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(54) DRAWWORKS EQUIPMENT FOR WELL DRILLING RIGS

(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 drawworks equipment.

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 requires 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 subzero 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 extreme weight.

When weather conditions or lack of roads and airfields prevent the use of ships or airplanes, 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 relatively 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 main drawworks and drawworks drive assembly comprised of self-contained, fully portable sub-components adapted to receive power from an adjacent power system; said drawworks and drawworks drive assembly comprising: power input means connectable to the power system by disconnectable coupling means; transmission means connectable to said power input means and comprising a fully portable, self-contained high speed transmission assembly and a fully portable, self-contained low speed transmission assembly; a drum drive assembly to receive power from both said transmissions and being a fully portable self-contained unit having a power output station; clutch means for releasably connecting said two transmissions to said drum drive assembly; and, a main drawworks drum assembly attachable to said power output station by disconnectable couplings, and comprising a main drawworks drum and a main drum brake assembly; the main drawworks drum and main drum brake assembly being self-contained, portable sub-components of said drum assembly and releasably coupled to each other.

According to a further aspect of the present invention there is provided a drawworks main drum assembly arranged for disassembly into self-contained sub-components, each transportable by helicopter, said assembly comprising: a main drawworks drum arranged in rotatable relationship; a brake drum shaft means attached to said drum and extending past one end of said drum; a brake hub attached to said brake drum shaft means and rotatable therewith; a rotatable, generally cylindrical brake drum for coaxial alignment with said main drum and attachment to said hub by releasable connection means;

and brake means encircling said brake drum and arranged to be engaged therewith in rotation-retarding relationship; said brake means being removable from said assembly as a single unit with said brake drum.

The invention will be better understood from the following description of a preferred embodiment 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;

Figure 7 is a partially cut-away view of the alignment mechanism on the chain case assemblies.

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 difficulty and 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 the 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 per-

manently 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 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 slit transmission into a drum 130

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 disconnectable coupling 53 to auxiliary brake shaft 54 containing auxiliary brake 55. The opposite end of main shaft 52 is coupled via disconnectable 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 releasable couplings and 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 motive 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 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 (Figures 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 flat flange 68 connected to web 67 by means of releasable fasteners 70. The brake shoe comprises a plurality of arcuate brake pads 71 of suitable friction enhancing heat resistant 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.

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 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 chain cases could have different sized or shaped ears with matching fences to differentiate

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from the other units and ensure the same location for each unit respective to the others when moving from one site to the next.

5 Each chain case generally has two sprocket shafts passing transversely therethrough, generally in parallel alignment, each being journaled in sidewall bearings in each side of the case and each carrying chain sprockets.
10 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 bearings and sprocket shafts passing there-
15 through are fluid tight in the case walls.

When the rig is being transported, the lift cable from the helicopter is usually hooked or tied in an eyebolt or similar attachment secured to the top of each case
20 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 set down in its proper place
25 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 shafts. The above operation applies generally to all of the chain cases
30 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 means and are helicopter transportable in-
35 dependently of their transmissions, radiators, and skids. Each engine is unbolted from the skid and transmission and disconnected from fuel lines and coolant lines and picked up by the helicopter. The skid, transmission, and
40 fuel and coolant systems for each engine then travel as a single unit by helicopter.

The particular arrangement of engines allows the maximum number of engines with the minimum amount of space and the mini-
45 mum number of power transferrance units such as chain drives and pulley drives. This compact layout allows for greater use of the limited amount of room on offshore rigs and the shortest exposure time to operating
50 and maintenances personnel in northern regions.

In addition to the compact design of the compound further advantage is obtained from the layout and design of the draw-
55 works drive system and of the main drum assembly.

In the drawworks drive system a split-
60 transmission arrangement to receive the accumulated prime mover force and transmit it to the drawworks utilizes two compact transportable transmissions as opposed to the old single unit two-speed transmission system. The single unit, two-speed trans-
65 mission is entirely too heavy and cumbersome to be transported by helicopter, where-

as each of the transmissions of this system are compact and light enough to be moved by helicopter. The split transmission in-
70 cludes a high speed unit and a low speed unit, each 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. Since the high speed transmission has a
75 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.

The main drum assembly allows quick, clean dissembly of the brake system from the main drum without disturbing the adjust-
80 ment or assembly of the individual brake 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 assem-
85 blies at one end of the drum rather than having brake pad assemblies 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, com-
90 pletely assembled but separable from the main drawworks drum, means that the brake assembly can be moved by helicopter separate from the main drum and later quickly re-united therewith. This also lightens the main drum to the point that it can be similarly
95 transported.

The auxiliary brakes preferably are both hydraulic retarding mechanisms which apply damping-type braking forces to partially
100 brake the drum drive. Each is 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
110 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
115 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. Further-
120 more, 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
125 propeller shaft driven.

Matters disclosed in this specification is disclosed and claimed in the Complete Specifications of Applications 35389/75 (Serial No. 1,522,985) and 33917/75 (Serial No. 130

1,522,983), and in the Complete Specification of Application 2462/78 (Serial No. 1,522,986) which is divided out of this application.

5 WHAT WE CLAIM IS:—

1. A main drawworks and drawworks drive assembly comprised of self-contained, fully portable subcomponents adapted to receive power from an adjacent power system; said drawworks and drawworks drive assembly comprising:
 - power input means connectable to the power system by disconnectable coupling means;
 - transmission means connectable to said power input means and comprising a fully portable, self-contained high speed transmission assembly and a fully portable, self-contained low speed transmission assembly;
 - a drum drive assembly to receive power from both said transmissions and being a fully portable self-contained unit having a power output station;
 - clutch means for releasably connecting said two transmissions to said drum drive assembly; and,
 - a main drawworks drum assembly attachable to said power output station by disconnectable couplings, and comprising a main drawworks drum and a main drum brake assembly; the main drawworks drum and main drum brake assembly being self-contained, portable subcomponents of said drum assembly and being releasably coupled to each other.
2. The main drawworks and drawworks drive assembly of claim 1 wherein said drawworks drum is secured to a rotatable drum shaft having a brake portion extending past said drum and a webbed brake hub secured to said shaft brake portion; with said brake assembly comprising brake band means, a brake band actuating linkage assembly, a plurality of arcuate brake pads attached to said brake band means, and a rotatable, generally cylindrical brake drum coactable with said brake pads in close proximity thereto; said brake drum having an inwardly projecting annular flange adapted to contact and be releasably fastened to said webbed hub.
3. The main drawworks and drawworks drive assembly of claim 1 or claim 2 wherein said drum drive assembly comprises a fluidically sealed case having generally parallel side walls; an input shaft passing transversely through said case and said side walls; an output shaft substantially parallel to said input shaft and passing transversely through said case and said side walls; bearings rotatably and sealingly supporting said two shafts and mounted in said side walls; and power transfer means coactively engaging said input and output shafts and arranged to transfer

rotary power from one said shaft to the other.

4. The main drawworks and drawworks drive assembly of claim 3 wherein said power transfer means comprises circular sprocket means on said input and output shafts, and looped chain drive means coengaging said sprocket means on said shafts.

5. The main drawworks and drawworks drive assembly of any preceding claim further comprising auxiliary braking means releasably connectable to said drum drive assembly and adapted to selectively apply hydraulic damping-type braking forces to said assembly.

6. The main drawworks and drawworks drive assembly of any preceding claim further comprising power take-off means releasably connectable to said power input means for driving a catworks assembly.

7. The main drawworks and drawworks drive assembly of claim 1 wherein said power input means comprises two propeller shaft assemblies to be connected to a power system to transfer power to said transmission means.

8. A drawworks main drum assembly arranged for disassembly into self-contained subcomponents, each transportable by helicopter, said assembly comprising:

a main drawworks drum arranged in rotatable relationship;

a brake drum shaft means attached to said drum and extending past one end of said drum;

a brake hub attached to said brake drum shaft means and rotatable therewith;

a rotatable, generally cylindrical brake drum for coaxial alignment with said main drum and attachment to said hub by releasable connection means; and

brake means encircling said brake drum and arranged to be engaged therewith in rotation-retarding relationship; said brake means being removable from said assembly as a single unit with said brake drum.

9. The main drum assembly of claim 8 wherein said brake means comprises:

a plurality of arcuate brake pads made of a friction enhancing, heat resistant material and arranged to make surface contact with said brake drum;

brake band means carrying said brake pads and arranged in close proximity to said brake drum; and,

linkage means on said brake band means arranged to move said brake band means into engagement with said brake drum.

10. The main drum assembly of claim 8 or claim 9 wherein said releasable connection means comprises a peripheral, radially outwardly directed web plate attached to said hub; a radially inwardly directed flat flange plate attached to the inner circumference of said brake drum; and a plurality of releasable fasteners passable through said flange

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1,522,983), and in the Complete Specification of Application 2462/78 (Serial No. 1,522,986) which is divided out of this application.

5 WHAT WE CLAIM IS:—

1. A main drawworks and drawworks drive assembly comprised of self-contained, fully portable subcomponents adapted to receive power from an adjacent power system; said drawworks and drawworks drive assembly comprising:

power input means connectable to the power system by disconnectable coupling means;

transmission means connectable to said power input means and comprising a fully portable, self-contained high speed transmission assembly and a fully portable, self-contained low speed transmission assembly;

a drum drive assembly to receive power from both said transmissions and being a fully portable self-contained unit having a power output station;

clutch means for releasably connecting said two transmissions to said drum drive assembly; and,

a main drawworks drum assembly attachable to said power output station by disconnectable couplings, and comprising a main drawworks drum and a main drum brake assembly; the main drawworks drum and main drum brake assembly being self-contained, portable subcomponents of said drum assembly and being releasably coupled to each other.

2. The main drawworks and drawworks drive assembly of claim 1 wherein said drawworks drum is secured to a rotatable drum shaft having a brake portion extending past said drum and a webbed brake hub secured to said shaft brake portion; with said brake assembly comprising brake band means, a brake band actuating linkage assembly, a plurality of arcuate brake pads attached to said brake band means, and a rotatable, generally cylindrical brake drum coactable with said brake pads in close proximity thereto; said brake drum having an inwardly projecting annular flange adapted to contact and be releasably fastened to said webbed hub.

3. The main drawworks and drawworks drive assembly of claim 1 or claim 2 wherein said drum drive assembly comprises a fluidically sealed case having generally parallel side walls; an input shaft passing transversely through said case and said side walls; an output shaft substantially parallel to said input shaft and passing transversely through said case and said side walls; bearings rotatably and sealingly supporting said two shafts and mounted in said side walls; and power transfer means coactively engaging said input and output shafts and arranged to transfer

rotary power from one said shaft to the other.

4. The main drawworks and drawworks drive assembly of claim 3 wherein said power transfer means comprises circular sprocket means on said input and output shafts; and looped chain drive means coengaging said sprocket means on said shafts.

5. The main drawworks and drawworks drive assembly of any preceding claim further comprising auxiliary braking means releasably connectable to said drum drive assembly and adapted to selectively apply hydraulic damping-type braking forces to said assembly.

6. The main drawworks and drawworks drive assembly of any preceding claim further comprising power take-off means releasably connectable to said power input means for driving a catworks assembly.

7. The main drawworks and drawworks drive assembly of claim 1 wherein said power input means comprises two propeller shaft assemblies to be connected to a power system to transfer power to said transmission means.

8. A drawworks main drum assembly arranged for disassembly into self-contained subcomponents, each transportable by helicopter, said assembly comprising:

a main drawworks drum arranged in rotatable relationship;

a brake drum shaft means attached to said drum and extending past one end of said drum;

a brake hub attached to said brake drum shaft means and rotatable therewith;

a rotatable, generally cylindrical brake drum for coaxial alignment with said main drum and attachment to said hub by releasable connection means; and

brake means encircling said brake drum and arranged to be engaged therewith in rotation-retarding relationship; said brake means being removable from said assembly as a single unit with said brake drum.

9. The main drum assembly of claim 8 wherein said brake means comprises:

a plurality of arcuate brake pads made of a friction enhancing, heat resistant material and arranged to make surface contact with said brake drum;

brake band means carrying said brake pads and arranged in close proximity to said brake drum; and,

linkage means on said brake band means arranged to move said brake band means into engagement with said brake drum.

10. The main drum assembly of claim 8 or claim 9 wherein said releasable connection means comprises a peripheral, radially outwardly directed web plate attached to said hub; a radially inwardly directed flat flange plate attached to the inner circumference of said brake drum; and a plurality of releasable fasteners passable through said flange



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plate and said web plate for attaching said plates securely together.

- 5 11. A main drawworks and drawworks drive assembly, substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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