

PATENT SPECIFICATION

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(54) PORTABLE DRILLING RIG COMPOUND

(71) We, DRESSER INDUSTRIES INC., a corporation organised and existing under the laws of the State of Delaware, United States of America, of the Dresser Building, Elm At Akard Streets, Dallas, Texas, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to well drilling equipment, and more particularly to a portable drilling rig compound.

In the production of hydrocarbons from underground formations located in Alaska, Canada, Peru, Indonesia, and any region where ground transportation is restricted or non-existent during all or part of the year, and in drilling for oil from offshore locations, and in remote jungle locations, it often becomes necessary to transport by air the materials and equipment needed to drill and explore for the oil.

Due to the cumbersome size and weight of the equipment comprising the average drilling rig, much of the rig must be tediously disassembled piece-by-piece and flown in by large air transport. This normally required disassembly of the heavy chain drive units, the final drive unit, and the drawworks for movement to the drilling site. This requires a timely and expensive reassembly at the site with a complicated realignment of the reassembled machinery. It often necessitates disassembly of each of the chain case assemblies which means draining of the oil and extensive protection to prevent contamination of the chains and sprockets with dirt, water, and other debris. Then the chain cases must be reassembled on site, often a task near impossible in sub-zero blizzard conditions or during heavy storms at sea.

Even though the art has progressed enough to place many individual components each on their own portable skid, these must be moved by ship to offshore locations or by large air transport to northern regions because of their weight.

When weather conditions or lack of roads and airfields present the use of ships or air-

planes, the driller must resort to helicopter transportation of the rigs which requires that each of the usual skid packages must be broken down even further due to the relative light carrying capacity of the helicopters available. This cancels the portability advantage of the normal skid units since reassembly of their components requires almost as much time as that of the older rigs did.

According to one aspect of the present invention there is provided a portable drilling rig compound comprising a plurality of prime movers arrangable in a plurality of sets of substantially parallel units; a skid unit for each said prime mover, with said skid unit having the requisite cooling, fuel, and power transmission means thereon for said prime mover; said prime movers being connectable to and disconnectable from each said skid unit, and said prime movers and said skid units each being a portable package; and a plurality of power transfer systems, each interconnectable with at least two of said power transmission means to receive power from said at least two power transmission means and transmit it through a power output shaft whereby said power transfer systems transfer power from said plurality of prime movers to a single output station, said power transfer systems being portable self-contained units having power input means, power output means, and power transfer means between said input and output means.

According to another aspect of the present invention there is provided a portable drilling rig compound having integral sub-components each transportable by helicopter as an integral self-contained unit, said compound comprising: six prime movers arranged in two groups, each said prime mover being fully portable; six portable skid units each adapted to receive one of said prime movers in disconnectable relationship, and further having power transmission means thereon for transmitting power from said prime mover; and, four power transfer assemblies inter-connected with said six prime mover transmitting means and arranged to transfer power

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from all six prime movers to a final output station, each said assembly being an integral, sealed, fully portable unit disconnectable from said prime mover transmitting means.

According to a further aspect of the present invention there is provided a portable drilling rig compound comprised of disconnectable subcomponents, each transportable by helicopter as an integral self-contained unit, said compound comprising: a plurality of prime movers arranged in close, substantially parallel relationship; a plurality of skid units each adapted to receive one of said prime movers in disengagible connection therewith; transmission means on each of said skid units adapted to be connected with said prime movers and to transmit power from said prime movers; and, a plurality of power transfer systems each interconnected with said prime movers and arranged to transmit power from all of said prime movers to a single output station, each said power transfer system being an integral, sealed, fully portable unit having power input means, power transfer means, and power output means.

The invention will be better understood from the following description of preferred embodiments thereof, given by way of example only, reference being had to the accompanying drawings, wherein:

Figure 1 is a plan view of a drilling rig layout;

Figure 2 is a side view of a main drum assembly;

Figure 3 is an end view of the main drum assembly of Figure 2, a catworks drive assembly, and a portion of a power drive assembly;

Figure 4 is an axial end view of a main brake assembly;

Figure 5 is a front view of a main brake equalizing linkage;

Figure 6 is a cross-sectional view of a main drum brake assembly; and

Figure 7 is a partially cut-away view of an alignment mechanism.

The drilling rig shown in the drawings comprises component packages each of which is an integral unit transportable by helicopter to the drilling site and easily re-assimilated into a drilling rig of almost any capacity desirable. The number of prime movers may be increased or decreased without changing the portability of the unit.

Figure 1 illustrates the structure and layout of a compound 10 and the drawworks and the components making up these assemblies. In the figure, a compound is shown utilizing six internal combustion engines for power, arranged in a compact arrangement particularly suited for offshore rigs and mountainous areas or any place where space is at a premium.

In the compound 10, half of the engines

(11, 12, and 13) are aligned adjacent to each other and the other half of the engines (14, 15, and 16) lie adjacent to each other opposite engines 11, 12, and 13. As pictured, the engines will provide rotary power through transmissions attached thereto, with the transmissions 11a, 12a, and 13a engaged in forward speeds while the transmissions 14a, 15a and 16a are engaged in reverse. Since all the engines rotate in the same direction initially, by having half of them opposed to the other half, three of the transmissions must run in reverse to obtain all final rotation in the same direction.

Engines 11 and 12, working through their transmissions, drive propeller shafts 11b and 12b which, acting through disconnectable couplings 11c and 12c, turn sprocket shafts 11d and 12d. The sprocket shafts are permanently mounted in bearings 17, 19 which in turn are secured in the parallel side walls of the chain case 18. The sprocket shafts 11d and 12d extend laterally through the chain case 18 between the bearings. Each of the shafts 11d and 12d carry chain drive sprockets 20 and 21 thereon inside the chain case 18. The chain drive sprockets 20 on shaft 11d are drivably connected to the sprockets 21 on shaft 12d by roller drive chains 22.

Sprocket shaft 11d has keyed thereon a power take-off in the form of a multiple V-belt drive pulley or sheaves 23 for driving V-belts to auxiliary power driven equipment, for example mudpumps, elsewhere on the rig (not shown). A clutch 24 is located at the end of the shaft 11d to engage and disengage the mudpumps from shaft 11d.

Shaft 12d extends through a chain case bearing 19 and carries at its end a disconnectable coupling 25 also connected to an intermediate propeller shaft 26 which in turn is attached to a disconnectable clutch 27.

The location, assembly and operation of engines 14 and 15, and chain case 28 is an identical mirror image of that of engines 11 and 12 except for the direction of rotation which is reversed in transmissions 14a and 15a to correspond to the rotational direction of engines 11 and 12. A similar power take-off assembly 29 is also driven from engine 14. Likewise, chain case 28 drives through an intermediate shaft 30 and clutch 31 to work with shaft 26 and drive a sprocket shaft 32 extending through chain case 33 in side wall bearings 34 similar to bearings 17 and 19.

Thus, it can be seen that, other than the power take-off to the mudpumps through sheaves 23 and 29, the combined power output of engines 11, 12, 14, and 15 ends up driving sprocket shaft 32 in chain case 33. This in turn drives a sprocket shaft 35 in chain case 33 which shaft is also driven by engine 13 through transmission 13a and 130

propeller shaft 36. At the opposite end of sprocket shaft 35, which shaft turns in bearings 37 secured in the parallel side walls of case 33, is connected an intermediate propeller shaft 38 coupled to another sprocket shaft 39 which is held by bearings 40 in an input chain case 41. The power from engines 11 to 15 is coupled through a propeller shaft 42 with the power of engine 16 and transmitted from sprocket shaft 39 via roller chains in the input case 41 to an input drive shaft 43 passing through the parallel side walls of case 41 in bearings 44.

The total power flow from all of the prime movers 11 to 16, except that which is provided through the power take-off to the mudpumps, is routed to the input shaft 43 in chain case 41 from whence it moves through a split transmission into a drum drive case 45 to power main drum assembly 46.

The split transmission comprises a high speed transmission 47 driven off one end of shaft 43 and a low speed transmission 48 driven off of the opposite end of shaft 43. The two transmissions 47 and 48 operating through clutches 49 and 50, respectively, are connected to drum drive shaft 51 which is connected via roller chains in case 45 to main drive shaft 52, shown in phantom in Figure 1.

Main drive shaft 52 is coupled through coupling 53 to auxiliary brake shaft 54 containing auxiliary brake 55. The opposite end of main shaft 52 is coupled via coupling 56 to drum shaft 57. Main shaft 52 is supported in bearings secured to parallel side walls of case 45 just as is drum drive shaft 51. The high speed transmission 47 also drives through auxiliary shaft 58 a catworks drive assembly 59 having a right angle gear box 60 connected by propeller shaft 61 to the catworks, usually located above the drawworks.

The main drum assembly 46 has a main drawworks drum 62, a drum housing 63, a main drum brake assembly 64, (shown in phantom in Figure 1) and may have an optional auxiliary brake assembly 65.

In operation, the prime-mover power accumulates in chain case 41 and is routed either through the high speed transmission 47 and clutch 49 or the low speed transmission 48 and clutch 50 to the drum drive case 45. There the power is transferred to main shaft 52 which in turn is connected to auxiliary brake assembly 55 and to the drum drive shaft 57 which turns the main drawworks drum 62. Rotation of the drum can be controlled by the various clutches in the above described system as well as by the main drum brake 64 and auxiliary brakes 55 and 65.

The catworks is driven through the high speed transmission input shaft 47a in case

47. Figures 2 and 3 illustrate ground level views of the main drum assembly and the catworks drive assembly, respectively.

Figure 4 illustrates an axial end view of the main brake assembly 64 inside the drum housing 63 and operating on the main drum shaft 57.

The main brake assembly (Figs. 4 and 6) comprises a central hub 66 on shaft 57 securedly attached thereto, a radial web 67 integrally formed on the outer perimeter of hub 66, and a brake drum 69 attached peripherally to web 67 by means of a radially inward projecting flange 68 connected to web 67 by means of fasteners 70 or by other means such as welding. The brake shoe comprises a plurality of arcuate brake pads 71 of suitable material such as asbestos aligned in a double row peripherally around the drum 69 and contactable therewith. Arcuate brake bands 72 and 73 pass around each row of the brake pads 71 in order to clamp the pads against the drum when braking is desirable. The pads preferably are bonded or riveted to the inside surface of the brake bands. A suitable linkage 74 is attached to bands 72 and 73 to allow tightening of the bands at the operator's command.

Adjustable turnbolts 75, 76, and 77 (Fig. 5) and links 78 and 79 serve to equalize the amount of braking attained from the two brake pad assemblies. Also, the brake assembly is designed so that with the normal counterclockwise rotation of the drum the brakes are self-energizing, meaning that the brakes utilize the rotation of the drum to add increasing pressure to the brake pads against the drum. This cuts down greatly the amount of force required from the operator working the brake controls.

Rollers 80 and threaded rods 81 attached to the drum housing supply support and alignment to the brake pad assemblies particularly while the brakes are not in use.

When the drilling rig is to be moved to the drilling site by helicopter, the entire rig is quickly broken down into integral components each below the maximum weight transportable by helicopter. Reinstalling the rig on site requires no complicated reassembly or adjustment. The rig is designed so that all the components are placed easily and quickly back into alignment and in operable condition almost instantaneously with setting them down on the rig floor.

Referring to Figure 7, a detailed close-up of apparatus for alignment of the chain cases is disclosed. Each chain case is a separable, integral unit in itself and can be moved by helicopter from one site to another without disturbing the alignment of the chains or chain sprockets, without having to drain the lubricant therefrom, and without exposing the workings therein to contaminants or the environment.

Each chain case preferably has a plurality of "ears" 82 extending outward from several locations on the lowermost edges of the case, consisting of flat plates or angle iron.

5 Likewise, the skid or platform receiving or supporting each chain case has a corresponding "fence" 83 or rail attached thereto sized and located to receive the "ears" of the chain cases. Each fence may comprise a rectangular or other shaped receptacle having 10 vertically extending sides and enclosing all of the exposed sides of the "ears" on the chain cases. The fences are preferably of the same general shape and slightly larger than the ears of the chain cases. Different 15 chain cases could have different sized or shaped ears with matching fences to differentiate from the other units and ensure the same location for each unit respective to the others when moving from one site to the 20 next.

Each chain case generally has two sprocket shafts passing transversely therethrough, generally in parallel alignment, each being 25 journaled in sidewall bearings in each side of the case and each carrying chain sprockets. A plurality of chains transfer power between the two sprockets carried by the shafts in each case. The cases themselves are self-contained and fluid tight and the sidewall 30 bearings and sprocket shafts passing there-through are fluid tight in the case walls.

When the rib is being transported, the lift cable from the helicopter is usually hooked 35 or tied in an eyebolt or similar attachment secured to the top of each case after the couplings or clutches at each end of the sprocket shafts have been disconnected. Then the case can be lifted straight up and transported to the new site intact, whereupon it is 40 set down in its proper place with the case ears sliding into the guide fences and the unit is ready for use upon reconnection of the various propeller shafts to the sprocket 45 shafts. The above operation applies generally to all of the chain cases 18, 28, 33, 41, and 45 as well as to the transmissions 47 and 48.

The individual engines 11-16 are provided with eyebolts or other hook receptacle 50 means and are helicopter transportable independently of their transmissions, radiators, and skids. Each engine is unbolted from the skid and transmission and disconnected from 55 fuel lines and coolant lines and picked up by the helicopter. The skid, transmission, and fuel and coolant systems for each engine then travel as a single unit by helicopter.

The particular arrangement of engines 60 allows the maximum number of engines with the minimum amount of space and the minimum number of power transference units such as chain drives and pulley drives. This compact layout allows for greater use of the 65 limited amount of room on offshore rigs and

the shortest exposure time to operating and maintenance personnel in northern regions.

In addition to the compact design of the compound further advantage is obtained 70 from the layout and design of the drawworks drive system and of the main drum assembly.

In the drawworks drive system a split-transmission arrangement to receive the accumulated prime mover force and transmit 75 it to the drawworks utilizes two compact transportable transmissions as opposed to the old signal unit two-speed transmission system. The single unit, two-speed transmission is entirely too heavy and cumbersome to be transported by helicopter, whereas 80 each of the transmissions of this system are compact and light enough to be moved by helicopter. The split transmission includes a high speed unit and a low speed unit, each 85 with its own clutch control into the drum drive case.

A power take-off from the high speed transmission also powers the catworks via a propeller shaft and right angle gear box. 90 Since the high speed transmission has a clutch between it and the drum drive, the catworks may be driven whether or not the drum drive is being driven by the high speed or the low speed transmission. 95

The main drum assembly allows quick, clean disassembly of the brake system from the main drum without disturbing the adjustment or assembly of the individual brake 100 parts. The entire braking system is removed from the main drum assembly intact and as a system rather than in pieces. This is possible because of the design of the main drum which places both brake pad assemblies at one end of the drum rather than 105 having one brake pad assembly at each end of the drum as the prior devices have.

Also, the design of the brake system with the brake bands, pads, linkage and brake drum all remaining in one package, completely assembled but separable from the 110 main drawworks drum, means that the brake assembly can be moved by helicopter separate from the main drum and later quickly reunited therewith. This also lightens the 115 main drum to the point that it can be similarly transported.

The auxiliary brakes preferably are both hydraulic retarding mechanisms used to partially brake the drum drive. Each is 120 separately helicopter transportable.

Although a specific preferred embodiment of the present invention has been described in the detailed description above, the description is not intended to limit the invention 125 to the particular forms of embodiments disclosed therein since they are to be recognized as illustrative rather than restrictive and it will be obvious to those skilled in the art that the invention is not so limited. For 130

instance, the prime movers may be of internal combustion type as shown or some other type such as electric powered or turbines. Also the number of such engines could be more or less than that shown. Furthermore, in some instances belt drives could be used in place of the chain drives, and vice versa. Also the catworks could be driven by belt drive or chain drive or could be electrically operated, rather than gear and propeller shaft driven.

Matter disclosed in this specification is disclosed and claimed in the Complete Specifications of Applications 33917/75 (Serial No. 1,522,983) and 34308/75 (Serial No. 1,522,984).

WHAT WE CLAIM IS:—

1. A portable drilling rig compound comprising a plurality of prime movers arrangeable in a plurality of sets of substantially parallel units; a skid unit for each said prime mover, with said skid unit having the requisite cooling, fuel, and power transmission means thereon for said prime mover; said prime movers being connectable to and disconnectable from each said skid unit, and said prime movers and said skid units each being a portable package; and a plurality of power transfer systems, each interconnectable with at least two of said power transmission means to receive power from said at least two power transmission means and transmit it through a power output shaft whereby said power transfer systems transfer power from said plurality of prime movers to a single output station, said power transfer systems being portable self-contained units having power input means, power output means, and power transfer means between said input and output means.

The rig compound of claim 1 wherein said prime movers number six and said power transfer systems number four.

3. The rig compound of claim 1 or claim 2 wherein said prime movers comprise internal combustion engines in two opposed groups of three parallel engines each.

4. The rig compound of any preceding claim comprising a power take-off system from at least one of said power transfer systems, arranged to power at least one auxiliary pump.

5. The rig compound of any preceding claim wherein said power transfer systems each comprise an input shaft and an output shaft in parallel relationship, passing transversely through the walls of a housing case and rotatably and sealingly engaged in said walls, with power transfer means engaging said shafts; each said power transfer system being a self contained, fully portable unit.

6. The rig compound of claim 5 wherein said case is completely sealed and fluid tight, and contains lubricant therein; said input

and output shafts each have a plurality of chain sprockets attached thereto; and said power transfer means comprises a plurality of closed-loop chains engaging sprockets on both of said shafts.

7. The rig compound of claim 5 or claim 6 wherein each said case further comprises alignment means thereon including at least one laterally projecting ear at the lower edge of said case, and at least one alignment fence matching said alignment ear and adapted to be attached to the well platform to receive said ear in aligning engagement therein.

8. The rig compound of any preceding claim further comprising at least one releasable clutch means coactably engaged between at least two of said power transfer systems.

9. A portable drilling rig compound having integral sub-components each transportable by helicopter as an integral self-contained unit, said compound comprising:

six prime movers arranged in two groups, each said prime mover being fully portable;

six portable skid units each adapted to receive one of said prime movers in disconnectable relationship, and further having power transmission means thereon for transmitting power from said prime mover; and,

four power transfer assemblies interconnected with said six prime mover transmitting means and arranged to transfer power from all six prime movers to a final output station, each said assembly being an integral, sealed, fully portable unit disconnectable from said prime mover transmitting means.

10. The portable drilling rig compound of claim 9 wherein said prime movers comprise internal combustion engines, said two groups are in opposed relationship with each other and each contains three engines, and said power transfer assemblies each comprise a fluidically sealed case, two parallel rotatable shafts passing transversely through the case and fluidically sealed therewith, sprocket means on said shafts, and chain drive means in said case engaged with said sprocket means on said shafts.

11. The portable drilling rig compound of claim 10 wherein said cases each have alignment means attached thereto and eye means formed on the top thereof for receiving a transfer cable.

12. A portable drilling rig compound comprised of disconnectable subcomponents, each transportable by helicopter as an integral self-contained unit, said compound comprising:

a plurality of prime movers arranged in close, substantially parallel relationship;

a plurality of skid units each adapted to receive one of said prime movers in disconnectable connection therewith;

transmission means on each of said skid units adapted to be connected with said

instance, the prime movers may be of internal combustion type as shown or some other type such as electric powered or turbines. Also the number of such engines could be more or less than that shown. Furthermore, in some instances belt drives could be used in place of the chain drives, and vice versa. Also the catworks could be driven by belt drive or chain drive or could be electrically operated, rather than gear and propeller shaft driven.

Matter disclosed in this specification is disclosed and claimed in the Complete Specifications of Applications 33917/75 (Serial No. 1,522,983) and 34308/75 (Serial No. 1,522,984).

WHAT WE CLAIM IS:—

1. A portable drilling rig compound comprising a plurality of prime movers arrangeable in a plurality of sets of substantially parallel units; a skid unit for each said prime mover, with said skid unit having the requisite cooling, fuel, and power transmission means thereon for said prime mover; said prime movers being connectable to and disconnectable from each said skid unit, and said prime movers and said skid units each being a portable package; and a plurality of power transfer systems, each interconnectable with at least two of said power transmission means to receive power from said at least two power transmission means and transmit it through a power output shaft whereby said power transfer systems transfer power from said plurality of prime movers to a single output station, said power transfer systems being portable self-contained units having power input means, power output means, and power transfer means between said input and output means.

The rig compound of claim 1 wherein said prime movers number six and said power transfer systems number four.

3. The rig compound of claim 1 or claim 2 wherein said prime movers comprise internal combustion engines in two opposed groups of three parallel engines each.

4. The rig compound of any preceding claim comprising a power take-off system from at least one of said power transfer systems, arranged to power at least one auxiliary pump.

5. The rig compound of any preceding claim wherein said power transfer systems each comprise an input shaft and an output shaft in parallel relationship, passing transversely through the walls of a housing case and rotatably and sealingly engaged in said walls, with power transfer means engaging said shafts; each said power transfer system being a self contained, fully portable unit.

6. The rig compound of claim 5 wherein said case is completely sealed and fluid tight, and contains lubricant therein; said input

and output shafts each have a plurality of chain sprockets attached thereto; and said power transfer means comprises a plurality of closed-loop chains engaging sprockets on both of said shafts.

7. The rig compound of claim 5 or claim 6 wherein each said case further comprises alignment means thereon including at least one laterally projecting ear at the lower edge of said case, and at least one alignment fence matching said alignment ear and adapted to be attached to the well platform to receive said ear in aligning engagement therein.

8. The rig compound of any preceding claim further comprising at least one releasable clutch means coactably engaged between at least two of said power transfer systems.

9. A portable drilling rig compound having integral sub-components each transportable by helicopter as an integral self-contained unit, said compound comprising:

six prime movers arranged in two groups, each said prime mover being fully portable; six portable skid units each adapted to receive one of said prime movers in disconnectable relationship, and further having power transmission means thereon for transmitting power from said prime mover; and,

four power transfer assemblies interconnected with said six prime mover transmitting means and arranged to transfer power from all six prime movers to a final output station, each said assembly being an integral, sealed, fully portable unit disconnectable from said prime mover transmitting means.

10. The portable drilling rig compound of claim 9 wherein said prime movers comprise internal combustion engines, said two groups are in opposed relationship with each other and each contains three engines, and said power transfer assemblies each comprise a fluidically sealed case, two parallel rotatable shafts passing transversely through the case and fluidically sealed therewith, sprocket means on said shafts, and chain drive means in said case engaged with said sprocket means on said shafts.

11. The portable drilling rig compound of claim 10 wherein said cases each have alignment means attached thereto and eye means formed on the top thereof for receiving a transfer cable.

12. A portable drilling rig compound comprised of disconnectable subcomponents, each transportable by helicopter as an integral self-contained unit, said compound comprising:

a plurality of prime movers arranged in close, substantially parallel relationship;

a plurality of skid units each adapted to receive one of said prime movers in disconnectable connection therewith;

transmission means on each of said skid units adapted to be connected with said



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prime movers and to transmit power from said prime movers; and,

5 a plurality of power transfer systems each interconnected with said prime movers and arranged to transmit power from all of said prime movers to a single output station, each said power transfer system being an integral, sealed, fully portable unit having power input means, power transfer means, and power output means.

10 13. The portable drilling rig compound of claim 12 wherein each power transfer system comprises:

15 an integral, fluidically sealed, chain case having parallel opposing side walls; an input shaft passing transversely through said side walls;

20 bearing means sealingly mounted in said side walls, receiving said input shaft in sealing, rotatable relationship;

an output shaft passing transversely

through said side walls generally parallel to said input shaft;

second bearing means sealingly mounted in said side walls, receiving said output shaft in sealing, rotatable relationship;

sprocket means on said input and output shafts;

a plurality of looped drive chains coactably engaging sprockets on said input and output shafts; and,

disconnectable couplings on at least one end of each of said shafts.

14. A portable drilling rig compound substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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