METHOD AND SYSTEM FOR HELICOPTER PORTABLE DRILLING

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ABSTRACT

There is provided a system for helicopter portable drilling comprising: a drill frame, a drill mast affixed a first end of the drill frame, a drill operatively coupled to the drill mast and operable using one of compressed air, pressurized hydraulic fluid and both compressed air and pressurized hydraulic fluid and a unified power source for providing compressed air and pressurized hydraulic fluid coupled to the drill, the total operating weight of the system being approximately 3000 pounds for allowing a single-pick move by a helicopter. A method of seismic line drilling comprising the steps of placing a first single-pick drilling system at a first location with a single pick, placing a second single-pick drilling system at a second location with a single pick, when finished drilling, moving the first single-pick drilling system to a third location with a single pick, when finished drilling, moving the second single-pick drilling system to a fourth location with a single pick.
METHOD AND SYSTEM FOR HELICOPTER PORTABLE DRILLING

FIELD OF THE INVENTION

[0001] The present invention relates to methods and systems for drilling and is particularly concerned with a helicopter portable drilling.

BACKGROUND OF THE INVENTION

[0002] Referring to FIG. 1 there is illustrated a known tracked drilling rig. The rig consists of a tracked vehicle 10 fitted with a drill 12, a hydraulic system 14 for operating the drill and a compressor 16 for providing pressurized air for cleaning the hole being drilled. The tracked vehicle 10 is used on road accessible land, which has terrain that allows unrestricted movement of such vehicles.

[0003] For areas that are inaccessible or where environmental impact is of concern, it is also known to use helicopter portable drilling systems. These drills are referred to as helicopter drills. The method of using them is called heli-drilling. The earliest examples of helicopter drills included three components: a drill, a compressor and a supplies basket, which must be separated due to weight limitations of various helicopters.

[0004] Referring to FIG. 2 there is illustrated a known drill from a three pick drilling system. Typically the drills are hydraulically operated and have either a gasoline or diesel motor for powering the hydraulic pump. These pumps are used to operate the various hydraulic components of the drill. The drill in FIG. 2 is from a two pick system but is atypical to a 3 pick.

[0005] The second component is the compressor system an example of which is shown in FIG. 3. The compressor has a diesel or gasoline engine that is used to operate a high-volume air compressor. A hose is used to connect the compressor to the drill. The air is used to operate an air hammer, which is down the hole. Once the air has left the hammer, it cleans out the drill hole by forcing the drill cuttings to the surface. Depending on the drilling conditions, the driller may choose to drill with an auger style bit rather than an air hammer. In this case the air is only used to clean out the hole.

[0006] The third pick typically contains drill stem, an explosive magazine, a cap magazine, drill mud, and any other supplies that the driller deems necessary (not shown in the figures).

[0007] As technology continued to improve all of the components that were typically in the third basket where moved to the drill and compressor picks. This was primarily due to improved helicopter performance. Reducing the number of picks required not only reduces the time that the helicopter spends in a dangerous hover condition, it also significantly reduces costs due to less equipment being moved by the helicopter.

[0008] A complete drill crew generally consists of six drills, six compressors and various accessory baskets. There are several reasons that the crew consists of six units. The first is that each drill has a driller and a driller’s helper for a total of 12 persons. The Bell 212, 210 and 205 series of helicopters are configured to have a pilot, co-pilot and thirteen passengers. Six drills also give the helicopter adequate work each day, while keeping the drills productive. It is referred to as a cycle every time all of the drills are moved. The logistics of each program varies. It is primarily dependent on terrain. A drill crew typically works on between one and three seismic lines.

[0009] Referring to FIG. 4 there is graphically illustrated a typical seismic program having about 9000 shots points to drill with helicopter drills.

[0010] Referring to FIG. 5 there is graphically illustrated a typical shot hole drilling sequence for a two-pick helicopter portable drilling system. Helicopter moves 20 drills from spot point A to next shot point to drill B. Then the helicopter returns 22 to A to pick up the compressor. The helicopter moves 24 the compressor to B. The helicopter then flies 26 to C to start the sequence again for a second drill, e.g. moving to shot point E-E is not on diagram but was meant to be included to show 3 drills working on a single line. Depending on the terrain, weather and drilling conditions there can be 2 to 6 drills working on a single line and multiple drill crews on a single program.

Industry Helicopters

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[0012] There are a number of dangers present with helicopter assisted drilling. The pilot and driller are both at risk when the drill is being picked or dropped. Every time the helicopter is in a hover position while working over the source point the pilot is working in what is referred to as the dead man’s curve. It is called this because if the helicopter has a mechanical failure, the height and altitude are not conducive to a safe landing, even on level ground. Typically not only is the ground uneven, but there are trees further endangering the pilot.

[0013] For the driller on the ground, it is equally dangerous, as they are working underneath a heavily loaded helicopter. Steep terrain, loose rocks and trees are also a hazard. The rotors wash from the helicopter is capable of knocking down trees and blowing off loose limbs. When placing drills and compressors in steep terrain, the helicopter may have to spend extra time to ensure the unit is secure. The risk for both the pilot and driller was significantly reduced twelve years ago when the two-pick system was developed Two pick drills were developed around 1995.

SUMMARY OF THE INVENTION

[0014] An object of the present invention is to provide method and system for helicopter portable drilling.

[0015] In accordance with an aspect of the present invention there is provided a system for helicopter portable drilling.
comprising: a drill frame, a drill mast affixed a first end of the drill frame, a drill operatively coupled to the drill mast and operable using one of compressed air, pressurized hydraulic fluid and both compressed air and pressurized hydraulic fluid and a unified power source for providing compressed air and pressurized hydraulic fluid coupled to the drill, the total operating weight of the system being approximately 3000 pounds for allowing a single-pick move by a helicopter.

[0016] In accordance with another aspect of the present invention there is provided a method of seismic line drilling comprising the steps of placing a first single-pick drilling system at a first location with a single pick, placing a second single-pick drilling system at a second location with a single pick, when finished drilling, moving the first single-pick drilling system to a third location with a single pick, when finished drilling, moving the second single-pick drilling system to a fourth location with a single pick. Once again depending on terrain, weather and drilling conditions there can be two to six drills working on a single line and multiple drill crews on a single program. The entire methodology of drilling will likely change due to the reduced number of picks. A crew will likely consist of between 9 and 12 drills instead of the traditional six.

[0017] In accordance with a further aspect of the present invention there is provided a method of seismic line drilling comprising the steps of placing a first drill carrier at a first location with a single pick, placing a first single-pick drilling system on the carrier at the first location with a single pick, when finished drilling, moving the first single-pick drilling system to a second location using the carrier and when meeting an obstacle between drilling locations, moving the first single-pick drilling system to a third location with a single pick, moving the first drill carrier at the third location with a single pick and placing the first single-pick drilling system on the carrier at the third location.

[0018] In an embodiment of the present invention there is a drill carrier for moving the drilling system between locations when the terrain permits.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0019] The present invention will be further understood from the following detailed description with reference to the drawings in which:

[0020] FIG. 1 illustrates a known tracked vehicle with drill holes;

[0021] FIG. 2 illustrates a drill for a known two-pick helicopter portable drilling method

[0022] FIG. 3 illustrates a compressor assembly for a known two pick helicopter portable

[0023] FIG. 4 graphically illustrates a typical seismic program having about 9000 shot points to drill with heli-portable drills;

[0024] FIG. 5 graphically illustrates a typical shot hole drilling sequence for a two-pick heli-portable drilling system;

[0025] FIG. 6 illustrates in a right side view a single pick drilling system in accordance with an embodiment of the present invention;

[0026] FIG. 7 illustrates in a right front perspective view the single-pick system of FIG. 6;

[0027] FIG. 8 illustrates in a left side view the embodiment of FIG. 6;

[0028] FIG. 9 illustrates in a perspective view a combined turbine, hydraulic pump and compressor for the embodiment of FIG. 6;

[0029] FIG. 10 graphically illustrates a method of heli-drilling in accordance with another embodiment of the present invention;

[0030] FIG. 11 illustrates a tracked carrier for use with the one-pick drilling system of FIG. 6 in accordance with a further embodiment of the present invention;

[0031] FIG. 12 illustrates in the single pick drilling system of FIG. 6 carried on the tracked carrier of FIG. 11 in accordance with another embodiment of the present invention;

[0032] FIG. 13 graphically illustrates a method of heli-drilling in accordance with another embodiment of the present invention;

[0033] FIG. 14 illustrates in a right side perspective a single pick drilling system in accordance with a further embodiment of the present invention;

[0034] FIG. 15 illustrates in a right front upper perspective view the single-pick system of FIG. 14;

[0035] FIG. 16 illustrates in a front perspective of the embodiment of FIG. 14;

[0036] FIG. 17 illustrates in a right side perspective view of the embodiment of FIG. 14;

[0037] FIG. 18 illustrates in a rear perspective of the embodiment of FIG. 14;

[0038] FIG. 19 illustrates in a top perspective of the embodiment of FIG. 14;

[0039] FIG. 20 illustrates in a left side perspective view of the embodiment of FIG. 14;

[0040] FIG. 21 illustrates in a right side perspective view a combined turbine, primary gearbox, secondary gearbox, hydraulic pump and compressor for the embodiment of FIG. 14;

[0041] FIG. 22 illustrates in an upper right perspective view a combined turbine, primary gearbox, secondary gearbox, hydraulic pump and compressor for the embodiment of FIG. 14;

[0042] FIG. 23 illustrates in a right side view a combined turbine, primary gearbox, secondary gearbox, hydraulic pump and compressor for the embodiment of FIG. 14;

[0043] FIG. 24 illustrates in a top plan view a combined turbine, primary gearbox, secondary gearbox, hydraulic pump and compressor for the embodiment of FIG. 14;

[0044] FIG. 25 illustrates in a left side view a combined turbine, primary gearbox, secondary gearbox, hydraulic pump and compressor for the embodiment of FIG. 14; and

[0045] FIG. 26 illustrates in a bottom plan view a combined turbine, primary gearbox, secondary gearbox, hydraulic pump and compressor for the embodiment of FIG. 14.

**DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

[0046] Referring to FIG. 6 there is illustrated in a right side view a single pick drilling system in accordance with an embodiment of the present invention. The single-pick drilling system 100 includes a drill frame 102, a drill mast 104, a combined power source, compressor and hydraulic pump 106. The single-pick drilling system 100 also includes a fuel tank 108, hydraulic tank 110 (not seen in drawing 100), a detonator magazine 112, an explosives magazine 114, loading poles 116, drill stems 118 and air and oil separator 120. The drill frame 102 stands on four adjustable legs 122.

[0047] Referring to FIG. 7 there is illustrated in a right side perspective view the single-pick system of FIG. 6. FIG. 7
shows the driller's station 124 with hydraulic and pneumatic controls. Hydraulic tank 110 is in bottom right corner under drill stem 118.

[0048] Referring to FIG. 8 there is illustrated in a left side view the embodiment of FIG. 6. FIG. 8 shows the detonator magazine 112, the explosives magazine 114 loading poles 116 and the drill stem, all visible from the left side. Hydraulic tank 110 is under drill stem.

[0049] Referring to FIG. 9 there is illustrated in a perspective view a combined motor turbine, hydraulic pumps (multiple pumps may be used, piggybacked together in some configurations) and compressor for the embodiment of FIG. 6. The gas turbine 130 drives the hydraulic pump 132 and compressor 134 through primary and secondary reductions gears 136. The combined clutch and gearbox assembly allow all of the components from a two pick system to be combined into a single unit. This configuration is still able to utilize the same helicopters in use with the two pick heli-drills.

[0050] An exemplary implementation of the single-pick system follow:

Key Components


[0052] a. The primary reduction gearbox will reduce the turbine output RPM from approximately 60,000 RPM to one of the following 6000 RPM, 6480 RPM or 8640 RPM depending on the configuration required.

2. Custom Gearbox, which consists of the following:

[0051] b. Manually engaged clutch (now configured as dual hydraulically engaged independent clutches)

[0054] i. Emergency stop which disconnects both clutches and shuts down turbine.

[0055] b. Secondary reduction gearing that will reduce the primary reduction gearbox RPM to between 2500 and 2800 RPM depending on the configuration requirements. Gearbox configured with one output shaft between 6000 and 6480 RPM and a second output between 2500 and 2800 RPM. Both clutches can be engaged/disengaged independently. Although the initial prototype will have a secondary gearbox I am ultimately working towards a single gearbox to further eliminate weight.

[0056] c. The secondary reduction gearbox will have dual output shafts. The primary shaft will be used for the compressor 6480-6000 RPM (manufacture and model may vary depending on program conditions), while the secondary shaft will be for operating the hydraulic pump 2500-2800 RPM (manufacture and model may vary depending on program conditions)

3. Helicopter portable tracked carrier for the heli-drill. This unit can be configured to either ride on or walk behind with remote controls.

[0057] The turbine and gearboxes are all housed in a protective box to reduce the likely hood of damage. The enclosure is also designed as a protective housing in case of mechanical failure (protect personnel and explosives from flying debris). The enclosure will also house an air filter system for the gas turbine.

[0058] The exhaust system will have at least one cold air intake to reduce exhaust gas temperatures. The exhaust pipe diameter will also be increased in diameter to reduce the pressure of exhaust gases.

[0059] The remaining drill components vary depending on end user and the specific requirements that they have. The following may also be available to further reduce the overall mass of the drill.

1. Composite drill must
2. Composite drill frame
3. Low mass air/oil separator
4. Low mass fuel tank
5. Low mass hydraulic tank

[0060] The complete drill configuration may include:

Drill Configuration

[0061] The drill has everything that is currently on the two separate drill components. Here is a list that includes the majority of items required. The items on the drill are not limited to this list; this is a basic configuration of the key elements

1. Compressor, air oil separator and compressor oil cooler
2. Detonator magazine
3. Drill frame and must
4. Drill stem (both auger and smooth—as per drillers requirements)

5. Drillers mud

[0062] 6. Drillers station (with hydraulic and air controls)
7. Emergency shutdown system
8. Explosive magazine
9. Fuel tank
10. Hydraulic tank and hydraulic oil cooler
11. Power source for compressor and hydraulic systems (turbine and gearbox)
12. Required hydraulic pumps and motors for the drill (as per end user requirements)
13. Rotary pull down (either a hydraulic cylinder or hydraulic motor)

14. Tool box

[0063] 15. Water pump

Carrier Configuration

[0064] The carrier is a self-propelled track carrier that is capable of hauling the single pick drill. On occasion it may be impractical to utilize the carrier due to the nature of terrain that the drills work in. The driller and drill coordinator will decide on which areas the carrier is used in.

[0065] Referring to FIG. 10 there is graphically illustrated a method of heli-drilling in accordance with another embodiment of the present invention. FIG. 10 illustrates one of many possible variations with a single-pick drill. With the system of FIG. 6, only a single trip is required to move the drill between shot holes, FIG. 10 shows how three single-pick drills 200, 202, and 204 could be moved. A helicopter moves 206 drill 200 from completed shot point A to drill next shot point B. The helicopter then flies 208 from B to move the next drill 202 from completed shot point C to next shot point D to be drilled 210. The helicopter then flies 212 from D to move the next drill 204 from complete shot point E.

[0066] Referring to FIG. 11 there is illustrated a tracked carrier for use with the one-pick drilling system of FIG. 6 in accordance with a further embodiment of the present invention. The tracked carrier 220 includes a platform 222 for receiving the single-pick drill system of FIG. 6 and a bulkhead 224. The tracked carrier of FIG. 11 has tracks 226 for
moving across a variety of terrains and includes optionally includes an operator’s position 230 with a seat 232, controls 234 and rollover protection system (ROPS) 236. Another configuration of tracked carrier 220 dispenses with operator position 230 and instead uses a remote control so that the operator can walk a safe distance from the tracked carrier. The heli-carrier will eliminate the need for the helicopter from shot point to shot point when the terrain allows. The heli-carrier is a lightweight self-propelled track carrier that is configured to move off the ground to a shot point with a heli-drill. Once the carrier and drill are on-site it is able to haul the drill to the next point.

[0067] Referring to FIG. 12 there is illustrated the one-pick drilling system of FIG. 6 carried on the tracked carrier of FIG. 11 in accordance with a further embodiment of the present invention. FIG. 12 shows the single-pick drill system of FIG. 6 placed on the tracked carrier 220 of FIG. 11.

[0068] Referring to FIG. 13 there is graphically illustrated a method of heli-drilling in accordance with another embodiment of the present invention. A drill 250 on a carrier 252 has completed drilling at shot position A. A helicopter moves 254 the drill to shot point B. The helicopter flies back 256 to shot point A to retrieve the carrier 252. The helicopter moves 258 the carrier 252 to shot point B. After traversing the obstacle (in FIG. 13 a river), the drill and carrier combination are able to move 260 from shot point B to shot point C, to move 262 from shot point C to shot point D, to move 264 from shot point D to shot point E, when the terrain permits such movement. Once a further obstacle is encountered, the helicopter repeats the process as from shot point A to shot point B.

[0069] Referring to FIG. 14 there is illustrated in a right side perspective a single pick drilling system in accordance with a further embodiment of the present invention. The single-pick drilling system 300 includes a drill frame 302, a drill mast 304, a combined power source, compressor and hydraulic pump 306. The single-pick drilling system 300 also includes a fuel tank 308, hydraulic tank 310 (310 not seen in drawing), a detonator magazine 312, an explosives magazine 314, drill stems 316 and air and oil separator 320.

[0070] Referring to FIG. 15 there is illustrated in a right front upper perspective view the single-pick system of FIG. 14. The hydraulic tank 310 can be seen in FIG. 15.

[0071] Referring to FIG. 16 there is illustrated in a front perspective view the embodiment of FIG. 14. The drill mast 304, fuel tank 308, the hydraulic tank 310 and Drill stems 316 can be seen in FIG. 16.

[0072] Referring to FIG. 17 there is illustrated in a right side perspective view of the embodiment of FIG. 14.

[0073] Referring to FIG. 18 there is illustrated in a rear perspective of the embodiment of FIG. 14.

[0074] Referring to FIG. 19 there is illustrated in a top perspective of the embodiment of FIG. 14.

[0075] Referring to FIG. 20 there is illustrated in a left side perspective view of the embodiment of FIG. 14. FIG. 20 shows the detonator magazine 312, the explosives magazine 314, and the drill stem 316, all visible from the left side.

[0076] Referring to FIG. 21 there is illustrated in a right side perspective view a combined turbine, hydraulic pump and compressor for the embodiment of FIG. 14. The gas turbine 330 drives the hydraulic pump 332 (cannot be seen in FIG. 21) and compressor 334 through primary and secondary reductions gears 336. The combined clutch and gearbox assembly allow all of the components from a two pick system to be combined into a single unit. This configuration is still able to utilize the same helicopters in use with the two pick heli-drills.

[0077] Referring to FIG. 22 there is illustrated in an upper right perspective view a combined turbine, hydraulic pump and compressor for the embodiment of FIG. 14. The hydraulic pump 332 can be seen in this view.

[0078] Referring to FIG. 23 there is illustrated in a right side view a combined turbine, hydraulic pump and compressor for the embodiment of FIG. 14.

[0079] Referring to FIG. 24 there is illustrated in a top plan view a combined turbine, hydraulic pump and compressor for the embodiment of FIG. 14.

[0080] Referring to FIG. 25 there is illustrated in a left side view a combined turbine, hydraulic pump and compressor for the embodiment of FIG. 14.

[0081] Referring to FIG. 26 there is illustrated in a bottom plan view a combined turbine, hydraulic pump and compressor for the embodiment of FIG. 14.

[0082] Numerous modifications, variations and adaptations may be made to the particular embodiments described above without departing from the scope patent disclosure, which is defined in the claims.

What is claimed is:

1. A system for helicopter portable drilling comprising:
   a drill frame;
   a drill mast affixed a first end of the drill frame;
   a drill operatively coupled to the drill mast and operable using one of compressed air, pressurized hydraulic fluid and both compressed air and pressurized hydraulic fluid; and
   a unified power source for providing compressed air and pressurized hydraulic fluid coupled to the drill;
   the total operating weight of the system being approximately 3000 pounds for allowing a single-pick move by a helicopter.

2. The system of claim 1 wherein the unified power source includes a gas turbine.

3. The system of claim 2 wherein the unified power source includes a first reduction gear coupled to the gas turbine.

4. The system of claim 3 wherein the unified power source includes a second reduction gear coupled to the first reduction gear.

5. The system of claim 4 wherein the unified power source includes a hydraulic pump coupled to the second reduction gear.

6. The system of claim 5 wherein the unified power source includes air compressor coupled to the second reduction gear.

7. A system for helicopter portable drilling comprising:
   a drill including a drill frame;
   a drill mast affixed a first end of the drill frame;
   a drill operatively coupled to the drill mast and operable using one of compressed air, pressurized hydraulic fluid and both compressed air and pressurized hydraulic fluid, and
   a unified power source for providing compressed air and pressurized hydraulic fluid coupled to the drill; and
   a drill carrier;
   the total operating weight of each of the drill and the drill carrier being approximately 3000 pounds.

8. The system of claim 7 wherein the unified power source includes a gas turbine.

9. The system of claim 8 wherein the unified power source includes a first reduction gear coupled to the gas turbine.
10. The system of claim 9 wherein the unified power source includes a second reduction gear coupled to the first reduction gear.

11. The system of claim 10 wherein the unified power source includes a hydraulic pump coupled to the second reduction gear.

12. The system of claim 11 wherein the unified power source includes an air compressor coupled to the second reduction gear.

13. The system of claim 7 wherein the drill carrier includes tracks.

14. The system of claim 7 wherein the drill carrier includes a driver position.

15. The system of claim 7 wherein the drill carrier includes a remote control.

16. A method of seismic line drilling comprising the steps of:
   placing a first single-pick drilling system at a first location with a single pick;
   placing a second single-pick drilling system at a second location with a single pick;
   when finished drilling, moving the first single-pick drilling system to a third location with a single pick; and
   when finished drilling, moving the second single-pick drilling system to a fourth location with a single pick.

17. The method of claim 16, further comprising the steps of:
   placing a third single-pick drilling system at a fifth location with a single pick; and
   when finished drilling, moving the third single-pick drilling system to a sixth location with a single pick.

18. A method of seismic line drilling comprising the steps of:
   placing a first drill carrier at a first location with a single pick;
   placing a first single-pick drilling system on the carrier at the first location with a single pick;
   when finished drilling, moving the first single-pick drilling system to a second location using the carrier; and
   when meeting an obstacle between drilling locations, moving the first single-pick drilling system to a third location with a single pick;
   moving the first drill carrier at the third location with a single pick and placing the first single-pick drilling system on the carrier at the third location.