

March 10, 1931.

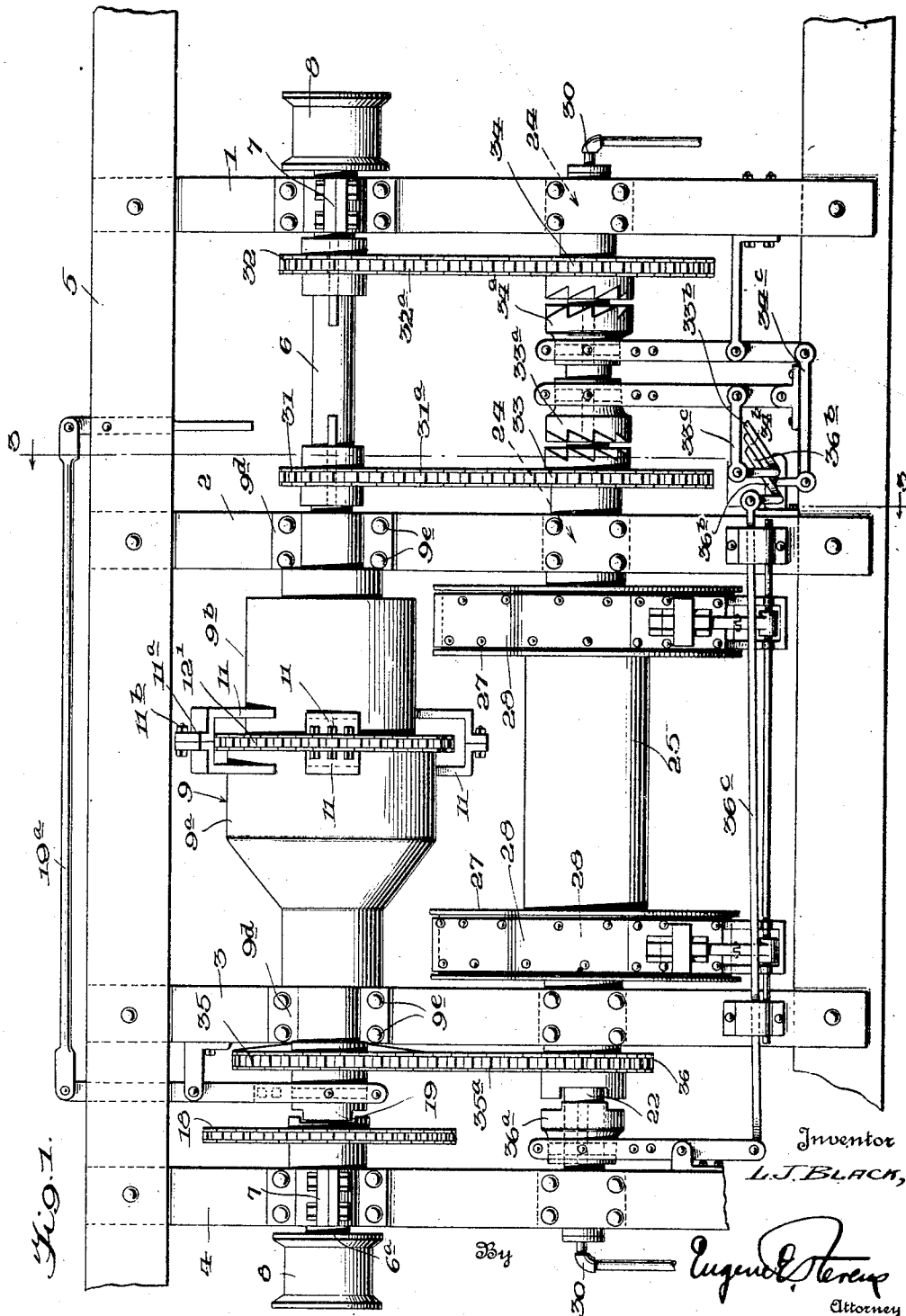
L. J. BLACK

1,795,706

ROTARY DRIVE AND DRAW WORKS

Filed March 23, 1927

3 Sheets-Sheet 1



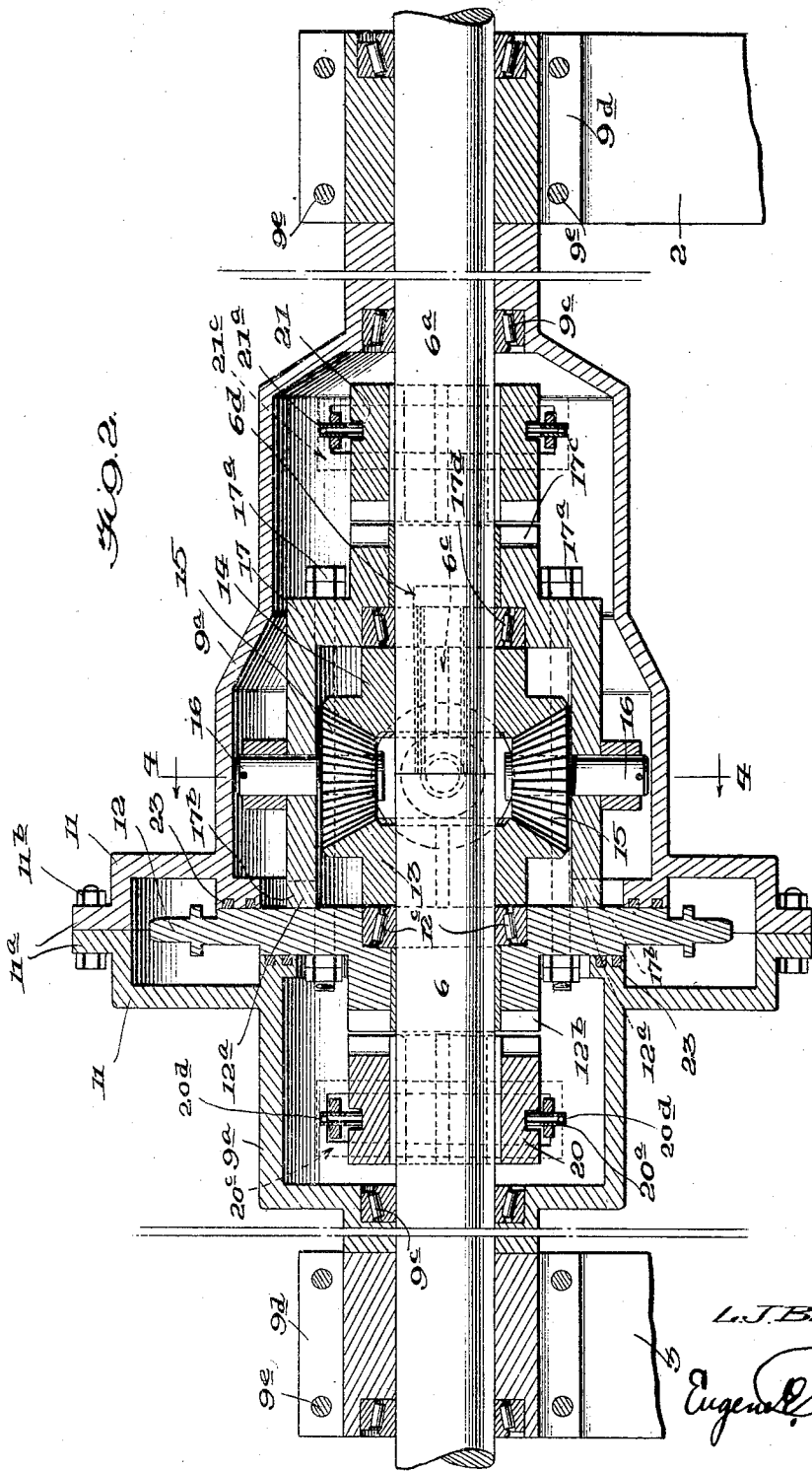
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ROTARY DRIVE AND DRAW WORKS

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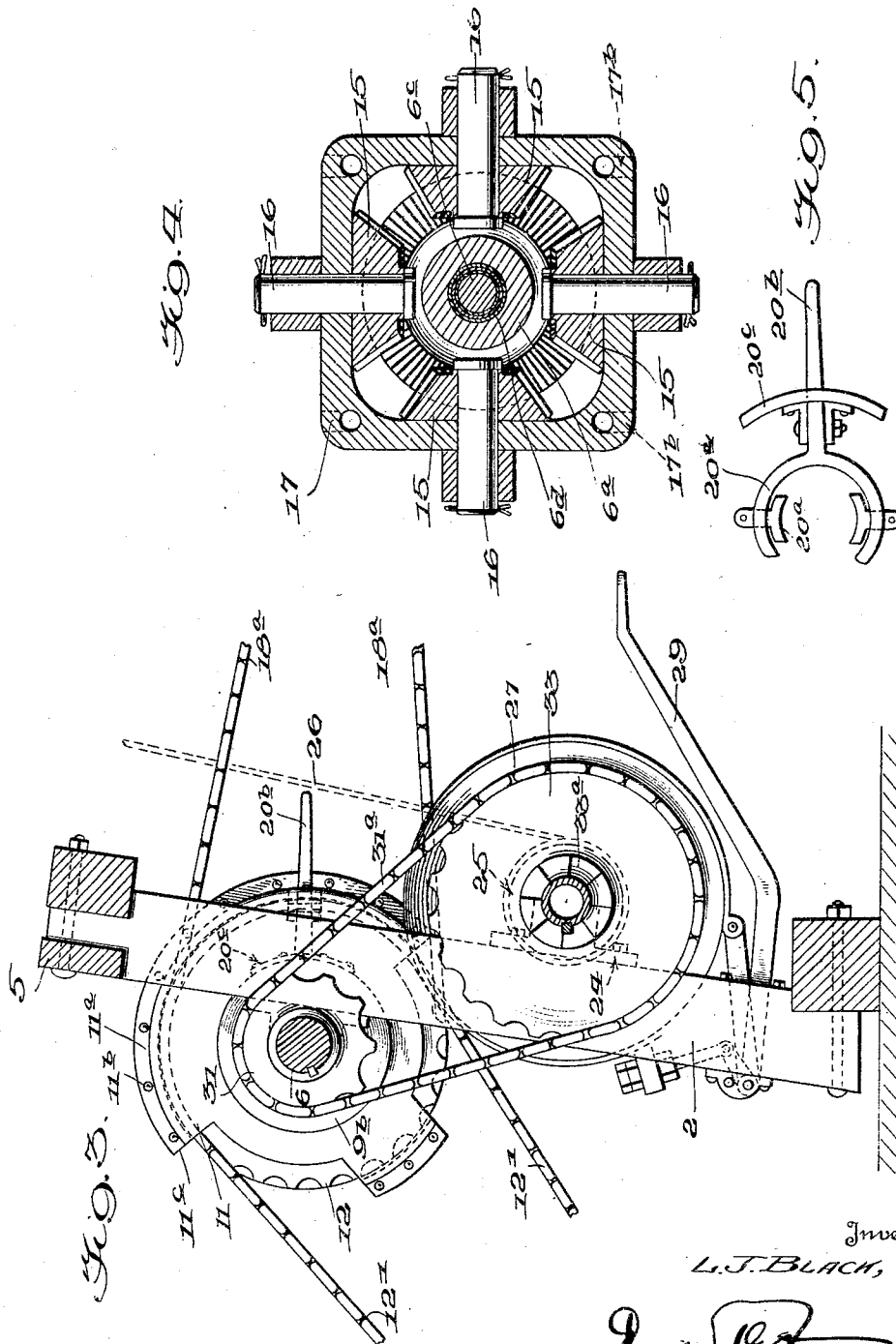
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ROTARY DRIVE AND DRAW WORKS

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3 Sheets-Sheet 3



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ROTARY DRIVE AND DRAW WORKS

Application filed March 23, 1927. Serial No. 177,765.

My invention relates generally to improvements in rotary earth drilling rigs, and more particularly to rotary hoists,—or draw works as they are known in the art.

5 The rotary well drilling rigs now used, and particularly in the oil fields, include a rotary hoist or draw works upon the drum of which is wound the derrick cable to which are connected the blocks and tackle which support the string of drilling tools in the well hole. The draw works receives its power from an engine or motor and also commonly has a driving connection between its line shaft and the rotary table, or "rotary", which is journaled over the well hole and serves to rotate the string of tools in the drilling operation. As the drilling progresses the derrick cable is ordinarily manually unwound from time to time to feed the drilling tools downward. Inasmuch as the operator has no means of knowing when the torque load on the string of tools reaches the danger point, the hand feeding of the string often results in the breaking off of the drill bit,—as for instance when the same lodges in a crevice. In many cases holes are lost at great depth as a result of bit twist offs, after thousands of dollars have been invested in them.

Various efforts, all more or less unsatisfactory,—have been made to overcome this difficulty by providing means in the shape of separate units, independent of the draw works, for automatically stopping the rotation of the drill string, or for acting upon the hoist to elevate the same, or both,—when the torque load upon the string becomes excessive. Ordinarily such units have necessitated the use of two separate sources of power, the torque and weight control of the drill stem being secured through the use of two or more electric motors and electrical field-controlled means for reversing the machinery under excessive drill stem torque. Some structures, while using a single source of power, have involved specially designed

units, independent of the usual draw works, and having a plurality of involved sets of planetary or other gearing for driving the rotary and controlling a winding drum to elevate the drill when it is under excessive torque. In devices of this latter class it is impossible to change from the planetary to a direct or standard drive, either as to the rotary or the winding drum, and accordingly they are incapable of use in lieu of the standard draw works for pulling tubing, placing casing and other operations.

Each class of structure mentioned is expensive and requires more or less attention to operate and keep up and further there is still the necessity for the usual draw works; which means that the torque and weight control unit is an additional and separate expense to the driller besides taking up considerable space.

It is therefore the primary object of my invention to overcome the objections noted and to provide, in a standard rotary drive and draw works, a means whereby the same may be readily used as an automatic torque and weight control for the drill stem during the drilling operation to stop the rotary and elevate the drill stem when the torque load becomes excessive, the same single source of power being employed when the device is used as a torque and weight control or as a draw works.

Another object is to furnish in a draw works, as characterized, a torque and weight control means for the drill stem which eliminates the necessity of a plurality of complicated sets of gearing and the reversing of the line or power shaft.

A still further, and more specific object of the invention resides in the provision of a rotary drive and draw works including a novel sectional line, or power shaft and supporting and alining means therefor combined with differential drive means for permitting the two line shaft sections to turn at differ-

ent speeds when the torque load on one section exceeds that of the other and making it possible for one section to remain stationary while the other its rotating, one line shaft section being adopted for operative connection to the rotary and the other to the winding drum, and means for clutching out the differential whereby said line shaft sections may be driven as a unit as when pulling or lowering tubing, etc.

Another object is to provide in a draw works a novel sectional line shaft and means for supporting, driving and holding the same assembled.

Other objects of the invention will be specifically referred to hereinafter or will be readily apparent to those skilled in the art.

The various features of novelty which characterize the invention are pointed out with particularity in the claims, annexed to and forming a part of this specification. However, for a better understanding of the invention and the advantages which it possesses, reference should be had to the accompanying drawings forming a part of this specification. While the drawings illustrate what I now regard as a preferred embodiment of the invention, it is of course to be understood that I reserve the right to make such changes and modifications therein as fairly fall within the spirit and scope of the subject matter claimed.

Referring specifically to the drawings, wherein the same reference characters have been used to designate the same parts throughout the several views,

Figure 1 is a rear elevational view of a three speed draw works constructed in accordance with my invention;

Figure 2 is a longitudinal sectional view through the intermediate portion of the line shaft and its casing and illustrating the associated gearing arrangement;

Figure 3 is a cross sectional view taken on the line 3—3 of Figure 1;

Figure 4 is a sectional view of the spider and line shaft joint taken on the line 4—4 of Figure 2, and

Figure 5 is an edge elevational view of one of the casing cover plates showing the application of one of the line shaft clutch operating levers thereto.

Referring specifically to the drawings, the structure comprises an upstanding frame which includes spaced posts 1, 2, 3 and 4 connected at their upper ends by suitable cross members or head timbers 5. The lower ends of the posts are bolted to the usual bed frame (not shown) which is positioned over the mouth of the well hole and in which is journalled the "rotary" for driving the drill.

The line or drive shaft for the rotary is made in two sections 6, 6^a which are journalled adjacent their outer ends in bearings

7 mounted upon the outermost posts 1, 4. The outer end of each shaft section extends beyond its respective post bearing 7 and has keyed thereon a cat head 8 as usual. As clearly shown in Figure 2 the shaft sections 6, 6^a extend into a casing 9, of annular cross section, formed by sections 9^a, 9^b each having a marginal flange 11 having an offset apertured portion 11^a receiving fastening bolts 11^b. Thus, the casing sections 9^a, 9^b are rigidly connected in spaced relationship at points removed from their peripheries. This permits the driven sprocket gear 12, which is loosely journalled upon line shaft section 6, to project outwardly between the casing sections 9^a, 9^b. Sprocket gear 12 is driven by a chain 12' from any suitable source of power (not shown), the flanges 11 being broken away as at 11^c for the passage of said chain. Novel clutch and differential means are availed of for establishing a driving connection between sprocket gear 12 and shaft 6, 6^a as will be presently explained.

Figure 2 illustrates that the reduced outer ends of casing sections 9^a, 9^b provide anti-friction bearings 9^c for shaft sections 6, 6^a; also that said outer casing section ends have apertured flange portions 9^d whereby the assembled casing 9 may be rigidly bolted to the intermediate posts 2 and 3 as indicated at 9^e.

As depicted in Figure 2 the inner end 6^c of the shaft section 6 is diametrically reduced and is rotatably received in a bronze bushed end recess 6^d in shaft section 6^a. Thus, shaft sections 6, 6^a are capable of simultaneous or relative rotation in the same fashion as the rear axle of an automobile, a differential drive gearing being here employed which will now be described.

This differential drive gearing includes a bevel gear 13 keyed to shaft section 6 adjacent the inner end thereof and a similarly positioned bevel gear 14 keyed to shaft section 6^a. As best shown in Figure 2, bevel gears 13, 14 are spaced to maintain constant mesh with the four bevel pinions 15 which are journalled upon short stub shafts 16 projecting inwardly from the side walls of a spider or frame 17. As shown, the spider 17 encloses the bevel gears 13, 14 and is bolted as at 17^a to one side of the loosely journalled driven sprocket 12. It is also noted that one end of the spider 17 flatly engages the adjacent face of gear 12 and is further formed with recesses 17^b which receive bosses 12^a projecting from the face of the sprocket. A very rigid attachment of the spider 17 to sprocket 12 is thus provided.

Assuming that the load on the respective line shaft sections 6, 6^a to be equal, it will be evident that when sprocket 12 is driven with spider 17 the shaft sections 6, 6^a will be simultaneously driven at a uniform speed through bevel pinions 15, and bevel gears 13, 14. However when the load on one line shaft

section 6, 6^a is greater such section will slow down in speed or remain stationary while the other will continue to rotate.

Loosely mounted upon line shaft section 6^a and adjacent post 4 is the rotary drive sprocket gear 18 over which the drive chain 18^a for the rotary is trained as illustrated in Figure 3. The conventional rotary and other details are old and well known and since they form no part of the invention, per se, they have not been illustrated. A dental clutch 19, keyed to line shaft section 6^a is operable by interconnected levers 19^a to mate with a hub recess of sprocket 18 to drive the same.

Referring to Figure 2, the outer hub portions of the driven sprocket gear 12 and spider 17 are seen to be provided with clutch teeth 12^b, 17^c with which clutches 20, 21, slidably keyed to the respective shaft sections 6, 6^a are designed to engage. These clutches 20, 21 are thrown in when it is desired to eliminate the differential feature and drive line shaft 6, 6^a as a unit,—as for instance when supplying power therefrom to the drum shaft 22 when pulling tubing or tools from the well hole. Operating levers for clutches 20, 21 are respectively denoted at 20^a, 21^a. It is observed that the bolting of casing sections 9^a, 9^b to posts prevents the casing 9 from rotating and also holds the entire shaft assembly in line.

Roller bearings 12^c, and 17^d in the respective hubs of sprocket 12 and spider 17 serve to facilitate free rotation of the unitary sprocket-spider 12, 17 upon either of line shaft sections 6, 6^a or both of them. Figure 2 also shows that bearings 12^c, 17^d also engage the outer faces of bevel gears 13, 14 to take the axial thrust therefrom. Friction between the driven sprocket 12 and the inner ends of case sections 9^a, 9^b is reduced by packing 23 disposed in circumferential grooves in the section ends.

The drum shaft 22, referred to incidently hereinabove, is journaled in bearing 24 secured to posts 1, 2, 3 and 4 located below and at the opposite sides of said posts from line shaft bearings 7. Keyed upon the drum shaft 22 between posts 2 and 3 is a winding drum 25 to which is attached the hoisting line 26 of a derrick, which line supports the weight of the drill stem in the well hole through the usual arrangement of multiple sheave hoisting blocks (not shown) for partially compensating for the weight of the drill stem. The drum 25 is shown provided with brake flanges 27 at each side within which work the contracting brake bands 28, operated through a link arrangement by a hand lever 29. As in my Patent No. 1,580,003 dated April 6, 1926, the drum shaft 22 is water cooled and has conduits (not shown) leading to the brake drum flanges 27.

Water conduits 30 are shown leading into drum shaft 22.

Figure 1 shows a comparatively small sprocket gear 31 and a relatively larger sprocket 32, in spaced relationship and keyed to line shaft section 6, chains 31^a and 32^a trained thereover and driving, respectively, sprocket gears 33 and 34 which are loose upon drum shaft 22. A still larger sprocket gear 35 is keyed to line shaft section 6^a and drives a loose drum shaft sprocket 36 by chain 35^a. The drum shaft sprockets 33, 34 have ratchet toothed hub ends while the hub of drum shaft sprocket 36 has a rectangular recess. The respective drum shaft sprockets are engageable by clutches 33^a, 34^a and 36^a slidably keyed to drum shaft 22 and operated by foot pedals 33^b, 34^b and 36^b through links 33^c, 34^c and 36^c. The gearing described gives the drum shaft 22 three distinct speeds. Clutch 33^a, when in, establishes a low speed drive through gears 31, 33; clutch 34^a an intermediate speed through gears 32, 34, and clutch 36^a a high speed drive through gears 35, 36. The clutches 33^a and 34^a are of the ratchet type so as to automatically disengage when the next higher clutch is thrown in, while clutch 36^a is of the dental type because at times it is necessary to put the drum shaft in reverse when the drilling engine is reversed.

The operation of the device may be summarized as follows:

When it is desired to adapt the draw works as a torque and weight control for the drill stem the dental clutch 19 is engaged with rotary drive gear 18 to couple the same to line shaft section 6^a. Clutches 20 and 21 are disengaged from their respective toothed hubs 12^b of sprocket 12, and 17^c of spider 17 thus permitting the unitary sprocket spider assembly 12, 17 to rotate freely on line shaft sections 6, 6^a. One of clutches 33^a, 34^a is thrown in to couple shaft section 6 to drum shaft 22, the cable 26, which extends over the derrick and engages the block rigging for supporting the weight of the drill, being wound upon drum 25 as usual. By adjustment of the drill supporting rigging, and the use of either the low or intermediate speed drive (31, 33 or 32, 34) of drum shaft 22 the gradual gravity feeding of the drill into the well hole will be permitted as the drilling progresses. If the feed of the drill stem is too rapid, then it can be retarded by effecting a slight pressure on the brake bands 28 on drum flanges 27 by manipulation of brake lever 29. The drill stem weight thus imparted to line shaft section 6 holds the same stationary. Thus, rotation of driven sprocket 12 with rigidly assembled spider 17 drives line shaft section 6^a through bevel pinions 15, and bevel gear 14. This drives

the rotary through rotary drive sprocket 18 and chain 18^a.

If, in the drilling operation, the bit strikes unusual resistance,—that is to say,—such resistance as will create a torque load on the drill stem that is greater than the weight load of the drill stem on line shaft section 6, then line shaft section 6^a slows down or stops and the companion section 6 will be rotated through bevel pinions 15, and bevel gear 13. This causes the cable 26 to be wound upon drum 25 to elevate the drill from the obstruction. As soon as the drill bit is cleared from the obstruction and consequently the excessive torque load,—it naturally commences rotation again and the weight control section 6 of the line shaft stops to permit the feeding of the drill as before.

When it is desired to use the apparatus as a draw works for pulling the drill stem or string from the well it is only necessary to engage the respective clutches 20, 21 with the hub teeth 12^b and 17^c of sprocket spider 12, 17 and disengage dental clutch 19 from rotary drive sprocket 18. The line shaft sections 6, 6^a and sprocket spider 12, 17 are now tied together into a solid unit and pedals 33^b, 34^b or 36^b may be selectively operated to drive drum 25 at the desired speed. Inasmuch as three gear or speed ratios are provided the draw works is capable of handling a considerable range of load.

Referring to the line shaft clutches 20, 21, Figure 5 shows that one of the yoke-like operating levers 20^a, 21^a, has its operating handle 20^b pivoted to a cover plate 20^c detachably secured over an opening in casing 9. Opposed shoes 20^d, 21^d pivoted to the branches of the respective levers 20, 21 engage in circumferential clutch grooves as shown. Since the clutch operating handles are pivoted on the inside of cover plates 20^c, 21^c and very close thereto, the casing 9 will be oil tight.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. In a rotary drive and draw works including a frame, a drum shaft journaled therein and having a drum for attachment of the drill supporting cable, a line shaft comprising independently rotatable sections journaled in said frame and having their inner ends interfitting to define a bearing whereby to maintain the said shaft sections in alinement, a driven gear loosely journaled upon one of said shaft sections and receiving power from a suitable source, bevel gears rigidly mounted upon said shaft sections adjacent the inner ends thereof and in spaced relation to each other, a spider rigidly fastened to one side of said driven gear and surrounding said bevel gears, bevel pinions journaled in said spider transversely of the axis of said line shaft and engaged by each of

said bevel gears, a casing rigidly secured to said frame intermediate the sides thereof and into which said shaft sections extend, said casing comprising separate sections, the inner ends of said sections providing shoulders engaging the opposite faces of said driven gear to hold the same against axial movement on said line shaft, means for securing said casing sections together beyond the periphery of said gear, the inner face portions of said driven gear and the outer end of said spider engaging the outer faces of said bevel gears to hold the inner ends of said shaft sections in bearing engagement and the bevel gears in engagement with said bevel pinions, clutch controlled means associated with one of said shaft sections for driving the drill stem rotary, selectively operable drum-driving means associated with said other shaft section for varying the load thereon, clutch means operable to couple said driven gear and line shaft sections together as a unit, and a clutch controlled high speed driving means for coupling said first mentioned shaft section with said drum shaft.

2. In a rotary drive and draw works including a frame, a drum shaft journaled therein and having a drum for attachment of the drill supporting cable, a line shaft comprising independently rotatable sections journaled in said frame and having their inner ends interfitting to define a bearing whereby to maintain the said shaft sections in alinement, a driven gear loosely journaled upon one of said shaft sections and receiving power from a suitable source, bevel gears rigidly mounted upon said shaft sections adjacent the inner ends thereof and in spaced relation to each other, a spider rigidly fastened to one side of said driven gear and surrounding said bevel gears, bevel pinions journaled in said spider transversely of the axis of said line shaft and engaged by each of said bevel gears, a casing rigidly secured to said frame intermediate the sides thereof and into which said shaft sections extend, said casing comprising separate sections, the inner ends of said sections providing shoulders engaging the opposite faces of said driven gear to hold the same against axial movement on said line shaft, means for securing said casing sections together beyond the periphery of said gear, the inner face portions of said driven gear and the outer end of said spider engaging the outer faces of said bevel gears to hold the inner ends of said shaft sections in bearing engagement and the bevel gears in engagement with said bevel pinions, clutch controlled means associated with one of said shaft sections for driving the drill stem rotary, and selectively operable drum driving means associated with said other shaft section for varying the load thereon.

3. In a rotary drive and draw works including a frame, a drum shaft journaled therein

and having a drum for attachment of the drill supporting cable, a line shaft comprising independently rotatable sections journaled in said frame and having their inner ends inter-
 5 fitting to define a bearing whereby to maintain the said shaft sections in alinement, a driven gear loosely journaled upon one of said shaft sections and receiving power from a suitable source, bevel gears rigidly mounted
 10 upon said shaft sections adjacent the inner ends thereof and in spaced relation to each other, a spider rigidly fastened to one side of said driven gear, and surrounding said bevel gears, bevel pinions journaled in said
 15 spider transversely of the axis of said line shaft and engaged by each of said bevel gears, a casing rigidly secured to said frame intermediate the sides thereof and into which said shaft sections extend, said casing comprising
 20 separate sections, the inner ends of said sections providing shoulders engaging the opposite faces of said driven gear to hold the same against axial movement on said line shaft, means for securing said casing sections together beyond the periphery of said
 25 gear, clutch controlled means associated with one of said shaft sections for driving the drill stem rotary, selectively operable drum driving means associated with said other shaft
 30 section for varying the load thereon, and clutch means operable to couple said driven gear and line shaft sections together as a unit.

4. In a rotary drive and draw works, a line shaft comprising independently rotatable
 35 sections having cooperating self carried bearing means associated with their inner ends to support the intermediate portion of said shaft, a driven gear loosely journaled upon one of said shaft sections, a drive gear keyed
 40 to each of said shaft sections adjacent the inner ends thereof, a spider rigidly secured to said driven gear, pinions journaled in said spider and transversely of the axis of said line shaft, said pinions engaging the respec-
 45 tive drive gears, the said spider and driven gear cooperating with said drive gears to prevent axial movement of said shaft sections to disengage the inner ends thereof, one of said shaft sections having a clutch controlled
 50 driving connection with a drill stem rotary, the other shaft section having means associated therewith for winding a drill supporting cable, and gearing strain relief and cutout clutch means for connecting said
 55 shaft sections directly to said driven gear and spider whereby to solidly connect said sections into a substantially unitary line shaft.

5. In a rotary drive and draw works, a line shaft comprising alined and rotatably
 60 connected sections, a driven gear loosely journaled on one of said sections, differential gearing in part carried by said driven gear and in part carried by said shaft sections for driving the latter, a driving con-
 65 nection between one of said shaft sections

and the drill stem rotary, winding means associated with said other shaft section for attachment of the drill stem supporting cable, the load of said drill stem on said second
 70 mentioned shaft section tending to hold the same stationary in the normal drilling operation, and a differential gearing strain relief and cutout comprising clutch means for locking said driven gear and shaft sections
 75 together to rotate as a unit solely through rotation of said driven gear and independently of said differential gearing.

6. In a rotary drive and draw works including a frame, a line shaft comprising alined and rotatably connected sections, one
 80 having means to drive the rotary and the other having means to lift the drill, a driven gear loosely journaled on one of said sections, differential gearing in part carried by said driven gear and in part carried by said
 85 shaft sections for driving the latter, the driven gear carried portion of said differential gearing having means for holding said shaft sections in rotatable engagement, the drill lifting means of said second shaft section
 90 including selectively operable sets of different ratio gearing whereby the drill stem load on said section may be varied with respect to the torque load on the other shaft section, and differential gearing strain relief
 95 and cutout clutch means for coupling said shaft sections to said driven gear whereby the entire line shaft may be directly driven as a unit.

7. A line shaft for a rotary drive and draw
 100 works comprising a casing, shaft sections in said casing and arranged end to end, a differential gearing drive means for said sections and including a driven frame portion rotatably supported thereon, and differential
 105 gearing cutout and strain relief means including clutch means for coupling said frame portion to each of said shaft sections whereby the same may be driven as a unit solely through said frame portion.

8. A differential-incorporating rotary drive
 110 and draw works including a frame and a line shaft journaled therein, a casing fixedly carried by said frame, said line shaft comprising alined sections and having their
 115 adjacent ends journaled in said casing, clutch controlled drum shaft driving means associated with each line shaft section, a clutch controlled drive connection between one line shaft section and the rotary, a differential
 120 gearing drive for said line shaft sections within said casing and including a frame rotatably supported by said sections, driving means for said frame, and differential gearing cutout and strain relief means
 125 including clutch means for positively coupling each line shaft section to the adjacent side of said differential drive frame whereby said shaft, sections and differential frames may be positively driven as a unit.

9. In a rotary drive and draw works having a winding drum, a line shaft comprising aligned sections and a driven differential drive containing casing journalled on said line shaft sections and having gearing therein providing a differential driving connection therewith; the combination of a clutch controlled drum shaft driving means associated with each line shaft section, a clutch controlled rotary drive means associated with one line shaft section, and differential gearing cutout and strain relief means for clutching each line shaft section to the differential drive unit.

15 In testimony whereof I affix my signature.
LEE J. BLACK.

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