Jan. 23, 1962 J. H. WILSON 3,017,782

MULTI-SPEED TRANSMISSIONS

Original Filed Nov. 26, 1956 5 Sheets-Sheet 1

Fig. 2

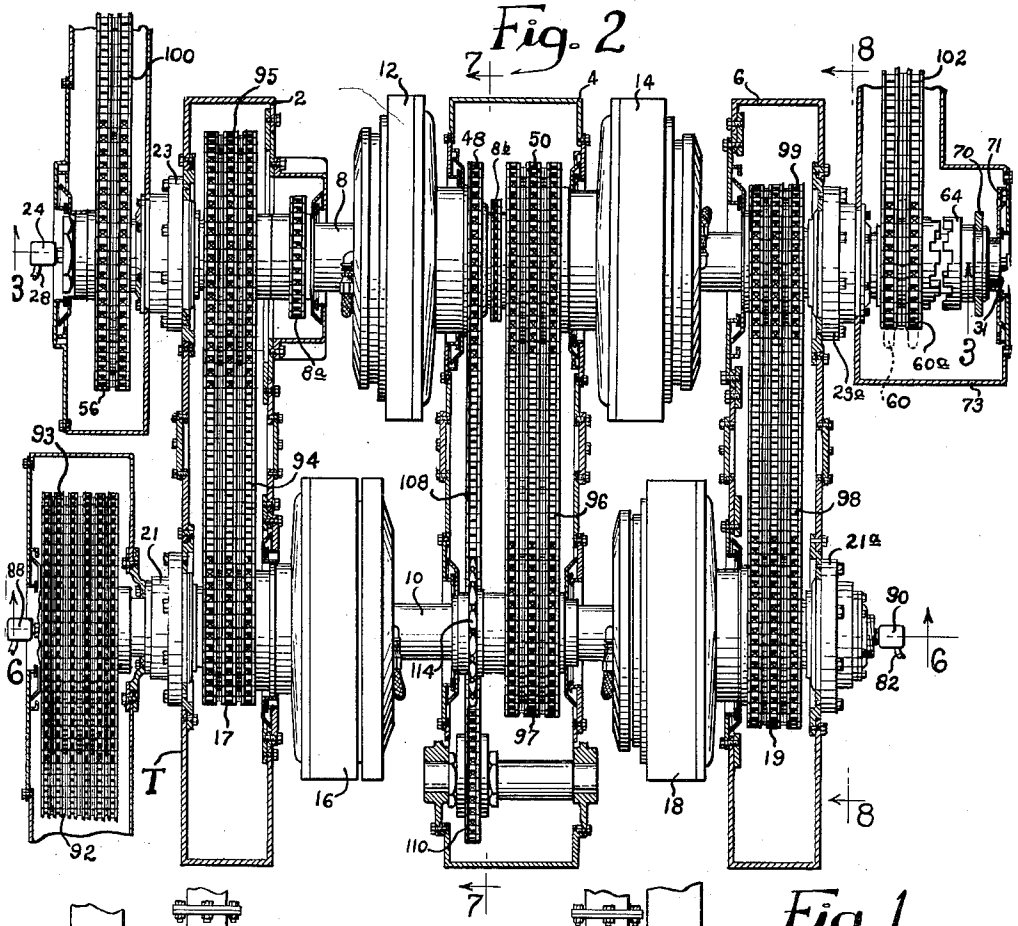
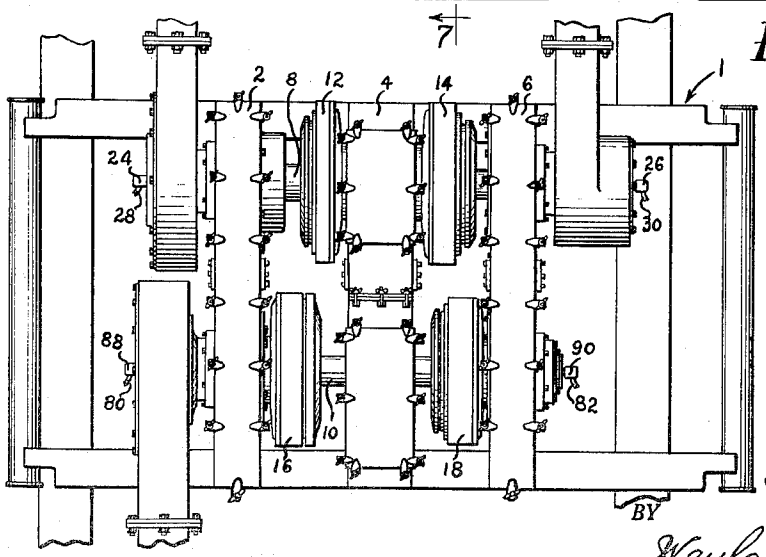


Fig. 1



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Fig. 3

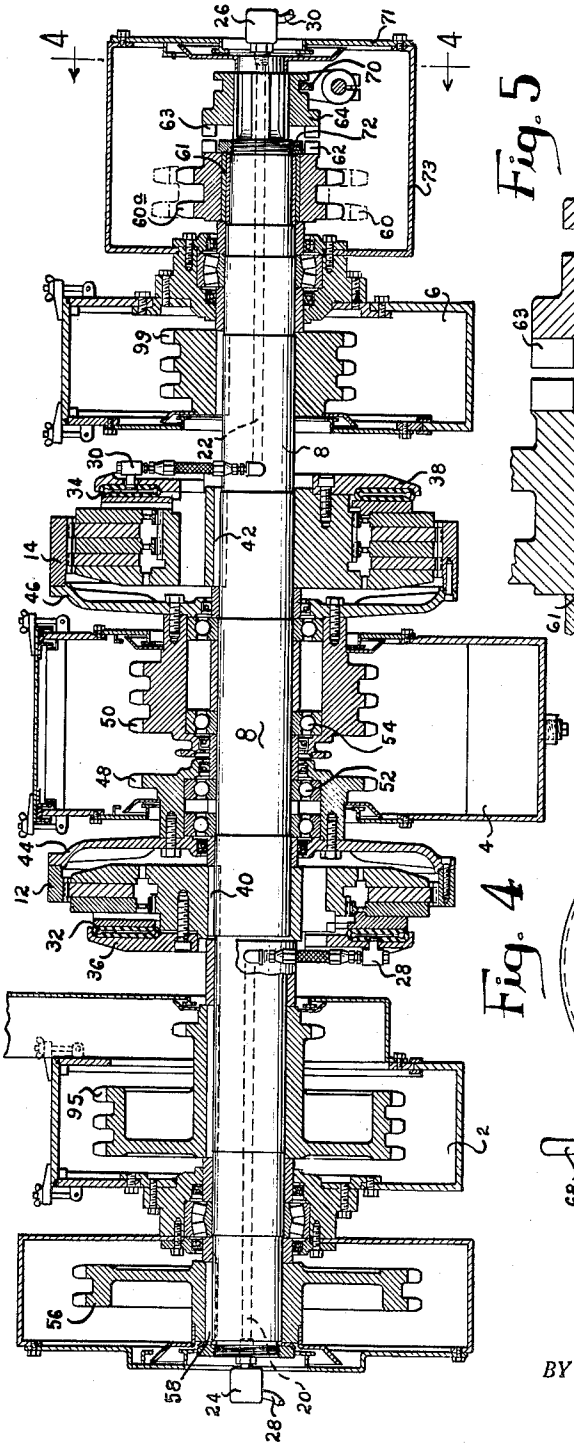


Fig. 5

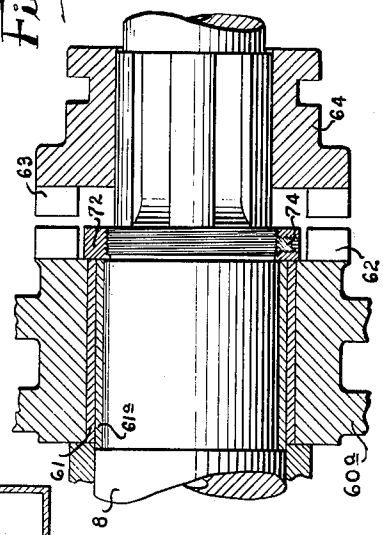
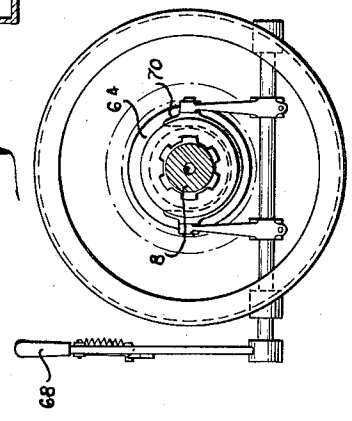


Fig. 4



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MULTI-SPEED TRANSMISSIONS

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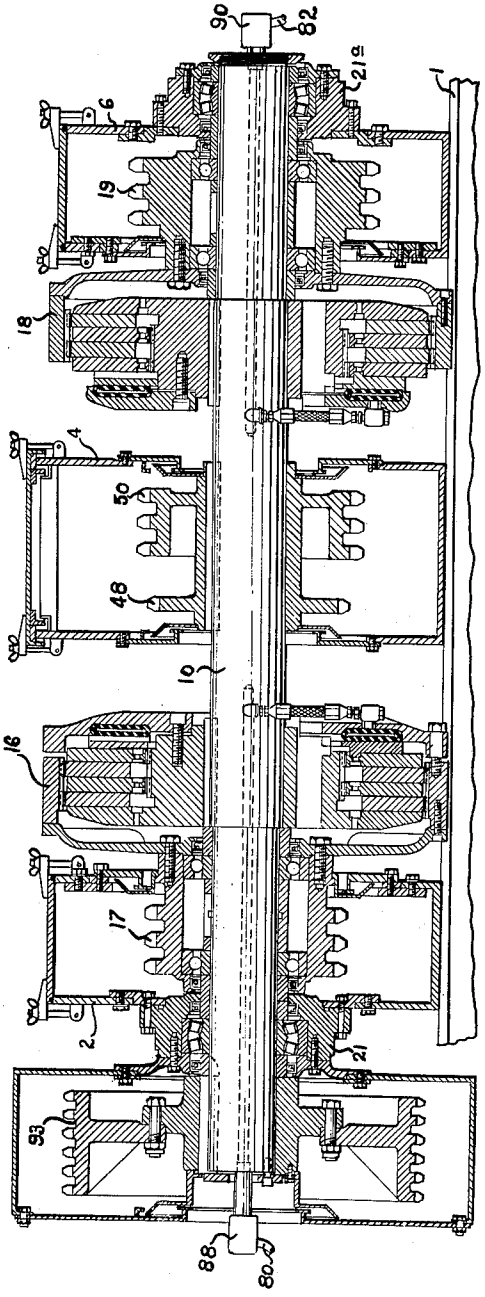


Fig. 6

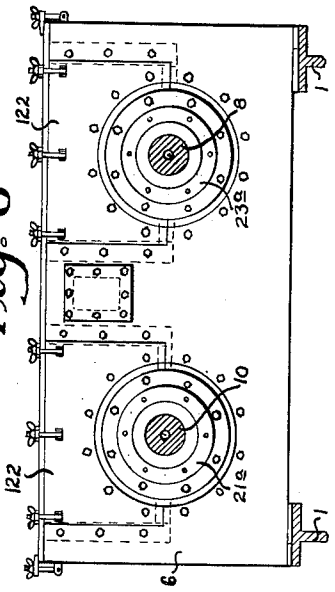


Fig. 8

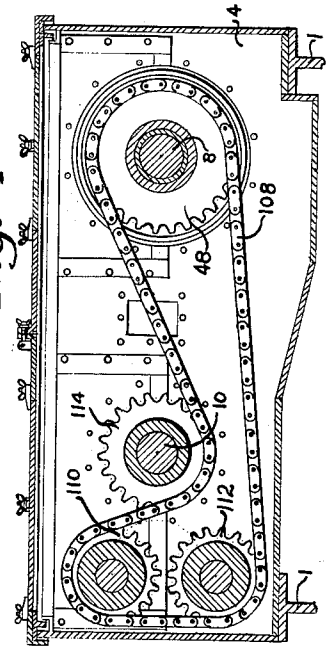


Fig. 7

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MULTI-SPEED TRANSMISSIONS

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Fig. 9

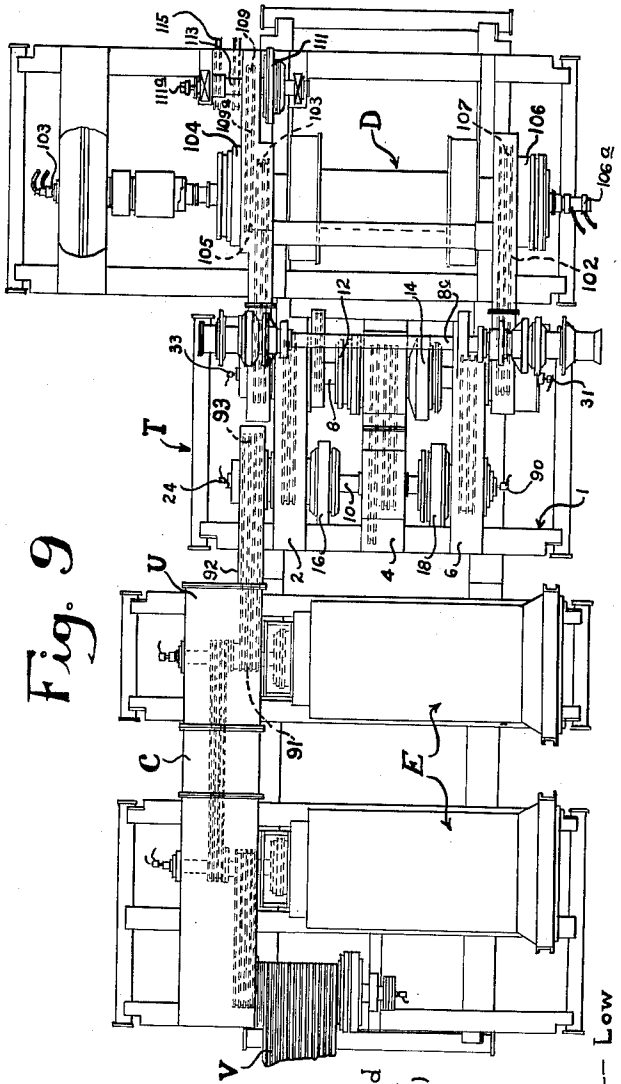


Fig. 10

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Fig. 11

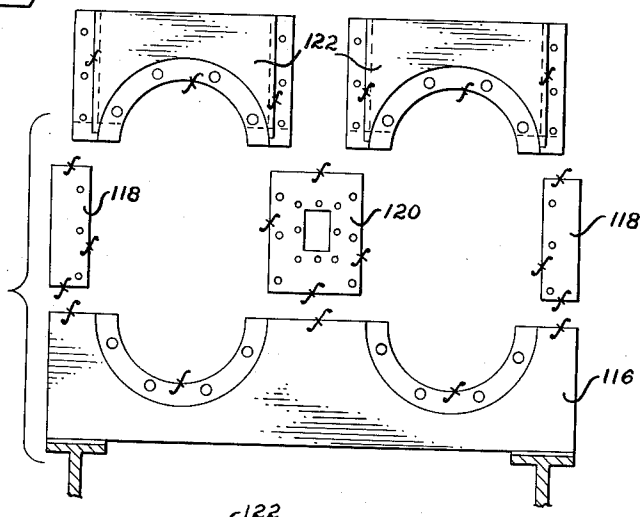


Fig. 13

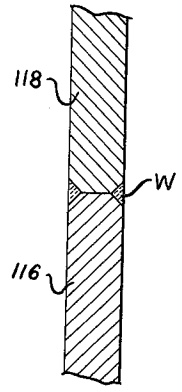


Fig. 12

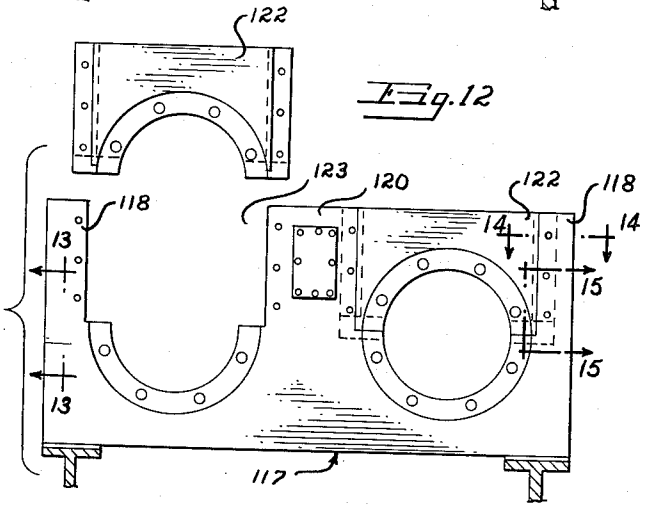


Fig. 15

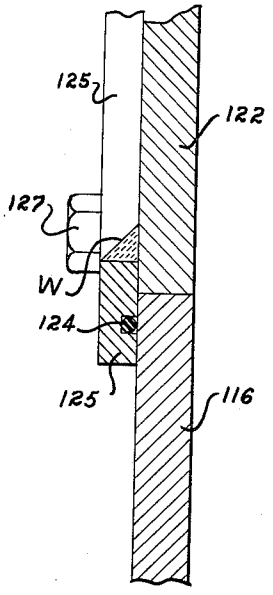
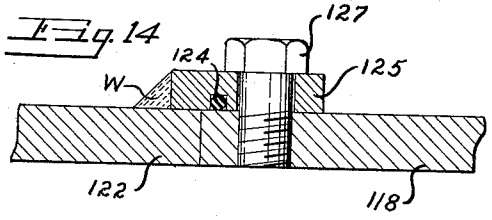


Fig. 14



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United States Patent Office 3,017,782 Patented Jan. 23, 1962

3,017,782
MULTI-SPEED TRANSMISSIONS

John Hart Wilson, % Wilson Manufacturing Co., P.O. Box 1031, Wichita Falls, Tex.

Original application Nov. 26, 1956, Ser. No. 624,307, now Patent No. 2,912,882, dated Nov. 17, 1959. Divided and this application Mar. 2, 1959, Ser. No. 796,337
3 Claims. (Cl. 74—218)

This invention relates to improvements in transmission units, and more particularly to multi-speed transmission units used with rotary well drilling equipment. This is a division of my prior application, Serial No. 624,307, filed November 26, 1956, for Multi-Speed Transmission Cases, now Patent No. 2,912,882, issued November 17, 1959.

Various transmission units have been proposed heretofore, but the speed range of these units was such, that it was difficult to obtain all the desired speeds, in a manner which would approach or exceed the efficiency of a torque converter drive.

The present device is a chain driven transmission unit which enables maximum horsepower to be transmitted with a transmission unit of minimum size and weight, and yet provide a unit with six, quickly shiftable, forward drum speeds. The present transmission is so constructed as to enable the use of air actuated friction clutches to enable the changing of speeds, within the transmission unit, with smoothness and efficiency which approaches or even exceeds that of a torque converter drive, and which far excels a positive clutch drive in operating efficiency.

The transmission unit, as shown in the accompanying drawings, is designed to give a reverse, and three forward speeds, and when used with two friction drum clutches, similar to those shown in my Patent No. 2,774,453, dated Dec. 19, 1956, for Pneumatic Clutches, will give a total of six forward, quickly shiftable, drum speeds. A quick change drive sprocket is provided, which enables a seventh forward speed to be obtained, thereby covering the entire range of hoisting and pulling speed requirements of a rotary drilling rig.

Heretofore, in order to provide an overall ratio which would give sufficiently high block speed in high gear, and sufficient pulling capacity to cover the range requirements above mentioned, would have required either eight drum speeds, which would increase the cost, weight and maintenance expense, or it would have required six drum speeds with considerably higher ratio between each speed, which would have meant that the pipe would have to be pulled a greater distance in one speed before it could be changed to the next higher speed, which would have meant increased hoisting time, and increased cost of operation.

An object of this invention is to provide a chain drive transmission unit, whereby the mechanism thereof is primarily engageable with air actuated clutches.

Another object of the invention is to provide a multi-speed chain drive transmission unit constructed as an independent unit, in such manner as to be readily disconnected and moved from place to place, with a minimum of disassembly.

Still another object of the invention is to provide a multi-speed, chain drive transmission unit, wherein, the air actuated clutches are exterior of the chain and sprocket housings.

A still further object of the invention is to provide a chain driven transmission unit which gives six, quickly shiftable, forward drum speeds for rotary drilling rigs, wherein a quick removable sprocket is provided to enable the changing of the sprocket, to provide a seventh forward speed for the transmission unit.

Yet a further object of the invention is to provide a sprocket and chain drive transmission unit which has three forward speeds and a reverse speed, the sprockets and chains for the low and high speeds being within separate oil bath cases, and the sprockets and chains for the intermediate and reverse speeds being in an oil bath case, intermediate the cases which house the sprockets and chains for the low and high speeds, air actuated friction clutches are disposed exterior of and between the central and outside cases.

Yet another object of the invention is to provide a welded steel, fabricated case of a type, the transverse shafts of which, both input and output, may be moved upward vertically by the removal of cap screws, without removing any sprockets or other parts from the transverse shafts.

With these objects in mind and others which will become manifest as the description proceeds, reference is to be had to the accompanying drawings, in which like reference characters designate like parts in the several views thereof, in which:

FIG. 1 is a top plan view of the transmission assembly mounted on a skid sill frame;

FIG. 2 is an enlarged top plan view of the chain drive transmission unit, with certain parts broken away, and with parts shown in section, to bring out the details of construction;

FIG. 3 is a sectional view taken on the line 3—3 of FIG. 2, looking in the direction indicated by the arrows;

FIG. 4 is an elevational, sectional view taken on the line 4—4 of FIG. 3, looking in the direction indicated by the arrows;

FIG. 5 is an enlarged, fragmentary sectional view, with parts shown in elevation, of a quick detachable sprocket arrangement;

FIG. 6 is a view similar to FIG. 3, but taken on the line 6—6 of FIG. 2, looking in the direction indicated by the arrows;

FIG. 7 is a sectional view taken on the line 7—7 of FIG. 2, looking in the direction indicated by the arrows;

FIG. 8 is a sectional view taken on the line 8—8 of FIG. 2, looking in the direction indicated by the arrows;

FIG. 9 is a diagrammatic plan view of a rotary drilling rig, embodying the transmission unit, and showing the relationship thereof with the various other parts;

FIG. 10 is a chart, showing diagrammatically the various speed curves of the present device and the comparable speed of a torque converter drive;

FIG. 11 is an exploded view of the side plate elements of the transmission case, prior to assembly;

FIG. 12 is an assembled view of the transmission plate elements welded together and showing one sliding bearing retainer member in place, and showing one such bearing member in exploded relation with respect to the case;

FIG. 13 is an enlarged, sectional view taken on the line 13—13 of FIG. 12, looking in the direction indicated by the arrows;

FIG. 14 is an enlarged, sectional view taken on the line 14—14 of FIG. 12, looking in the direction indicated by the arrows; and

FIG. 15 is a fragmentary, sectional view of the transmission case structure.

With more detailed reference to the drawing, the numeral 1 designates generally, a skid frame, which forms a base to support the housings 2, 4, and 6, which house the chain and sprocket elements, as will be explained in greater detail hereinafter.

Shafts 8 and 10 pass transversely through housings 2, 4, and 6. The shaft 8 has air actuated clutches 12 and 14 operably mounted thereon, and the shaft 10 has air

actuated clutches 16 and 18 operably mounted thereon. The shaft 8 has bores 20 and 22 longitudinally thereof, as will best be seen in FIG. 3, which bores extend inward, so as to direct air under pressure from the respective rotary fluid seals 24 and 26 to hose connections 28 and 30, respectively, which hose connections connect with the respective, axially expansible tubes 32 and 34. The axially expansible tubes 32 and 34 are mounted with portions 36 and 38, respectively, thereof keyed to shaft 8 by means of the respective keys 40 and 42.

The portions 44 and 46 of the respective clutches 12 and 14 have the respective sprockets 48 and 50 secured thereto by means of cap screws or the like, which portions 44 and 46 of the respective clutches are rotatably mounted on the respective bearings 52 and 54, between shaft 8 and the respective body portions of sprockets 48 and 50, so as to enable the sprockets 48 and 50 to be relatively rotatable with respect to shaft 8, when the respective clutches are disengaged, and which sprockets rotate with the shaft 8, upon engagement of the respective clutches.

A sprocket 56 is fixedly secured to shaft 8, near an end thereof, by means of a key 58. At the opposite end of shaft 8, a sprocket 60, as indicated in dot-dash outline in FIG. 3, has a bushing or bearing 61 therein, which bushing journals the sprocket on a hardened and ground steel sleeve 61*a*, which sleeve forms a bearing surface for bushing 61, and at the same time forms a spacer sleeve against which a nut 72 is screwed, so as to retain the sprocket 60 or 60*a* against longitudinal movement with respect to shaft 8, but permits relative rotation thereon. The sprocket 60 has positive, toothed clutch jaws 62 thereon, which jaws complementally engage with jaws 63 of a sliding, toothed clutch member, which clutch member 64 has splined connection with shaft 8, so as to be slidable longitudinally therealong and rotatable therewith. The clutch 64 may be shifted by operation of a clutch lever 68, which moves clutch shift yoke 70 longitudinally of the shaft 8 so that the clutch teeth 62 and 63 may be selectively engaged and disengaged.

A sprocket 60*a* is shown in full outline in FIGS. 2 and 3, which sprocket may replace sprocket 60, by removing retaining ring 72, when it is desired to obtain a lower drum speed with greater torque. The sprocket 60*a* has jaws 62 thereon, which jaws are adapted to engage toothed jaws 63 on slidable jaw clutch 64, in the same manner as hereinbefore set out. The sprocket 60 or 60*a* is journaled on bushing 61 on the reduced end of shaft 8, and the screw threaded ring 72 threadably engages a threaded portion of shaft 8 intermediate sprocket 60 or 60*a* and clutch member 64, so as to retain the sprocket in fixed longitudinal relation with respect to the shaft 8.

The advantage of having the sprocket 60 removable is to enable the changing to sprocket 60*a* to give a supplemental drive, which is at a lower speed and higher torque, which speed is required only under unusual circumstances, such as to fulfill the following requirements:

(1) Setting an extremely heavy string of casing;

(2) Loss of engine power, for instance, on a three engine rig, should one or two engines "go out," then either one or two engines will have to pull the load normally hoisted by three engines;

(3) When drill pipe becomes stuck and the operator considers it necessary to risk pulling the pipe in two, in an effort to loosen the pipe;

(4) When it is desirable to hoist pipe at an exceedingly slow speed.

These four conditions are practically the only conditions under which the seventh speed, that is, the lowest speed, would be required, and when such conditions are encountered there is time to make a change of sprockets.

The shaft 8 has a spline on one end thereof adjacent the hardened and ground steel sleeve 61*a*, with a threaded portion on the shaft intermediate the inner end of the spline and the outer end of the hardened and ground steel sleeve, so as to enable a sprocket to be readily removed, first by moving the clutch lever 68 outward, after plate 71 has been removed from housing 73, and with the clutch yoke 70, having an open top, the yoke will pass downward out of the groove of clutch member 64, which will permit the clutch 64 to be removed from the splines on shaft 8. This will make readily accessible the threaded ring or nut 72, which ring may be unscrewed, after removing set screw 74. After the ring is removed, the sprocket 60 or 60*a*, with clutch teeth 62 thereon, may be moved longitudinally outward and be replaced by a sprocket 60 or 60*a* of a different size, but having thereon toothed jaws which are similar to the jaws 62, whereupon, the splined clutch 64 may be replaced on shaft 8, with the yoke 70 within the annular groove therein. This whole operation will require only a few minutes time.

The clutches 12, 14, 16 and 18 are friction clutches of the axially expansible, fluid tube type, which are actuated by remote controls, in a manner well known in the art, and from which controls air is directed through hose elements 28, 30, 80 and 82 into the respective rotary fluid seals 24, 26, 88 and 90, to direct air to the respective air actuated clutches 12, 14, 16, and 18, which will enable any combination of drives to be transmitted from input drive chains 92 through transmission chains 94, 96 and 98, which drive the drum D through drive chains 100 and 102 leading to the sprockets on the drum clutches 104 and 106, respectively.

In order to obtain any desired forward gearing ratio within the transmission unit, one of the clutches 14, 16 or 18 is engaged, then by selectively engaging either clutch 104 or 106, which is connected in driving relation with shaft 8, by chains 100 or 102, and with different ratio sprockets and chains on each sprocket of the drum clutches, various speeds and torques can be obtained, as is shown graphically on speed curve A in FIG. 10. By having this particular arrangement for obtaining different speed ratios, it will be seen that the present transmission unit approaches or even exceeds the efficiency of a torque converter drive, as represented by a speed curve as indicated at B, in FIG. 10.

A sliding jaw clutch 64 is provided on shaft 8, so when chain 100 is driving through a sprocket attached to the drum clutch 104, the sliding jaw clutch 64 may be disengaged so that chain 102 will remain idle or substantially so, thereby relieving this chain 102 of wear, as when operating the rotary table.

A pneumatically actuated clutch 12 is provided on shaft 8 which engages sprocket 48 in driving relation with chain 108, which chain 108 passes over idler sprockets 110 and 112, as will best be seen in FIG. 7, and beneath sprocket 114, which sprocket 114 is fixedly secured to shaft 10 for rotation in reverse relation to that at which the chains will be driven when clutches 14, 16, and 18 are engaged, thereby rotating the drum D in such manner as to unspool the cable therefrom, or to operate the rotary table in the reverse direction.

By positioning clutches 12, 14, 16 and 18 exterior of housings 2, 4, and 6, such arrangement enables the clutches to be serviced without disassembling the housings.

Construction of the transmission case

The present transmission cases are constructed of fabricated plate material in such manner that precision accuracy may be had in the machining and assembly thereof. The transmission cases, designated generally by the numerals 2, 4, and 6 are fabricated to give ready access to the interior and at the same time are constructed in such manner, that the cases may be accurately machined before welding the component plate elements together and subsequently welding the plate elements together so that the finished product is readily assembled and disassembled.

FIGS. 7, 8 and 11 through 15 show detailed construction of cases, and particular attention is directed to FIGS.

8, 11, 12, and 13, wherein said plate elements 116, 118 and 120 are usually ⅜" to ¾" in thickness, and wherein the individual edges of each plate, indicated at *f* (italic) are finished to the exact assembly size by grinding, and after the plates are thus finished on the edges so marked, and the contours so indicated, they are placed in a precision jig and welded together in such manner as to present a unform plate surface. This enables square, machine ground corners to be had at points where it would be impractical to machine after assembly.

By providing oil seal packing elements, such as O-ring strips 124 between detachable plate elements 122 and the adjacent surface of plate 118 and plate 120 of the transmission case 117, an oil tight juncture may be had. After the detachable plate elements 122 are fitted into the respective notches 123, the transmission case 117 is machined, drilled and tapped to form round holes, each of which holes is to receive a flange type bearing housing as indicated at 21, 21*a*, 23, and 23*a*, respectively, in the outer wall of the outer transmission cases. The detachable, interfitting slide plate elements 122 are fitted within the recesses 125 in such manner as to be oil tight, and yet be readily removable from the case, by removing a few cap screws.

The construction of the case, as described above, and as shown in FIGS. 2, 7, 8, and 11 through 15, is such that two detachable slide plate elements 122 are provided, which hold the bearings of each transverse shaft in place, so by removing a few cap screws, the slide elements and shafts may be readily removed without the disassembly of the sprockets and bearing elements thereon.

The vertical sealing strip 125 overlaps the joint between the plates 118 and 122 on one side of the case and between plates 118 and 120 on the opposite side thereof, and with the strip 125 being welded to the detachable slide plate elements 122, these detachable slide plate elements 122 may be fastened in place by cap screws, with the O-ring strip 124 being within a groove in strip 125, so as to provide an oil tight seal between the strips 125 and the respective plates 118 and 120.

The strip 125 overlaps the horizontal joint between plate 116 and plate 122 in such manner as to cause a gravity seal, as best seen in FIG. 15, so that oil in the case which runs down strips 125 will drop off at the outer side, and not run out through the horizontal joint between the slide elements 122 and plate 116.

It is to be pointed out that the cases 2 and 6 are of the same general construction, with shaft supporting bearings mounted on the outer walls thereof.

The construction described above, gives unusual accuracy and enables ready assembly, without the usual misfit of bearing members and mis-alignment of shafts, which is inherent in such cases, that are not accurately made up, but at the same time a case is provided which is relatively light in weight, in view of the heavy duty it performs, thereby enabling a substantial saving of material.

Operation

The chains and sprockets on this transmission are arranged in a certain location for a specific reason, and which reasons are set out hereinafter.

With the engines E connected together by a compound unit C, the power from the compound engines may be directed to transmisison T, or to drive through V-belts V to a pump or the like. However, with one or more engines E connected to transmission T in driving relation, by input chain 92 surrounding sprockets 91 and 93, power is transmitted through said transmission input chain to the input sprocket 93 which is secured to shaft 10, which sprocket 93 is adjacent bearing 21 of transmission T. The air actuated clutch 16, having sprocket 17 connected therewith, which sprocket is adjacent bearing 21 but on the side opposite sprocket 93, is engaged in driving relation with shaft 10. The chain 94 surrounds sprockets 17 and 95, to connect the shaft 8 in driving relation with input chain 92 through air actuated clutch 16.

The sprocket 95 is secured to shaft 8 and is adjacent bearing 23. Power is transmitted through shaft 8 to sprocket 60 or 60*a*, and thence through chain 102 to sprocket 107 on air actuated clutch 106 of the drum shaft, to drive the drum D, so as to give a first speed to the drum D.

With the shaft 10 being driven by input chain 92 in the manner set out above, and with sprocket 97 secured to shaft 10 in driving relation therewith, and with transmission drive chain surrounding sprocket 97 on shaft 10 and sprocket 50, which is journaled on shaft 8, power is transmitted to sprocket 50, and with sprocket 50 connected in driving relation to air actuated clutch 14, which clutch is secured to shaft 8, power may be transmitted from input chain 92 to shaft 8, when clutch 14 is engaged, and with the clutch teeth 62—63 engaged to connect the shaft 8 in driving relation with sprocket 60 or 60*a*, the sprocket 60 or 60*a* may be rotated. With a transmission chain 102 surrounding sprocket 60 or 60*a* and sprocket 107 on air actuated drum clutch 106, power is transmitted to clutch 106, so when the clutch is engaged in driving relation with drum D, the power is transmitted from input chain 92 to drum D, which drum will be driven in a second speed.

With the shaft 10 being driven by input chain 92, in the manner set out above, and with clutch 18 engaged to connect shaft 10 in driving relation with sprocket 19, which sprocket 19 is adjacent bearing 21*a*, the chain 98 which surrounds sprockets 19 and 99 will be driven to rotate shaft 8, and with clutch 64 slidably secured to shaft 8, and with clutch jaws 62—63 engaged, chain 102 will drive sprocket 107 on air actuated drum clutch 106, and with the clutch 106 engaged, the drum D will be driven in a third speed.

By driving in any of the above mentioned three speeds and with air actuated drum clutch 106 disengaged and with air actuated drum clutch 104 engaged, three additional speeds, or speeds four, five and six of the drum will be had in successive steps, as graphically set forth in FIG. 10, and designated throughout by dotted outline A. The comparative speed ranges of a torque converter drive is shown in the graph in FIG. 10, wherein B designates a series of solid lines, giving the capacities of a similar rig, but with a four speed transmission and a torque converter.

When it is desired to reverse the drum, as for unspooling cable, or to drive the rotary table in reverse direction, air actuated clutch 12 is provided on shaft 8, which clutch 12 is driven through sprockets 114 on shaft 10. When the input chain 92 rotates shaft 10, the sprocket 114 will engage the upper side of the upper reach of chain 103, which chain passes around idler sprockets 110 and 112 to drive sprocket 48 in reverse direction to the direction of sprockets 50, 95, and 99. However, the sprocket 48 is journaled on shaft 8 and is connected to air actuated clutch 12, so upon engaging clutch 12 by the introduction of air thereto through hose 28 and rotary seal 33, the clutch which engages shaft 8 will rotate shaft 8 in the direction counter to the rotation of the other three forward speeds, and will drive chains 100 and 102 also in the opposite direction to that set out above. Since it is usually expedient to drive the drum at a slow rate of speed, when unspooling cable, drum clutch 106 is engaged, which will connect chain 102 in driving relation between sprocket 60 and sprocket 107, so as to connect the drum clutch 106 in driving relation with drum D. The sprocket 105 will drive sprocket 109 in reverse manner through chain 109*a*, which in turn, will drive air actuated clutch 111. With the clutch 111 engaged, the shaft 113 will be driven, which in turn, will drive chain 115 leading to a rotary table, or other source of use. The reverse drive arrangement, as described, enables the rotary table to be used for such purposes as fishing jobs or other work requiring the rotary table to be driven in reverse manner.

Sprockets 8*a* and 8*b* are provided on shaft **8** to drive the cathead 8*c* and the oil pump (not shown).

Clutches **12, 14, 16, 18, 104, 106** and **111**, as well as each of the respective engine clutches are preferably of the air actuated type which utilize rotary air seals **29, 31, 33, 90, 103, 106***a*, and **111***a* and a hollow shaft to transmit the air from the respective rotary seals to the respective clutches.

The low speed drive and driven sprockets **17** and **95** and chain **94** which surrounds the sprockets, are disposed on shafts **10** and **8**, respectively, immediately adjacent the respective bearings **21** and **23**. This arrangement minimizes bending strain on the shafts, due to the high torque exerted by this drive.

The high speed drive comprises drive sprocket **19** and driven sprocket **99** mounted on shafts **10** and **8**, respectively, which sprockets are surrounded by chain **98**, these sprockets being positioned adjacent bearings **21***a* and **23***a* in which the respective shafts **10** and **8** are journaled. In this manner severe bending strain on the shafts, due to shock, is minimized, so there is relatively little bending moment on the shaft at this particular point, therefore, a smaller shaft may be used, than if the sprockets were spaced farther away from the bearings.

Having thus clearly shown and described the invention, what is claimed as new and desired to secure by Letters Patent is:

1. A multi-speed transmission for drilling rigs and the like comprising; a base, at least two spaced apart, independent transmission cases mounted on said base, pairs of spaced apart, axially aligned bearings mounted on the outer sidewall only of the respective transmission cases, the axes of said bearings being parallel, the inner walls of said respective transmission cases having holes formed therein and lying within the respective axes of said bearings, at least a first and a second shaft journaled in said respective pairs of axially aligned bearings and extending through the holes in said inner walls of said transmission cases so that the axes of said shafts will be parallel, at least four sprockets mounted on said shafts with at least two of said sprockets being fixedly secured to at least one of said shafts on which said sprockets are mounted, the other two of said sprockets being journaled on at least one of said shafts on which they are mounted in aligned, complementary, driving relation with said fixedly secured sprockets, transmission chains surrounding respective pairs of sprockets in aligned, complementary, driving relation, each said pairs of sprockets with the surrounding transmission chain being encased within the respective cases, clutches mounted on the shaft on which said respective sprockets are journaled, which clutches are exterior of the respective cases and adjacent said respective journaled sprockets, means fixedly securing an element of said respective clutches on said shaft on which the respective clutches are mounted, means fixedly connecting another element of the respective clutches with the respective journaled sprockets, air actuating means within the respective clutches to selectively connect said clutch elements thereof in driving relation, remote air actuating means interconnected with the means within the respective clutches to selectively actuate said clutch engaging elements within said clutches to connect said clutch elements in driving relation, drive means connected to one of said shafts, and driven means connected to the other of said shafts.

2. A multi-speed transmission for drilling rigs as defined in claim 1; wherein a further transmission case is mounted on said base intermediate said first mentioned transmission cases and spaced from the respective cases, said last mentioned case having holes formed therein, which holes lie within the spaced apart, parallel axes of said respective bearings, a further pair of sprockets, one being fixedly secured to one of said shafts within said last mentioned transmission case, the other of said last mentioned sprockets being journaled on the other of said shafts within said last mentioned transmission case, which sprocket is in aligned, complementary, driving relation therewith, a further transmission chain surrounding said last mentioned sprockets in driving relation, an air actuated clutch mounted on said shaft on which said last mentioned sprocket is journaled, which clutch is adjacent said sprocket and which clutch is exterior of said last mentioned casing, said clutch having drive and driven elements therein, one of said elements being fixedly connected to said sprocket and the other of said elements being fixedly connected to said shaft, air actuating means within said clutch to selectively connect said clutch drive and driven elements in driving relation, and a further remote air actuating means interconnecting with said means within said last mentioned clutch to selectively actuate said clutch engaging elements within said clutch to connect said elements in driving relation.

3. A multi-speed transmission as defined in claim 1, wherein the sprockets mounted on said shafts adjacent one of said outer walls are the low speed drive sprockets, and wherein the sprockets mounted adjacent the other of said outer walls are the high speed drive sprockets, with at least two other of said sprockets mounted on said shafts being the intermediate speed sprockets.

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