Sept. 9, 1952 J. B. PICARD 2,610,026

ROTARY DRILLING RIG

Filed April 12, 1949 4 Sheets-Sheet 1

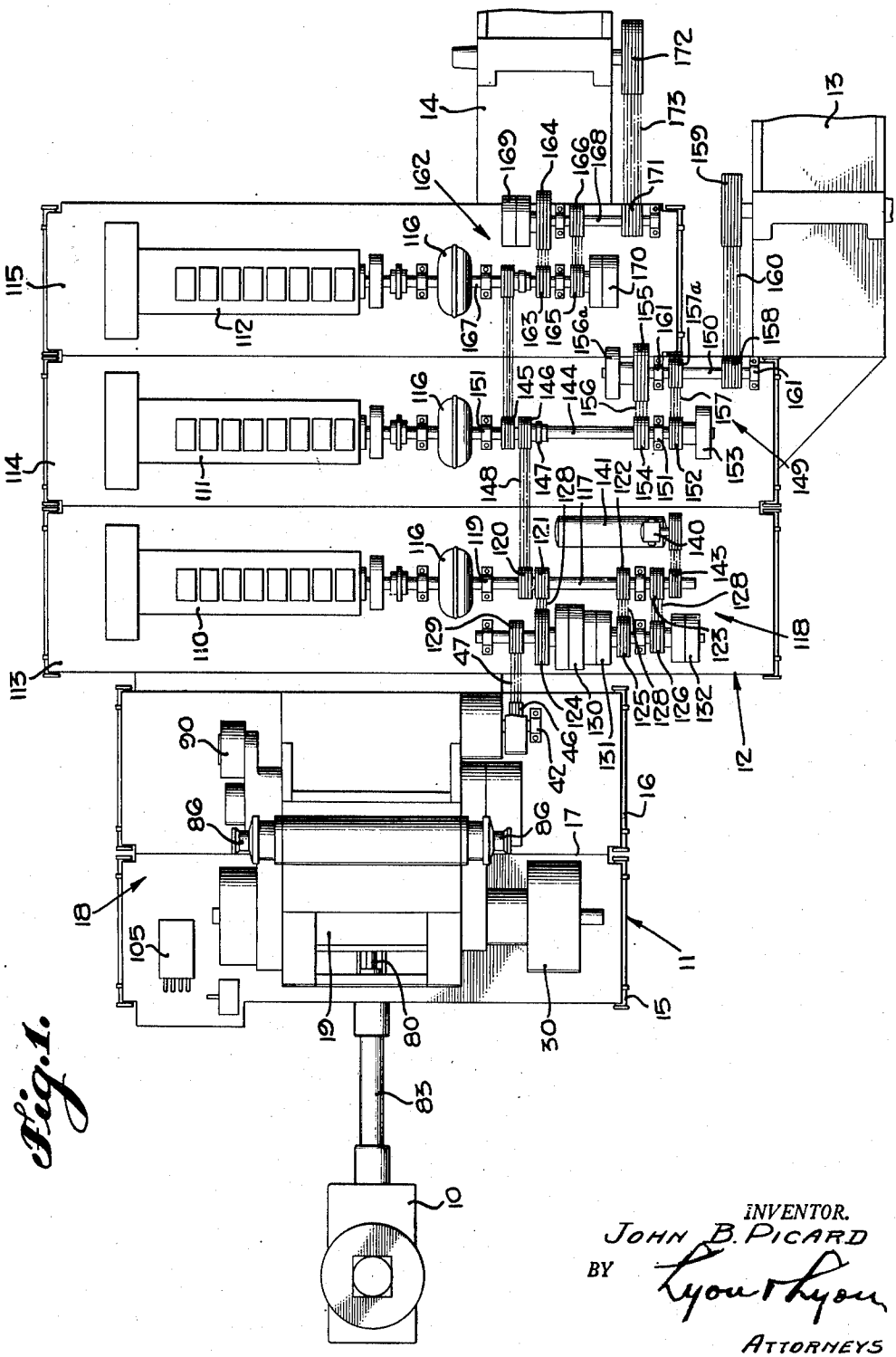


Fig. 1.

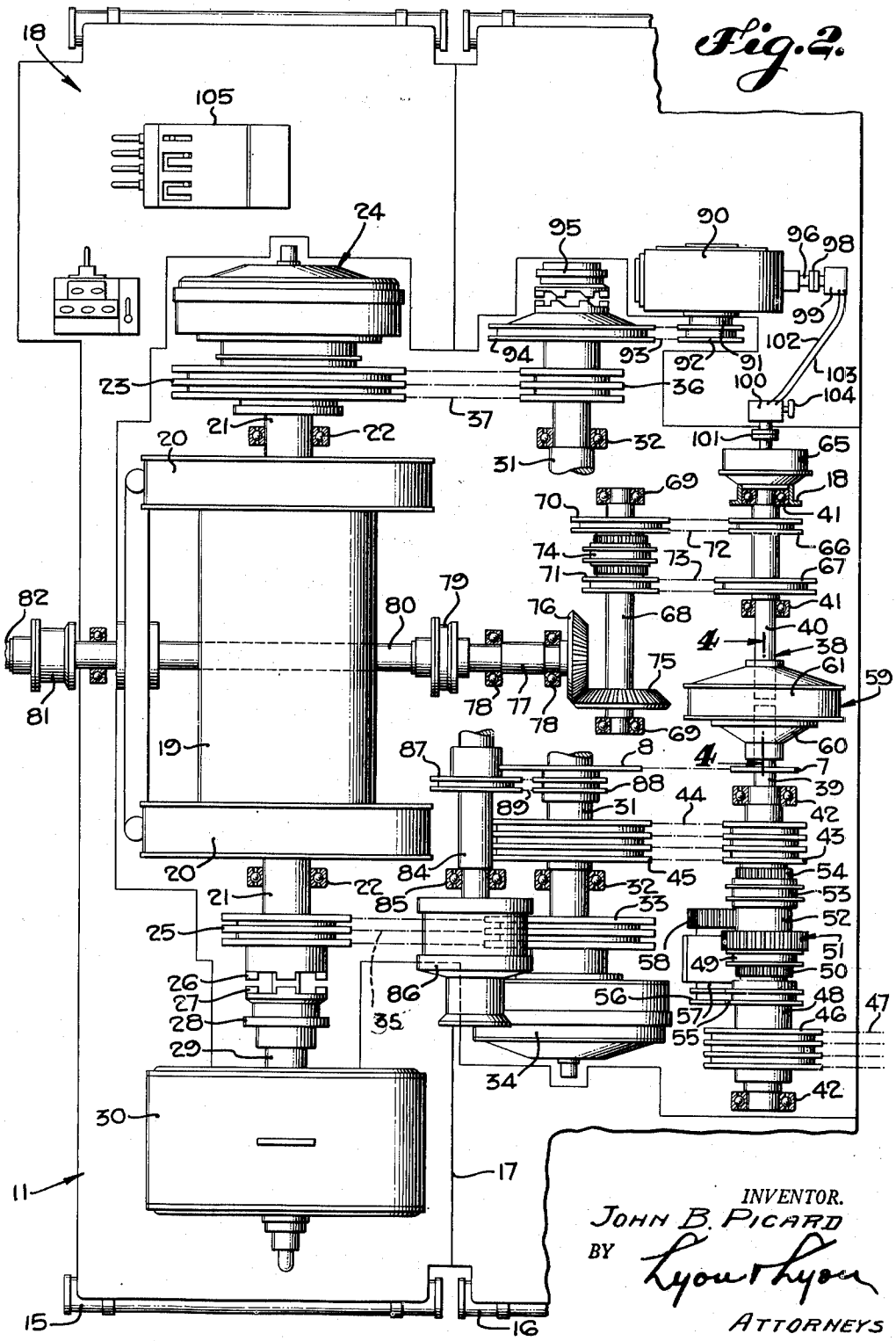
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Fig. 2.




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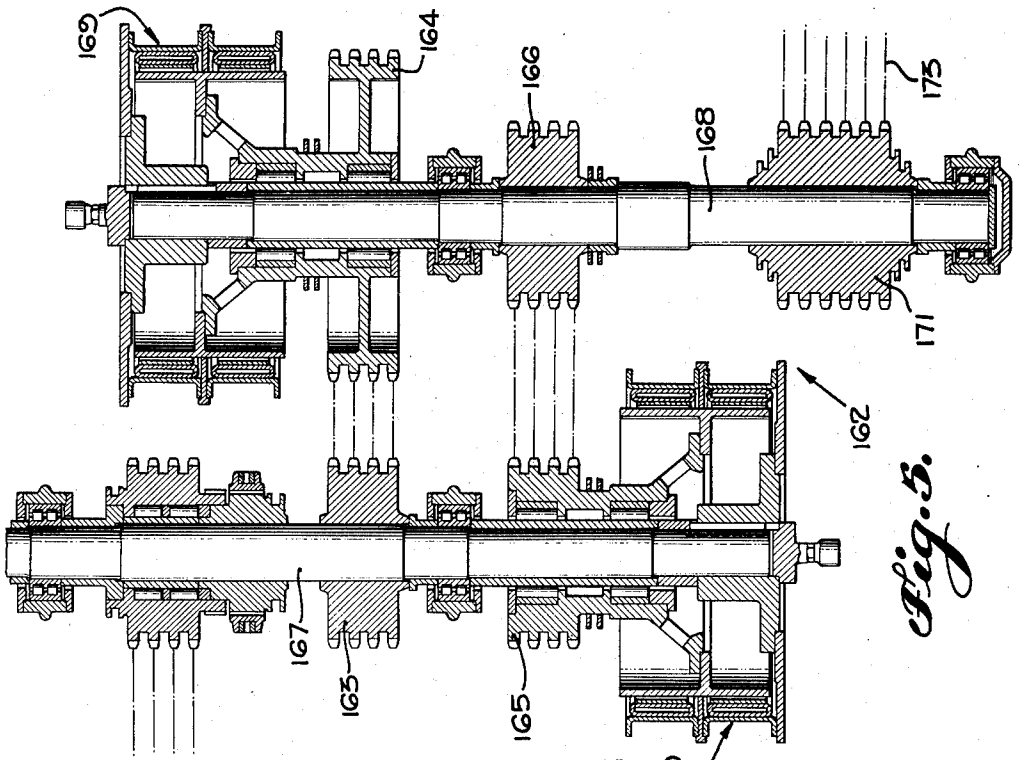



Fig. 5.

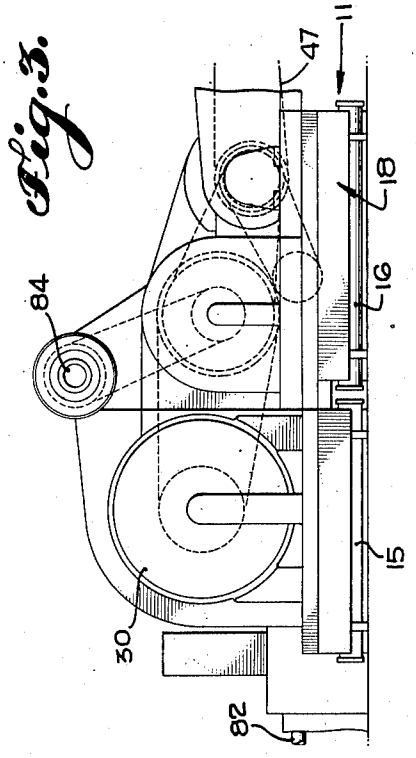



Fig. 3.

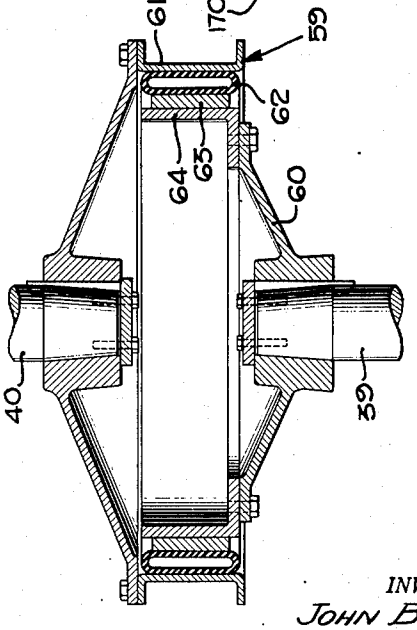



Fig. 4.

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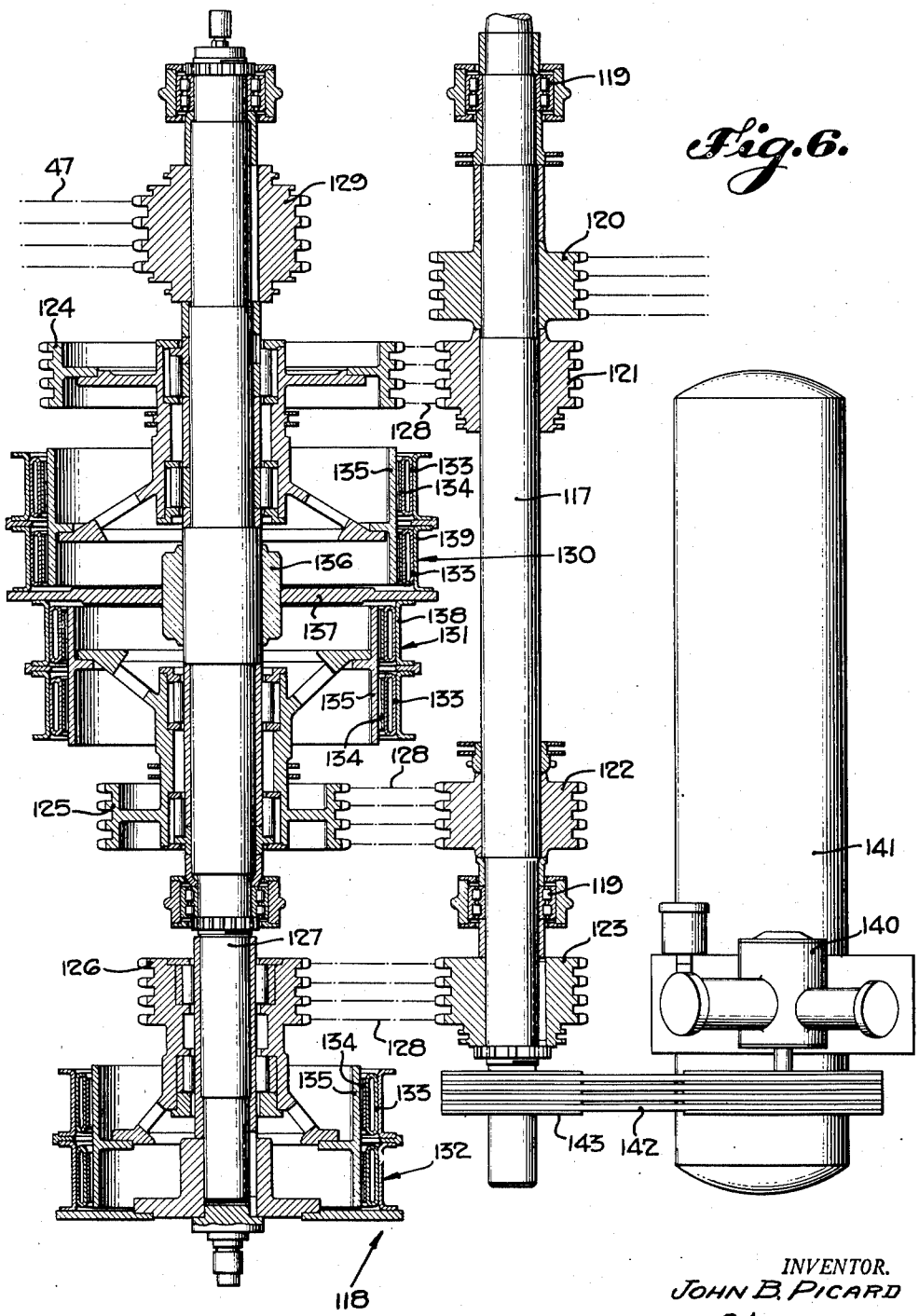



Fig. 6.

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# UNITED STATES PATENT OFFICE

2,610,026

## ROTARY DRILLING RIG

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Application April 12, 1949, Serial No. 86,875

9 Claims. (Cl. 254—187)

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This invention relates to drilling apparatus of the type employed in connection with the drilling of oil, gas, water and other wells, and is particularly directed to improvements in the power plant and drawworks portions of such rotary drill rigs.

Among the objects of my invention is to provide a heavy duty, high capacity rotary drilling rig incorporating a plurality of prime mover units, which rig is unusually flexible in its operation so that the power of the prime mover units may be divided between the pumps and rotary machine or may be compounded to drive the drawworks or any one of the pumps.

Another object is to provide a multiple speed air controlled change speed transmission of novel design driven by one of the prime mover units and positioned on the same skid frame therewith, the transmission being adapted to drive a drawworks.

Another object is to provide a plurality of prime mover units mounted on separate skid frames and positioned in side-by-side relationship, each of the prime mover units having a change speed transmission associated therewith and arranged to drive a driven mechanism, together with power compounding means whereby the combined power of any combination of prime mover units may be delivered to any one of the driven mechanisms.

Another object is to provide a rotary drilling rig having a drawworks provided with a divided jackshaft, one jackshaft section being arranged to drive the spooling drum of the drawworks and the other jackshaft section being arranged to drive the rotary machine, the latter jackshaft section also being adapted to drive a feed-off drilling control for the spooling drum by way of a speed reduction unit.

Other and more detailed objects and advantages will appear hereinafter.

In the drawings:

Figure 1 is a plan view showing a preferred embodiment of my invention in diagrammatic form.

Figure 2 is an enlarged view, partly in section and partly broken away, illustrating the preferred drawworks construction embodying features of my invention.

Figure 3 is a side elevation, partly broken away, showing the drawworks unit.

Figure 4 is a sectional elevation taken substantially on the lines 4—4 as viewed in Figure 2.

Figure 5 is a sectional plan view showing details of construction of the change speed transmission on the No. 3 prime mover frame.

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Figure 6 is a sectional plan view showing details of construction of the change speed transmission mounted on the No. 1 prime mover frame.

Referring to the drawings, the rotary drilling rig embodying my invention and shown diagrammatically in Figure 1 includes a shaft driven rotary machine 10, a drawworks unit generally designated 11, a power plant generally designated 12 and a pair of power driven slush pumps 13 and 14.

The drawworks unit 11 includes a pair of skid frames 15 and 16 connected together along the juncture line 17. These skid frames together with the supporting structure carried thereon is hereinafter referred to as the drawworks frame 18. A spooling drum 19 provided with the usual brake rims 20 is fixed on a drum shaft 21. This drum shaft is supported on axially spaced bearings 22. These bearings, as well as other bearings hereinafter described, are supported by elements of the frame 18 omitted in Figure 2 for purposes of clarity of illustration.

A low speed drive sprocket 23 is rotatably mounted on the drum shaft 21 and is adapted to be connected in driving relationship with the drum shaft 21 by means of the air operated friction clutch 24. The high speed drive sprocket 25 is fixed on the drum shaft 21 and is provided with jaws 26 for connection with mating jaws 27 on the clutch 28. The clutch 28 is splined to the brake shaft 29 for operating the auxiliary brake 30. A line shaft 31 rotatably supported in axially spaced bearings 32 carried by the frame 18, is provided with a high speed drive sprocket 33 rotatably mounted on the line shaft and arranged to be connected in driving relation therewith by means of an air operated friction clutch assembly 34. The sprocket 33 is adapted to drive the sprocket 25 by means of the drive chain 35. A low speed drive sprocket 36 is fixed on the line shaft 31 and is arranged to drive the sprocket 23 through the drive chain 37.

A jackshaft assembly generally designated 38 includes a pair of aligned jackshaft sections 39 and 40 rotatably supported in axially spaced bearings 41 and 42. These bearings are carried by the drawworks frame 18. A driving sprocket 43, rotatably mounted on the jackshaft section 39, is connected by a chain 44 to drive the sprocket 45 fixed to the line shaft 31. Means are provided for driving the jackshaft section 39 and as shown on the drawings, this means includes a power receiving sprocket 46 driven by a chain 47. The sprocket 46 is fixed to a sleeve 48 rotatably mounted on the jackshaft section 39. An axially shiftable clutch 49 is provided with splined teeth

50 on one end and a gear 51 on the other end. The member 49 may be shifted to engage the splined teeth 50 with similar splined teeth (not shown) within the sleeve 48, thereby connecting the sleeve 48 in driving relationship with the sleeve 52. The sleeve 52 is rotatably mounted on the jackshaft section 39.

A splined clutch 53 may be shifted axially of the sleeve 52 to connect its inner splined teeth (not shown) with the splined ring 54 fixed on the sprocket 43. Thus, the sprocket may be driven in a forward direction and the splined clutch 53 engages the splined ring 54 when the splined clutch 49 engages the sleeve 48.

A reverse drive is provided for rotating the jackshaft section 39 in a reverse direction when required. This reverse drive includes a double sprocket 55 fixed on the sleeve 48 and connected by chain to drive the sprocket 56 fixed on the countershaft sleeve 57. The countershaft sleeve 57 is mounted on suitable bearings (not shown) and is provided with a driving gear 58 fixed thereon. The countershaft sleeve 57 is constantly rotated with the power receiving sprocket 46, but it merely idles under normal driving conditions. When a reverse drive is required the clutch 49 is moved axially to place the gears 51 and 58 into mesh, thereby disengaging the splined teeth 50. The sleeve 52 is then driven in a reverse direction and upon closing of the splined clutch 53 the sprocket 43 and jackshaft section 39 are rotated in a reverse direction.

An air operated friction clutch assembly generally designated 59 is provided for connecting the adjacent ends of the jackshaft sections 39 and 40. This clutch assembly 59 includes a ring 60 fixed to the jackshaft section 39 and a housing 61 fixed to the jackshaft section 40. An inflatable rubber-like ring 62 on the housing 61 carries friction shoes 63 adapted to contact the periphery of the drum 64 formed on the ring 60. From this description it will be understood that inflation of the annular ring 62 serves to effect a driving engagement whereby the jackshaft assembly 40 is driven from the jackshaft section 39. When the inflatable ring 62 is deflated the shoes 63 move out of engagement with the drum 64, with the result that the driving connection is interrupted. An inertia brake assembly 65 may be provided for holding the jackshaft section 40 from rotation when desired.

Means are provided on the jackshaft section 40 for driving the rotary machine 10 at a plurality of speeds. As shown on the drawings, this means includes a pair of driving sprockets 66 and 67, which are fixed on the jackshaft assembly 40. A countershaft 68 rotatably supported by the axially spaced bearings 69 carries a pair of sprockets 70 and 71 connected by chains 72 and 73 to be driven from sprockets 66 and 67 respectively. The driven sprockets 70 and 71 are rotatably mounted on the countershaft 68 and either may be connected in driving relationship with the countershaft 68 by means of the axially shiftable clutch 74. From this description it will be understood that the countershaft 68 may be driven at either of two speeds with respect to the jackshaft section 40.

A beveled gear 75 fixed on the countershaft 68 drives a similar beveled gear 76 fixed on the stub shaft 77, which is carried on bearings 78. A self-aligning coupling 79 connects one end of the power transmission shaft 80 to the stub shaft 77 and a second self-aligning coupling 81 connects the other end of the transmission shaft 80 to the



power transmission shaft 82. This latter shaft 82 extends under a guard 83 and is connected to rotate the drive shaft of the rotary machine 10.

A cat shaft 84 is rotatably mounted in axially spaced bearings 85 carried on the drawworks frame 18. This cat shaft may be provided with a cat head assembly 86 on each end thereof as shown in Figure 1. The cat shaft is provided with a driven sprocket 87 fixed thereon arranged to be driven from driving sprocket 88 rotatably mounted on the line shaft 31. A chain 89 connects the sprockets 87 and 88. A sprocket 7 fixed on the jackshaft section 39 drives the sprocket 8 which is fixed to the sprocket 88.

In conventional drilling rigs the cable which is wound on the spooling drum 19 is payed out gradually in order to feed the drill string and bit into the formation. This feed-off operation is accomplished conventionally by relaxing the brake bands (not shown) which are trained over the brake rims 20. The feed-off accomplished by relaxation of the brake bands is irregular and intermittent, and it is known that it does not act to maintain constant feeding pressure on the drill bit.

In accordance with a feature of my invention I provide feed-off control means which are controlled by the driller but which are independent of the feed available by relaxing the brakes. In accordance with my invention I provide a speed reduction unit 90 which may include a single or double worm gear reduction. The slow speed shaft 91 of this unit 90 is connected by means of sprocket 92 and chain 93 to the sprocket 94 which is rotatably mounted on one end of the line shaft 31. A jaw clutch 95 is provided for releasably connecting the sprocket 94 in direct driving relationship with the line shaft 31. The high speed shaft 96 on the unit 90 is connected by coupling 98 to a hydraulic motor 99. A hydraulic pump 100 is connected by coupling 101 in direct driving relationship with the jackshaft section 40. Hydraulic lines 102 and 103 connect the hydraulic motor 99 with the hydraulic pump 100 so that the pump may drive the motor. A suitable control device 104 of conventional type is operatively positioned in the lines 102 and 103 or associated with the pump 100 for regulating the volume of flow of hydraulic fluid between the pump 100 and motor 99.

From this description it will be understood that the rotating jackshaft section 40 may drive the pump 100 which in turn drives the hydraulic motor 99. The motor 99 drives the shaft 96 at a relatively high speed, and the output shaft 91 turns at a very much slower speed. This slow speed drive is then communicated via sprockets 92, 94, 36 and 23 to turn the spooling drum 19 very slowly in a direction to pay off or to unspool the cable for feeding the drill string. The control 104 may have remote actuating mechanism positioned at the driller's control panel 105 if desired. This control 104 may be set by the driller to provide a fixed rate of flow in the lines 102 and 103 so that regardless of the speed of the jackshaft section 40 the pump 99 turns the shaft 96 at a rate to produce the desired rate of feed-off rotation for the spooling drum 19.

The provisions for supplying air to each of the air operated friction clutches and for supplying cooling water for the brake rims 20 of the drum 19 are largely omitted from the drawings for purposes of clarity of illustration. Similarly the lubricating connections, fittings, piping, etc., which convey lubricants to the various bearings

of the device are also omitted from the drawings.

The power plant 12 preferably includes a plurality of prime mover units 110, 111 and 112, each mounted on an individual skid frame 113, 114 and 115, arranged in side-by-side relationship. Each of the prime mover units 110 may comprise a single unit or multiple unit engine and each may deliver its power through a suitable hydraulic coupling 116. This coupling is preferably of the type wherein the quantity of fluid in the working circuit may be varied under the control of the driller. Each of the hydraulic couplings 116 is arranged to drive a power output shaft, which is aligned with the prime mover unit on that particular skid frame.

The power output shaft 117, which is driven by the prime mover unit 110, forms one shaft in a change speed transmission assembly generally designated 118. This change speed transmission assembly is entirely mounted and carried on the skid frame 113, which also supports the prime mover unit 110. As shown clearly in Figure 6, the shaft 117 is rotatably supported on axially spaced bearings 119 and is provided with four sprockets 120, 121, 122 and 123, each of which is fixed to the shaft 117. Driven sprockets 124, 125 and 126 are each rotatably mounted on the countershaft 127 of the transmission 118 and these sprockets are connected by chains 128 to the driving sprockets 121, 122 and 123 respectively.

A power take-off sprocket 129 is fixed on the countershaft 127. Clutch means are provided for releasably engaging any one of the driven sprockets 124, 125 and 126 to the countershaft 127 as desired. As shown in the drawings, air operated friction clutches 130, 131 and 132 are employed for accomplishing this purpose. Each of these clutches employs a pair of annular inflatable rings 133, which cause friction shoes 134 to engage the surface of a drum 135. The clutch 130 is effective to connect the sprocket 124 to the shaft 127. The clutch 131 acts to connect the sprocket 125 to the shaft 127 and the clutch 132 connects the sprocket 126 to the shaft 127. In each of these clutches inflation of the annular ring or sack 133 moves friction shoes 134 radially inwardly into driving contact with the inner ring or drum 135.

Clutches 131 and 130 may be provided with a common driving member and as shown in the drawings, this means includes a central hub 136 shrunk on the shaft 127 and having an annular disk 137 fixed thereto. The disk carries shell assemblies 138 and 139, which rotate with the shaft 127. In effect the air operated clutches 130 and 131 are placed back-to-back and provided with a common driving member. Air for operating the clutches 130, 131 and 132 is conveyed through passageways in the shaft (not shown) and connected by conventional piping systems to the annular rings 133. As shown, each of the individual air clutches employs a pair of inflatable rings 133. This increases the capacity of the clutch over that provided by a single inflatable ring without increasing the diameter. It will be understood that a single inflatable ring may be employed in each case if desired or, likewise, more than two inflatable rings may be incorporated into each clutch assembly for increasing the capacity, if necessary.

An air compressor 140 may be mounted on a suitable air receiver 141 and arranged to be driven from a V-belt assembly 142 driven by a pulley 143 fixed on the shaft 117.

The driven shaft 144, which is carried on the skid frame 114 and driven by the prime mover unit 111, carries a pair of sprockets 145 and 146. The sprocket 145 is fixed to the shaft 144 while the sprocket 146 is rotatable thereon and is arranged to be connected in driving relation therewith by means of an axially shiftable clutch 147. A chain 148 connects the sprockets 120 and 146. A change speed transmission assembly generally designated 149 is mounted on the skid frame 114 and is wholly carried thereby. The shaft 144 forms the driving shaft of this change speed transmission and the countershaft 150 forms the driven shaft thereof. Axially spaced bearings 151 support the shaft 144. On the overhanging end of the shaft 144 a driving sprocket 152 is mounted. An air operated friction clutch 153 is provided for connecting the sprocket 152 in driving relationship with the shaft 144.

The driving sprocket 154 is fixed on the shaft 144 and is arranged to drive sprocket 155 through the chain 156. The sprocket 155 is rotatably mounted on the countershaft 150 and is arranged to be connected in driving relation therewith by means of the air operated friction clutch 156*a*. A chain 157 connects the driving sprocket 152 to the driven sprocket 157*a*, which is fixed on the countershaft 150. A power take-off sprocket 158 is fixed on the countershaft 150 and drives the pump sprocket 159 by way of the chain 160. The pump 13 may be of any conventional design.

It will be observed that the sprocket 155 and clutch 156*a* are outside the bearings 161, which support the shaft 150. The clutch 153 is similarly mounted on an overhanging end of its shaft 144. Accordingly, the clutches 153 and 156*a* are easily available for disassembly in order to replace the friction elements when worn.

A change speed transmission generally designated 162 is mounted on the skid frame 115 and is adapted to be driven by the prime mover unit 112 by way of the hydraulic coupling 116. This transmission assembly 162 may be substantially the same as the transmission assembly 149 and may include a low speed drive through aligned sprockets 163 and 164 and a high speed drive through aligned sprockets 165 and 166. Sprockets 163 and 166 are fixed to the shafts 167 and 168 respectively, while sprockets 164 and 165 are rotatably mounted on their respective shafts and are arranged to be connected in driving relation therewith by means of air operated friction clutches 169 and 170 respectively. It will be observed that the clutches 169 and 170 are mounted on the overhanging ends of the shafts 168 and 167. A power take-off sprocket 171 is fixed on the countershaft 168 and is adapted to drive the pump sprocket 172 via chain 173.

The two-speed pump transmission assemblies 149 and 162 provide a very compact self-contained assembly which affords two speeds for each of the pumps 13 and 14. These change speed transmissions are wholly supported on their respective skid frames 114 and 115, and are transportable with the prime mover unit as a complete subassembly. In a similar way the change speed transmission 118 mounted on the subframe 113 is transportable as a unit with the prime mover unit 110.

Having fully described my invention, it is to be understood that I do not wish to be limited to the details herein set forth, but my invention is of the full scope of the appended claims.

I claim:

1. In a rotary drilling rig, the combination of a drawworks having a spooling drum, a line shaft, power transmission connections including a releasable clutch whereby the line shaft may drive the drum, a divided jack shaft assembly including a pair of jack shaft sections rotatably mounted in axial alignment, a clutch operatively connecting the jack shaft sections for rotation as a unit, transmission connections whereby one of the jack shaft sections may drive the line shaft, means whereby said jack shaft section may be driven from a source of power, means whereby the second jack shaft section may drive a driven mechanism, a speed reduction unit, releasable means for connecting said unit to the line shaft, and means for driving the speed reduction unit from the second jack shaft section.

2. In a rotary drilling rig, the combination of a drawworks having a spooling drum, a line shaft, power transmission connections including a releasable clutch whereby the line shaft may drive the drum, the clutch being positioned coaxially of the drum, second power transmission connections including a clutch whereby the line shaft may drive the drum, the latter said clutch being positioned coaxially of the line shaft, a divided jack shaft assembly including a pair of jack shaft sections rotatably mounted in axial alignment, a clutch operatively connecting the jack shaft sections for rotation as a unit, transmission connections whereby one of the jack shaft sections may drive the line shaft, means whereby said jack shaft section may be driven from a source of power, means whereby the second jack shaft section may drive a driven mechanism, a speed reduction unit, releasable means for connecting said unit to the line shaft, and means for driving the speed reduction unit from the second jack shaft section.

3. In a rotary drilling rig, the combination of a drawworks having a spooling drum, a line shaft, power transmission connections including a releasable clutch whereby the line shaft may drive the drum, the clutch being positioned coaxially of the drum, a divided jack shaft assembly including a pair of jack shaft sections rotatably mounted in axial alignment, a clutch operatively connecting the jack shaft sections for rotation as a unit, transmission connections whereby one of the jack shaft sections may drive the line shaft, means whereby said jack shaft section may be driven from a source of power, means whereby the second jack shaft section may drive a driven mechanism, a worm gear speed reduction unit having a high speed shaft and a low speed shaft, releasable means for connecting the low speed shaft of said unit to the line shaft, and variable speed drive means for driving the high speed shaft of the speed reduction unit from the second jack shaft section.

4. In a rotary drilling rig, the combination of a drawworks having a spooling drum, a line shaft, power transmission connections including a releasable clutch whereby the line shaft may drive the drum, the clutch being positioned coaxially of the drum, a divided jack shaft assembly including a pair of jack shaft sections rotatably mounted in axial alignment, a clutch operatively connecting the jack shaft sections for rotation as a unit, transmission connections whereby one of the jack shaft sections may drive the line shaft, means whereby said jack shaft section may be driven from a source of power, a speed reduction unit having a high speed shaft and a low speed shaft, releasable means for connecting the low speed shaft of said unit to the line shaft, means for connecting the high speed shaft of the speed reduction unit to the second jack shaft section, said means including a hydraulic pump driven by the second jack shaft section and connected to drive a hydraulic motor connected to the speed reduction unit.

5. In a rotary drilling rig, the combination of a drawworks having a spooling drum, a line shaft, power transmission connections including a releasable clutch whereby the line shaft may drive the drum, the clutch being positioned coaxially of the drum, second power transmission connections including a clutch whereby the line shaft may drive the drum, the latter said clutch being positioned coaxially of the line shaft, a divided jack shaft assembly including a pair of jack shaft sections rotatably mounted in axial alignment, a clutch operatively connecting the jack shaft sections for rotation as a unit, transmission connections including a clutch positioned coaxially of the line shaft whereby one of the jack shaft sections may drive the line shaft, means whereby said jack shaft section may be driven from a source of power, means whereby the second jack shaft section may drive a driven mechanism, a speed reduction unit, releasable means for connecting said unit to the line shaft, and means for driving the speed reduction unit from the second jack shaft section.

6. In a rotary drilling rig, the combination of a drawworks having a spooling drum, a line shaft, power transmission connections including a releasable clutch whereby the line shaft may drive the drum, a divided jack shaft assembly including a pair of jack shaft sections rotatably mounted in axial alignment, a clutch operatively connecting the jack shaft sections for rotation as a unit, transmission connections whereby one of the jack shaft sections may drive the line shaft, means whereby said jack shaft section may be driven in either forward or reverse direction from a unidirectional source of power, a speed reduction unit, releasable means for connecting the low speed end of said unit to the line shaft, and a hydraulic transmission connecting the high speed end of the speed reduction unit to the second jack shaft section, said transmission including means for varying the relative speeds of the second jack shaft section and the speed reduction unit.

7. In a rotary drilling rig, the combination of a drawworks having a spooling drum, a line shaft, power transmission connections whereby the line shaft may drive the drum, a divided jackshaft assembly including a pair of jackshaft sections rotatably mounted in axial alignment, a clutch operatively connecting the jackshaft sections for rotation as a unit, transmission connections whereby the first of the jackshaft sections may drive the lineshaft, means whereby the second jackshaft section may drive a driven mechanism, a power-receiving sprocket rotatably mounted on the first jackshaft section, a reverse shaft, means for driving the reverse shaft from the power-receiving sprocket, means including releasable clutch means for driving the first jackshaft section in a reverse direction from the reverse shaft, and releasable means for connecting the power receiving sprocket in direct driving relation with the first jackshaft section.

8. In a rotary drilling rig, the combination of a drawworks having a spooling drum, a line shaft, power transmission connections whereby the line

shaft may drive the drum, a divided jackshaft assembly including a pair of jackshaft sections rotatably mounted in axial alignment, a clutch operatively connecting the jackshaft sections for rotation as a unit, transmission connections whereby the first of the jackshaft sections may drive the lineshaft, means whereby the second jackshaft section may drive a driven mechanism, a power-receiving sprocket rotatably mounted on the first jackshaft section, a reverse shaft having a second sprocket and driving gear mounted for rotation as a unit, a third sprocket mounted for rotation with the power-receiving sprocket and arranged to drive the second sprocket, a driven gear rotatably mounted on the first jackshaft section and axially slidable into mesh with the driving gear, and selective clutch means for driving the first jackshaft section in a forward direction from said power-receiving sprocket and in a reverse direction through said gears.

9. In a rotary drilling rig, the combination of a drawworks having a spooling drum, a divided jack shaft assembly including a pair of jack shaft sections rotatably mounted in axial alignment and in end-to-end relationship, a clutch operatively connecting the adjacent ends of said jack shaft sections for rotation as a unit, power transmission connections whereby the first of the jack shaft sections may be operatively connected to drive the drum, means whereby the second jack shaft section may drive a driven mechanism, a feed control device for controlling turning movement of the drum during drilling, said feed control device including a speed reduction unit, means whereby one of said jack shaft sections may be driven from a source of power, power transmission means connecting the speed reduction unit to the other jack shaft section, and transmission means establishing a driving connection between said spooling drum and said speed reduction unit whereby the drum may turn in an unspooling direction under the control of said speed reduction unit.



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