March 22, 1955 D. M. DUNCAN 2,704,653

DRILLING RIG

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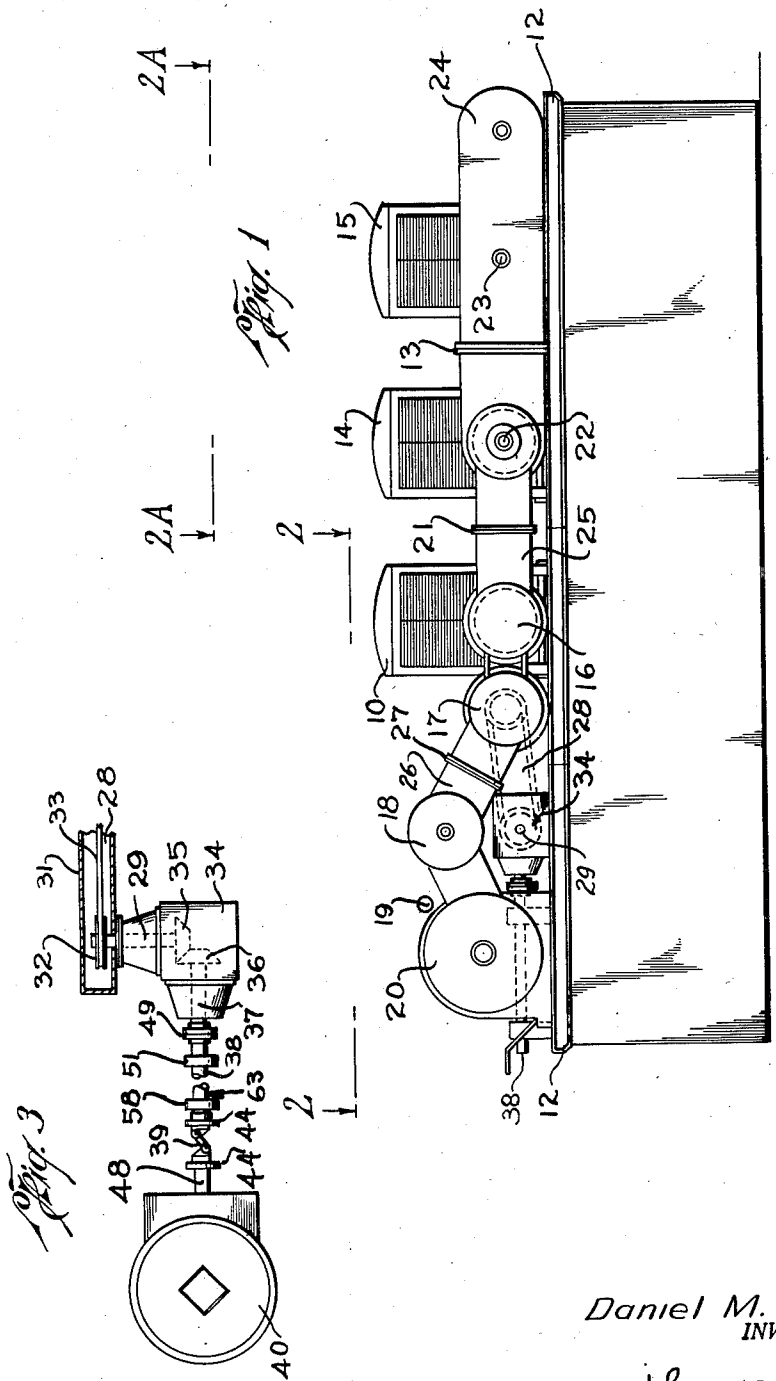


Fig. 1

Fig. 3

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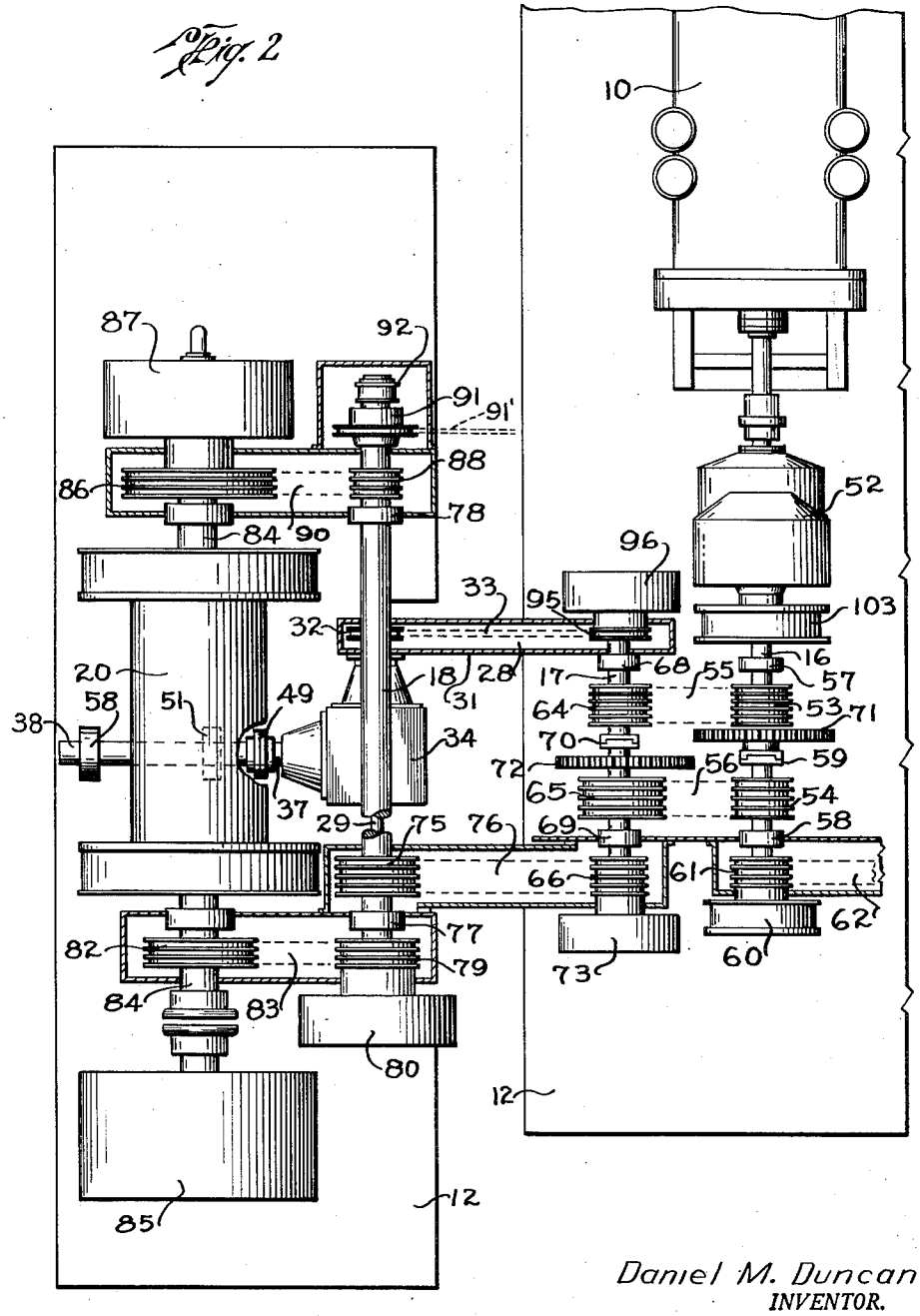
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DRILLING RIG

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Fig. 2



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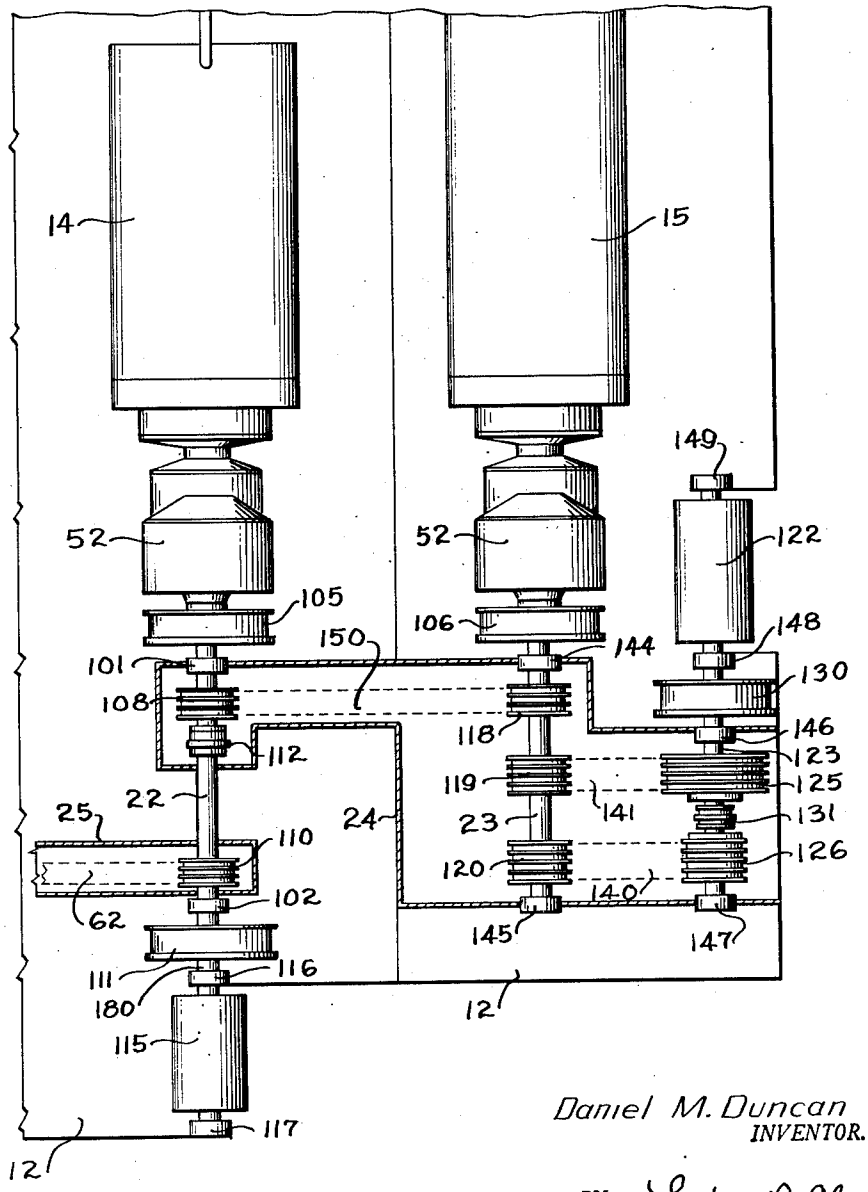
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DRILLING RIG

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Fig. 2A



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Fig. 4

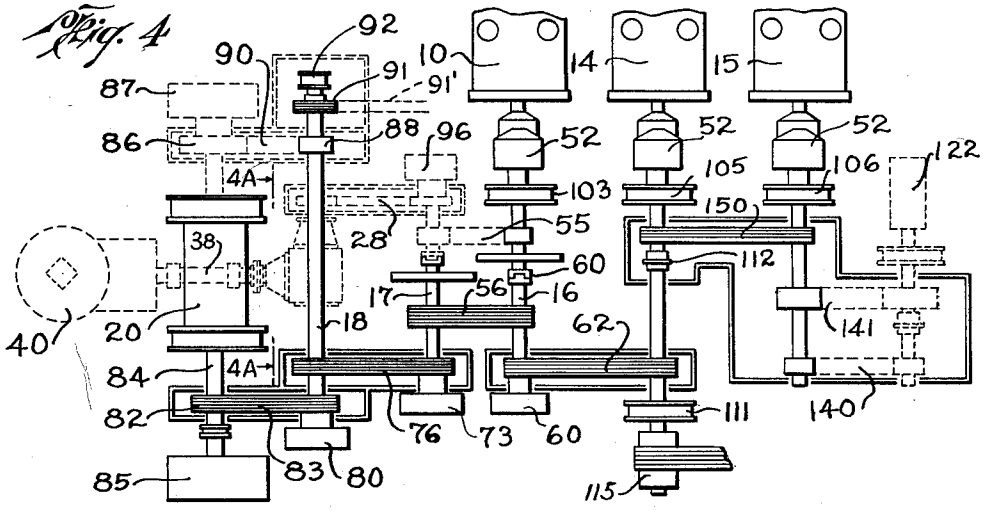


Fig. 5

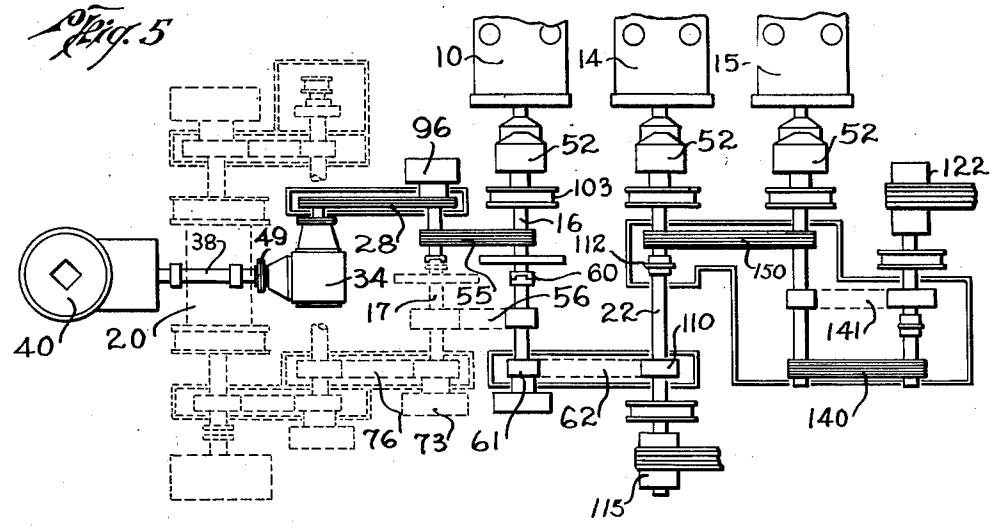
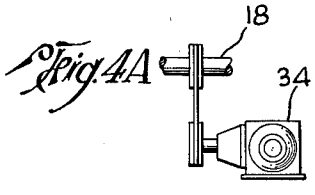


Fig. 4A



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Fig. 6

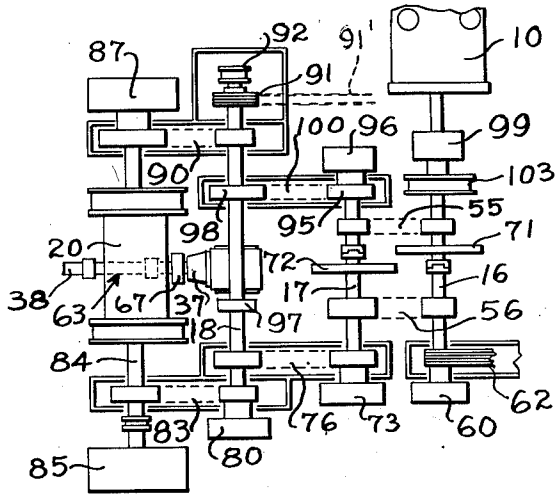


Fig. 7

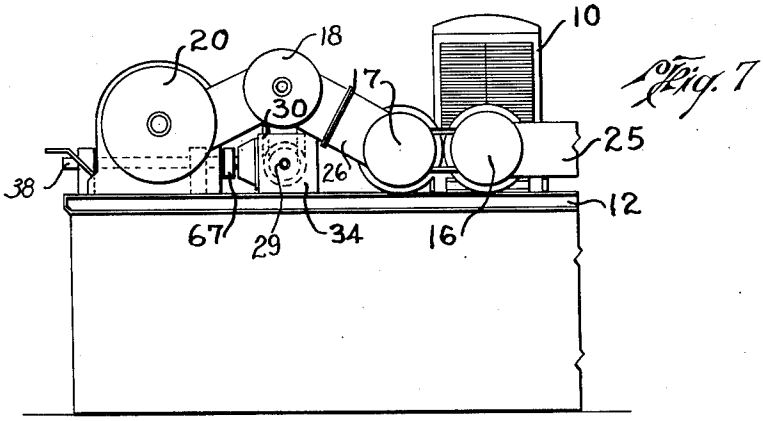
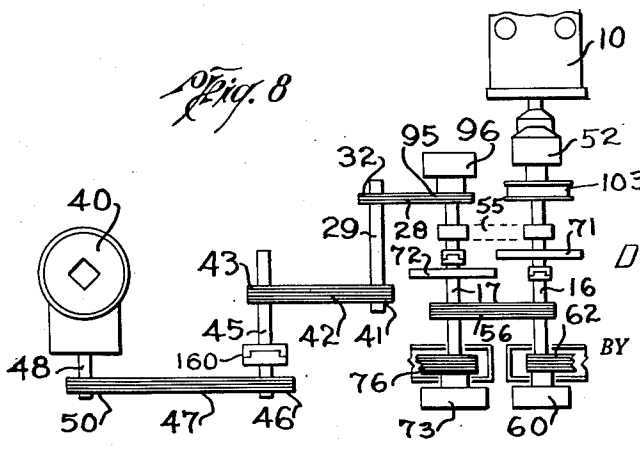


Fig. 8



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Fig. 3A

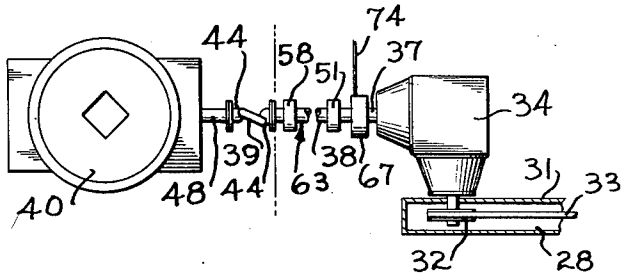


Fig. 3B

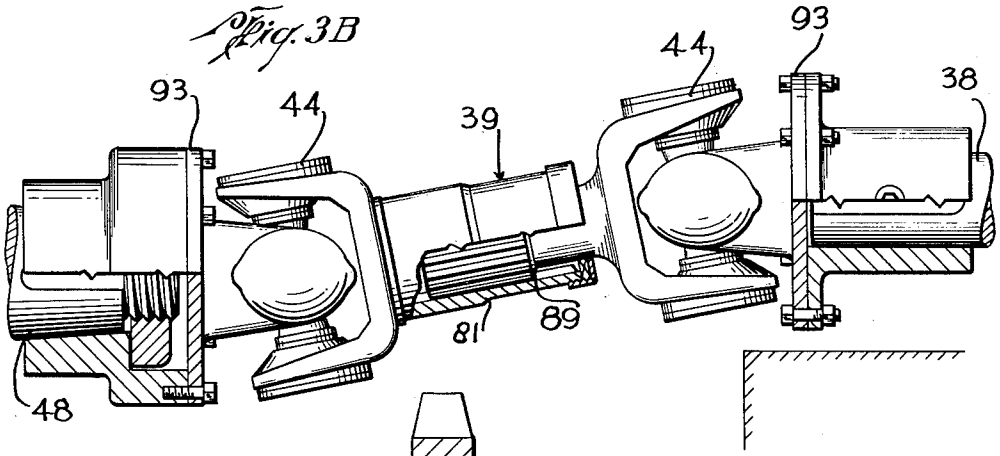
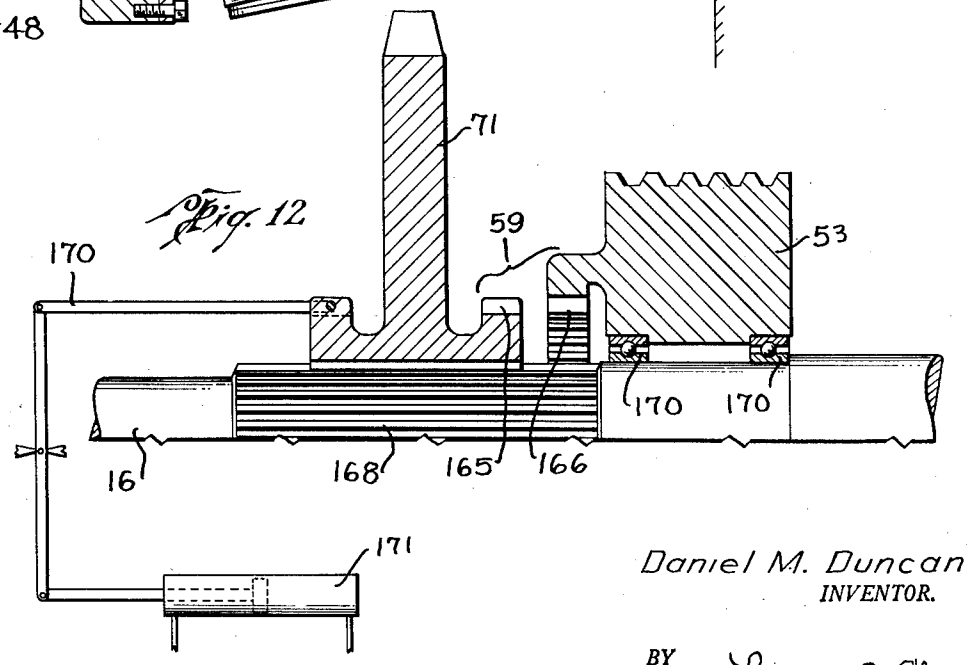


Fig. 12



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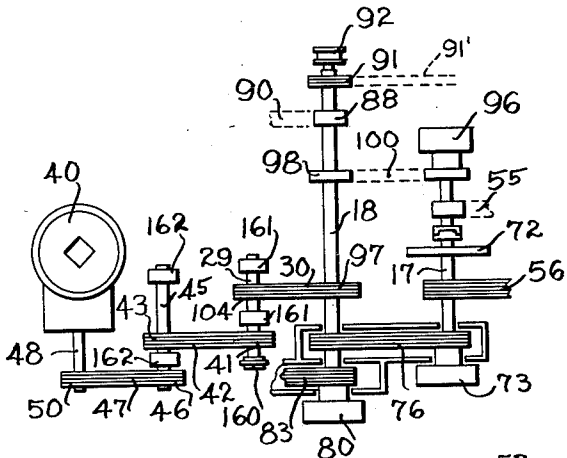


Fig. 8A

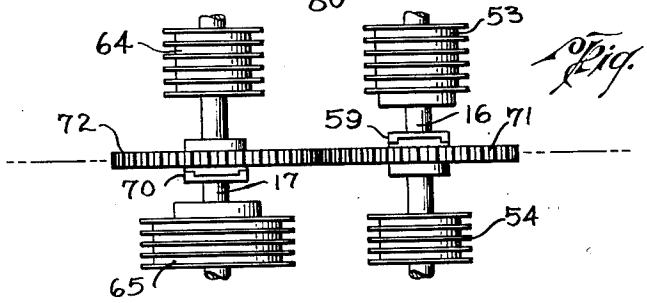


Fig. 9

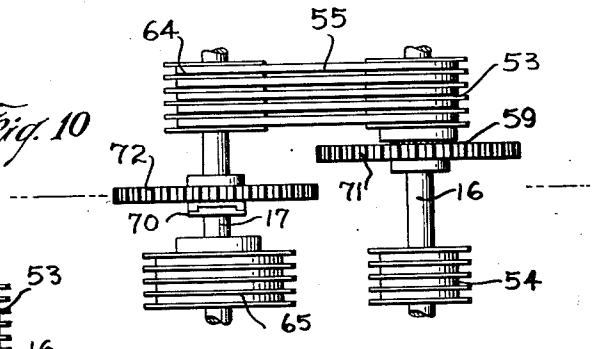
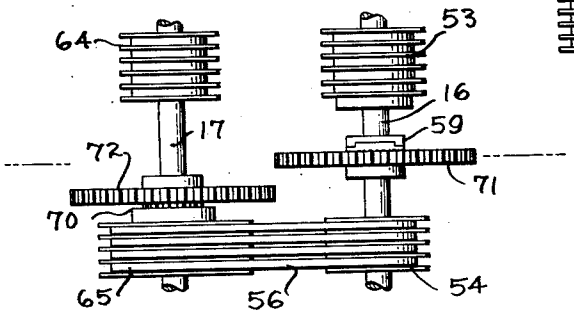


Fig. 10

Fig. 11



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United States Patent Office 2,704,653 Patented Mar. 22, 1955

2,704,653

DRILLING RIG

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Application October 11, 1951, Serial No. 250,854
2 Claims. (Cl. 255—19)

This invention relates to a drilling rig apparatus in which the drive to the drawworks and to the rotary table are so combined that the sticking of the drill pipe within the well bore due to a clutch or drive failure is eliminated.

One of the most costly and troublesome features in the drilling of oil wells or other types of wells by the rotary method of drilling has heretofore been the hazard of sticking the drill pipe within the well bore, in the event that the drawworks for any reason beomes inoperative. The primary causes of failure in the drawworks are in the chain and clutch breakdown. It is rare, however, that more than one chain failure or clutch failure will occur at one time. It has been recognized that when the drawworks become inoperative to thus prevent the raising of the drill pipe, the sticking of the drill pipe in the well bore can be prevented if it is possible to circulate the drilling mud in the well bore as well as to continue to rotate the drill pipe with the rotary table. Likewise, if there is a failure of the rotary table drive, the drill pipe can be prevented from sticking by raising it out of the well bore with the drawworks.

It is therefore an object of this invention to provide a drilling rig apparatus in which sticking of the drill pipe in the well bore may be minimized and whereby no single chain failure or clutch failure in the drawworks or in the rotary rig table can present a hazard to the drilling operation.

Another object of this invention is to provide a drilling rig apparatus wherein either the rotary table drive or the drawworks will be operable even after any single chain or clutch failure, while at the same time providing a compact rotary table and drawworks drive from a single engine or engines compounded therewith.

Another object of this invention is to provide a drilling rig having dual clutched drives throughout for double protection against chain or clutch failures so that in the event of any single chain or clutch failure, in any drive, the drive does not become inoperative because it can still be operated by the utilization of the other clutch and chain.

Another object of this invention is to provide a drilling rig having a high and low drum drive with either usable in case of failure of the other chain drive or clutch.

Another object of this invention is to provide a torque convertor drilling rig wherein either hoisting of the drill pipe with the drawworks or rotation of the rotary table is possible despite a failure in either the drawworks drive or the rotary table drive due to the fact that a transmission output shaft is interposed between an engine drive shaft and a lineshaft, with the transmission output shaft having a sprocket connected by a chain to a sprocket on the lineshaft, and a second sprocket on the transmission shaft which is connected directly to a right-angled gear box or rotary countershaft for operation of the rotary table.

Another object of this invention is to provide a drilling rig wherein high speed and low speed drives are utilized from a first engine drive shaft to a transmission output shaft so that either drive may be placed in operation in the event of a failure in the clutch or chain of the other drive.

Another object of this invention is to provide a drilling rig having a first engine drive shaft operable by either a first engine directly in line or by a second, so that in the event of a failure in any engine one of the other engines may be used to operate the first engine drive shaft.

Another object of this invention is to provide in a drilling rig a drive shaft and a transmission output shaft with a high speed drive, a low speed drive and a reverse drive located from the drive shaft to the transmission output shaft, and each of the drives being provided with

clutches to enable operation of each of the drives separately.

Another object of this invention is to provide in a drilling rig a mechanical coupling or air friction clutch between the engines and their respective drive shafts and to additionally provide in this mechanical rig two power drives between a transmission shaft and a drawworks lineshaft shaft so that operation of one of the drives may be continued despite a clutch or chain failure in the other of the drives, and to locate the drives and clutches therefor outboard of their respective shafts for ready accessibility for replacement or repair.

Another object of this invention is to provide a drilling rig apparatus having a torque converter drive from one of the driving engines to the drive shaft, and in that combination to provide at least four speeds for hoisting with the drawworks and two speeds for the operation of the rotary table.

Another object of this invention is to provide a driving engine coupled to a drive shaft with a transmission shaft substantially parallel to the drive shaft and having connected therewith a low and a high speed drive with power take-offs or drives from the transmission shaft to a counter-shaft for operation by suitable connection to the rotary table and additional drives or take-offs from the transmission shaft to a lineshaft, which in turn may be connected by chain drives to the hoisting drawworks drum for high and low speed operations.

Another object of this invention is to provide a combination rotary table drive and drawworks drive from the same engine by transmittal through a transmission shaft, a lineshaft, and a rotary counter-shaft or right-angled gear box and providing clutches on the shafts so positioned at the outer end of the shaft to permit ready accessibility to the clutches for replacement or repair.

Another object of this invention is to provide for the compounding of engines in a drilling rig apparatus so that the power or more than one engine may be employed in driving the rotary table and the drawworks drum, and if desired the additional engine or engines may be employed for the driving of one or more slush or mud pumps.

Another object of this invention is to provide a drilling rig apparatus wherein a mechanical coupling or clutch coupling is used between the engines and the drive shaft instead of torque converters, and on this mechanical rig providing additional speeds by providing two drives from the transmission shaft to the lineshaft which in conjunction with a two-speed drive in the transmission and two drives to the drawworks drum from the lineshaft will give eight drum hoisting speeds and likewise, by a drive from the lineshaft to rotary table right-angled gear box or a counter-shaft, will give four rotary table speeds.

A further object of this invention is to provide a drilling rig apparatus so constructed that with the same basic components either a torque convertor rig having four hoisting speeds and two rotary table speeds or a mechanical rig having eight hoisting speeds and four rotary table speeds, may be utilized and having the basic components so constructed that the drilling rig apparatus may be changed from a torque convertor rig to a mechanical rig or vice versa with the minimum of alteration, structural changes and expense.

Other and further objects of this invention will become apparent when the following description is considered in connection with the accompanying drawings, wherein:

Fig. 1 is an elevation view showing the relationship of the driving engines, the drawworks drum, and the rotary table drive of this invention.

Fig. 2 is a plan view taken on line 2—2 of Fig. 1 and illustrating in particular the relationship of the transmission shaft, the first engine drive shaft, the lineshaft, the rotary table counter-shaft or right-angled gear box, and the drum shaft, and the chain drives related therewith, for the torque convertor equipped drilling rig.

Fig. 2A is a plan view taken on lines 2A—2A of Fig. 1, and illustrates the connections possible when the additional driving engines are utilized in connection with slush or mud pumps or for compounding with the first drive engine shown in Fig. 2.

Fig. 3 is a partial plan view showing the rotary table drive in one modification suitable for use with the torque convertor rig of this invention.

Fig. 3A is a partial plan view showing the rotary table drive in another modification suitable for use with the mechanical drilling rig of this invention.

Fig. 3B is a detailed elevation view of the propeller shaft assembly or universal connection used in the rotary table drive of this invention.

Fig. 4 is a diagrammatic plan view of the drilling rig apparatus of this invention, illustrating one operational connection in which the drawworks hoisting drum is being driven by all three engines through a compound drive arrangement.

Fig. 4A is a fragmentary sectional elevation taken along line 4A—4A of Fig. 4.

Fig. 5 is a diagrammatic plan view of the drilling rig apparatus of this invention illustrating an operational connection in which the rotary table is being driven by the first engine while the two slush pumps are being driven by the second and third engines in compound.

Fig. 6 is a diagrammatic plan view illustrating the mechanical rig of this invention, wherein eight speeds are available to drive the hoisting drum, and four speeds are available to drive the rotary table.

Fig. 7 is an elevation view showing a modification suitable for use with the mechanical rig illustrated in Fig. 6.

Fig. 8 is a diagrammatic plan view illustrating a counter-shaft drive to the rotary table as used with the torque convertor rig of this invention.

Fig. 8A is a diagrammatic plan view illustrating a counter-shaft drive to the rotary table as used with the mechanical rig of this invention.

Figs. 9–11 are plan views of the particular transmission drives of this invention, illustrating the reverse drive in operation in Fig. 9, the high speed drive in operation in Fig. 10, and the low speed drive in operation in Fig. 11.

Fig. 12 is a detailed sectional view of the splined clutch device of this invention as used in the transmission shown in Figs. 9–11, and illustrating in particular the combination clutch and reverse gear member of this invention declutched from the high speed drive.

Following is a detailed description of this invention, wherein like parts are referred to like numerals in all figures of the drawings.

In Fig. 1 the general arrangement of the drilling rig apparatus of this invention can be seen, wherein is shown the first engine **10** positioned on a platform or skid **12** along the side of a second driving engine **14** and a third driving engine **15**. The outboard side of the first engine drive shaft **16** can be seen disposed substantially parallel and adjacent to the transmission shaft **17**, which is interconnected by chain or similar drive means to the drawworks lineshaft **18**, which in turn is positioned in proximity to the drawworks hoisting drum **20**.

It will be observed that the first engine drive shaft **16**, the transmission shaft **17** and the drawworks hoisting drum **20** are all positioned on substantially the same level on the platform **12**, although the drawworks **20** can be elevated as desired above the transmission output shaft **17**, and likewise shaft **17** can be elevated above the first engine drive shaft **16**. The drawworks lineshaft **18** is ordinarily below the level of the transmission shaft **17**, but it has been shown in Fig. 1 as raised thereabove for clarity. Adjacent and parallel to the lineshaft **18** is a catshaft **19** shown in section. The catheads (not shown) are on the catshaft **19** which is suitably connected to the lineshaft **19** by drives (not shown). The catshaft **19** arrangement has not been shown in detail for clarity and the manner of connecting drives from the lineshaft **18** to the catshaft **19** will be readily understood by those skilled in the art. The outboard end of the second engine drive shaft **22** and the third engine drive shaft **23** can be seen diagrammatically in Fig. 1, but the bulk of the apparatus is covered by guards **24**, **25** and **26**, which provide oil tight housings for the purpose of pressure lubricating the connecting drive chains and/or bearings. These guards **24**, **25** and **26**, have flanges **13**, **21** and **27**, respectively, to permit disassembly for transportation.

For a torque convertor rig the rotary table drive **28** is shown in Fig. 1 as coming from the transmission shaft **17** for connection with the counter-shaft **29**, of the right-angled gear box **34** positioned in the drawworks skid **12** substantially below and between the drawworks drum **20** and lineshafts. The arrangement of the rotary table drive **28**, as illustrated in Fig. 1, from the transmission on shaft **17** to the countershaft **29**, is the modification used when each of the driving engines **10**, **14** and **15** utilize a torque convertor for the coupling between the engines and their respective drive shafts.

When it is desirable to use a mechanical type of connection between the driving engines and their respective drive shafts, it is preferable to employ a rotary table drive **30** directly from the lineshaft **18** to the counter-shaft **29**, as best seen in Fig. 7. Such an arrangement provides additional speeds for the rotary table as well as for the drawworks drum, which additional speeds become desirable when a mechanical coupling between an engine and a drive shaft are employed instead of the preferred torque convertor coupling.

One type of rotary table drive arrangement which can be employed is shown in Fig. 3, wherein the rotary drive **28** is shown only partly, but which is connected to the transmission shaft **17** when using the torque convertor rig, or to the lineshaft **18** when using the mechanical rig. The oil bath guard **31** is provided for lubrication purposes. The counter-shaft **29** has thereon a sprocket **32** which receives the chain **33**, so that the counter-shaft **29** is rotated upon rotation of the chain **33**, thus causing rotation of the bevel gear **35** which meshes with a second bevel gear **36** located in the right-angled gear box **34** at right angles to the gear **35**, so that the direction of movement of the counter-shaft **29** is transmitted at a right angle to the rotary stub shaft **37**.

On the torque convertor rig, as illustrated in Fig. 3, the stub shaft **37** will be coupled by a mechanical coupling **49** to an in-line counter shaft **38** extending to the front of the drawworks, thence by a propeller drive shaft **39**, equipped with universal joints **44**, to the rotary table pinion shaft **48**. The in-line counter-shaft **38** is supported in bearings **51** and **58**. The shafts **37**, **38**, **39** and **48** and their related parts are referred to herein as the rotary drive shaft **63**.

On the mechanical version of the above rig, as illustrated in Fig. 3A, a clutch coupling **67**, such as an air friction clutch, will be inserted between shaft **37** and the above referred to in-line counter-shaft **38**. An air inlet line **74** is shown diagrammatically for actuation of the clutch **67**.

In Fig. 3B, a detailed showing of the propeller drive shaft **39** is shown as comprising the universal joints **44**, a splined assembly made up of an outer sleeve **81** and an inner shaft **89**, and flanges **93**. This propeller drive shaft **39** provides a flexible connection for the rotary table drive **63** due to the universal joints **44** and the sliding movement made possible by reason of the construction of the splined inner shaft **89** sliding within the splined outer sleeve **81**.

In some instances, instead of using the right-angled gear box **34**, as shown in Fig. 3, it may be more convenient to use a counter-shaft arrangement, such as shown in Fig. 8, wherein the counter-shaft **29**, instead of having the gear **35** thereon, may have a sprocket at its other end from the sprocket **32**, namely sprocket **41**, which is connected by a chain **42** to a sprocket **43** on another counter-shaft **45**, which has at its opposite end a sprocket **46** connected by a chain **47** to a sprocket **50** connected to the rotary table pinion shaft **48** of the rotary table **40**. Thus, it is possible to use either the counter-shaft arrangement of Fig. 8 or the right-angled gear box arrangement of Fig. 3 for driving the rotary table **40** when using either the torque convertor rig as in Fig. 8 or the mechanical drive rig as in Fig. 8A.

It will be noted that in the mechanical rig counter-shaft arrangement shown in Fig. 8A that drive **30** is between a sprocket **97** on lineshaft **18** and sprocket **104** on counter-shaft **29** instead of the drive **29** shown in Fig. 8 for the torque convertor which is taken directly from the transmission output shaft **17** to the counter-shaft **29**. Of course, the drive **30** is also connected from the lineshaft **18** when the right-angled gear box **34** is used as illustrated in Figs. 6 and 7, described more in detail hereinafter.

In the mechanical rig counter-shaft arrangement of Fig. 8A, there is positioned outboard of shaft **29** a clutch **160** to enable disengagement of the rotary table drive when desired. This clutch **160** is shown in Fig. 8 posi-

tioned on shaft 45 at its outboard end. Bearings 161 are provided for shaft 29 and bearings 162 are provided for shaft 45 as seen in Fig. 8A. Although not shown in Fig. 8, similarly positioned bearings would also be provided for shafts 29 and 45 in that modification.

Referring now to Fig. 2, the details of one of the main aspects of this invention can be seen. Therein is shown the first engine 10 which may employ either a torque convertor coupling to the drive shaft 16 or a mechanical-type coupling connection. The torque convertor 52 is illustrated diagrammatically in Fig. 2, as that is the preferred type of driving coupling for each engine.

This invention does not depend upon the use of the second engine 14 and the third engine 15. Instead, if desired, the first engine 10, alone, may be used for operation of the drilling rig apparatus of this invention. Thus, in Fig. 2 it is shown that the first engine 10, through the torque convertor 52, drives the drive shaft 16.

The drive shaft 16 has thereon two sets of sprockets, 53 and 54, the sprocket 53 being for connection to the high speed drive 55 and the sprocket 54 being for connection to the low speed drive 56. The shaft 16 is supported on bearings 57 and 58.

A mechanical clutch 59 is provided on the shaft 16 for engaging the high drive 55. A mechanical clutch 70 is used to engage the low speed drive 56. With both clutches 70 and 59 disengaged, the gears 72 and 71 are moved into mesh to provide a reverse drive to the drawworks drum 20 or to the rotary table 40. Interlocks (not shown) would be provided so that the high and low drives 55 and 56 would not be simultaneously engaged. At the outboard side of the shaft 16 is positioned a compounding clutch 60 which controls the engagement and disengagement of the sprocket 61 on the shaft 16. This sprocket 61 is for connection to a compounding drive 62 which operates in conjunction with the shaft 22 of the second driving engine 14, as will be more fully described hereinafter.

Positioned ahead of the drive shaft 16 and substantially parallel thereto is a transmission shaft 17. The transmission shaft 17 has thereon sprockets 64, 65, 66 and 95. The sprocket 64 is connected to the sprocket 53 by a chain forming the high speed drive 55. In a similar manner the sprocket 65 is connected to the sprocket 54 by a chain, forming the low speed drive 56. Bearings 68 and 69 are provided for the shaft 17. The various clutch positions provided for the high speed drive 55, the low speed drive 56, and the reverse drive obtained by the engagement of the gears 71 and 72, are best illustrated in Figs. 9–11. The mechanical clutches 59 and 70 indicated in Figs. 9–11, are preferably of splined construction, as shown in detail in Fig. 12, with the inner splined clutch ring 165, for gear 71, fitting with a splined sleeve 166 for engagement.

The gear 71 is itself on a splined portion 168 of the shaft 16 so that motion of the shaft 16 is transmitted to the gear 71. A shifting linkage 170 actuated by a pneumatic or hydraulic cylinder 171 is provided by moving the gear 71 and the connected clutch ring 165 into and out of engagement with the splined sleeve 166 on the sprocket 53. As will be understood by those skilled in the art, the shifting linkage 170 will be suitably connected so as not to interfere with the gear 71 when in rotation. The gear 72 has clutch 70 associated with it, and is of identical construction with the gear 71 and clutch 59 shown in detail in Fig. 12, except that its splined clutch ring is on the opposite side of the gear 72 for engagement with a splined sleeve within the sprocket 65, not shown in Figs. 9–11, for operating the low speed drive 56.

It should be pointed out that the sprockets 53 and 65 are bearing mounted by bearings such as 170, whereas sprockets 54 and 64 are keyed or otherwise secured to their respective shafts.

In operation of the reverse drive as shown in Fig. 9, the clutches 59 and 70 are both disengaged and the gears 71 and 72 are in mesh. In operation of the high speed drive 55, as shown in Fig. 10, the clutch 59 is engaged to drive the sprocket 53, chains 55 and sprocket 64. The gears 71 and 72 are not meshed and the clutch 70 for the low speed drive 56 is disengaged. In operation of the low speed drive 56, as shown in Fig. 11, the clutch 70 is engaged so that motion of the drive shaft 16 is transmitted through the sprocket 54, the chains 56, and the sprocket 65 to the shaft 17. The reverse gears 71 and 72 are not meshed and the clutch 59 is disengaged.

The sprocket 66, as shown in Fig. 2, is engaged or disengaged by means of the clutch 73, which is at the outer end or outboard side of the shaft 17 for ready accessibility in case of repairs or replacement. The sprocket 66 is connected to a sprocket 75 on the line shaft 18 through a chain drive forming the drawworks drive 76. There is generally no other drive from the transmission shaft 17 to the line shaft 18 when using the torque convertors such as 52 shown in Fig. 2. However, as shown diagrammatically in Fig. 6, the combination may be modified to include an additional sprocket 98 on the line shaft when using a mechanical type of coupling connection between the engines and their respective drive shafts, as will be explained more fully hereinafter.

The shaft 18 is supported in the hearings 77 and 78. At one end of the line shaft 18 is a sprocket 79, having connected therewith a clutch 80. This sprocket 79 is connected to a sprocket 82 on the drum shaft 20 by means of a chain, forming the high speed drive 83 for the drawworks drum 20. An auxiliary brake and coupling connection 85 may be provided at the end of the drum shaft 84. At the other end of the drum shaft 84 is a sprocket 86 suitably connected with its clutch 87. The sprocket 86 is connected with the sprocket 88 on the lineshaft 18 through a chain, forming the low speed drive 90 for the drum 20. At one end of the lineshaft 18 is disposed a feed-off device sprocket 91 having a mechanical or direct air friction clutch therewith 92, which sprocket 91 may be used for various feed-off operations commonly known in the well drilling field.

When it is desired to use a feed-off device through sprocket 91, the low speed drum clutch 87 is engaged, the high speed drum clutch 80 and the input drive clutch 73 are disengaged, allowing the descent of the drill pipe to be controlled by the feed-off device through low speed drum drive 90 and through sprocket 91 to the feed-off device. Sprocket 91 would be clutched to lineshaft 19 by clutch 92. Such feed-off device 91' is indicated in dotted lines in Figs. 2, 4, 6 and 8A.

The above description applies only to the torque convertor rig. In the mechanical rig, sprocket 88 must be a clutch sprocket and sprocket 91 must be clutched to sprocket 88, due to the fact that lineshaft 18 will be rotating for operating the rotary drive. To prevent the lineshaft 18 from acting against the drum 20 in such case, the sprocket 88 is declutched therefrom, but the descent of the drill pipe can be controlled, when the clutch sprocket 88 is disengaged, by conventional connection or transmission means, not shown, from the feed-off device 91' through the sprockets 91 and 88, thence to the drive 90, sprocket 86 and drum 20.

It is believed readily apparent that in the torque convertor rig, with the operation of the first engine 10 and by engagement of the clutch coupling 103 and the consequent rotation of the drive shaft 16, that by operation through either the sprocket 53 or the sprocket 54 the transmission shaft 17 may be driven at either the high or low speed, respectively, and that rotation may be transmitted through the sprocket 66 and the drawworks drive 76 to the lineshaft 18 by means of the chain connection to the sprocket 75. The drive then transmitted to the lineshaft 18 may be continued on to the drum 20 by connecting either the high speed drive 83 or the low speed drive 90.

It will be observed that in all instances where possible the clutches 87, 80, 73, 60 and 92 have been disposed at the outboard or outer end of their respective shafts for ready accessibility to make repairs and replacements.

It should be pointed out that, although clutch 80 for the high speed drum drive 83 is shown as positioned on the lineshaft 18 outboard of the sprocket 79 and bearing 77 for accessibility, this clutch 80 may be positioned on the drum shaft 84 outboard of the sprocket 82, although in so doing because of the position of the auxiliary hydromatic or dynamatic brake 85, the accessibility of the clutch 80 would be impeded.

The rotary table drive shaft 63 previously referred to is also driven through the drive shaft 16, coupled with the rotation of the transmission output shaft 17. The transmission shaft 17 has a sprocket 95 thereon suitably connected with a clutch 96 so that when the clutch 96 is engaged and the motion of the drive shaft 16 is imparted to the transmission shaft 17, through either the sprocket 64 or the sprocket 65, the sprocket 95 is operated to

transmit its motion to the rotary table drive 28 and from there to the sprocket 32, and then finally transmitted to the rotary table 40, as previously explained in connection with Figs. 3 and 8.

In the mechanical rig, as illustrated in Figs. 6 and 7, instead of the torque convertors 52 being positioned between the engines 10, 14 and 15 and their respective drive shafts, coupling 99 may be used, such as a hydraulic coupling or an electric coupling, either of which may be used in conjunction with a direct air clutch coupling or a mechanical coupling 103; also the coupling 103 may be used alone to couple the engine to its respective in-line countershaft.

In the mechanical rig, due to the elimination of the torque convertor 52, it is desirable to have more speed ratios for the hoisting drum as well as for the rotary table than is the case when a torque convertor 52 is used. To that end an additional sprocket 98 and a sprocket 97 are added to the lineshaft 18 so as to provide a second power input drive 100 from the sprocket 95 on shaft 17 to sprocket 98 on shaft 18. By the addition of the extra power drive 100 in the mechanical rig, it will be appreciated that eight speeds are made available for the drawworks hoisting drum 20 instead of the four drum speeds available with the set-up used with the torque convertor rig.

The rotary table speeds in the mechanical rig are also increased to provide four speeds instead of the two speeds available with the torque convertor rig, due to the addition of the second power drive 100 in the mechanical rig. The drive 30 to the right-angled gear box 34 as shown in Fig. 7 or the counter-shafts as shown in Fig. 8A are brought from a sprocket 97 on the lineshaft 18 instead of from the transmission output shaft 17 as in the torque covertor rig.

As was previously explained, when the countershaft arrangement of Fig. 8A is used, the rotary table 40 is declutched when desired by means of the clutch 160. When the right-angled gear box 34 is used with the mechanical rig, as shown in Fig. 6, there is provided a clutch 67 between the stub shaft 37 and the in-line counter shaft 38 so as to enable declutching of the rotary drive 63 when the lineshaft 18 is rotating for operation of the hoisting drum 20.

One of the most important features of the drilling rig of this invention is its versatility as regards conversion from a torque convertor rig to a mechanical rig, since only a minimum of alteration and change are required to make the change-over. For example, assuming that a torque convertor rig, as shown in Fig. 2, particularly, has been constructed; to change the torque convertor rig to a mechanical rig, a larger width sprocket 95 should be substituted for the rotary drive sprocket 95 used on the torque convertor rig. Likewise, clutch 96 would have to be larger in the mechanical rig than in the convertor rig. Suitable provision would have to be made on the shaft 17 so that the larger sprocket 95 and clutch 96 can be substituted thereon in the mechanical rig so that the entire shaft 17 does not have to be changed in making the conversion. Additionally, provision must be made on the lineshaft 18 to receive the sprockets 97 and 98; splines could be provided, for example, so that it would only be necessary to slide the additional sprockets on the shaft 18. The chain drive 30 is on the opposite side of the right-angled gear box 34 and thus a changing of the shaft 29 to locate the sprocket 32 on the opposite side should be effected. Such changes are in all very simple and require only a minimum of time, with the result that the same basic components of the rig are usable on either the mechanical rig or the convertor rig.

An understanding of the principle of operation and the advantages obtainable by the combination of this invention may be best visualized by the schematic drawings of Figs. 4 and 5. Since one of the main advantages of this invention is that both the drawworks and the rotary table are driven through a single engine, or one or more engines compounded therewith, while still maintaining the faculty of driving either the rotary table or the drawworks separately, on the event of failure of a clutch or chain drive in either the drawworks or the rotary table driver. The diagrammatic showing of Fig. 4 illustrates the operation when the rotary table drive 28 or rotary clutch 96 has failed or otherwise is inoperative, while Fig. 5 illustrates the operation of the rotary table drive when the drawworks drive 76 or input clutch 73 has failed, or is otherwise inoperative.

Referring now to Fig. 4 and assuming that the low speed drive 56 is used for driving the transmission shaft 17, the drawworks drive 76 then transmits the power to the lineshaft 18, which in turn carries the power through the high speed drum drive 83 to the drum 20. Of course, other speeds would be possible if the high speed drive 55 were utilized instead of the low speed drive 56 or if the low speed drive 90 were utilized instead of the high speed drive 83 for the drum 20. As will be appreciated, the combinations possible in connecting the drives for the drum 20 total four speeds in the arrangement of Figs. 2 and 4, wherein the torque convertor 52 is used, and wherein the rotary shaft drive 28 is brought directly from the transmission shaft 17 to the counter-shaft 29, as shown in Fig. 8 or to the right-angled gear box 34, as shown in Fig. 2.

In Fig. 5, it is assumed that there has been a clutch or chain failure of some sort in the drawworks drive so that the drawworks drive is shown dotted and the rotary table drive is shown solid, contrary to the showing in Fig. 4. In the arrangement of Fig. 5 with the drawworks 20 disabled, the rotary table 40 may be operated to prevent the sticking of the drill pipe until the drawworks is repaired, so that the drill pipe can then be raised to the surface.

The first engine 10 drives the drive shaft 16, and then through either the low speed drive 56 or the high speed drive 55, the transmission shaft 17 is rotated. From the transmission shaft 17 the rotary shaft drive 28 may then be operated as previously described. As can be seen, since either the drive 55 or the drive 56 may be used for the rotary table, there is a possibility of at least two speeds for driving the rotary table when the torque convertor rig is utilized.

By comparing the two views, Figs. 4 and 5, particularly, it is believed apparent that this invention minimizes the possibility of sticking the drill pipe in the well bore. This is due to the fact that if there is a chain or clutch failure in either the rotary table drive 28 or in the drawworks input drive 76, the other may be operated so that either the drill pipe may be hoisted with the drawworks to prevent sticking, or, if hoisting of the drill pipe is impossible, then the drill pipe may be rotated with the rotary table and circulation maintained with the mud pumps (not shown) to prevent sticking until it is possible to accomplish the hoisting.

It will be observed that in Fig. 4, the three engines 10, 14 and 15 are all being used in compound for both the operation of the drawworks drum 20 and the slush pump sheave or sprocket 115. The slush pump (not shown), connected to the sheave or sprocket 115 will be used for circulating the mud in the well bore or for mixing the mud in the mud pits as desired. In most cases, however, clutch 111 will be disengaged so that the sheave or sprocket 115 is also disconnected, because ordinarily the mud pumps will not be used when the hoisting operation is performed.

In Fig. 5, since drilling is being carried on when the rotary table 40 is rotating, the mud pumps are both being operated through the sheaves or sprockets 115 and 122 by means of the engines 14 and 15 in compound, so that adequate mud circulation can be maintained in the well bore.

Referring now to the operation of the second engine 14 and the third engine 15 in detail, references are made to Fig. 2A and Figs. 4 and 5, particularly. Connected to the second engine 14 is the second engine drive shaft 22, which is coupled therewith by means of a torque convertor 52 or, if desired, by a mechanical drive 99, indicated in Fig. 6, for the first engine 10. Bearings 101 and 102 are provided for the second engine drive shaft 22. In the first engine 10 a clutch 103 is provided for engaging or disengaging the engine 10 from the shaft 16, and a clutch 105 is provided for engaging or disengaging the engine 14 from the shaft 22 and a clutch 106 is provided for engaging or disengaging the engine 15 from the shaft 23.

A sprocket 108 is provided on the shaft 22 at one end thereof near the engine 14, which, in conjunction with the sprocket 118 on shaft 23 and the connecting chain drive 150, provides a means of compounding the power of engines 14 and 15 by engaging clutch 112 on shaft 22.

At the opposite end of shaft 22 is a sprocket 110 which in conjunction with sprocket 61 on shaft 16 and the con-

necting chain drive **62** provides a means of compounding engine **14**, or engines **14** and **15**, with the power of engine **10** by use of clutch **60** on shaft **16**. It will be noted that a mechanical clutch **112** is indicated for compounding engines **14** and **15**, whereas a direct air friction clutch **60** positioned outboard for easy service and accessibility is used for compounding engines **10** and **14**, or **10**, **14** and **15**.

In drilling operations, it is normal procedure to maintain the second and third engines **14** and **15** clutched or compounded together for long periods of time, and, therefore, the mechanical clutch **112** is entirely adequate, although, of course, a direct air friction clutch may be used. On the other hand, as the kelly is drilled down and an additional joint of drill pipe must be added, it is usually necessary to use the hoisting power of more than one engine. Therefore, for this frequently repetitive operation, it is an advantage to provide a direct air friction clutch **60** for compounding two or more engines to enhance the speed of operations.

At the outermost end of shaft **22** is disposed a countershaft **180** supporting pump driving sheave or sprocket **115**, supported in line with shaft **22** on bearings **116** and **117** with this sheave or sprocket **115** driving the slush pump (not shown) by chain or belts by engaging clutch coupling **111**.

In connection with the third engine **15** it is arranged similarly to the other engines, and the shaft **23** has thereon three sets of sprockets **118**, **119** and **120**. The first sprocket **118** is connected with the sprocket **108** of the second engine **14** through chain drive **150** and clutch **112** as referred to above. Two additional sprockets **119** and **120** provide low and high speed drives, respectively, to pump counter-shaft **123**. The sprocket **119** is connected with the sprocket **125** and the sprocket **120** is connected with the sprocket **126**. A direct air friction clutch coupling **130** is provided to couple or uncouple the slush or mud pump drive sheave or sprocket **122**, and a clutch **131** is provided for engaging either the high speed drive **140** or the low speed drive **141**.

The arrangement as shown constitutes a two-speed pump drive desirable on a mechanical rig. If such two-speed pump drive is not desired, one drive as **140** and the clutch **131** may be omitted.

Other variations of the clutching arrangement of the two-speed pump drive are possible, such as a direct air friction clutch positioned outboard on shaft **23** controlling drive **140**, and a like clutch positioned outboard on shaft **123** controlling drive **141**. In this instance pump drive sheave or sprocket **122** would be mounted directly on shaft **123**. Bearings **144** and **145** support the shaft **23**, while bearings **146** and **147** support the shaft **123**, and additional bearings **148** and **149** are used to support the slush pump drive sheave **122**. The guard **24** previously mentioned serves as an oil tight enclosure as well as protection for the enclosed chain drives.

As illustrative of the possible combinations in the use of the three engines **10**, **14** and **15**, in addition to those shown in Figs. 4 and 5, the third engine **15** could drive the slush or mud pump drive sheave **122** through the low speed drive **141**. Alternatively, of course, the high speed drive **140** could be used. The second engine **14** could drive the slush pump drive sheave **115** alone; or if desired, it may be entirely unclutched at the clutch **105** and may be left idle if only one slush or mud pump is necessary. Alternately, engine **14** may be compounded with engine **15** by engaging clutch **112** to drive the back pump through drive sheave or sprocket **122**, or conversely engines **14** and **15** can be used to drive the side pump through drive sheave or sprocket **115** by engaging clutch **111**, or engine **15** can be used separately to drive the back pump through sheave **122** and engine **14** to drive side pump through drive sheave or sprocket **115**, enabling both pumps to be driven at different relative speeds.

It is believed readily apparent that a drilling rig apparatus has been provided wherein a single engine, or engine compounded therewith, may be used in driving both the drawworks and the rotary table, while at the same time the sticking of drill pipe within a well bore due to a chain or clutch failure in the drive is eliminated, due to the fact that either the rotary table may be operated or the drawworks drum may be operated so that rotation of the drill pipe will be possible, to prevent its sticking should it become impossible to hoist the pipe for any reason, and it will be possible to hoist the pipe should the rotary table drive become inoperative.

Broadly, this invention contemplates a drilling rig apparatus wherein, from a single engine, or engines compounded therewith, a rotary table drive and a drawworks drum drive may be operated to minimize the sticking of drill pipe within a well bore.

Further mention should be made of the advantages derived from the drilling rig of this invention with regard to the feed-off sprocket **91** which gives a provision for a feed-off device (not shown), which gives a provision of the overall drive arrangement can be clutched directly to the drawworks lineshaft **18** with the sprocket **88** keyed to the lineshaft **18**, so that in the torque convertor rig, when the rotary table is being driven, the lineshaft **18** can remain free of the power drive **76** by declutching clutch **73**, thus enabling control of the descent of the drill pipe through the feed-off sprocket **91**, sprocket **88**, drive **90**, and sprocket **84** while operating the rotary table. In prior art rigs, the shaft **18** or similar shaft would be rotating to operate the rotary table, so that an additional clutch for the sprocket **88** would be required for the control of the descent of the drill pipe through the feed-off device.

It should also be noted that the catshaft **19** shown in Fig. 1 diagrammatically, has been omitted from the other figures for clarity. However, another advantage is present in the torque convertor rig in the use of the catshaft **19** which would be driven by a chain drive from a sprocket on lineshaft **18** to a sprocket on the catshaft **19**. By actuation of the drive **76** when the clutch **73** is engaged, the catshaft drive (not shown) could be actuated; due to the separation of the drawworks drive and the rotary drive, the catshaft **19** can be operated while the rotary table **40** is operating. Thus, instantaneous engagement of the catshaft **19** is made possible, particularly since it is controlled by the direct air clutch **73**.

What is claimed is:

1. In a drilling rig combination, a drawworks drive shaft having a driven sprocket fixed thereon, a rotary table drive shaft having a driven sprocket fixed thereon, a transmission shaft having a pair of driving sprockets drive-connected with said driven sprockets, independently operating clutch mechanisms to clutch the driving sprockets to the transmission shaft, a pair of driven sprockets, respectively fixedly mounted and rotatably mounted on the transmission shaft, a slidable gear and clutch element for detachably coupling the rotatably mounted sprocket to the transmission shaft, a power shaft having a driving sprocket fixed thereon and drive-connected with the driven sprocket which is clutchable to the transmission shaft and a driving sprocket rotatably mounted thereon and drive-connected with the driven sprocket fixed to the transmission shaft and a slidable gear and clutch element on the power shaft arranged for selective clutching engagement with the last mentioned driving sprocket and mesh engagement with the other gear element.

2. A drilling rig power drive for a drawworks and a rotary table, including a power input shaft, a power output shaft, a driving sprocket rotatably mounted on the input shaft, a driven sprocket drive-connected thereto and fixed on the output shaft, a second driving sprocket fixed on the input shaft, a driven sprocket drive-connected thereto and rotatably mounted on the output shaft, a combined clutch and gear slidably splined on the input shaft and slidable in one direction to clutch the rotatably mounted driving sprocket thereto, a combined clutch and gear slidably splined on the output shaft and slidable in one direction to clutch the rotatably mounted driven sprocket thereto, said gears being slidable out of sprocket clutching relation and into mesh with one another, a pair of independently operable clutch mechanisms at opposite ends of the output shaft, and drive transmitting connections for a drawworks and a rotary table joined to said clutch mechanisms respectively for selective drive.

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