March 11, 1952 C. M. O'LEARY 2,589,121

AUTOMATIC DRILLING MACHINE

Filed June 13, 1946 3 Sheets-Sheet 1

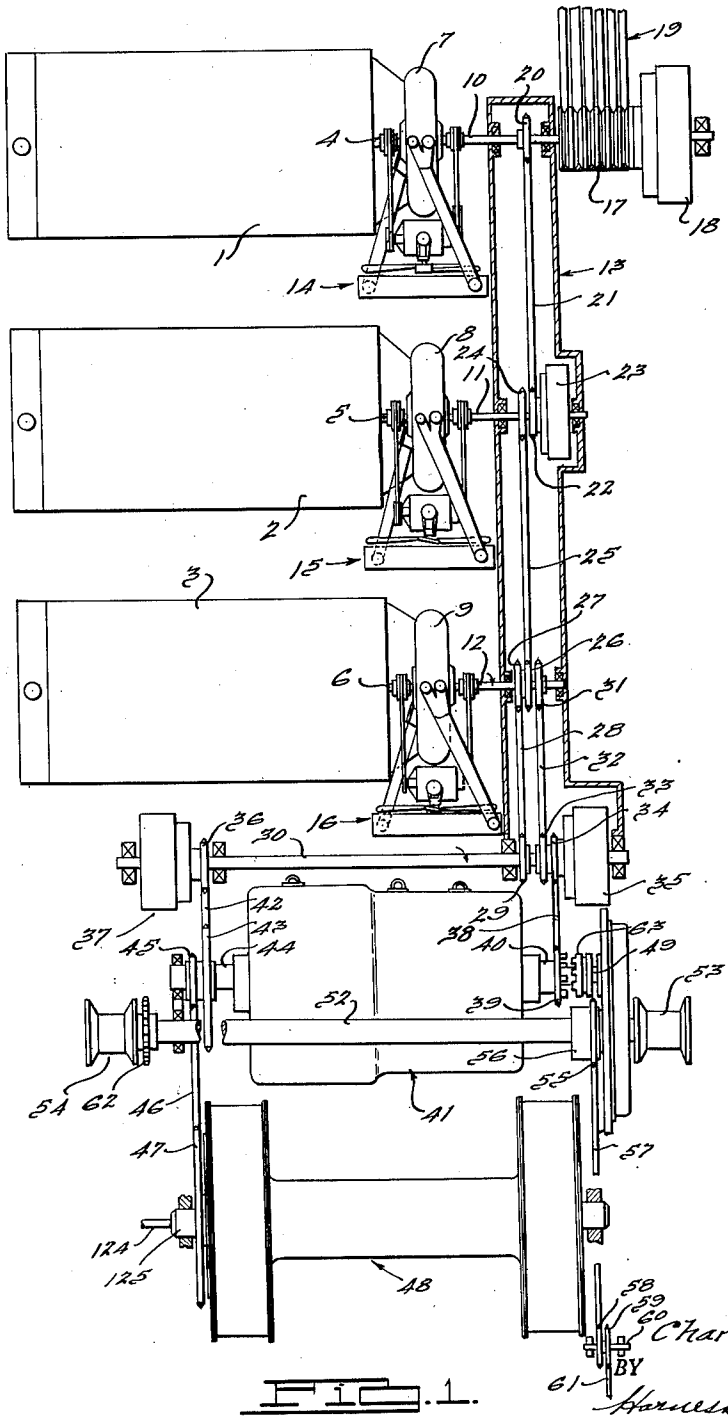


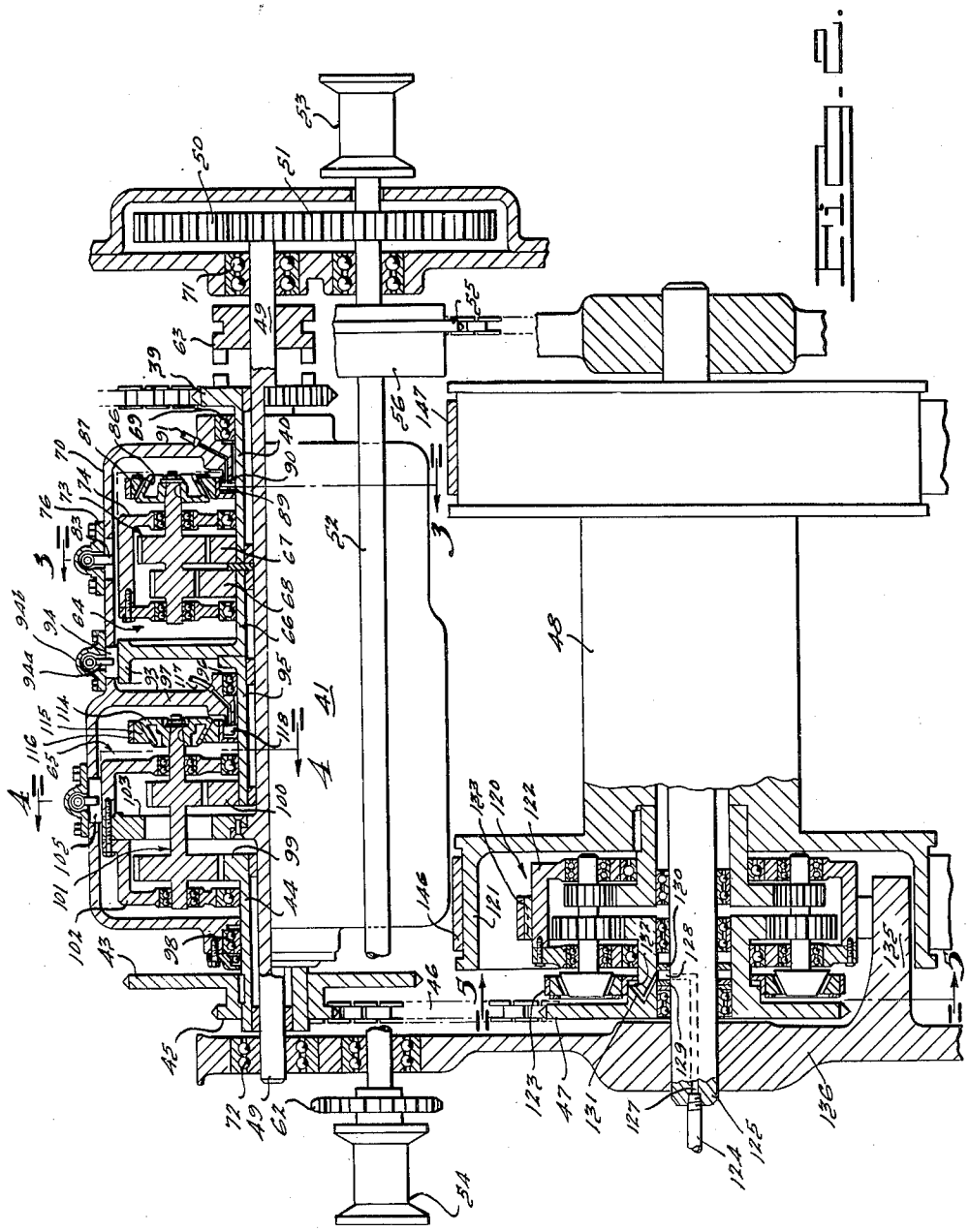
FIG. 1.

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AUTOMATIC DRILLING MACHINE

Filed June 13, 1946 3 Sheets-Sheet 3

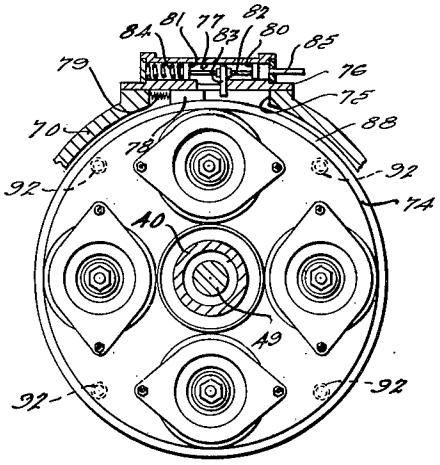


Fig. 3.

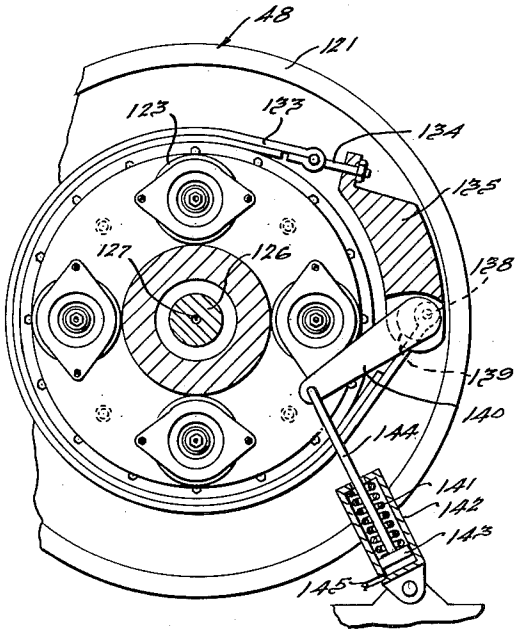


Fig. 5.

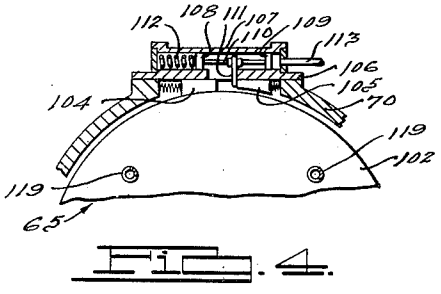


Fig. 4.

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UNITED STATES PATENT OFFICE

2,589,121

AUTOMATIC DRILLING MACHINE

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Application June 13, 1946, Serial No. 676,450

20 Claims. (Cl. 255—19)

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The present invention relates to rotary well drilling machines and constitutes an improvement on the invention disclosed in applicant's copending applications, Serial No. 602,620, filed June 30, 1945, on Automatic Well Drilling Mechanism, and Serial No. 647,677, filed February 15, 1946.

Rotary well drilling machines conventionally include a hoisting mechanism for hoisting, lowering or supporting part of the weight of the drill stem, a rotary table for rotating the drill stem, one or more slush pumps for forcing the drilling fluid or mud into the drill stem during drilling, and a suitable source of power. The operation of drilling requires a simultaneous supply of power to the rotary table and slush pump while the weight of the drill stem is partially supported by a hand-operated brake band on the hoisting drum. As the drilling progresses, additional lengths of drill stem are added from time to time. When it is necessary to change drill bits, all of the drill stem must be hoisted step by step and the successive lengths disconnected and laid aside. In order to reduce the time lost in removing the drill stem from the hole and reinserting the stem, the hoisting and lowering operations must be conducted at high speed. Since, particularly in deep drilling operations, the weight of the drill stem is exceedingly high, this necessitates the application of great power to the hoist for rapid hoisting and exceedingly high braking forces to the drum in order to terminate each successive lowering operation in the minimum time interval. During drilling operations, lesser amounts of power are required to separately drive the rotary table and the slush pumps.

In applicant's copending application, Serial No. 647,677, filed February 15, 1946, means are provided for achieving the above results, including a plurality of engines which are connected through individual hydrokinetic torque converters and a multiple speed transmission either jointly to the hoisting drum or separately to the slush pump and rotary table. The multiple speed transmission may be controlled manually or, in the case of hoisting, may be subject to automatic control effective to maintain the speed ratio of the torque converters within an efficient range. The torque converters may be employed to brake the hoisting drum during drill stem lowering operations. To make possible operation of the torque converters at inefficient speed ratios, including stall and reverse braking conditions, they are preferably provided with differentially driven cooling mechanisms of the type disclosed in applicant's copending applications, Serial No. 571,656, filed January 6, 1945, and now abandoned and Serial No. 666,626, filed May 2, 1946.

It has been proposed that for drilling purposes, means be provided for varying the pressure of the drill bit on the bottom of the hole

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inversely with respect to the torque required to drive the rotary table in order to obtain optimum drilling conditions and avoid twist-offs of the drill stem. In applicant's copending application, Serial No. 602,620, filed June 30, 1945, improved means for this purpose are disclosed. The mechanism there disclosed is characterized by the fact that an increase in the table torque imposes an increased lifting force on the hoisting drum which is a lower percentage of the total lifting force exerted by the drum on the drill stem than the percentage increase in table torque. This result is achieved automatically by transmitting to the hoisting drum a substantially constant drill stem lifting torque which is sufficient to balance the major portion of the weight of the drill stem and by driving the rotary table through a differential mechanism which imposes an additional drill stem lifting torque on the drum which is proportional to the table torque but which in no case exceeds a minor proportion of the force required to support the drill stem.

It is a general object of the present invention to provide an improved rotary drilling machine incorporating all of the features of the previous inventions in the copending applications in a compact, practical mechanism.

Another object of the present invention is to provide, in the drive connection between the engine and the hoisting drum and table, a single multiple speed ratio transmission mechanism of improved design and construction which may be selectively employed to change the speed ratio in the drive connections to either the hoisting drum or the table.

Another object is to provide a transmission mechanism of the type last mentioned which includes a change speed planetary transmission unit effective to vary the speed ratio in the drive from the engines to either the hoisting drum or the rotary table when they are driven separately, and which may also be employed during automatic drilling to impose on the hoisting drum a drill stem balancing force proportional to the table torque.

Another object of the present invention is to provide an improved and simplified means for varying the ratio between the table torque and the table torque reaction imposed upon the drum during automatic drilling.

Another object of the present invention is to provide, in connection with the hoisting drum, a combination two-speed transmission and clutch unit which is positioned to a large extent within the confines of the usual brake flange on the hoisting drum.

Another object of the present invention is to provide an improved selective drive connection between a plurality of engines and the slush pump, rotary table and hoisting drum of a drilling machine to the end that any desired combination of engines may be operatively con-

nected to any one of the three above-mentioned driven elements.

Other objects and advantages of the invention will become apparent from the following specification, the accompanying drawings and the appended claims.

Referring to the drawings:

Figure 1 is a more or less diagrammatic plan view showing the general arrangement of the major elements of the complete machine, with the slush pump and rotary table omitted;

Figure 2 is an enlarged plan view, partly in section, of the hoisting drum and transmission units disclosed in Figure 1;

Figure 3 is a fragmentary transverse section taken on the line 3—3 of Figure 2;

Figure 4 is a fragmentary section taken on the line 4—4 of Figure 2; and

Figure 5 is an elevation view taken partly in section on the line 5—5 of Figure 2.

As best shown in Figure 1, the preferred form of the apparatus includes three engines 1, 2 and 3, the output shafts of which are connected, respectively, to the input shafts 4, 5 and 6 of three hydrokinetic torque converters 7, 8 and 9. The output shafts 10, 11 and 12 of the torque converters extend into a suitable housing, indicated generally at 13. Each of the hydrokinetic torque converters is provided with a fluid cooling unit including a differentially driven air circulating fan and indicated generally at 14, 15 and 16. Since the detailed design and construction of the engines, the torque converters and the differentially driven cooling units, per se, form no part of the present invention, they need not be further described. However, reference may be had to applicant's copending applications, Serial No. 571,656, filed January 6, 1945, and Serial No. 666,626, filed May 2, 1946, for a more complete disclosure of these features.

The output shaft 10 of torque converter 7 projects entirely through the housing 13 and carries a multiple V-belt pulley 17, which is freely journaled on the shaft 10 but may be connected thereto by engagement of an air operated clutch, indicated diagrammatically at 18. A multiple V-belt drive, indicated generally at 19, extends from the pulley 17 to the slush pumps, not shown, in the usual manner.

A sprocket 20 is fixed on the shaft 10 within the housing 13 and is connected by means of a chain 21 to a sprocket 22, which is freely journaled on the shaft 11 within the housing but which may be connected to the shaft 11 by engagement of an air operated clutch, indicated generally at 23. A second sprocket 24 is fixed on the shaft 11 within the housing 13 and is connected by a chain 25 to one of a pair of fixedly connected sprockets 26 and 27, which are freely journaled on the shaft 12 within the housing. The other sprocket 27 of the pair is connected by a chain 28 to a sprocket 29 fixed on a countershaft 30, which is journaled in any suitable manner on the base of the drilling machine, not shown. A sprocket 31 is fixed on the shaft 12 within the housing 13 and connected by a chain 32 to a sprocket 33, which is one of a pair of sprockets 33 and 34 which are fixedly connected together and freely rotatable upon the shaft 30. The double sprocket 33 and 34 may be fixed to the shaft 30 by engagement of an air operated clutch, indicated diagrammatically at 35.

As a result of the above connections, it will be apparent that engine 2 is always connected to shaft 30, that engine 3 may also be connected to shaft 30 by engaging clutch 35, or engine 1 may also be connected to shaft 30 by engaging clutch 23. All three of the engines may be connected to shaft 30 by engaging both of the clutches 23 and 35. It will also be noted that engine 3 is always connected to the double sprocket 33—34. Engine 1 may be connected to the slush pump by engaging clutch 18; engine 2 may be connected to the slush pump by engaging clutches 18 and 23; and all three of the engines may be connected to the slush pump by engaging clutches 18, 23 and 35. Thus, a wide variety of combinations of engine drive connections may be achieved by the control of only three clutches.

The opposite end of the shaft 30 is provided with a sprocket 36, which is normally freely rotatable with respect to the shaft 30 but may be fixed thereto by operation of an air clutch 37. The sprocket 34 of the double sprocket 33—34 is connected by a chain 38 to a sprocket 39 mounted on a tubular shaft 40 projecting from one end of a multiple speed transmission, indicated generally at 41, while the sprocket 36 is connected by a chain 42 to a sprocket 43 on a shaft 44 projecting from the opposite end of the transmission 41. Likewise fixed to the shaft 44 is a sprocket 45 which is connected by a chain 46 to the drive sprocket 47 for the hoisting drum, indicated generally at 48. The transmission 41 has a second output shaft 49 projecting from its right-hand end and connected by a pair of change gears 50 and 51 to a countershaft 52 upon the ends of which are mounted a pair of cat heads 53 and 54. A sprocket 55 is normally freely rotatable upon the countershaft 52, but may be fixed thereto by engagement of an air operated clutch 56. Sprocket 55 is connected by means of a chain 57 to a double sprocket 58—59 journaled on a shaft 60, and the sprocket 59 is connected by a chain 61 to a conventional rotary table (not shown). The shaft 52 is positioned at a substantially higher elevation than the axis of transmission 41 and, consequently, the chain drive 57 will pass over the right-hand support for the stationary drum shaft. In addition to the cat heads and sprocket 55, shaft 52 carries a sprocket 62 from which the usual sand reel may be driven by a suitable chain.

It will be apparent from the mechanism so far described that one or more of the engines may be connected through chain 38, tubular shaft 40 and transmission 41 either to the hoisting drum 48 or to the rotary table through shaft 49 and the table drive connections. Alternatively, by engaging clutch 37, a drive may be established directly to the hoisting drum from shaft 30 through chain 42, sprockets 43 and 45 and chain 46, or shaft 30 may be connected to the table through chain 42, shaft 44, transmission 41, shaft 49 and the associated table drive connections. In addition, as hereinafter more fully pointed out, the tubular shaft 40 may be fixed to the shaft 49 by engagement of a dog clutch 63. In that case, the chain drive 38 may drive into the transmission 41 through shaft 49 to drive the hoisting drum in reverse, or the chain drive 38 may drive the shaft 49 and, by engagement of clutch 56, the countershaft 52, thus providing a direct drive for the table, the cat heads or the sand reel.

As best shown in Figure 2, the transmission 41 includes a pair of planetary transmission units connected in series and indicated generally at 64 and 65. Transmission unit 64 includes the previously mentioned tubular input shaft 40 and a

tubular output shaft 66 on which is fixed a pair of sun gears 67 and 68, respectively. The tubular shaft 40 is journaled by means of suitable bearings 69 on the casing 70 of the transmission, and both of the tubular shafts are journaled by means of suitable bearings on the internal shaft 49, which extends internally through the transmission 41 and is journaled at its ends in bearings 71 and 72. The gears 67 and 68 mesh with a plurality of planet gear clusters, one of which is indicated generally at 73. Each gear cluster is journaled in a planet cage 74, which, in turn, is journaled upon the tubular shafts 40 and 66.

As the result of this construction and the relative sizes of the gears in the transmission unit 64, rotation of the tubular input shaft 40 will effect rotation of the tubular output shaft 66 in the same direction but at a reduced speed when the planet cage 74 is held stationary. Any desired change in the speed ratio may be provided but, for purposes of illustration, it may be assumed that under the above stated conditions shaft 66 is rotated at one-half the speed of shaft 40. When torque is transmitted from shaft 40 to shaft 66 in this manner, a torque reaction on the planet cage 74 is in a direction opposite to that of the torque delivered to shaft 66.

With the particular connections illustrated in the drawings, shaft 40 will tend to rotate in a counterclockwise direction, as viewed in Figure 3, and, consequently, the torque reaction on the planet cage 74 will tend to cause a clockwise rotation of the cage. In order to prevent such rotation automatically and thus hold the planet cage stationary, a plurality of one-way clutch blocks is provided between the housing 70 and the planet cage. The construction of one of these clutch blocks is shown in section in Figure 3. As there illustrated, the casing 74 is provided with an opening 75 which is closed by means of a cover plate 76 having a cylinder 77 formed therein. A one-way clutch block 78 is fitted between the flat underside of the cover plate 76 and the periphery of the planet cage 74 in such a manner that any tendency of the planet cage to rotate in a clockwise direction will cause a wedging of the block 78 between the cover plate and the cage and thus act to prevent such rotation. A coil spring 79 normally urges the clutch block toward wedging position. It will be observed, however, that the clutch block 78 will not resist rotation of the planet cage in a counterclockwise direction. Means are provided for shifting the clutch block 78 to the left, as viewed in Figure 3, when it is desired to permit clockwise rotation of the cage. This means includes a pair of pistons 80 and 81 positioned within the cylinder 77 and a piston rod 82. A dog 83 is fixed to the rod 82 and projects through a suitable slot in the plate 76 into a position opposite the end of clutch block 78. A coil spring 84 normally holds the pistons and associated dog 83 in an inoperative position, as illustrated in Figure 3, in which position the dog does not interfere with normal operation of the block 78. When it is desired to render the block 78 inoperative, air under pressure is admitted through a pipe 85 at the right-hand end of the cylinder 77, thus forcing the pistons and dog to the left and disengaging the block 78. Under these circumstances, the planet cage is free to rotate in clockwise direction, as viewed in Figure 3.

Means are provided for establishing a 1–1 driving connection between the tubular shafts 40 and 66. This means includes a separate clutch cone 86 fixed axially on each planet gear cluster and a plurality of cone clutch elements 87 carried by a plate 88, which is rotatably journaled on the tubular shaft 40. The inner portion of the plate is provided with an annular recess 89, which constitutes a cylinder adapted to receive an annular projection or stationary piston 90 fixed to the casing 70. When air is supplied through a pipe 91 to the interior of the cylinder 89, the plate 88 will be shifted to the left, as viewed in Figure 2, thus engaging the planet cluster cone clutches and thereby preventing rotation of the planet clusters about their own axes. This establishes a 1–1 drive connection between the tubular shafts 40 and 66. Since on such rotation, the planet cage turns with the tubular shafts 40 and 66 in a counterclockwise direction, as viewed in Figure 3, the one-way clutch blocks 79 automatically disengage. When no air is supplied through pipe 91, the planet cluster cone clutches are disengaged by a plurality of coil springs positioned between the planet cage 74 and the plate 88 in the positions indicated in dotted lines at 92 in Figure 3.

Thus, the planetary transmission unit 64 automatically provides one speed ratio when air is admitted under pressure to pipe 91 and another when no pressure is applied through that pipe. Any suitable means under either manual or automatic control may be provided for supplying air to the pipe 91 as desired, a suitable apparatus for that purpose being disclosed in applicant's copending application, Serial No. 647,677, filed February 15, 1946.

Fixed to the tubular shaft 66 is an enlarged brake flange 93, which is adapted to be engaged by a plurality of one-way clutch blocks similar in construction and mode of operation to the previously described clutch blocks 78. However, the clutch blocks 94 associated with the flange 93 are positioned on the opposite side of the clutch block release dog 94*a*, as compared with the arrangement shown in Figure 3. Consequently, when air under pressure is supplied to the cylinder 94*b*, the clutch blocks 94 may engage and prevent counterclockwise rotation of the flange 93, as viewed from the right-hand end of the transmission. When no air is supplied to the cylinder 94*b*, springs similar to the spring 84 shift the clutch blocks 94 to inoperative position. Since the mechanism for holding the brake flange 93 and, consequently, the tubular shaft 66 stationary is otherwise identical to that illustrated in Figure 3, further illustration or description is believed unnecessary.

Tubular shaft 66 is fixed in any suitable manner to the tubular input shaft 95 of the second planetary transmission 65. The shaft 95 is journaled in suitable bearings 96 carried by a web 97 forming a portion of the housing 70, and is also journaled by additional bearings on the internal shaft 49. The previously mentioned tubular output shaft 44 of the transmission 41 constitutes one output shaft of the transmission unit 65, the shaft 44 being journaled in suitable bearings 98 carried by the casing and also being journaled on the internal shaft 49. The tubular shafts 44 and 95 carry spur gears 99 and 100, respectively, which mesh with a plurality of planet gear clusters. Each of these clusters includes two gears fixedly connected together, and one of the clusters is indicated generally at 101 in Figure 2. The planet gear clusters are journaled in a planet cage 102, which is journaled on the shafts 44 and 95 and

which is fixed by means of a central web 103 to the internal shaft 49 in any suitable manner.

It will be observed that the planet cluster gears of transmission unit 65 are reversed in their position with respect to those in transmission unit 64, with the result that when power is supplied to the shaft 95 and the planet cage 102 is held stationary, shaft 44 will rotate in the same direction as shaft 95 but at a higher speed. During such operation, the torque reaction on the planet cage 102 tends to rotate the planet cage in the same direction as the shafts 44 and 95, namely a counterclockwise direction, as viewed in Figure 4.

As best shown in Figure 4, means are provided for selectively preventing rotation of the planet cage 102 in either direction. This means comprises a plurality of pairs of oppositely disposed one-way clutch blocks 104 and 105, which are adapted to be wedged between the periphery of planet cage 102 and the undersurface of a plate 106 fixed to the casing 70. A cylinder 107 is fixed to the plate 106 and contains a pair of pistons 108 and 109 connected by a piston rod 110 to which is fixed a dog 111. A spring 112 normally urges the pistons and associated dog 111 to the right, as viewed in Figure 4, thereby effecting disengagement of the one-way clutch block 105. When air under pressure is admitted to pipe 113, the pistons and associated dog 111 are shifted to the left against the action of the spring 112, engage the one-way clutch block 104, and render that clutch block inoperative. Normally no air is applied to the cylinder 107, and consequently, the parts remain in the position shown in Figure 4, in which the planet cage 102 is free to rotate in a counterclockwise direction, as viewed in that figure.

In order to establish a 1–1 drive connection through the transmission unit 65, each of the planet gear clusters is provided with a clutch cone element 114 adapted to cooperate with a cone clutch 115 carried by a plate 116 journaled on shaft 95. The construction and arrangement of the cone clutch elements 114 and associated clutches 115 are identical to that of the previously described clutch cones 86 and associated clutches 87 except that the apex of the cone clutches is reversed. Consequently, when air is supplied through a pipe 117 to the annular clutch operating cylinder 118, the clutch plate 116 is shifted to the left, as viewed in Figure 2, thereby disengaging the cone clutches. A plurality of coil springs 119 positioned between planet cage 102 and the clutch plate 116, in the positions best indicated in Figure 4, normally operates to hold the cone clutches 115 in engagement with the clutch cones 114, thereby locking the planetary transmission unit 65 in a 1–1 ratio.

In order to provide additional speed ratios in the drive connections to the hoisting drum and at the same time secure a disengageable clutch connection between shaft 44 of transmission 41 and the hoisting drum, an additional two-speed planetary transmission, indicated generally at 120, is positioned within the brake drum flange 121 of the hoisting drum 48. Since this transmission is to a large extent identical in construction to the transmission unit 64 previously described, a detailed description of the mechanism is unnecessary. It may be noted, however, that the transmission is so arranged that when the planet cage 122 thereof is held stationary, the drum will be rotated at a lower speed than the drive sprocket 47. When the planet cage cone clutches 123 are engaged, the drum will rotate at the same speed as the drive sprocket 47. The cone clutches 123 are engaged by air pressure and disengaged by spring pressure, in the manner described in connection with the clutches 87. The air for effecting engagement of the clutches 123 is supplied through a pipe 124 to a passageway 127 in the stationary shaft 125 which supports the hoisting drum. The passageway 127 communicates with an annular space 128 surrounding the shaft 125 and defined by a pair of seals 129 and 130. The annular space 128, in turn, is connected by a passageway 131 to the interior of the cylinder 132 formed by the cone clutch plate.

While, if desired, one-way clutch blocks of the type shown in Figures 3 and 4 may be employed to hold the planet cage 122 stationary when desired, in the preferred form of the invention illustrated this function is performed by means of a brake band 133 which engages the periphery of the planet cage. As best shown in Figure 5, one end of the brake band is adjustably anchored by an eye-bolt 134 to an arm 135, which is fixed to the frame 136 that supports the shaft 125. The arm 135 projects within the drum flange, as best shown in Figure 2, to serve as an anchor for the brake band 133. The opposite end of the brake band 133 is fixed eccentrically at 138 to a cylindrical member 139, which is journaled on the arm 135. The arm 140 fixed to the cylindrical member 139 is normally held in the position illustrated in Figure 5, in which the brake is applied, by means of a coil spring 141 positioned within a cylinder 142 and acting on a piston 143 which is connected to the arm 140 by a piston rod 144. When air under pressure is supplied through a pipe 145, the spring 141 will be compressed and the arm 140 rotated in a clockwise direction, as viewed in Figure 5, thereby releasing the brake.

It will be apparent from the above that when no air is supplied to either of the pipes 124 and 145, the transmission unit 120 will be in its lower speed ratio, in which the drum rotates at a speed less than that of the drive sprocket 47. Application of air under pressure to both of the lines 124 and 145 will establish the higher or 1–1 speed ratio drive between the sprocket 47 and the drum. If air is supplied only to the pipe 145, the sprocket will be disconnected from the drum and the latter will then be free of all drive connections to the transmission. The hoisting drum 48 is provided with a pair of brake bands 146 and 147 adapted on application to hold the drum stationary in the usual manner.

It will be apparent that in lieu of the clutch blocks employed in connection with the planetary transmission units 64 and 65 and the brake flange 93, brake bands similar in construction and mode of operation to that illustrated in Figure 5 may be employed. However, the one-way clutch blocks are preferred inasmuch as they may be spaced equally about the periphery of the planetary cage or brake flange, with the result that the braking loads on the bearings of the transmission are balanced.

While the means for supplying air to effect engagement of the clutches 18, 23, 35 and 37 are not illustrated, they may be supplied with the air through the clutch shafts by passageways in the shafts communicating with stationary air supply manifolds mounted on the ends of the shafts in the usual manner. The air supply for the clutch 56 is similarly arranged except that the air supply manifold is preferably located intermediate the ends of the shaft 52. The interior construc-

tion and mode of operation of these air clutches may be of any known or conventional type.

The number and magnitude of the different speed ratios provided by the transmission mechanism of the present invention may be varied widely, as desired, by changing the relative sizes of the sprockets and gears employed in the mechanism. However, for purposes of illustration, it will be assumed that the relative proportions of these elements are as follows. All of the sprockets 20, 22, 24, 26, 27, 29, 31, 33, 34 and 39 are of the same size. Transmission unit 64 is so proportioned that when the planet cage 74 is held stationary, shaft 66 will rotate in the same direction but at half the speed of shaft 40. Transmission unit 65 is of such construction that when the planet cage 102 is held stationary, shaft 95 will rotate in the same direction and at half the speed of shaft 44; when shaft 44 is held stationary, planet cage 102 will rotate in the same direction but at twice the speed of shaft 95; and when shaft 95 is held stationary, planet cage 102 will rotate in the opposite direction from that of shaft 44 but at the same speed. The diameter of the sprocket 43 is four times the diameter of the sprocket 36, and the diameter of sprocket 47 is three times the diameter of sprocket 45. The planetary transmission unit 120 is similar in design to transmission unit 64 in that when the planet cage 122 is held stationary, the hoisting drum travels in the same direction but at half the speed of the drive sprocket 47. The speed ratio of the complete drive connection between shaft 49 and the rotary table may be varied at will by substituting different sets of change speed gears 50 and 51, but may, for example, be a ratio of approximately 6–1 between the speed of shaft 49 and the speed of rotation of the table.

The operation of the transmission mechanism is as follows:

Hoisting

When no control air is supplied to any of the clutches or brakes in the apparatus and the manually operated clutch 63 is disengaged, engine 3 is connected to the hoisting drum 48 and the overall transmission drive is in its lowest speed ratio, which, in the example given above, would be a ratio of 12–1 between the speed of rotation of the shaft 12 and the speed of rotation of the drum 48. The drive to the drum under these conditions is from shaft 12 through sprockets 31, 33, 34 and 39 to the tubular input shaft 40 of the transmission 41.

Under these conditions, the clutch 87 will be held disengaged by the springs 92 and the planet cage 74 will be held against clockwise rotation, as viewed in Figure 3, by the one-way clutch blocks 78. Consequently, shaft 66 will rotate in the same direction as shaft 40 but at half speed. Since no air is supplied to the cylinder 94b, the clutch blocks 94 for the flange 93 will be held in inoperative position, thus permitting rotation of the shaft 66 and the connecting input shaft 95 of the transmission unit 65. Since no air is supplied through the pipe 117 to disengage clutch 115, that clutch will be held engaged by the springs 119. Consequently, shaft 44 will be locked to shaft 95 and rotate therewith. The planet cage 102, which likewise rotates in unison with the shafts 44 and 95, is free to rotate in its forward or clockwise direction, as viewed in Figure 4, since the clutch blocks 105 are held in inoperative position by the springs 112. A double sprocket 43—45 is fixed to the shaft 44 and, consequently, drives the sprocket 47 for the hoisting drum. The cage 122 of the drum planetary transmission unit 120 will be held stationary by the brake band 133, since no air is supplied to the pipe 145, and the clutches 123 will be held disengaged by their clutch release springs, which are similar in construction and operation to the previously mentioned springs 92. Therefore, the hoisting drum will rotate in the same direction but at one-half the speed of the sprocket 47. Since clutch 56 is disengaged, no power will be supplied to the rotary table under these conditions.

None of the clutches 16, 23, 35 or 37 is involved in any of the speed ratio changes required during forward or hoisting rotation of the drum 48. Consequently, in the lowest speed ratio drive connection mentioned above or in any of the higher speed ratios hereinafter described, additional engines may be connected to the drum through the transmission without changing the mechanical speed ratio in the drive connection. Thus, if in addition to engine 3 it is desired to connect engine 2 to the drum, clutch 35 is engaged. If it is desired to connect all three of the engines to the drum, clutches 23 and 35 are engaged.

In order to establish the second or next higher speed ratio to the transmission, it is only necessary to supply air through pipe 91 to effect engagement of the cone clutches 87 of transmission unit 64. This provides a 1–1 direct drive through the transmission unit 64 and thus doubles the speed ratio of the overall drive. Under these conditions, the speed ratio between shaft 12 and the drum is 6–1. The next higher speed ratio is achieved by simultaneously supplying air under pressure to the previously mentioned pipe 91 and also to the pipes 113 and 117. The application of air pressure through the pipe 117 disengages the cone clutch elements 115 and the application of air through the pipe 117 shifts the clutch block dogs 111 to the left, as viewed in Figure 4, thereby permitting the clutch blocks 105 to hold the planet cage 102 against counterclockwise rotation, as viewed in Figure 4. Under these circumstances, the planet cage remains stationary and shaft 44 is rotated in the same direction but at twice the speed of shaft 95. This increases the overall speed ratio between the shaft 12 and the drum to a ratio of 3–1.

To provide the fourth or highest speed ratio, air under pressure is supplied simultaneously to the pipes 91, 113, 117, 124 and 145. This involves no change of the conditions within the transmission 41 but effects a 1–1 drive connection through the planetary transmission unit 120 between the drive sprocket 47 and the drum 48. This provides an overall speed ratio between the shaft 12 and the drum of 1½–1.

It will be appreciated that the four different speed ratios thus provided may be obtained either by manually actuating suitable control valves in the air pressure supply lines or by subjecting such control valves to the action of an automatic shifting control mechanism such as that disclosed in applicant's previously mentioned copending application, Serial No. 647,677, filed February 15, 1946.

Reverse drum drive

In order to drive the drum in reverse, it is necessary to manually engage clutch 63, thus locking the shaft 40 to the shaft 49, and also supply air under pressure to the pipe 95, cylinder 94b and pipe 117. Under these conditions, power

is supplied through the chain 38 and sprocket 39 to the internal shaft 49 to rotate the planet cage 102 of the transmission unit 65 in a counterclockwise direction, as viewed in Figure 4. The application of air under pressure to the cylinder 94b renders the one-way clutch blocks 94 operative to lock the flange 93 and, consequently, tubular shaft 95 against clockwise rotation, as viewed from the right-hand end of the transmission 41. Thus, while the planet cage 102 rotates in a counterclockwise direction, the gear 100 is held stationary. This effects a reverse rotation of the shaft 44 with respect to the direction of rotation of the shaft 49 at a 1–1 ratio. Accordingly, two different reverse drum speeds may be secured, depending upon the condition of the two-speed planetary drum transmission 120. Thus if, in the example given, the planetary transmission is in its 2–1 speed ratio, the overall speed ratio between the shaft 12 and the drum will be 6–1. This ratio is achieved when no air is supplied to the pipes 124 and 145. By supplying air under pressure to both of these pipes, a 1–1 drive connection through the planetary transmission 120 is provided, with the result that the overall speed ratio to the drum from shaft 12 will be 3–1.

Forward table drive

When it is desired to drive the table forwardly, clutch 56 is engaged by supplying air under pressure thereto. The transmission is then capable of driving the table at four different speed ratios in the following manner. To establish the lowest speed ratio, which, in the example given, is a ratio of 24–1, between the shaft 12 and the table, air is supplied to clutch 37, pipe 85 and pipe 145. The drive to the table will then be from engine 2 to shaft 30 and thence by sprockets 36 and 43 to the tubular shaft 44. Since air is supplied to the pipe 145, the drum 48 is disconnected entirely from the sprocket 47, thus permitting a free rotation of the shaft 44. The cone clutches 116 of planetary transmission 65 will be engaged by the springs 119. This locks the shaft 49 to the shaft 44, thereby establishing a direct drive from the sprocket 43 to the shaft 49 from which the table is driven through change gears 50 and 51, clutch 56, sprockets 55, 57 and 59 and the chain 61.

In order to establish the second speed ratio, which will be 12–1 in the example given, the air supplied to clutch 37 and pipe 85 is cut off, leaving an air supply under pressure to the clutch 56 and pipe 145. Under these conditions, the drive to the table is from engine 3 to chain 38 and thence to the tubular shaft 40 and through the planetary transmission 64, which will then be in its 2–1 speed ratio. Since the planetary transmission unit 65 is still locked in a 1–1 ratio, the output shaft 66 of transmission unit 64 will be fixed with respect to and drive the shaft 49 and, consequently, will drive the rotary table which is connected thereto.

In order to establish the third speed ratio, the only change required from the conditions described above for the second speed ratio is to supply air under pressure through the pipe 91 to effect engagement of the planet clutches 87 of transmission unit 64. This locks the transmission unit 64 in its 1–1 ratio and thus provides an increased drive speed to the shaft 66 and thence through transmission unit 65 to the table drive shaft 49.

In order to establish the fourth or highest speed ratio for the table, air is supplied only to the clutch 56 and pipes 91, 117 and 124. This maintains the 1–1 speed ratio through the planetary transmission unit 64 but effects a disengagement of the clutches 115 of transmission unit 65. At the same time, it locks shaft 44 stationary by reason of its connnection to the drum planetary transmission unit 120, which, by reason of the supply of air to the pipe 124 and the absence of an air supply to the pipe 145, is locked against rotation. With shaft 44 stationary, shaft 49 will be driven in the same direction as shaft 95 but at twice the speed, thereby establishing an overall speed ratio between shaft 12 and the rotary table of 3–1.

Reverse table drive

To reverse the table drive, air under pressure is supplied to clutches 37 and 56, pipes 85, 117 and 145, and cylinders 94b. The supply of air under pressure through pipe 145 disconnects the drum 48 from the sprocket 47 and thus permits the delivery of power from shaft 30 through sprockets 36 and 43 to the shaft 44 without causing drum rotation. The supply of air under pressure to the cylinders 94b permits return of the one-way clutch blocks 94 to operative position, thus locking the flange 93 and shaft 95 against counterclockwise rotation, as viewed in Figure 4. With shaft 95 thus held stationary and shaft 44 rotated in a counterclockwise direction, the planet cage 102 and, consequently, the shaft 49 will be rotated in a direction opposite to that of shaft 44 but at the same speed. This provides a reverse table drive at a ratio of 24–1. During such reverse table drive, the supply of air to the pipe 85 renders the clutch blocks 78 inoperative, thus permitting the planet cage 74 of transmission 64 to rotate freely in a counterclockwise direction under the influence of the counterclockwise rotation of shaft 40 while shaft 66 is held stationary.

Automatic drilling

The transmission of the present invention may also be employed to control the pressure of the drill bit on the bottom of the hole during drilling operations and to vary that pressure inversely with respect to the table torque but at a lower percentage rate of change in order to provide an automatic weight control and at the same time prevent twist-offs of the drill stem due to excessive drill bit pressure.

During automatic drilling, engine 1 is connected to the slush pumps by engaging clutch 18; engine 2 is connected through its torque converter 8 directly to the drum through chains 25 and 28, shaft 30, sprockets 36, 43, 45 and 47 and the drum planetary transmission 120 by engaging clutch 37; and engine 3 is connected to the rotary table through sprockets 31, 33, 34 and 38, transmission unit 41, shaft 49, etc. Since during drilling operations the rate of rotation of the hoisting drum is negligible, the torque converter 8 associated with engine 2 will be operated under substantially full stall conditions. As a result, the torque which is transmitted from engine 2 through the torque converter 8 and the direct drive connections to the drum will deliver to the drum a substantially constant torque which may be adjusted at will by varying the throttle setting of the engine. This torque is preferably so adjusted in this manner or by changing the speed ratio of the drum planetary transmission 120 that it balances the major portion of the weight of the

drill stem and other mechanism supported by the hoisting drum. It will be observed that the proportion of the drill stem supporting force which is thus supplied by engine 2 and torque converter 8 will remain substantially constant, regardless of variations in the rate of drill bit penetration.

During automatic drilling, the power required to rotate the table, as previously mentioned, is supplied from engine 3 to the tubular shaft 40 and thence through the transmission unit 64 to the input shaft 95 of the planetary transmission unit 65. Since the output shaft 44 of the transmission unit 65 is fixed to the hoisting drum through sprocket 45, chain 46, etc., the shaft 44 will remain substantially stationary. As a result, the planetary cage 102 and shaft 49 will rotate in a counterclockwise direction, as viewed in Figure 4, at a speed twice that of the shaft 95 and will in turn drive the rotary table in the manner previously described. However, the torque reaction imposed upon the output shaft 44 of planetary transmission 65 by the table drive torque applied through shaft 95 will act on the shaft 44 in a counterclockwise direction, and will be transmitted through the sprocket 45, chain 46, sprocket 47 and the planetary transmission 120 to the hoisting drum in a direction to assist in supporting the weight of the drill stem. This added increment of drill stem supporting torque will constitute a fixed proportion of the table torque and, consequently, will, on an increase in the table torque, decrease the pressure of the drill bit on the bottom of the hole, and vice versa in the manner more fully set forth in applicant's copending application, Serial No. 602,620, filed June 30, 1945.

In order to achieve the above result, it will be appreciated that air must be supplied through pipe 117 to effect disengagement of the cone clutches 115 of the transmission unit 65. Two different table drive speeds may be secured, depending upon whether or not air under pressure is supplied to the pipe 91 to control the speed ratio of the transmission unit 64 in the manner previously described.

It will be appreciated that the magnitude of the drill stem supporting torque supplied to the drum 48 by the torque reaction from the table drive mechanism may be varied as compared with the table torque by changing the ratios of the change speed gears 50 and 51, by changing the relative sizes of the sprockets 45 and 47, by changing the speed ratio of the drum planetary transmission unit 120, or by changing the relative sizes of the gears employed in the planetary transmission unit 65. For a transmission having a design and construction of the illustrative ratios mentioned, the drill stem supporting torque supplied to the hoisting drum as the result of a table torque reaction will be 2.66 times the table torque, regardless of the speed ratio provided by transmission unit 64.

Cat head and sand reel drive

Since the cat heads are mounted on the shaft 52 and the sand reel is likewise driven from that shaft by sprockets 62, they may be operated either at four different speed ratios forward or in reverse in the manner described above in connection with the forward table drive. It will be appreciated, however, that in such case the table drive clutch 56 will be disengaged.

To facilitate an understanding of the manner in which the different speed ratios and drilling functions are performed by the mechanism of the present invention, reference may be had to the following chart, which shows the various control instrumentalities to which air under pressure must be supplied to adjust the mechanism for each of its principal operating conditions.

The letter "X" in the chart indicates that the instrumentality indicated at the top of the column in which the "X" appears is to receive operating air under pressure. Under some circumstances, a supply of air to one or more of the clutches 18, 23 and 35 is optional, depending upon the number of engines required to handle the load. Where a choice in this respect is possible, the letter "O" appears in the chart, indicating that an air supply is optional.

Control air supply chart

Speed Ratios	Clutches					Transmission Elements						
	18	23	35	37	56	85	91	94b	113	117	124	145
Forward Drum:												
Low, 12–1		O	O									
2nd, 6–1		O	O				X					
3rd, 3–1		O	O				X		X	X		
High, 1½–1		O	O				X		X	X	X	X
Reverse Drum: (Engage 63 Manually)												
Low, 6–1		O	O			X		X		X		
High, 3–1		O	O			X		X		X	X	X
Forward Table:												
Low, 24–1	O	O	O	X	X	X						X
2nd, 12–1	O	O	O		X							X
3rd, 6–1	O	O	O		X		X					X
High, 3–1	O	O	O		X		X			X	X	
Reverse Table, 24–1	O			X	X	X		X		X		X
Automatic Drilling:												
Low Drum Torque—												
Slow Table, 6–1	X			X	X					X	X	X
Fast Table, 3–1	X			X	X		X			X	X	X
High Drum Torque—												
Slow Table, 6–1	X			X	X					X		
Fast Table, 3–1	X			X	X		X			X		

In addition to the above, a still lower speed ratio of 24–1 may be obtained for hoisting by driving the drum from shaft 30 through sprockets 36, 43, 45 and 47 while the drum transmission 120 is in its low ratio of 2–1. This is achieved by engaging clutch 37 and supplying air under pressure to line 117 to disconnect the drive through transmission 41. The drum will then be driven by engine 2, or by additional engines if clutches 35 or 23 or both are engaged.

Alternatively, the four speed ratios of 12–1, 6–1, 3–1 and 1½–1 for the hoisting drum may all be obtained while the drum transmission 120 is in its 1–1 ratio. This is accomplished by driving the drum from shaft 30 through sprockets 36, 43, 45 and 47, in the manner described above,

while air under pressure is supplied to lines 124 and 145 to obtain a 12–1 ratio. The 6–1 ratio is then obtained by driving through transmission 41 while the latter is in its low gear ratio (no air supplied to lines 85, 91, 113 and 117). The 3–1 ratio is then obtained by supplying air under pressure to line 91, and the 1½–1 ratio by supplying air under pressure to lines 91, 113 and 117. Since for most purposes a geared ratio of 12–1 is sufficiently low, particularly when torque converters are used between the engine and drum, it is thus possible to eliminate the transmission 120 altogether and utilize a conventional hoisting drum, if desired. This would eliminate the low speed reverse drum drive and the high drum torque automatic drilling drives given on the above table, but low speed reverse is seldom required on the drum and the torque to the drum during automatic drilling can be varied widely by changing the speed of engine 2.

In addition to the above, it may be noted that at any time the hoisting drum may be entirely disconnected from the transmission mechanism by supplying air under pressure to pipe 145 without supplying air to pipe 124, the drum may be locked in a stationary position by supplying air to pipe 124 but not to pipe 145.

While only one form of the invention has been shown and described, it will be apparent that variations in the design and details of construction may be indulged in without departing from the spirit of the invention or the scope of the appended claims. Thus, for example, any desired number and arrangement of engines may be employed, one or more engines may be connected through a single torque converter, as distinguished from an individual torque converter for each engine, additional planetary transmissions similar to the transmission unit 64 may be employed in series with the transmission unit 64, either ahead of or behind the transmission unit 65, and the drum transmission unit 120 may be omitted, if desired. The particular type of sprocket and chain connections and the speed ratios of those connections, as well as relative sizes of the gears, may likewise be varied to meet any desired operating requirements. Likewise, the type of multiple speed ratio transmission mechanisms employed may be planetary transmissions of a different type than that indicated generally at 64 or, with the exception of the transmission unit 65, need not be planetary transmissions. In addition, other forms of clutches and brakes may be substituted for the cone clutches 87, 115 and 123 and the one-way clutch blocks 78, 94 and 105 without changing the performance characteristics of the transmission.

An important features of the invention resides in the use of the low torque three-speed constant mesh geared transmission 41. The constant mesh geared type of transmission, in which friction clutches control the gear ratio, is highly desirable because of its compactness and ease of control. However, such transmissions are more costly than conventional transmissions. In the present case, a substantial saving in cost and size is achieved by limiting the maximum torque on the transmission to a relatively low value and thus making possible the use of a smaller and less expensive unit. This result is achieved by a combination of several features: first, by compounding, i. e. connecting in series, two two-speed transmission units 64 and 65, one of which gives an overdrive or step-up speed ratio and the other a step-down speed ratio, the maximum load on the gear teeth is kept at a low level; second, the major portion of the torque multiplication is placed between the transmission 41 and the hoisting drum; and, third, the fact that the transmission 41 provides only three speed ratios is taken care of by providing a fourth speed ratio change independently of the transmission, either in a special transmission positioned within the hoisting drum brake flange within the space occupied by a clutch on conventional hoisting drums or by an auxiliary chain drive for low gear which by-passes the transmission.

Certain of the features herein claimed are disclosed in applicant's copending applications, Serial No. 647,677, filed February 15, 1946, and Serial No. 602,619, filed June 30, 1945.

What is claimed is:

1. A transmission for selectively driving either one of two power consuming instrumentalities in reverse or forward at a plurality of speed ratios, comprising a planetary transmission consisting of three interconnected elements, one of said instrumentalities being connectable to one of the elements and the other to another of the elements, means for selectively delivering power directly to each of the elements independently of the other elements, selectively operable means for holding either one of two of the elements stationary, and means for fixing one of said elements against rotation relative to another.

2. A transmission for selectively driving either one of two power consuming instrumentalities in reverse or forward at a plurality of speed ratios, comprising a planetary transmission consisting of three interconnected elements, one of said instrumentalities being connectable to one of the elements and the other to another of the elements, means for selectively delivering power directly to each of the elements independently of the other elements, selectively operable means for holding any one of the elements stationary, and means for fixing one of said elements against rotation relative to another.

3. A transmission for selectively driving either one or both of two power consuming instrumentalities in reverse or forward at a plurality of speed ratios, comprising a planetary transmission consisting of three interconnected elements, one of said instrumentalities being connectable to one of the elements and the other to another of the elements, means for selectively delivering power directly to each of the elements independently of the other elements, selectively operable means for holding either of two of the elements stationary, and means for fixing one of said elements against rotation relative to another.

4. A transmission for selectively driving either one or both of two power consuming instrumentalities in reverse or forward at a plurality of speed ratios, comprising a planetary transmission consisting of three interconnected elements, one of said instrumentalities being connectable to one of the elements and the other to another of the elements, means for selectively delivering power directly to each of the elements independently of the other elements, selectively operable means for holding any one of the elements stationary, and means for fixing one of said elements against rotation relative to another.

5. A transmission, including a pair of axially spaced concentric gear members, a planet gear support member journaled concentrically with respect to said gear members, a planet gear

cluster journaled on said support member and having gears meshing respectively with said first mentioned gear members, a pair of power take-offs adapted to be connected respectively to said support member and one of said first mentioned gear members, means for selectively delivering power directly to either of said first mentioned gear members or to said support member independently of the other members, selectively operable means for holding either said support member or one of said first mentioned gear members stationary, and selectively operable means to prevent relative rotation between said first mentioned gear members.

6. A transmission, including a pair of axially spaced concentric gear members, a planet gear support member journaled concentrically with respect to said gear members, a planet gear cluster journaled on said support member and having gears meshing respectively with said first mentioned gear members, a pair of power take-offs adapted to be connected respectively to said support member and one of said first mentioned gear members, means for selectively delivering power directly to either of said first mentioned gear members or to said support member independently of the other members, selectively operable means for holding either said support member or either one of said first mentioned gear members stationary, and selectively operable means to prevent relative rotation between said first mentioned gear members.

7. A transmission, including a pair of axially spaced concentric gears, a planet gear support journaled concentrically with respect to said gears, a planet gear cluster journaled on said support and having gears meshing respectively with said first mentioned gears, a pair of power take-offs adapted to be connected respectively to said support and one of said first mentioned gears, selectively operable means for delivering power to either of said first mentioned gears, selectively operable means for holding the support stationary, and selectively operable means for fixing the support with respect to one of said first mentioned gears.

8. A transmission, including a pair of axially spaced concentric gears, a planet gear support journaled concentrically with respect to said gears, a planet gear cluster journaled on said support and having gears meshing respectively with said first mentioned gears, a pair of power take-offs adapted to be connected respectively to said support and one of said first mentioned gears, selectively operable means for delivering power to either of said first mentioned gears, selectively operable means for holding either the support or one of said first mentioned gears stationary, and selectively operable means for fixing the support with respect to one of said first mentioned gears.

9. A transmission including a pair of aligned shafts at least one of which is tubular, gears on the adjacent ends of said shafts respectively, a planet gear support journaled coaxially with respect to said shafts, planet gears journaled on said support and meshing with said first mentioned gears, a shaft journaled within said tubular shaft and connected directly to said support, a source of power connected to one of said shafts, and a pair of power take-offs for the rotary table and hoisting drum adapted to be connected to the other shafts respectively at points on opposite sides of said first gears.

10. A hoisting drum having a brake flange fixed thereto at one end, a combined planetary two-speed transmission and clutch mounted coaxially with respect to the drum and within said flange, said transmission including a pair of concentric gears connected by planet gears, a support for the planet gears concentrically journaled with respect to said first gears, selectively operable means located within said flange for holding said support stationary, selectively operable means for fixing said concentric gears against relative rotation, and means for driving one of said concentric gears.

11. In a well drilling machine, a plurality of engines, a hoisting drum, a rotary table driving shaft, a change-speed transmission, independent selectively operable means for connecting said hoisting drum and said rotary table drive shaft to the transmission, a countershaft, a drive connection from one of said engines to said countershaft, a driving connection including a clutch between said countershaft and said hoisting drum independent of the transmission, a pair of sprockets fixed together and journaled on said countershaft, a clutch for engaging said pair of sprockets to said countershaft, a drive from one of said pair of sprockets to said change-speed transmission, and a drive from another engine to the other of said pair of sprockets on said countershaft.

12. In a well drilling machine, a plurality of engines, a hoisting drum, a rotary table drive shaft ,a change-speed transmission, independent selectively operable means to connect the transmission to the hoisting drum or the rotary table drive shaft, driving connections including selectively operable clutch means for connecting one or more of said engines to said transmission, and driving connections for selectively connecting one or more of said engines to said hoisting drum independently of said transmission, said driving connections and means being operative to simultaneously connect one engine to the rotary table through the transmission and another engine to the hoisting drum independently of said transmission.

13. In a well drilling machine, a plurality of engines, a hoisting drum, a rotary table drive shaft, a change-speed transmission, selectively operable means to connect the transmission to the hoisting drum or the rotary table drive shaft, driving connections including selectively operable clutch means for connecting one or more of said engines to said transmission, driving connections for selectively connecting one or more of said engines to said hoisting drum independently of said transmission, said driving connections and means being operative to simultaneously connect one engine to the rotary table through the transmission and another engine to the hoisting drum independently of said transmission, and means in said independent drive connection for transmitting a torque proportional to the difference between the engine speed and the drum speed.

14. An engine compounding drive, including, in combination, a shaft, a pair of sprockets freely journaled on said shaft and fixed together, a clutch for connecting the sprockets to said shaft, means for connecting an engine to said shaft independently of said sprockets, means for connecting a second engine to one of said sprockets, a power take-off including a disengageable clutch connected to the other sprocket, and a second power take-off including a disengageable clutch connected to the first engine.

15. In combination, a shaft, a pair of sprockets

freely journaled on said shaft and fixed together, a clutch for connecting the sprockets to said shaft, means for connecting an engine to said shaft independently of said sprockets, means for connecting a second engine to one side of said sprockets, a power take-off connected to said shaft independently of said sprockets, and a second power take-off connected to the other of said pair of sprockets, at least one of said power take-offs comprising a power transmitting mechanism containing a clutch so that by operating said clutches both power take-offs may be independently connected to separate engines or the other power take-off may be connected alone to either one or both engines.

16. A power transmitting apparatus for well drilling machines, including a shaft member and a member journaled freely on said shaft member, a pair of power take-offs having driving connections to said members respectively and adapted for connection one to the hoisting drum and one to the rotary table, separate engines connected respectively to said members, a clutch adapted to fix said members together, and disengageable clutches in the driving connections to said power take-offs.

17. A power transmitting apparatus for well drilling machines, including a shaft member and a member journaled freely on said shaft member, a pair of power take-offs having driving connections to said members respectively and adapted for connection one to the hoisting drum and one to the rotary table, separate engines connected respectively to said members, a clutch adapted to fix said members together, a third engine, a power take-off for a slush pump having a driving connection with the third engine, means adapted to connect the third engine to one of said members, and disengageable clutches in the driving connections to said power take-offs.

18. A transmission for a rotary well-drilling machine comprising a power take off shaft for driving a rotary table, a hoisting drum driving shaft, a planetary transmission having a pair of concentric gear members and a planet cage member and planet gears journalled on said cage member and meshing with said concentric gear members, a jack shaft, a rotary driving element, a pair of independent power sources, a driving connection between one power source and said jack shaft, a driving connection between the other power source and said rotary driving element, a disengageable driving connection between said rotary driving element and one of said members, a disengageable driving connection between said jack shaft and another of said members, a disengageable driving connection between said last mentioned member and said hoisting drum driving shaft, a disengageable driving connection between said power take off shaft and the third of said members independently of the other members, means including a clutch for establishing a driving connection between said element and said jack shaft, selectively operable brake means for holding said third one of said members stationary, and selectively operable means for fixing one of said members against rotation relative to the other.

19. A transmission for a rotary well-drilling machine comprising a power take off shaft for driving a rotary table, a hoisting drum driving shaft, a planetary transmission having a pair of concentric gear members and a planet cage member and planet gears journalled on said cage member and meshing with said concentric gear members, a jack shaft, a rotary driving element, a pair of independent power sources, a driving connection between one power source and said jack shaft, a driving connection between the other power source and said rotary driving element, a disengageable driving connection between said rotary driving element and one of said members, a disengageable driving connection between said jack shaft and another of said members, a disengageable driving connection between said last mentioned member and said hoisting drum driving shaft, a disengageable driving connection between said power take off shaft and the third of said members independent of the other members, means including a clutch for establishing a driving connection between said element and said jack shaft, selectively operable brake means for holding said third one of said members stationary, and selectively operable means for fixing one of said members against rotation relative to the other.

20. A transmission for a rotary well drilling machine, comprising a power take-off shaft for driving a rotary table, a hoisting drum drive shaft, a planetary transmission having a pair of concentric gear members and a planet cage member and planet gears journaled on said cage member and meshing with said concentric gear members, a disengageable driving connection between one of said members and the drum drive shaft, a disengageable driving connection between said power take-off shaft and a second of said members independent of the other members, two independent sources of power, a disengageable driving connection between one of said sources of power and the third of said members, a disengageable driving connection between the other power source and said drum drive shaft independent of said transmission, and selectively operable means for fixing two of said members against relative movement or holding said second one of said members stationary in order to provide two different drive ratios to said drum drive shaft from said one power source through said transmission or permitting independent movement of all three members to effect simultaneous torque transmission from said one power source to said drum drive shaft and said power take-off shaft through said transmission.

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