

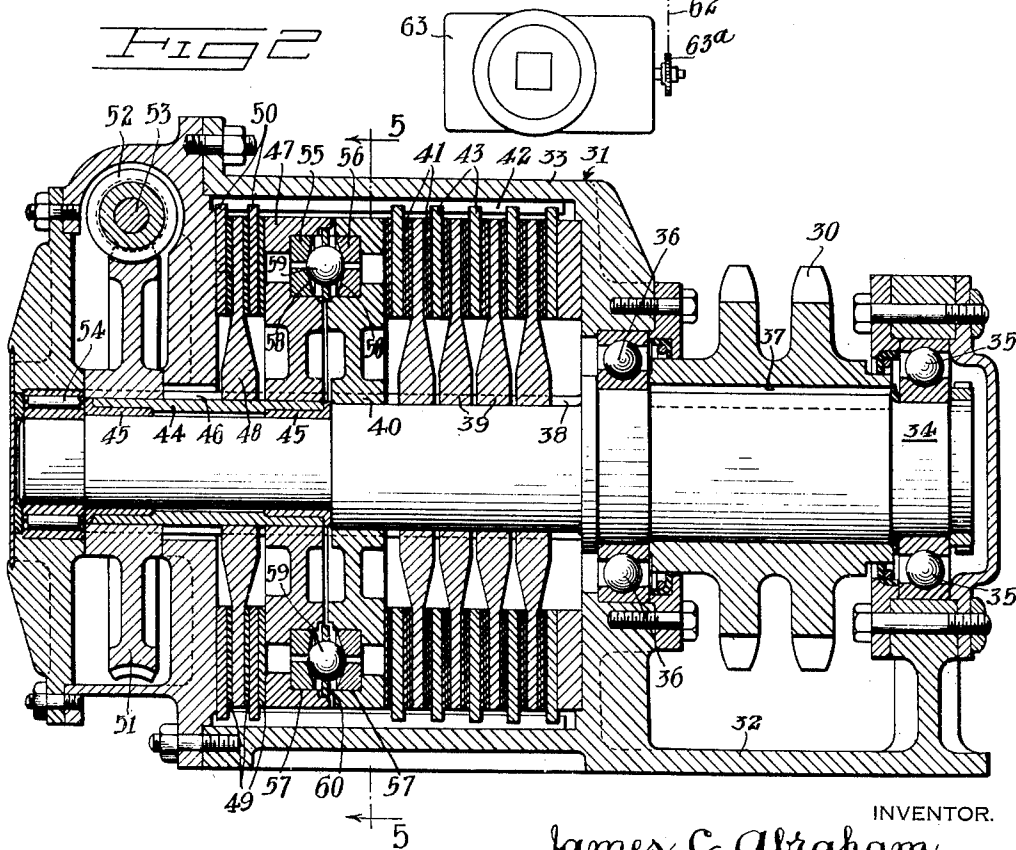
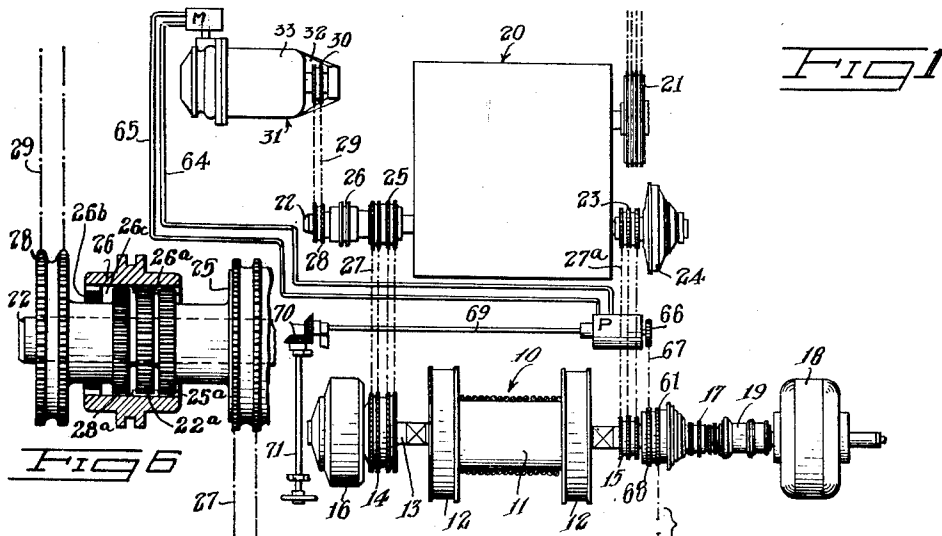
Sept. 1, 1953

J. G. ABRAHAM
DRAWWORKS FEED CONTROL

2,650,796

Filed Feb. 9, 1948

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

FIG 3

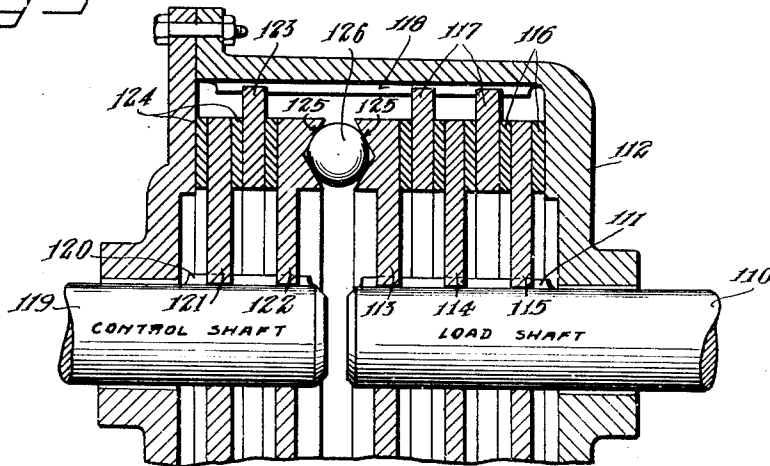
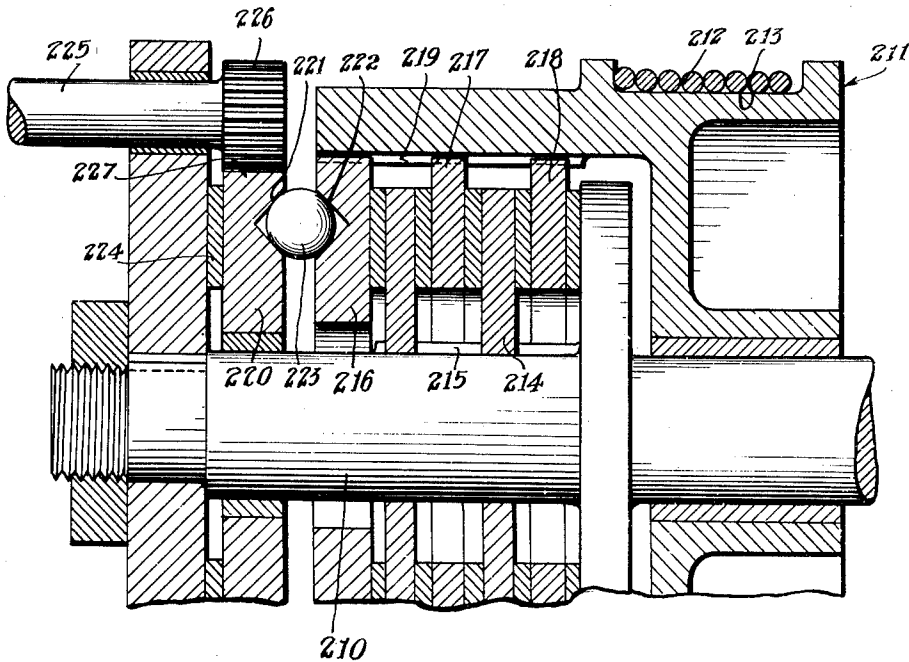


FIG 4



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3 Sheets-Sheet 3

FIG 5

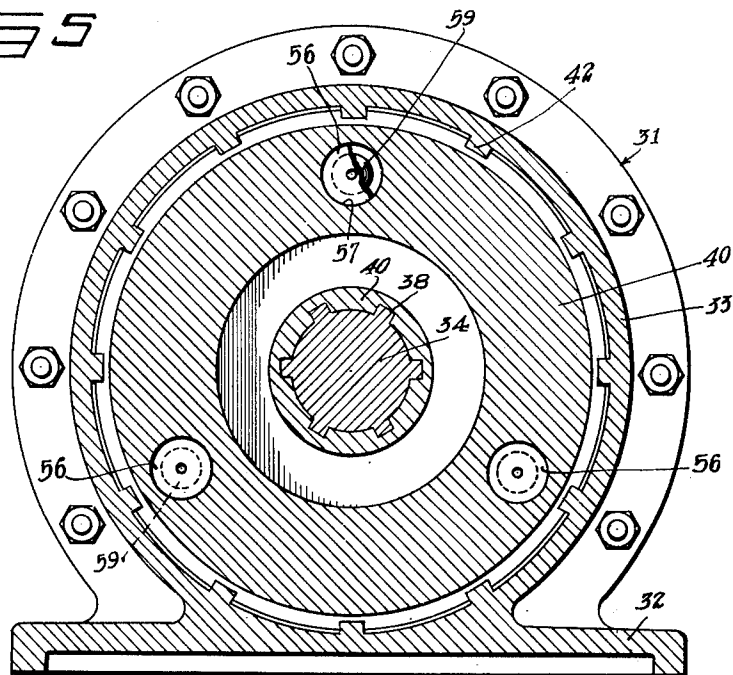
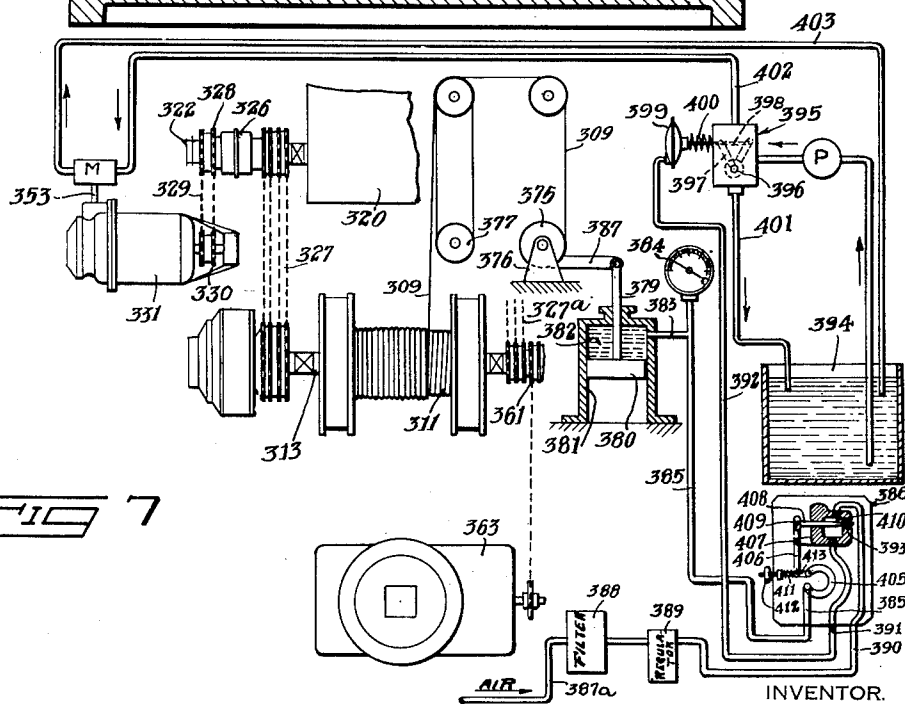


FIG 7



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UNITED STATES PATENT OFFICE

2,650,796

DRAWWORKS FEED CONTROL

James G. Abraham, Laguna Beach, Calif., assignor to The National Supply Company, Pittsburgh, Pa., a corporation of Pennsylvania

Application February 9, 1948, Serial No. 7,237

9 Claims. (Cl. 255—19)

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This invention relates to feed-off devices and is particularly directed to improvements in apparatus for controlling the turning movement of a rotary member subjected to a torque load. This invention finds particular usefulness in controlling the rate of unspooling of a tensioned line or cable from a spooling drum.

I have chosen to describe the essential features of my invention in connection with rotary well drilling machinery, but this is by way of illustration and not to be regarded as a limitation. Rotary well drilling machinery ordinarily includes a drawworks having a drum on which a cable is spooled. The drum is turned to raise and lower the drill string during drilling operations and is also employed as a feed-off device for paying out the cable to control the rate of advancement of the bit into the formation. The conventional practice is to employ large diameter brake rims fixed to the spooling drum and to operate flexible bands over the rims. This conventional form of brake is satisfactory for preventing rotation of the drum when desired, but its characteristics when serving as a feed-off device are rather poor.

When the driller wishes to pay out line from the drum in order that the drill string may continue to advance into the hole, he raises the brake actuating lever to allow the drum to turn under torque applied by the tensioned cable. When the drum starts to turn, however, the driller must immediately reapply the brake by lowering the brake actuating lever. This is true because well known characteristics of friction surfaces require a greater torque to initiate movement than that required to sustain movement after it has commenced. Accordingly, the driller must constantly apply and release the brake lever and no uniform turning movement of the spooling drum is possible.

It is the principal object of my invention to provide feed-off mechanism for controlling the turning movement of a rotary member which is subjected to a torque load.

Another object is to provide a novel form of drawworks feed control which enables the spooling drum to rotate uniformly to pay out the cable.

Another object is to provide a servo-mechanism for controlling the turning movement of a member under torque load, the mechanism including a series of co-axial interengaging friction discs and having means acting on one of the discs effective to release the load on all of the discs to permit the member to turn.

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Another object is to provide a device for controlling the paying out of a tensioned cable from a spooling drum, the rate of unspooling being automatically regulated by the tension in the cable.

Another object is to provide a novel form of feed control for rotary drilling apparatus in which the rate of feed is proportional to the speed of rotation of the drill string.

Another object is to provide rotary drilling apparatus including a rotary drill string supported by a tensioned cable and in which feed control means are provided for the cable for paying out the cable at a rate proportional to the magnitude of tension in the cable.

Another object is to provide a friction drag device employing a plurality of co-axial interengaging friction discs and having roller elements interposed between a pair of adjacent discs acting to subject all of the discs to axial loading to resist rotation, and means for turning one of the discs in the direction of the applied torque load to decrease the effectiveness of the device.

Other objects and advantages will appear hereinafter.

In the drawings:

Figure 1 is a plan view in diagrammatical form showing a rotary well drilling drawworks and a feed-off device embodying my invention.

Figure 2 is a longitudinal sectional elevation of a preferred construction embodying my invention.

Figure 3 is a sectional elevation in diagrammatical form, the portion of the mechanism below the center line being omitted.

Figure 4 is a sectional view of a modified construction shown diagrammatically and having the portion of the device below the center line omitted.

Figure 5 is a sectional elevation taken substantially on the lines 5—5, as shown in Figure 2.

Figure 6 is an enlarged view partly in section of a portion of the device shown in Figure 1.

Figure 7 is a plan view in diagrammatic form showing a modified form of feed-off device embodying my invention.

Referring to the drawings, the drawworks, generally designated 10, includes a spooling drum 11 provided with the usual brake rims 12. Friction bands (not shown) are trained over these rims to serve as brakes to prevent rotation of the drum 11. A drum shaft 13 rotatably mounted on suitable bearings is fixed within the drum 11 and rotatably supports a lowspeed sprocket 14 and a highspeed sprocket 15. An air operated friction

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clutch 16 is provided for connecting the lowspeed sprocket 14 in driving relation to the drum shaft 13, and a spline clutch 17 is provided for engaging the sprocket 15 in driving relation with the shaft 13 when desired. A supplementary brake 18 which may be hydraulically or electrically operated may be connected to the drum shaft 13 by means of the releasable coupling 19. A change speed transmission 20 is adapted to be driven by the sprocket 21 from a suitable source of power (not shown). A driven shaft 22 extends outwardly at both ends from the transmission case. On one end a highspeed sprocket 23 is rotatably mounted and adapted to be connected to the shaft by means of the friction clutch 24. On the other end of the shaft 22 a lowspeed sprocket 25 is rotatably mounted, and a spline clutch 26 is provided for connecting the sprocket 25 in driving relation with the shaft 22. A chain 27 connects the sprockets 25 and 14 and a chain 27a connects the sprockets 23 and 15.

A sprocket 28 rotatably mounted on the shaft 22 may be connected directly with the sprocket 25 when desired by means of the spline clutch 26. This connection is independent of the shaft 22 so that when the sprockets 25 and 28 are connected together neither is connected to the shaft 22. The spline clutch 26 is provided with an internal series of relatively long splines 26a at one end and an internal series of relatively short splines 26b at the other end. A space 26c separates the long splines 26a from the short splines 26b. External splines 28a are carried on the sprocket member 28. Similarly, external splines 22a are fixed relative to the shaft 22. In like manner external splines 25a are fixed on the sprocket member 25. When the spline clutch 26 is in the position illustrated in Figure 6 of the drawings the splines 22a and 25a are connected in driving relationship by the internal series of long splines 26a, thereby connecting the sprocket 25 in driving relationship with the shaft 22. In this position the external splines 28a are positioned within the space 26c and hence the sprocket 28a is not connected to the shaft 22 nor to the sprocket 25. When the spline clutch 26 is shifted to the left the external splines 22a and 28a are connected by the internal series of long splines 26a, thereby connecting the shaft 22 and sprocket 28 in driving relationship. In the latter position of the spline clutch 26 the external splines 25a are disconnected from the splines 26a so that the sprocket 25 is not connected to either the shaft 22 nor the sprocket 28. When the sprocket 26 is shifted toward the right from the position shown in Figure 6 the splines 26b and 28a are brought into mesh. The splines 25a and 26a remain in mesh, but the splines 22a are received within the space 26c. The result is that the sprockets 25 and 28 are connected in driving relationship, but neither is connected to the shaft 22.

A chain 29 connects the sprocket 28 with a sprocket 30 carried by the feed control device generally designated 31. As shown Figure 2 the device 31 includes a stationary base 32 provided with a housing 33. A torque shaft 34 is rotatably mounted on the base 32 by means of suitable spaced anti-friction bearings 35 and 36. The sprocket 30 is keyed to the shaft 34 by means of the key 37. The shaft 34 extends into the housing 33 and is provided with a series of straight splines 38.

A plurality of friction discs 39 are each mounted in interengaging relation on the splines 38

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so that the discs 39 are slidably but nonrotatably mounted on the torque shaft 34. An actuator disc 40 is also slidably and nonrotatably mounted on the splines 38 of the torque shaft 34. Friction lining 41 is secured on opposite sides of each of the friction discs 39 and on one side of the actuator disc 40. Splines 42 are provided within the housing 33 and extend parallel to the splines 38. Nonrotary discs 43 are each slidably mounted on the splines 42 and extend between adjacent pairs of the rotary discs 39 and 40. A sleeve 44 is rotatably supported on the torque shaft 34 by means of spaced bearings 45, and this sleeve carries external splines 46. A synchronizer disc 47 and a rotary disc 48 are each slidably but nonrotatably mounted on the splines 46. Friction lining 49 is carried on opposite sides of the disc 48 and also upon one side of the synchronizing disc 47. Nonrotary discs 50 are connected to the housing 33 by means of the spline 42 and are positioned on opposite sides of the disc 48.

A worm wheel 51 is fixed on one end of the sleeve 44 by means of the splines 46, and a worm pinion 52 is provided for turning the worm wheel 51. A control shaft 53 extends out of the housing 33 for actuation by any convenient means, hereinafter described.

A bearing 54 may be provided for supporting the end of the shaft 34 within the housing 33. Spreader means are provided which are normally effective under the applied torque load to subject each of the friction discs to axial loading and thereby prevent rotation of the torque shaft 34. As shown in the drawings, this spreader means includes pairs of cups 55 and 56 received in suitable recesses 57 provided in the synchronizer disc 47 and the actuator disc 40. Each of the cups 55 and 56 is provided with opposed pockets 58 having slanting walls for contact with balls 59. A retainer 60 may be provided to hold the balls in proper angular spacing.

When a torque load is applied to the torque shaft 34 by the sprocket 30 the actuator disc 40 turns through a small arc with respect to the relatively stationary synchronizer disc 47. This is true because the actuator disc 40 is keyed slidably to the shaft 34 while the synchronizer disc 47 is keyed slidably to the nonrotary housing 33. The torque load applied by the sprocket 30 to the shaft 34 is derived from the tension in the load-supporting cable which has one end spooled on the drum 11. This relative motion between the discs 40 and 47 causes the balls 59 to ride upwardly on the inclined surfaces of the pockets 58 and thereby spread the discs 40 and 47 to apply axial loading on each of the friction linings 41 and 49. The number and size of the discs and the character of the lining are proportioned to resist the maximum torque load expected on the shaft 34. Hence, movement of the balls 59 to spread the discs 40 and 47 brings the friction linings and discs into engagement with sufficient force to effectively prevent rotation of the shaft 34. So long as the torque is applied by the chain 29 to the sprocket 30 the spreader means including the ball 59 and pockets 58 maintains the brake elements in frictional engagement.

When it is desired to allow the sprocket 30 to turn under the applied load the control shaft 53 is rotated. The worm pinion 52 then rotates the worm wheel 51 and the sleeve 44. The rotation of the sleeve 44 is in the same direction as the torque applied by the sprocket 30. Rotation

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of the sleeve 44 turns the synchronizer disc 47 in a direction to reduce the spreading effect of the balls 59 between the pockets 58. A portion of the axial loading on the friction surfaces 41 and 49 is thereby relieved, and the discs 39, 40, 47 and 48 then turn relative to the housing 33 under the torque applied by the sprocket 30 to the shaft 34. The turning motion of the shaft 34, however, continues only so long as the sleeve 44 is rotated.

A further outstanding advantage of this feature of my invention is that practically no effort is required to turn the control shaft 53. The synchronizer disc 47 is normally urged by the balls 59 to turn in the direction of the torque applied to the shaft 34. This turning effort applied by the balls 59 to the synchronizer disc 47 is resisted by the frictional resistance offered by the lining 49 on the disc 47 which contacts the nonrotary discs 50. By choosing the type of lining 49 to provide the desired coefficient of friction, and by forming the inclined sides of the pockets 58 at the proper angle, it is possible to balance the rotating forces applied to the synchronizer disc 47 so that only a very small torque applied by the sleeve 44 is sufficient to cause the synchronizer disc 47 to rotate. It will be understood that the total torque load applied to the shaft 34 is split up between the interengaging discs 39 and 43, and 48 and 50, so that only a proportionate share of the torque load is carried by the discs 40 and 47.

The housing 33 may be completely enclosed if desired in order that the discs may operate in a bath of oil. Under such conditions the friction linings give very uniform action, and the oil may be circulated through a cooler and filter (not shown) in order to extract heat developed on the friction surfaces.

The drawworks 10 may be operated in the conventional manner for turning a rotary machine 63 via the sprocket 61 and chain 62 or for withdrawing the drill string from the hole and reinserting it after changing bits. These conventional operations are performed while the spline clutch 26 is positioned to disconnect the sprocket 28 from the sprocket 25. When it is desired to feed the bit into the formation the spline clutch 26 is shifted to bring the sprocket 28 into direct driving relationship with the sprocket 25. The air operated friction clutch 16 is then engaged to connect the lowspeed sprocket 14 with the drum shaft 13. The tension in the cable spooled on the drum then applies a torque load through the sprocket 14 to the sprocket 25 by way of the chain 27, and this torque load is transmitted through the sprocket 25, chain 29, sprocket 30 and shaft 34 to the friction discs 39, 40, 47 and 48. The spreading action of the balls 59 within the inclined walls of the pockets 58 then automatically applies axial loading to the interengaging friction discs to prevent rotation of the shaft 34.

When the driller wishes to lower the bit into the formation, he causes the control shaft 53 to turn. This may be done directly by mechanical connection if desired or any suitable remote acting device may be employed to permit the driller to rotate the shaft 53 at any desired speed. As shown in Figure 1, such remote acting device may include the fluid pump P adapted to deliver a fluid under pressure to the fluid motor M which may be connected to turn the control shaft 53. The fluid may be delivered through hydraulic line 64 and returned to the pump through the line 65. The pump may be driven from any conveni-

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ent or suitable source of power, but it is preferred to drive it at a rate proportional to the speed of the rotary machine sprocket 63a. Accordingly, the pump sprocket 66 may be driven by a chain 67 from a sprocket 68 attached to the rotary drive sprocket 61.

Means are provided for varying the rate of discharge of the fluid from the pump P, and as shown in Figure 1 this means may include a regulating shaft 69 connected by miter gears 70 with a hand wheel shaft 71 which extends to the driller's position. By turning the shaft 71 the driller controls the output of the pump P and hence regulates the speed of the motor M. For any particular setting of the shaft 71 the speed of the pump P, and hence the speed of the motor M, is proportional to the rate of rotation of the rotary machine sprocket 63a.

The gear ratio of the worm and wheel connection 52-51 and the ratios of the teeth in the sprockets 30-28 and 25-14 determine the number of revolutions which the control shaft 53 must make in order to produce one revolution of the drum 11. This over-all ratio may be varied within wide limits and may be on the order of 100:1 as an example. It is a very desirable feature that this ratio remains constant and although only a few inch-pounds of torque may be required to turn the control shaft 53, very large torques of many thousands of foot-pounds on the drum 11 may be easily controlled.

The driller ordinarily watches the conventional weight indicator which provides a visual indication of the total weight of the drill string. When the bit rests on bottom a portion of this load is no longer supported and the indicator shows this difference. The present invention provides a means whereby the driller need only to rotate the control shaft 53 at a uniform rate to maintain the desired weight on bit without undesirable fluctuations. If the driller wishes to feed the bit twice as fast he need only rotate the control shaft at double the speed.

In Figure 3 I have shown diagrammatically the essential elements of my control device. The load shaft 110 which is normally subjected to a twisting moment is provided with longitudinally extending splines 111 within the enclosure provided by the stationary housing 112. Rotatable friction discs 113, 114 and 115 are slidably mounted on the splines 111 and carry friction lining 116. Nonrotary discs 117 which are slidably keyed to the housing by means of the spline 118 extend between the rotary discs 113, 114 and 115. A control shaft 119 mounted coaxially of the load shaft 110 is also provided with splines 120 on which rotary discs 121 and 122 are slidably mounted. A nonrotary disc 123 extends between the discs 121 and 122 and is slidably mounted on the spline 118. Suitable friction lining 124 is provided on the discs 121 and 122. The adjacent discs 122 and 113 are provided with opposed pockets 125 for reception of balls 126.

As described in connection with the form of my invention shown in Figure 2, the balls 126 ride on inclined surfaces of the pockets 125 to act as a spreader means between the discs 122 and 113. Spreading of these discs puts all of the friction surfaces under axial loading and serves to prevent rotation of the load shaft 110 with respect to the stationary housing 112. When it is desired to allow the shaft 110 to turn the control shaft 119 is turned, thereby releasing the spreader means and causing the balls to be received within the deeper portions of the pockets 125. The discs

122 and 113 approach each other, releasing the axial load on the friction linings 116 and 124, thereby permitting the load shaft 10 to rotate. Although only a very small torque may be required to turn the control shaft 19, a very large torque on the load shaft may be controlled. Furthermore, one revolution on the control shaft is reflected in exactly one revolution of the load shaft.

In the form of my invention illustrated in Figure 4, the shaft 210 is stationary and the housing 211 rotates. A torque may be applied to the housing by any suitable means such as, for example, by spooling a cable 212 around a cylindrical portion 213 of the housing which serves as a spooling drum. Nonrotary friction discs 214 may be connected to the stationary shaft by means of the axial spline 215, and the interengaging rotary discs 216, 217 and 218 are slidably mounted on the rotary housing 211 by means of the axial spline 219. A synchronizing disc 220 rotatably mounted on the shaft 210 is provided with a series of angularly spaced pockets 221. The rotary disc 216 is also provided with a similar series of pockets 222, and these pockets cooperate to support balls 223. The balls 223 and the inclined surfaces of the pockets 221 and 222 cooperate in the manner described in Figures 2 and 3 to serve as spreader means to apply axial loading to the friction linings 224 under the torque load imposed by the rotary housing 211. When it is desired to permit the housing to rotate under the load applied by the cable 212, the control shaft 225 may be turned to cause the pinion gear 226 to turn the spur gear 227 formed on the outer rim of the synchronizer disc 220. The disc 220 is turned in the direction of the torque applied by the housing 211, and accordingly the balls 223 move into the deeper portions of the opposed pockets 221 and 222 to relieve the axial load on the friction linings 224.

In the modified form of my device illustrated in Figure 7 the transmission 320 is adapted to drive the drumshaft 313 by means of the chains 327 and 327a in the same manner as pointed out in connection with that form of my invention shown in Figure 1. The rotary machine 363 is driven from the sprocket 361 on the drumshaft. The feed-off control device 331 is connected by chain 329 with the drive sprocket 328 on the transmission shaft 322. The sprocket may be engaged with the shaft by means of the clutch device 326. The mechanism within the device 331 may be the same as that illustrated in Figure 2, and the connection of the device by chain 329, shaft 322, and chain 327 to the drumshaft 313 may be also substantially identical to that described above.

The distinguishing feature of the modified form of my invention shown in Figure 7 is that the tension in the cable 309 is employed to automatically regulate the speed of the control shaft 353. As shown in the drawing this function is accomplished by securing the dead end of the cable 309 to the hold-down drum 375 pivotally mounted on the stationary support 376. This hold-down device is preferably of the type disclosed in the copending application of John D. Spalding, Serial No. 572,835, filed January 15, 1945, now Patent No. 2,488,070, issued November 15, 1949. It will be understood that one end of the cable 309 is secured to the spooling drum 311, the other end to the anchoring drum 375, and intermediate its ends the cable passes over the blocks 377. A torque arm 387 fixed to the drum 375 is piv-

otally connected to a piston rod 379 attached to piston 380 within the hydraulic cylinder 381. By this construction it will be understood that the unit pressure existing in the hydraulic fluid 382 within the cylinder 381 is proportional to the tension in the cable 309. The unit pressure of the fluid body 382 is transmitted through piping 383 to the pressure gage 384 which is calibrated as a weight indicator. Pressure in the fluid body 382 is also communicated by way of line 385 to a pressure control device, generally designated 386. Air under pressure delivered to the supply pipe 387a passes through the filter 388 and pressure regulator 389 into the inlet pipe 390 of the pressure regulating device 386. Pressure regulating means are provided to vary the air pressure in the outlet pipe 391 in accordance with the hydraulic pressure in the conduit 385. This may be accomplished by any conventional apparatus, and as shown may include a Bourdon tube 405 connected to the hydraulic line 385 and adapted to actuate one end of a lever 406 through linkage 413. The lever 406 may be pivoted at 407 and adapted at its upper end to actuate a needle valve 408 through a connecting pin 409. The needle valve is adapted to close a vent port 393 leading from the chamber 410, to which the inlet and outlet air lines are connected. A compression spring 411 may be provided for actuating the lever to move the needle valve 408 toward open position. Adjusting means 412 permit adjustment of the force exerted by the spring 411. Under relatively high pressure the Bourdon tube 405 moves the lever 406 in a direction to restrict the vent port 393 and thereby applies a greater proportion of the air pressure in the chamber 410 to the outlet line 391. Conversely a reduction in the hydraulic pressure in the line 385 acts to open the needle valve to permit escape of a large proportion of air and thereby reduces the pressure in the outlet line 391.

A pump P driven from any convenient source of power and preferably in timed relation with the speed of the rotary machine driven sprocket 361 is adapted to pump fluid from a supply sump 394 to a diversion valve 395. The diversion valve 395 includes a movable valve element 396 operated by a crank arm 397. A link 398 pivotally connected to the arm 397 is adapted to be actuated by a diaphragm contained within the chamber 399. The piping 392 connects with the diaphragm chamber 399 so that the pressure in the piping 392 determines the position of the arm 397 and valve element 396. The movement of the link 398 may be resisted by a compression spring 400. From the above description it will be understood that the output of the pump P is controlled by the valve element 396 to apportion it between the return pipe 401 leading back to the sump 394 and the delivery pipe 402 leading to the fluid motor M. A return line 403 leads from the fluid motor M back to the sump 394.

In operation the drawworks, including the transmission 320 and spooling drum 311, may be operated in the conventional manner for hoisting pipe from the drilled hole and for reinserting it, and the drawworks may be used to drive the rotary machine 363 in the conventional manner. When the bit is on bottom the drum 311 is allowed to rotate slowly in a direction to pay out the cable 309 and thus feed the drill string and bit downwardly. The rate of unspooling of the drum 311 is controlled by the rate of turning of the sprocket 330 on the feed-off device 331 via the

chains 329 and 327. When the bit is subjected to the desired load the tension in the cable 309, and hence the unit pressure within the fluid body 332, is sufficiently low to cause the device 386 to bleed the piping 392 to atmosphere through the vent 393. Under this condition the spring 400 returns the arm 397 on the valve element 396 so that the entire output from the pump P returns to the sump 394 through the line 401 and substantially no fluid is delivered to operate the motor M. Accordingly, the control shaft 353 remains at rest. Hence the sprocket 330 also remains at rest and the spooling drum does not pay out cable.

Continued rotation of the drill string by means of the rotary machine 363 causes the bit to cut away the formation, thereby lessening the load on the bit and increasing the tension in the cable 309. This is reflected in an increase in unit pressure of the fluid body 332, and accordingly air pressure is admitted into the piping 392 by means of the control device 386. This pressure, acting on the diaphragm within the chamber 399, opens the diversion valve 395 to allow a portion of the fluid delivered by the pump P to enter the line 402 and operate the fluid motor M. Rotation of the control shaft 353 then causes the spooling drum 311 to pay out the cable and again reestablish the desired load on the bit. If the bit should encounter a harder formation or if it should become dulled through use, or if for any other reason the load on the bit becomes greater than the desired value, the tension on the cable 309 is reduced and the pressure of the fluid body 332 is proportionately reduced. Under this circumstance the control device 386 bleeds the piping 392 to atmosphere through the vent 393, thereby preventing further delivery of fluid from the pump P to the motor M. Accordingly, rotation of the spooling drum 311 is arrested. Continued rotation of the bit abrades the formation, and hence relieves the pressure so that the feeding device may again become active.

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

I claim:

1. In a rotary drilling rig having a rotary machine and a spooling drum for a tensioned cable, the combination of: a work member operatively connected with the spooling drum and subjected to a torque load proportional to the tension of the cable; brake means including interengaging friction discs adapted to prevent rotation of the work member, said brake means including coaxial wedging members operative to effect engagement of the friction discs; a control element mounted coaxially of the work member operatively connected to move the wedging members to non-wedging position and thereby permit the work member to rotate in synchronism with the control element; and means for turning the control element at a speed proportional to the speed of the rotary machine.

2. In a rotary drilling rig having a rotary machine and a spooling drum for a tensioned cable, the combination of: a work member operatively connected with the spooling drum and subjected to a torque load proportional to the tension of the cable; brake means including interengaging friction discs adapted to prevent rotation of the work member, said brake means including coaxial wedging members operative to effect engagement of the friction discs; a control element mounted

coaxially of the work member operatively connected to move the wedging members to non-wedging position and thereby permit the work member to rotate in synchronism with the control element; a fluid pump adapted to be driven at a speed proportional to the speed of the rotary machine; and a fluid motor driven by the fluid pump and adapted to turn the said control element.

3. In a rotary drilling rig having a rotary machine and a spooling drum for a tensioned cable, the combination of: a work member operatively connected with the spooling drum and subjected to a torque load proportional to the tension of the cable; brake means including interengaging friction discs adapted to prevent rotation of the work member, said brake means including coaxial wedging members operative to effect engagement of the friction discs; a control element mounted coaxially of the work member operatively connected to move the wedging members to non-wedging position and thereby permit the work member to rotate in synchronism with the control element; a fluid motor adapted to turn said control element; a fluid pump adapted to be driven at a speed proportional to the speed of the rotary machine; and means including hydraulic lines whereby the pump may drive the motor, said means including an adjustable means for varying the speed of the motor independently of the speed of the pump.

4. In a rotary drilling rig having a rotary machine and a spooling drum for a tensioned cable, the combination of: a work member operatively connected with the spooling drum and subjected to a torque load proportional to the tension of the cable; brake means including interengaging friction discs adapted to prevent rotation of the work member, said brake means including coaxial wedging members operative to effect engagement of the friction discs; a control element mounted coaxially of the work member operatively connected to move the wedging members to non-wedging position and thereby permit the work member to rotate in synchronism with the control element; a fluid motor adapted to turn said control element; a fluid pump adapted to be driven at a speed proportional to the speed of the rotary machine; means including hydraulic lines whereby the pump may drive the motor, said means including an adjustable means for varying the speed of the motor independently of the speed of the pump; means confining a fluid body under pressure proportional to the tension in the cable; and means responsive to the pressure of said fluid body for regulating said adjustable means.

5. In a rotary drilling rig having a spooling drum for a tensioned cable, the combination of: a work member operatively connected with the spooling drum and subjected to a torque load proportional to the tension of the cable; brake means including interengaging friction discs adapted to prevent rotation of the work member, said brake means including coaxial wedging members operative to effect engagement of the friction discs; a control element mounted coaxially of the work member operatively connected to move the wedging members to non-wedging position and thereby permit the work member to rotate in synchronism with the control element; power means for turning the control element; and regulating means responsive to the tension in the cable adapted to regulate the speed of rotation of the control element.

6. In a rotary drilling rig having a spooling

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drum for a tensioned cable, the combination of: a work member operatively connected with the spooling drum and subjected to a torque load imparted thereby; a worm wheel operatively connected to said work member; a worm gear meshing with said worm wheel; power means for turning the worm gear; a cable-tension measuring device having a fluid body under pressure proportional to the cable tension, and regulating means responsive to pressure of the fluid body for varying the speed ratio between the power means and the worm gear.

7. A feed control device for a rotary drilling rig, the rig having a spooling drum for spooling one end of a tensioned cable and having a cable-tension measuring device employing a fluid body under pressure proportional to the cable tension, the improvement comprising in combination: a friction brake, means operatively connecting the friction brake in driving relationship with the spooling drum, means for actuating the friction brake to prevent rotation of the spooling drum under the torque load applied by the tensioned cable, hydraulically operated brake-releasing means operatively connected to release the friction brake to permit the spooling drum to unspool the tensioned cable, a power driven pump, a supply line supplying hydraulic fluid to said pump, means including a hydraulic line connecting the pump to said brake-releasing means, a pressure-operated valve operatively interposed in said hydraulic line for regulating the rate of flow of hydraulic fluid supplied to said brake-releasing means, a pneumatic line connected to said pressure-operated valve, a supply pipe for delivering pneumatic fluid under pressure, a valve operatively interposed between the supply pipe and the pneumatic line for varying the pressure in said pneumatic line and thereby controlling the rate of flow in the hydraulic line, and means responsive to pressure of said fluid body for operating the latter said valve.

8. A feed control device for a rotary drilling rig, the rig having a spooling drum for spooling one end of a tensioned cable and having a cable-tension measuring device employing a fluid body under pressure proportional to the cable tension, the improvement comprising, in combination: a friction brake, means operatively connecting the friction brake in driving relationship with the spooling drum, means for actuating the friction brake to prevent rotation of the spooling drum under the torque load applied by the tensioned cable, fluid pressure operated brake-releasing means operatively connected to release the friction brake to permit the spooling drum to unspool the tensioned cable, a power driven pump, a sup-

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ply line supplying fluid to said pump, means including a fluid pressure line connecting the pump to said brake-releasing means, a pressure-operated valve operatively interposed in said fluid pressure line for regulating the rate of flow of fluid supplied to said brake-releasing means, a control line connected to said pressure-operated valve, a supply pipe for delivering fluid under pressure, a valve operatively interposed between said supply pipe and the control line for varying the pressure in said pressure line, and means responsive to pressure of said fluid body for operating the latter said valve.

9. In a rotary drilling rig, the combination of: a drum for spooling a tensioned cable, a cable-tension measuring device employing a fluid body under pressure proportional to the cable tension, a friction brake, means including speed-increasing means operatively connecting the friction brake in driving relationship with the spooling drum, means for actuating the friction brake to prevent rotation of the spooling drum under the torque load applied by the tensioned cable, hydraulically operated brake-releasing means operatively connected to release the friction brake to permit the drum to unspool the tensioned cable, a power driven pump, a supply line supplying hydraulic fluid to said pump, means including a hydraulic line connecting the pump to said brake-releasing means, a pressure-operated valve operatively interposed in said hydraulic line for regulating the rate of flow of hydraulic fluid supplied to said hydraulically operated means, a pneumatic line connected to said pressure-operated valve, a supply pipe for delivering pneumatic fluid under pressure, a valve operatively interposed between the supply pipe and the pneumatic line for varying the pressure in said pneumatic line and thereby controlling the rate of flow in the hydraulic line, and means responsive to pressure in said fluid body for operating the latter said valve.

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