 1-9; figuren 1-5B *	1-22	INV. E21B44/00 E21B15/00
A	US 6 094 910 A (VATNE PER [NO]) 1 augustus 2000 (2000-08-01) * kolommen 1-5; figuren 1, 3-13 *	1-22	
A	US 2004/262015 A1 (MAZZELLA MARK [US] ET AL) 30 december 2004 (2004-12-30) * samenvatting; figuren 1-6 * * alineas [0001] - [0007], [0018] - [0040] *	1-22	
A	US 7 918 285 B1 (GRAHAM WILLIAM DOUGLAS [US] ET AL) 5 april 2011 (2011-04-05) * samenvatting; figuren 1-2 * * kolommen 1-4 *	1-22	
A	US 2002/000157 A1 (SPRATT PAUL R [US]) 3 januari 2002 (2002-01-03) * alineas [0001], [0008]; figuur 1 *	1-22	Onderzochte gebieden van de techniek
A	US 2006/283321 A1 (BAIR EUGENE C [US]) 21 december 2006 (2006-12-21) * alineas [0002], [0008], [0026]; figuren 1A-14 *	1-22	E21B G05B G05D G05G

Indien gewijzigde conclusies zijn ingediend, heeft dit rapport betrekking op de conclusies ingediend op:

Plaats van onderzoek:	Datum waarop het onderzoek werd voltooid:	Bevoegd ambtenaar:
's-Gravenhage	6 september 2017	Brassart, P

[1] CATEGORIE VAN DE VERMELDE LITERATUUR

X: de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur
Y: de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht
A: niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft
O: niet-schriftelijke stand van de techniek
P: tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur
T: na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding
E: eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven
D: in de octrooiaanvrage vermeld
L: om andere redenen vermelde literatuur
&: lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

EPO FORM 1503 (P04149)

AANHANGSEL BEHORENDE BIJ HET RAPPORT BETREFFENDE HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK, UITGEVOERD IN DE OCTROOIAANVRAGE NR.

NO 139776
NL 1042220

Het aanhangsel bevat een opgave van elders gepubliceerde octrooiaanvragen of octrooien (zogenaamde leden van dezelfde octrooifamilie), die overeenkomen met octrooischriften genoemd in het rapport.
De opgave is samengesteld aan de hand van gegevens uit het computerbestand van het Europees Octrooibureau per
De juistheid en volledigheid van deze opgave wordt noch door het Europees Octrooibureau, noch door het Bureau voor de Industriële eigendom gegarandeerd; de gegevens worden verstrekt voor informatiedoeleinden.

06-09-2017

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
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EPO FORM P0459

Algemene informatie over dit aanhangsel is gepubliceerd in de 'Official Journal' van het Europees Octrooibureau nr 12/82 blz 448 ev

SCHRIFTELIJKE OPINIE

DOSSIER NUMMER	INDIENINGSDATUM	VOORRANGSDATUM	AANVRAAGNUMMER
NO139776	13.01.2017	01.02.2016	NL1042220

CLASSIFICATIE
INV. E21B44/00 E21B15/00

AANVRAGER
Halliburton Energy Services, Inc.

Deze schriftelijke opinie bevat een toelichting op de volgende onderdelen:

- ☒ Onderdeel I Basis van de schriftelijke opinie
- ☐ Onderdeel II Voorrang
- ☐ Onderdeel III Vaststelling nieuwheid, inventiviteit en industriële toepasbaarheid niet mogelijk
- ☐ Onderdeel IV De aanvraag heeft betrekking op meer dan één uitvinding
- ☒ Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid
- ☐ Onderdeel VI Andere geciteerde documenten
- ☒ Onderdeel VII Overige gebreken
- ☒ Onderdeel VIII Overige opmerkingen

DE BEVOEGDE AMBTENAAR
Brassart, P

Aanvraag nr.:

SCHRIFTELIJKE OPINIE

NL1042220

Onderdeel I Basis van de Schriftelijke Opinie

1. Deze schriftelijke opinie is opgesteld op basis van de meest recente conclusies ingediend voor aanvang van het onderzoek.

2. Met betrekking tot **nucleotide en/of aminozuur sequenties** die genoemd worden in de aanvraag en relevant zijn voor de uitvinding zoals beschreven in de conclusies, is dit onderzoek gedaan op basis van:

   a. type materiaal:

   ☐ sequentie opsomming

   ☐ tabel met betrekking tot de sequentie lijst

   b. vorm van het materiaal:

   ☐ op papier

   ☐ in elektronische vorm

   c. moment van indiening/aanlevering:

   ☐ opgenomen in de aanvraag zoals ingediend

   ☐ samen met de aanvraag elektronisch ingediend

   ☐ later aangeleverd voor het onderzoek

3. ☐ In geval er meer dan één versie of kopie van een sequentie opsomming of tabel met betrekking op een sequentie is ingediend of aangeleverd, zijn de benodigde verklaringen ingediend dat de informatie in de latere of additionele kopieën identiek is aan de aanvraag zoals ingediend of niet meer informatie bevatten dan de aanvraag zoals oorspronkelijk werd ingediend.

4. Overige opmerkingen:

Aanvraag nr.:

SCHRIFTELIJKE OPINIE

NL1042220

Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid

1. Verklaring

Nieuwheid	Ja:	Conclusies 1-22
	Nee:	Conclusies
Inventiviteit	Ja:	Conclusies 1-22
	Nee:	Conclusies
Industriële toepasbaarheid	Ja:	Conclusies 1-22
	Nee:	Conclusies

2. Citaties en toelichting:

Zie aparte bladzijde

Onderdeel VII Overige gebreken

De volgende gebreken in de vorm of inhoud van de aanvraag zijn opgemerkt:

Zie aparte bladzijde

Onderdeel VIII Overige opmerkingen

De volgende opmerkingen met betrekking tot de duidelijkheid van de conclusies, beschrijving, en figuren, of met betrekking tot de vraag of de conclusies nawerkbaar zijn, worden gemaakt:

Zie aparte bladzijde

1 **Re Item V**

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1.1 Reference is made to the following documents:

D1 US 9 133 669 B1 (STREETY JIMMY DUANE [US] ET AL) 15 september 2015 (2015-09-15)

D2 US 6 094 910 A (VATNE PER [NO]) 1 augustus 2000 (2000-08-01)

1.2 The subject matter of claims 1-9 is seen to be novel and inventive.

1.3 Claims 10-22 do not mee the requirements of clarity (see Re Item VIII).

1.3.1 If claims 10 and 18 were appropriately amended to address the lack of clarity raised in Re Item VIII, claims 10-22 would also be seen to be novel and inventive.

2 **Re Item VII**

Certain defects in the application

2.1 The features of all the claims are not provided with reference signs placed in parentheses.

2.2 The relevant background art disclosed in D1-D2 is not mentioned in the description, nor is this document identified therein.

3 **Re Item VIII**

Certain observations on the application

3.1 Although claims 1 and 10 have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought and in respect of the terminology used for the features of that subject-matter. The aforementioned claims therefore lack conciseness.

3.2 Claim 10 also broadly defines the control valves, their location and their relationship with the other components of the hydraulic workover system, in terms of their function, namely "the plurality of control valves having at least one extend control valve, at least one retract control valve, and at least one float control valve, and a logic control system communicatively coupled with the plurality of control valves and configured to transition the plurality of control valves between the closed position and the open position, thereby

controlling flow between the at least two sets of hydraulic cylinders and the extend supply pump, retract supply pump, and float supply pump". As such, the subject matter of claim 10 as currently drafted can be interpreted to comprise embodiments wherein said control valves are located upstream of all pumps (i.e. not between said pumps and each of the cylinders but between an upstream supply source and said pumps).

However, the description and drawings (see Fig 1-2 for instance) convey the impression that this function can only be carried out in a particular way, namely by locating said valves between said pumps and said cylinders [as done in claim 1], and no alternative means (such as upstream of said pumps) are envisaged.

Hence, claim 10 is also not supported by the description.

3.3 Claims 10 is also not clear because **the** float supply pump is not defined in claim 10 prior being referred to.

3.4 To overcome the objections raised in above §3.1-3.3, the applicant should make claim 10 dependent on claim 1 to overcome .

3.5 The application aims at solving the problem of tedious and time consuming valve operations (description §0002)

It is clear from the description that all the features of claim 1 pertaining to and defining the control valves and their relationship to all cylinders, ports, pumps and the logic control system are therefore essential to the definition of the invention.

Since independent claim 18 does not contain these features, it does not meet the requirement of clarity that any independent claim must contain all the technical features essential to the definition of the invention.

3.6 Further to the above §3.5, the subject matter of claim 18 is silent on the at least two sets of cylinders being coupled with a single load, such that claim 18 can be interpreted to mean that each of the at least two sets of cylinders is coupled to a different load, which is also not supported by the description.

3.7 Further to the above §3.6, the features of claim 18, namely "a load transitionable between a plurality of operating modes" can be interpreted to mean a load transitionable between physical states, i.e. between a gas and a liquid state or between a closed and an open state, which is also not supported by the description.

3.8 To overcome the objections raised in above §3.5-3.7 and to avoid a non unity of invention, the subject matter of claim 18 should also be aligned with that of claim 1.