May 7, 1968 J. BARTOS 3,381,584

VANE TYPE ROTARY DEVICES

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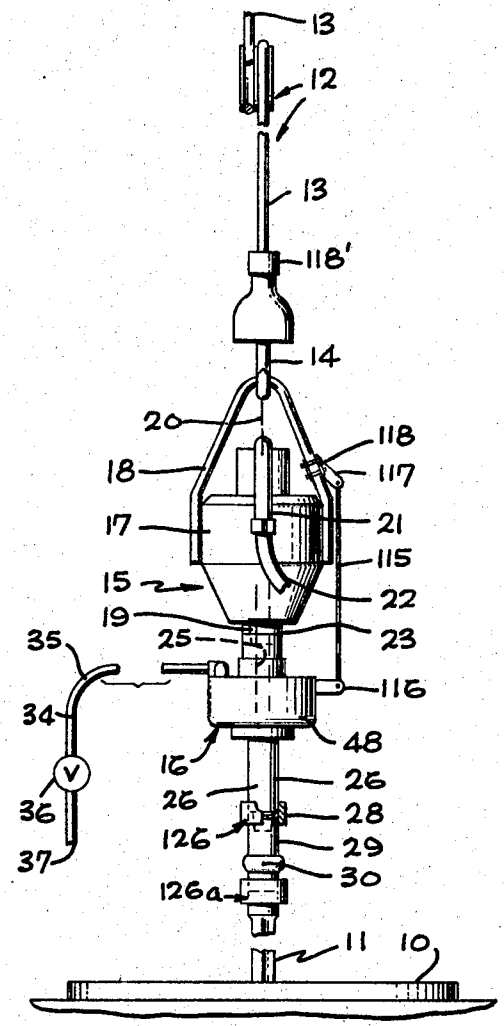


Fig. 1

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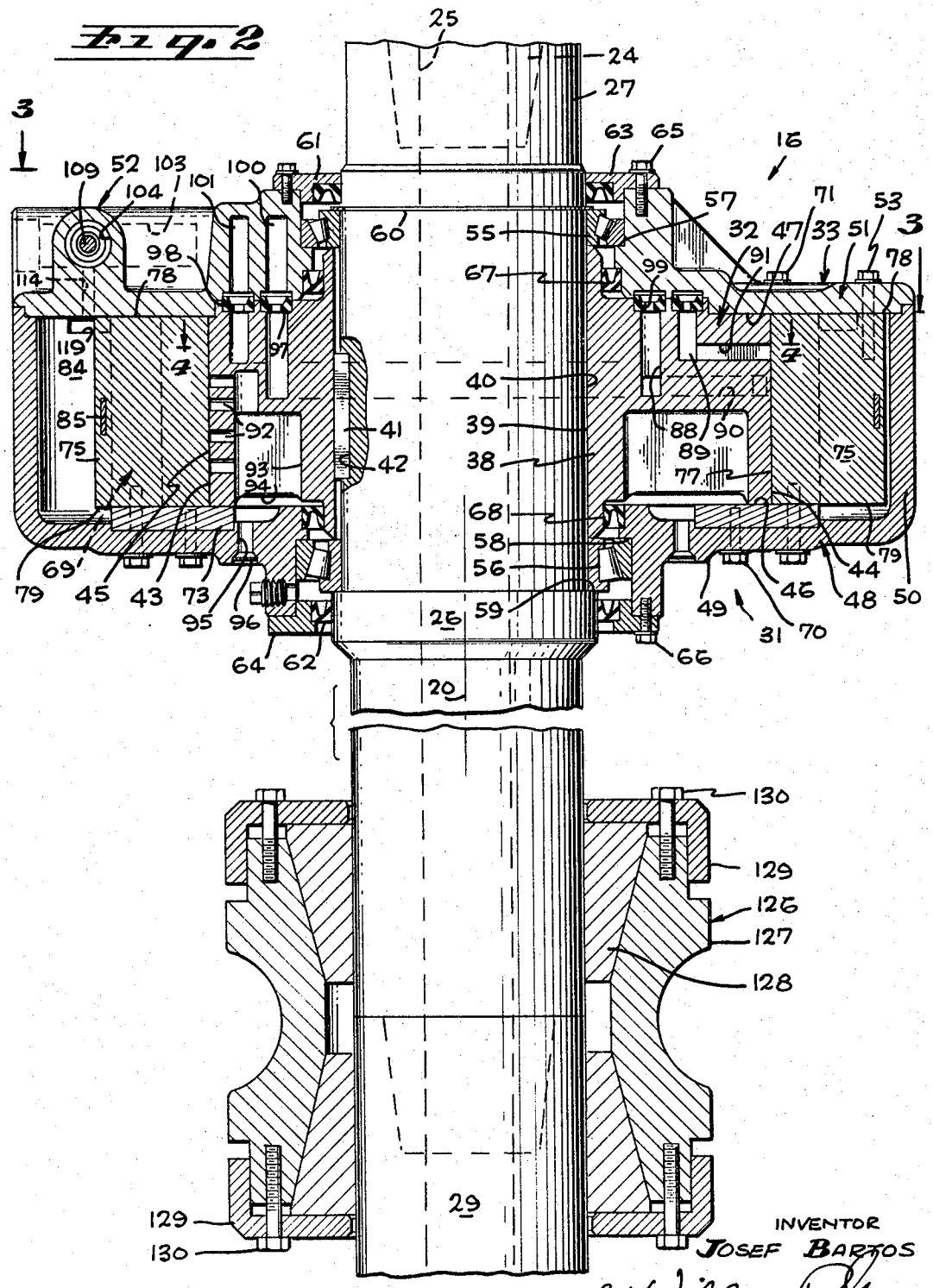
BY William P. Green
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VANE TYPE ROTARY DEVICES

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Fig. 2

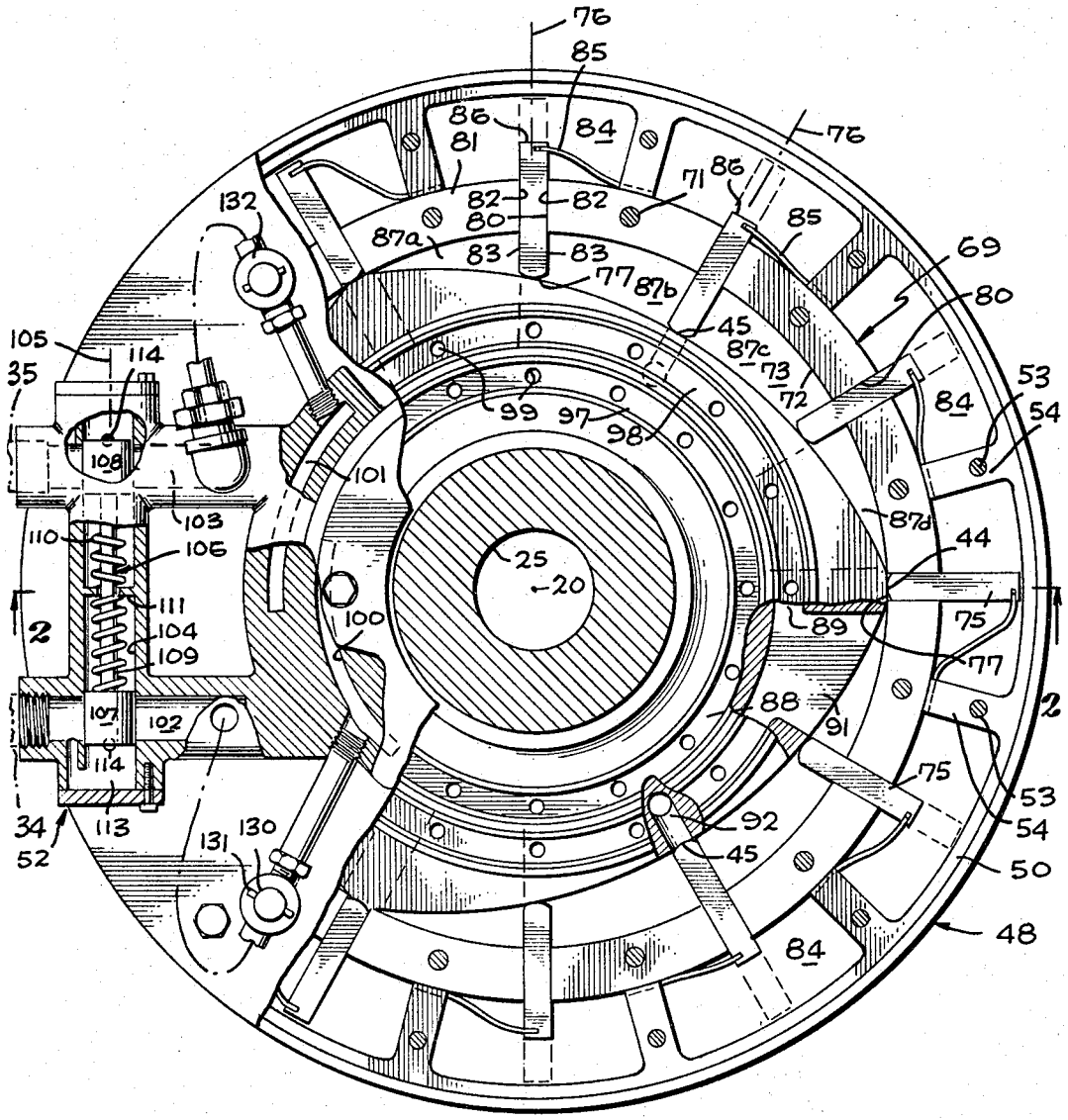


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VANE TYPE ROTARY DEVICES

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Fig. 3



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Fig. 4

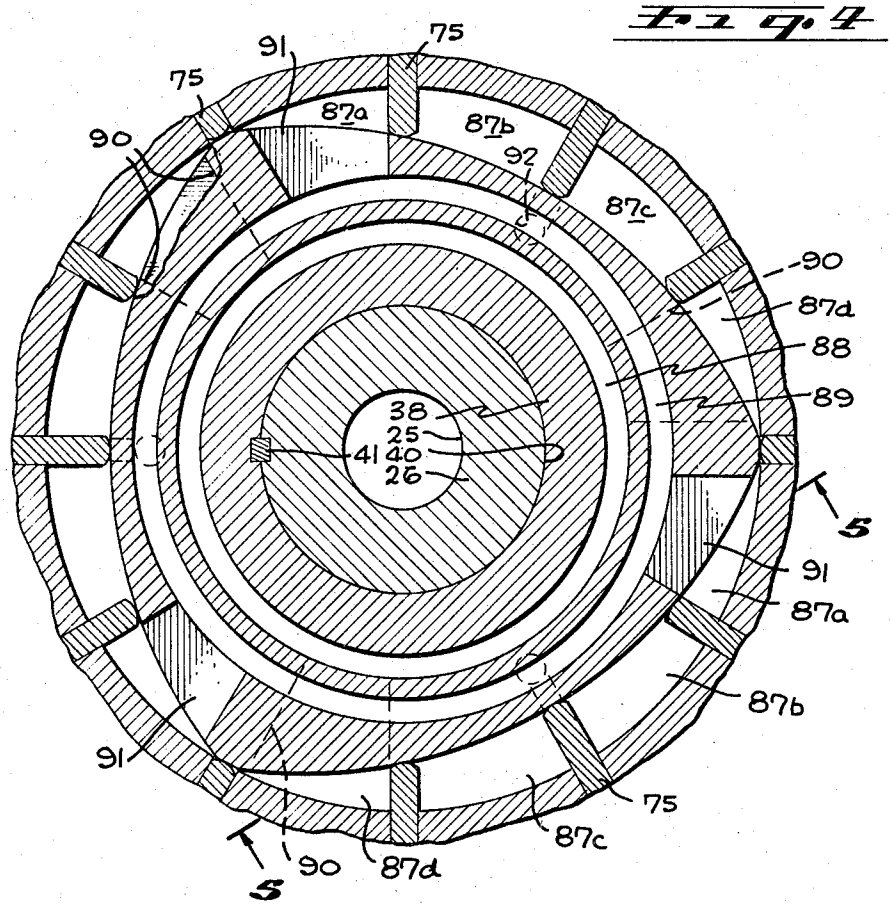
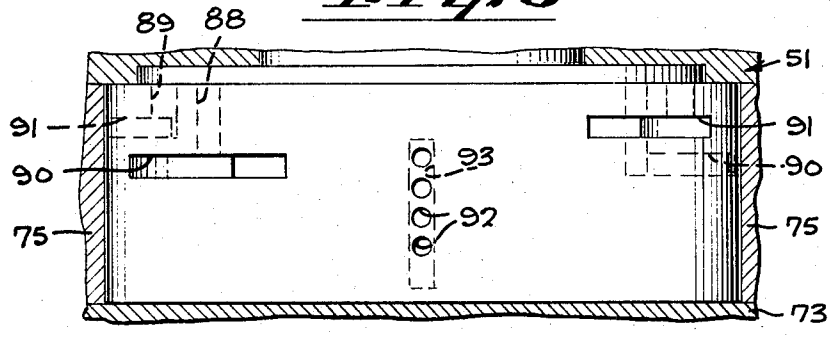


Fig. 5



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VANE TYPE ROTARY DEVICES

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Fig. 6

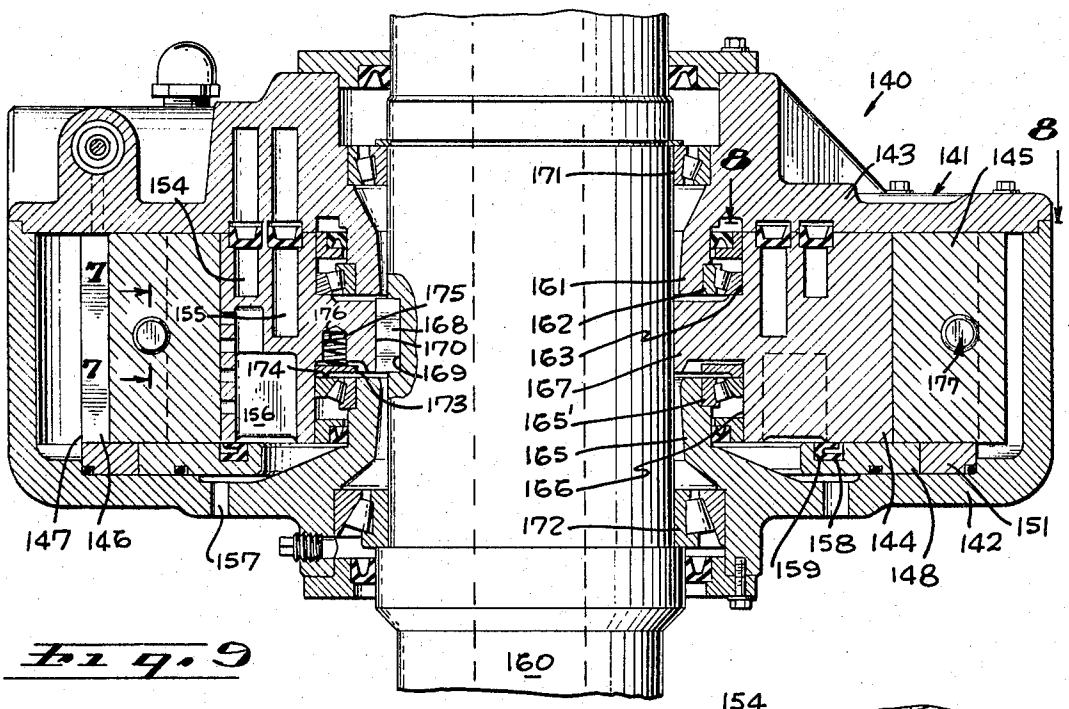


Fig. 9

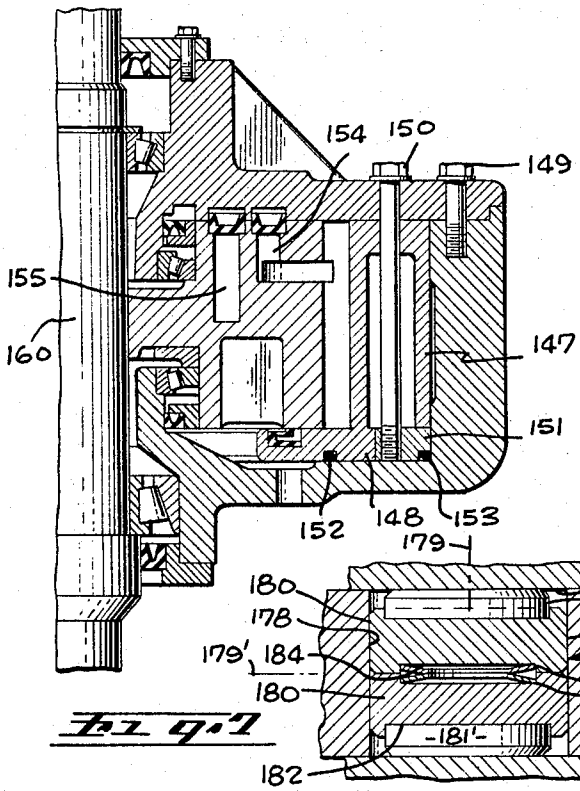


Fig. 7

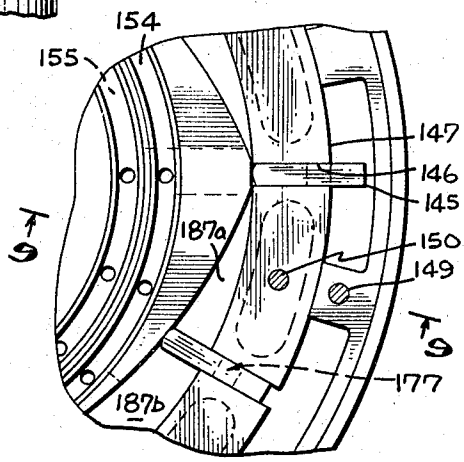


Fig. 8

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United States Patent Office 3,381,584 Patented May 7, 1968

3,381,584

VANE TYPE ROTARY DEVICES

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Filed May 7, 1965, Ser. No. 454,055
15 Claims. (Cl. 91—104)

ABSTRACT OF THE DISCLOSURE

A rotary vane type fluid handling mechanism, especially useful as a well pipe spinner, to be connected to the underside of a well swivel, and rotatively drive the kelly. The device has a rotor with a plurality of lobes which coact with vanes mounted movably to an outer housing, and with the rotor containing fluid inlet and outlet passages for introducing pressure fluid in a relation driving the rotor and the swivel stem in either of two opposite directions.

This invention relates to improved vane type rotary fluid handling mechanisms, such as fluid motors or pumps. The invention will be discussed primarily as applied to fluid driven motors, but it is to be understood, and will be apparent, that some features of the invention are also broadly applicable to pumps. Certain specific features of the invention are especially concerned with the use of the unit as a well pipe "spinner," for turning an upper portion of a well string in order to make or break a threaded joint in the string.

When a well pipe spinner is provided on a drilling rig, the spinner is usually located beneath the swivel, to turn the pipe at that location. The spinner is actuated only at certain specified times, as during a joint making or breaking operation, and at other times remains inactive, for instance while the rotary table acts through the "kelly" to turn the drill string in an actual drilling operation. In order to prevent damage to the spinner during the extended intervals when the spinner is not actually in use, conventional spinners contain clutches which act to uncouple the motor of the spinner from the well pipe, so that the latter may turn without corresponding rotation of, and without wear of, the motor. Though this arrangement has to a certain extent served to desired purpose of protecting the motor against damage, the resulting structure has had several decided disadvantages, in that it has necessitated the use of a more complex overall spinner structure than would be desired, and one which by reason of the provision of the clutching mechanism was subject to malfunctioning, particularly under the very high loads which were encountered in turning a drilling pipe.

A major object of the present invention is to provide a rotary fluid mechanism (either pneumatic or hydraulic) which may serve as a well spinner, or serve other motor or pumping purposes, and which is so constructed as to be convertible between an active fluid driven or fluid pumping condition and an inactive position in which the rotary element of the device may turn without either pumping fluid or being driven by fluid. Especially contemplated is an arrangement of this type in which no clutching means are required for coupling and uncoupling the unit with respect to another structure, but instead in which the pump or motor is internally convertible between the two discussed active and inactive conditions without actuation of any coacting clutch parts. In the active condition, the rotating portion of the mechanism may be free to turn without substantial wear of any type between the portions of the rotating and stationary sections of the apparatus which normally tend to experience wearing engagement.

Structurally, a rotary mechanism embodying the invention is of the vane type, having one or more, preferably several, vanes which define with the rest of the mechanism a chamber or chambers whose sizes vary as the apparatus turns about its axis. The vane or vanes, which desirably are carried by a non-rotating section of the device, serve as partitions or sides of the chambers, and are movable in a manner compensating for the change in size of the chambers as the rotating section of the device turns. An important feature of novelty of the present invention resides in the mounting of these vanes for retracting movement to inactive positions in which they may remain as the rotating section of the apparatus turns, so that the vanes no longer serve as the discussed partitions or sides of the fluid chamber or chambers, and the apparatus therefore loses its capacity to function as a motor or pump. When it is desired to again convert the device to operative condition, the vane or vanes are merely actuated to their active positions in which they again serve as partitions for defining the variable size chamber or chambers as the rotating section of the apparatus turns.

In conjunction with the retractable vanes, I preferably employ means for actuating the vanes between their active and retracted positions. For best results, it is found desirable that the actuation to active position be under the influence of fluid pressure, which may be applied to the vanes in a manner urging them from their retracted to their active positions. Also, means may be provided for retracting the vanes when desired, typically by suitable retracting springs which become effective when the fluid pressure is withdrawn. The same fluid pressure which is utilized to drive the apparatus as a motor may be employed to automatically actuate the vanes to active settings when the fluid pressure is first admitted to the motor.

When used as a well pipe spinner, the motor structure is disposed about a tubular fluid passing element, which may be connected into the drill string at a location above the kelly and beneath the swivel. The drilling mud may then be forced downwardly through this tubular body about which the spinner is carried.

Certain particular features of the invention relate to the preferred manner of retention of the main body of the spinner against rotation, so that the application of fluid pressure to the device can have the effect of turning a rotary second section of the unit and the connected drill pipe. For this purpose, I preferably utilize a connecting structure which extends upwardly from the spinner to the top of the swivel, and connects to the bail by which the swivel is suspended. For best results, this connection takes the form of a flexible cable, which is connected at its upper end to the bail and is connected at its lower end to the body of the spinner, and which acts by virtue of the flexibility of the cable to introduce a cushioning effect into the operation of the spinner for preventing damage to either the spinner or the actuated well pipe or swivel.

The above and other features and objects of the invention will be better understood from the following detailed description of the typical embodiments illustrated in the accompanying drawings, in which:

FIG. 1 is a side view of a well swivel and spinner arrangement constructed in accordance with the invention;

FIG. 2 is a vertical section through the spinner of FIG. 1 and taken on the irregular line 2—2 of FIG. 3;

FIG. 3 is a horizontal section taken primarily on line 3—3 of FIG. 2;

FIG. 4 is a section taken on line 4—4 of FIG. 2;

FIG. 5 is a side view of the rotor taken on line 5—5 of FIG. 4;

FIG. 6 is a view similar to FIG. 2 but showing a variational form of the invention;

FIGS. 7 and 8 are fragmentary sections taken on lines 7—7 and 8—8 respectively of FIG. 6; and

FIG. 9 is a fragmentary axial section taken on line 9—9 of FIG. 8.

Referring first to FIG. 1, I have shown in that figure a well drilling rig, including a rotary table 10 through which a non-circular "kelly" 11 extends in rotatively driven relation. The drill string is connected in the usual manner to the lower end of kelly 11, and is driven thereby. The string is suspended by a conventional elevator assembly 12, taking the form of a block and tackle which is power actuated and whose cable 13 carries a suspending hook 14. Hook 14 in turn suspends a swivel 15 beneath which there is provided a spinner 16 with which the present invention is primarily concerned.

Swivel 15 includes an outer non-rotating body 17 from which a bail 18 projects upwardly for reception about and suspension by hook 14. The swivel also includes a rotating vertically extending tubular element or spindle represented at 19, mounted by suitable bearings for rotation relative to and within housing 17 about the vertical axis 20 of the well. Drilling mud or fluid is fed into the upper end of tubular spindle 19 of the swivel through a gooseneck 21, which receives the fluid from a flexible supply hose 22. The lower end 23 of spindle 19 projects downwardly beneath body 17 of the swivel, and has a threaded end portion 24 which is connectible to spinner 16. The inner passage 25 through tubular spindle 19 extends vertically along the entire length of that spindle, to carry the drilling fluid downwardly to the lower end 23 of the spindle for discharge from that lower end into the spinner.

To describe now the structure of the spinner itself, reference is made particularly to FIGS. 2, 3 and 4. From these figures, it will be apparent that the spinner includes a main vertically extending short pipe section 26 having an internally threaded "box" end 27 at its upper end into which the externally threaded lower end portion 24 of spindle 19 of the swivel is connected in supporting and fluid conducting relation. At its lower end, the pipe section 26 has an externally threaded "pin" portion 28 which is connected to the upper end of the well string, typically by connection into an upper "box" end of a tubular kelly-cock section 29 containing a valve at 30 for closing off the flow of fluid through the string if desired. Pipe section 26 of course contains a vertically extending passage 31 (FIG. 2), through which the drilling fluid may pass downwardly from the spindle for delivery to and through kelly-cock section 29 into kelly 11 and the connected drill string. During a drilling operation, the central short pipe section portion 26 of spinner 16 turns with the rest of the drill string and the spindle of the swivel, with this entire structure being driven by rotary table 10.

The threaded joint between pipe sections 26 and 29 may be locked against accidental detachment, as by a suitable locking ring structure 126 (FIGS. 1 and 2). This structure may include a sleeve 127 containing tapered pipe gripping slips 128 which are tightenable against both of the pipes 26 and 29 by end rings 129 (which are actuable by screws 130). A similar device 126a may lock section 29 against unscrewing motion relative to kelly 11.

About section 26, the spinner 16 forms and functions as a fluid actuated motor 31, having its rotor 32 mounted to turn with and drive section 26, and also having an outer non-rotating housing or main body structure 33. Actuating air or other pressure fluid is fed to the housing 33 through either of two air inlet lines 34 or 35, the former of which admits air for forward or right hand rotation of the drill string, while the latter (line 35) admits air for reverse or left hand rotation of the drill string. A reversing or selector valve represented at 36 in FIG. 1 selectively connects lines 34 and 35 respectively to an air

inlet line 37. As will be understood, when one of the lines 34 or 35 is connected to the air source line 37, the other of the two lines 34 or 35 is suitably connected to atmosphere for discharge thereto through valve 36. Also, the selector valve 36 of course has an "off" position, in which actuating air is not supplied to either of the two lines 34 or 35.

The rotor 32 of the air driven motor has a tubular vertically extending hub portion 38 (FIG. 2), containing a vertically extending cylindrical passage 39 which closely receives an outer cylindrical surface 40 of the central pipe section 26 of the spinner. The rotor is keyed to section 26 for rotation therewith by means of a key represented at 41, having portions extending into opposed axially extending key-ways 42 in section 26 of rotor 32. The rotor is defined peripherally by a vertically extending outer surface 43, which in horizontal cross section has the non-circular configuration illustrated in FIGS. 3 and 4. More particularly, outer surface 43 may have a plurality of (desirably three) maximum diameter lobe portions 44, which are evenly circularly spaced, and between which surface 43 progressively reduces in diameter to a minimum diameter location 45, and then progressively increases in diameter to the next successive lobe 44. Surface 43 may be considered as continuous entirely about the periphery of the rotor, and as vertically continuous between two horizontal non-rotating surfaces 46 and 47 (FIG. 2), except insofar as surface 43 is interrupted at the locations of certain air inlet and discharge passages which will be discussed in detail at a later point in this description.

The outer housing 33 of the spinner includes a main section 48 having a bottom annular wall 49 and a radially outer vertically extending wall 50. The housing also includes a top cover plate or element 51, which is essentially annular except for the provision of an automatic valve structure 52 at one side thereof, and which extends across the upper side of housing section 48 to form therewith an essentially annular space within which the rotor turns. Housing sections 48 and 51 are rigidly secured together in any convenient manner, as by screws represented at 53 in FIGS. 2 and 3. These screws may extend downwardly through top plate 51 and into a series of evenly circularly spaced radially inwardly projecting walls 54 which are integral with and project from outer wall 50 of housing part 48.

The rotor 32 and its connected rotating central pipe section 26 are mounted for rotation relative to housing 33 by means of two upper and lower roller thrust bearings 55 and 56, whose outer races bear against upper and lower shoulders 57 and 58 on the housing to prevent upward or downward movement of the housing relative to section 26. The inner race of bearing 56 is confined between a shoulder 59 on section 26 and the lower end of rotor 32, and the inner race of bearing 55 is confined between the upper end of the rotor and a snap ring 60 contained within a groove in section 26, all in a manner preventing axial movement of either of the bearings relative to section 26. Two resilient annular seal elements 61 and 62 may be carried by annular plates 63 and 64, which may be retained to the housing by screws 65 and 66, to prevent the admission of any dirt, dust, or the like to the bearings or the interior of the motor. Similarly, two resilient annular seal rings 67 and 68 may be provided at the second sides of the bearings, and between the rotor and the outer housing of the spinner to further protect the bearings and retain lubricant therein.

At a location spaced radially inwardly from outer cylindrical wall 50 of the housing, the housing structure rigidly carries an essentially cylindrical wall 69 centered about axis 20 and containing a series of evenly circularly spaced slots or passages 80 extending radially through wall 69. Slots 80 thus divide wall 69 into a series of arcuate partial cylindrical wall segments 81 (FIG. 3), which may be held together by providing wall 69 at its

lower end with an annular flange **73** which is integral with wall **69** and extends radially inwardly therefrom. The part **69–73** may be suitably secured to part **48** of the housing by screws **70** (FIG. 2), and to top plate **51** of the housing by screws **71** (FIGS. 2 and 3). Wall **69** and its segments **81** form a series of partial cylindrical surfaces **72**, which are centered about the main vertical axis **20** of the spinner and well, and are of a diameter corresponding substantially to the maximum diameter **44** of the rotor. Surfaces **72** extend vertically between the two previously mentioned surfaces **46** and **47** of FIG. 2 to define therewith a cylindrical space within which the rotor turns. The surface **46** at the bottom of the space may if desired be formed on the above discussed flange **73** on wall **69**.

The wall **69** movably carries a series of evenly circularly spaced vanes **75** (FIG. 3), each of which may take the form essentially of a flat vertically extending rigid member, lying and moving in one of a series of planes **76** extending radially outwardly from and containing axis **20**. As viewed in these planes, the vanes have the rectangular vertical cross section illustrated in FIG. 2. As viewed in a horizontal plane, the vanes also have an essentially rectangular but radially elongated cross section (FIG. 3), but with this cross section being rounded at the radially inner edges **77** of the vanes. The horizontal cross section of the vanes illustrated in FIG. 3 continues along the entire vertical height of the vanes, between surfaces **46** and **47**, with each of the vanes having upper and lower horizontal parallel surfaces **78** and **79** which slidably engage housing surfaces **47** and **46** respectively. The inner rounded vertically extending edge **77** of each vane engages the outer surface **43** of the rotor along a vertical line extending between surfaces **46** and **47**, to form a fluid seal therewith.

Each of the vanes **75** may be slidably mounted for movement relative to the housing radially inwardly and outwardly, as between the broken line and full line positions of FIG. 3, by sliding reception of each vane within one of the radially extending vertical slots **80** formed in ring **69**. The surfaces **82** which form slots **80** extend vertically between surfaces **46** and **47** of FIG. 2, and slidably engage the opposite side surfaces **83** of the vanes continuously between those surfaces, to form an effective fluid seal between the vanes and ring **69**, to confine actuating air against escape radially outwardly past the vanes and into the chambers **84** formed between walls **54** of the housing. The vanes may be yieldingly urged radially outwardly to a position in which their inner curved surfaces **77** are at substantially the same diameter as inner surface or surfaces **72** of ring **69**, with this effect typically being attained by leaf springs **85**, whose opposite ends may be connected to walls **54** and the outer extremities of the vanes respectively. The springs **85** are however sufficiently yieldable to enable the vanes to be actuated radially inwardly against the influence of the springs by the action of air pressure applied to the radially outer surfaces **86** of the vanes, within outer chambers **84** in the housing formed between walls **54**.

As will be apparent from FIG. 3, there are formed by the housing, rotor, and vanes, a series of chambers **87***a*, **87***b*, **87***c*, **87***d*, etc. (between successive vanes), which progressively change in volume or size as the rotor turns. Compressed air is fed to these chambers through two annular passages **88** and **89** in rotor **32**, passage **88** being utilized for right hand rotation of the motor and drill string, and passage **89** being utilized for left hand rotation. As seen best in FIGS. 2 and 4, passage **88** communicates with certain specified ones of the chambers **87***a* about the rotor through three radially outwardly extending passages **90**, which may flare outwardly as seen in FIG. 4, and may have a circular extent just slightly less than the circular distance between two successive vanes **75**. These three passages **90** communicate with the space radially between the rotor and wall segments **69** at locations just circularly behind (offset in a counter-clockwise direction from) the maximum diameter portions **44** of outer surface **43** of the rotor. The second annular passage **89** similarly communicates with the space at the outside of the rotor through three passages **91** (of a circular extent slightly less than the spacing between successive vanes **75**), with these passages **91** being at the leading side of maximum diameter locations **44**, that is, offset slightly from those maximum diameter locations in a clockwise direction as viewed in FIG. 3. At the minimum diameter or radius portions **45** of the rotor surfaces **43**, there are provided a number of air discharge passages **92** (FIGS. 2 and 3), which conduct air radially inwardly into the interior of the rotor, and into chambers or cavities **93** formed in the rotor from which the air may discharge through an annular clearance space **94** between the rotor and housing, and into a series of air outlet passages **95** leading past screens **96** to the outside of the apparatus.

To describe now the manner in which air is delivered to rotor passages **88** and **89**, it will be seen in FIG. 2 that there are provided at the upper ends of these passages a pair of annular typically rubber seal rings **97** and **98**, which rest in annular recesses in the upper surface of the rotor, and which contain circularly spaced apertures **99** through which air may pass downwardly into passages **88** and **89**. Rings **97** and **98** annularly engage both the rotor and the upper housing plate or cover **51**, and communicate with two arcuate air delivery passages **100** and **101** in cover **51** to receive air therefrom. Air is in turn delivered to passage **100** through a pressure regulating and pressure reducing valve **130** (having an adjusting handle **131**), which receives air from a passage **102** leading from valve unit **52** (FIG. 3). Similarly, air is delivered to arcuate passage **101** through a second adjustable pressure regulating and pressure reducing valve **132** and a passage **103** from an opposite side of valve unit **52**. Passage **102** receives air from inlet hose **34**, and passage **103** receives air from inlet hose **35**. Disposed transversely across passages **102** and **103**, the material of cover **51** forms and contains a cylindrical slide valve bore **104**, within which there is slidably mounted, for movement along transverse axis **105**, a slide valve element **106** having two enlarged heads **107** and **108** interconnected by a reduced diameter shaft **109**. Springs **110** bear against heads **107** and **108** respectively, and against a central reduced diameter partition **111** in passage **104**, to normally yieldingly retain valve element **106** in the FIG. 3 position. In that position, heads **107** and **108** prevent the admission of any air through passage **102** or **103**, and past valve head **107** and **108**, to the rotor. The valve in this setting does, however, admit some air through a by-pass passage **112** into an end chamber **113**, from which the air may flow downwardly through a passage **114** which is partially but not completely covered by head **107**. This passage extends downwardly from the bottom side of the bore **104**, and conducts some air downwardly into one of the chambers **84** at the outside of the vanes. A similar passage **114** is provided at the opposite end of valve element **105**, being normally partially covered by head **108** (see FIGS. 2 and 3), and being in communication with air supplied through hose **35**.

The housing or main body structure **48** of spinner **16** is preferably retained against rotation by connection to the non-rotating apparatus at the upper end of the swivel. More particularly, it is preferred that the housing **48** be retained against rotation by means of a flexible (wire rope) cable **115** (FIG. 1), whose lower end is connected to an integral lug **116** projecting outwardly from housing **48**, and whose upper end may be connected to a similar lug or arm **117** on a bracket **118** which is rigidly clamped onto bail **18** of the swivel.

To now describe the manner in which the spinner **16** is utilized, it may be first pointed out that the spinner device, as seen in FIG. 2, forms a unitary structure carried by its central pipe section **26**, which structure may be connected into the well string at a location beneath the

swivel by merely breaking the usual connection between kelly-cock section 29 and swivel spindle 23, and connecting section 26 in at that location. The cable 115 may then be attached at its upper and lower ends to the spinner body and the swivel bail to complete the assembly.

After the spinner has been installed, the rotary table 10 and other apparatus may be employed in completely conventional manner to drill the well, without interference of any type by the presence of the spinner unit. During such normal drilling, when the spinner 16 is not being employed for turning the well string, vanes 75 are all retained in their radially outermost positions, in which their inner curved ends 77 are substantially aligned circularly with inner surface 72 of the housing. The vanes are retained in these positions by springs 85, and when so located may be just slightly outwardly of the cylinder defined by surface 72, so that there is no engagement of any of the vanes with any portion of the rotor as the rotor turns. Thus, the rotor is free to turn without contacting the vanes, and without damage to or wear of either the vanes or the rotor. Also, it is preferred that the extreme outermost portions 44 of the rotor be very slightly spaced from even the surface or surfaces 72 themselves, the spacing typically being on the order of a few thousandths of an inch, say for example 1 to 4 thousandths, so that the rotor peaks and the housing surface 72 are themselves not worn.

When it is desired to spin section 26 of the spinner device, and the connected portions of the drill string, in a clockwise direction as viewed in FIG. 3, valve 36 of FIG. 1 is actuated to admit air through hose 34 to slide valve assembly 52. This air initially is blocked by slide valve head 107 against admission to the rotor, but may immediately pass, at full line pressure, through passage 112 into the partially exposed passage 114, from which it passes into one of the chambers 84 within which the outwardly retracted vanes are contained. All of these various chambers 84 (FIG. 3) are in communication with one another, as by provision of cutaways or recesses 119 in radial walls 54 (see FIG. 2), so that the admission of air to one of the chambers 84 admits air to all of these chambers. This air acts radially inwardly against outer faces 86 of the vanes 75, to pneumatically actuate each of these vanes radially inwardly until its inner curved end 77 contacts the radially opposite portion of rotor surface 43 (full line positions of the vanes in FIG. 3).

The admission of air to chamber 113 at the end of the slide valve 106 also has the effect of actuating head 107 of the slide valve toward the central divider 111, to thus, after a predetermined delay period during which slide valve 106 is being moved, allow air to pass through passage 102 and pressure reducer 130 into arcuate passage 100, and from that passage downwardly into annular passage 88, and from that annular passage radially outwardly through the three rotor passages 90 into three of the intervane chambers at the outside of the rotor. For example, air is admitted through one of the passages 90 to the chamber designated 87*d* at the right side of FIG. 3. The air in this and the other two similarly located chambers causes the three chambers corresponding to 87*d* of FIG. 3 to tend to increase in size, with this result being attained by rotation of the rotor in a clockwise direction, as viewed in FIG. 3. As soon as passage 90 comes into communication with the next successive inter-vane chamber, it also tends to increase the tendency for right hand or clockwise rotation. Thus, so long as any chamber is in communication with one of the passages 90, that chamber is effective as a driving force for producing clockwise rotation. Immediately after the trailing end of one of the passages 90 passes one of the vanes 75, and thus leaves its position of communication with one of the inter-vane chambers (as has occurred in the case of chamber 87*c* in FIG. 3, for example), the discharge apertures 92 at one of the minimum radius locations 45 move into communication with that chamber to allow the compressed air to discharge therefrom to atmosphere. After the discharging operation is completed, the chamber is in readiness for reception of actuating air when the next successive feed passage 90 moves into communication with the chamber.

Valve 106 preferably introduces a delay between the initial delivery of air to outer chambers 84 and the subsequent delivery of air to rotor chamber 87*a* etc., with this delay being sufficient to enable the vanes to be actuated inwardly against the rotor before the latter commences to turn. Also, pressure regulator 130 reduces the pressure of the air admitted to chambers 87*a*, 87*b*, etc. sufficiently beneath the pressure of air in chambers 84 to assure that the latter will always be capable of maintaining the vanes inwardly against the rotor, and against the reverse tendency of the pressure in chambers 87*a*, 87*b*, etc. For example, if the line pressure which is supplied to chambers 84 is 100 p.s.i., regulator 130 may be set to reduce this pressure to a value of 80 p.s.i. in chambers 87*a* etc.

When it is desired to reverse the direction of rotation of the rotor, air is admitted through hose 35 to the outer side of valve head 103, to again be delivered through one of the passages 114 to the chambers 84, whose pressurization (at full line pressure) acts to displace the vanes radially inwardly from their inactive positions to their active positions of engagement with the rotor, following which the air acting against head 108 moves that head to a position in which it will pass air through regulator 132 into arcuate passage 101 (at reduced pressure) and through that passage into the annular passage 89 in the rotor, to flow outwardly through three passages 91 of the rotor. These passages are so located as to communicate with inter-vane chambers at the clockwise side of maximum diameter portions 44 of rotor surface 43, to cause left hand or counter-clockwise rotation of the rotor in a manner which will be apparent from the above discussion of the clockwise driving action. The same discharge passages 92 act to discharge the expanded air from the inter-vane chambers after it has been utilized.

When air is being admitted to the rotor through passage 102 of valve 52, head 108 of the valve allows air to discharge from the chambers which are in communication with passages 91 of the rotor, through passage 103, and through hose 35 to the atmosphere discharge outlet of valve 36. Similarly, when air is admitted through passage 103, it discharges from the opposite side of the rotor through passage 102 in line 34.

If the speed of rotation of the rotor in either direction becomes excessive, due to an excessive increase in pressure, the vanes may be unable to return radially inwardly rapidly enough to always maintain full contact with the rotor, and as a result some leakage past the blades may occur in a manner automatically limiting the maximum speed of the rotor and preventing damage thereto.

The cable connection 115 between the spinner and the upper end of the swivel introduces some flexibility into the spinner operation, so that whenever the spinner is energized to drive in a particular direction, the housing of the spinner may rotate very slightly in the opposite direction, being restrained ultimately by flexible cable 115 after rotation through a few circular degrees, to thus remove any excessive shock which might otherwise be introduced into the apparatus by sudden change in condition. Also, it is found desirable to connect the spinner housing to the swivel bail as discussed, rather than to the underside of the non-rotating portion 17 of the swivel, in view of the difficulty often encountered in attempting to connect to the underside of the swivel, and the damage which may be incurred by the swivel housing in making such a connection.

FIGS. 6 through 9 show another form of spinner constructed in accordance with the invention, and which

may be considered as essentially the same as the spinner 16 of FIGS. 1 through 5 except with respect to the specific differences discussed in detail below. As best seen in FIG. 6, the spinner 140 has a housing 141 formed of a main hollow lower section 142 and a cover 143. Rotor 144 is of the same shape as the rotor in FIGS. 1 through 5, and coacts with a series of circularly spaced vanes 145 mounted for radial sliding movement within slots 146 formed within a cylindrical wall 147 corresponding to wall 69 of the first form of the invention. This wall 147 has a lower integral flange portion 148 corresponding to flange 73 of FIG. 2, to define with the cover 143 and the rotor a series of chambers 187*a*, 187*b*, etc. such as those shown at 87*a*, 87*b*, etc. in FIG. 3.

As seen best in FIG. 9, the two housing sections 142 and 143 are secured rigidy together by bolts 149. The slotted ring 147 and its flange 148 are secured in fixed position relative to cover 143 by a series of elongated vertically extending bolts 150 (FIGS. 8 and 9), which extend downwardly through ring 147 and connect at their lower ends into a retaining ring 151 bearing upwardly against the underside of ring 147, at a location radially outwardly of flange 148. Elements 148 and 151 may be sealed annularly with respect to the housing by suitable O-rings represented at 152 and 153. Air may be delivered selectively to either of two annular inlet passages 154 and 155 in the rotor, as in the first form of the invention, and air may be discharged from the rotor through outlet chambers 156 leading to atmosphere at 157. The underside of the rotor may be sealed with respect to flange 148 by means of an elastomeric seal ring 158, received within a suitable annular groove 159 in flange 148.

A particular feature of the form of the invention shown in FIGS. 6 through 9 resides in the manner in which the rotor is mounted rotatively directly to the housing, rather than to the main pipe section 160 about which the device is carried. More particularly, the cover 143 of the housing may have a downwardly projecting annular portion 161 for engaging the inner race of a roller bearing 162, whose outer race is engaged within an annular recess 163 formed in the upper side of rotor 144. Similarly, the bottom wall of the housing may have an upwardly projecting annular portion 165 engaging the outer race of a roller bearing 165', whose inner race is received and confined within an annular recess 166 formed in the underside of the rotor. Vertically between the recesses 163 and 166, the rotor may have a radially inwardly projecting annular portion 167 which is received about the outer surface of pipe section 160, and is keyed against rotation relative thereto by means of a key 168 received within a key way 169 in section 160 and within a spline recess 170 extending axially within the rotor. The key 168 is sufficiently loose within the spline recess 170 to allow very slight axial movement of the rotor relative to the key and therefore relative to section 160, as necessary to allow bearings 162 and 165' to always remain concentric with main bearings 171 and 172 which mount the main housing to section 160.

To minimize wear on the lower bearing 165', and to prevent any tendency for locking of the rotor in the housing chamber if such wear does occur, I preferably spring urge the rotor of FIG. 6 upwardly relative to the housing and against upper rotor bearing 162. For this purpose, there is provided at the underside of portion 167 of the rotor an annular ring 173, which bears downwardly against the outer race of bearing 165 at 174, and against which yielding force is exerted downwardly by a series of evenly circularly spaced coil springs 175 received within evenly circularly spaced circular recesses 176 formed in the underside of portion 167 of the rotor. These springs 175 are always maintained under compression, and exert an upward force on the rotor equal to a substantial portion of the weight of the rotor, preferably between about 25% and 75% of the weight of the rotor, and for optimum results about 50% of that weight. As will be apparent, of one of the two bearings 162 or 165 wears in a manner tending to introduce looseness into the bearing mounting for the rotor, this looseness is compensated for by springs 175, which urge the two races of each of the bearings together with sufficient force to prevent any tendency for wobble of the rotor within the housing.

In the arrangement of FIGS. 6 through 9, the vane returning springs 85 of FIG. 3 have been deleted, and in their place I have provided friction units 177 (FIGS. 6 and 7) carried by the various vanes and acting to introduce sufficient friction into the vane movement to maintain the vanes in their radially outer positions except when they are forcibly urged inwardly by actuating air pressure. For receiving units 177, each of the vanes contains a circular opening or passageway 178 centered about an axis 179 which is disposed transversely of the plane 179' of the vane, and therefore the plane of movement of the vane. Within cylindrical passageway 178, there are provided two desirably bronze buttons or discs 180 having outer cylindrical surfaces 181 which are close fits within passage 178. Each of these buttons carries a facing disc 181', also typically circular and received and located within a circular recess 182 in the associated button. The two buttons or discs 180 are yieldingly urged away from one another by two annular spring washers 183 which are received within shallow opposed recesses 184 in the discs 180, and urge the discs apart with sufficient force and far enough to cause the outer planar surfaces 185 of elements 181' to press lightly against the inner surfaces 186 of the radial slot in wall or ring 147 within which the vane is slidably received. The light spring pressed engagement of elements 181' with surfaces 186 thus serves the intended purpose of yieldingly retaining each vane in its radially outermost position except when air pressure applied to the outer end of the vane forceably actuates it radially inwardly. Preferably, elements 181' are of a material which is not readily subject to wear, and whose friction is sufficiently low to avoid the introduction of inefficiencies into the operation of the apparatus. For this purpose, I prefer to utilize a suitable fluorocarbon, such as tetrafluoroethylene, as sold under the trademark "Teflon."

The operation of the form of the invention shown in FIGS. 6 through 9 is of course essentially the same as the first form of the invention, except in the particular respects discussed above, and therefore will not be described further except by reference to the operation of the first form of the invention.

I claim:

1. A well pipe spinner for use with a swivel having a non-rotating body suspended from an elevator, and having a rotating spindle; said spinner comprising a power actuated drive unit beneath said swivel body connected to said spindle in driving relation, said drive unit having a first section and having a second section which turns relative to the first section and drives the spindle, and including motor means for driving said second section relative to the first section, a flexible cable structure for holding said first section against rotation and adapted to extend upwardly from beneath said swivel body and connect to a non-rotating element, and bearing means connecting said second section to said first section for rotation relative thereto and including thrust bearing means supporting the weight of said first section from said second section so that said cable structure is not required to support said weight.

2. A well pipe spinner for use with a swivel having a non-rotating body with an upwardly projecting bail to be suspended from an elevator, and having a rotating spindle; said spinner comprising a power actuated drive unit beneath said swivel body connected to said spindle in driving relation, said drive unit having a first section and having a second section which turns relative to the first section and is connectible to and drives the spindle, and including motor means for driving said second section relative to the first section, a structure for holding

said first section against rotation and adapted to extend from beneath said swivel body and upwardly past a portion of said body and connect to said bail, and bearing means connecting said second section to said first section for rotation relative thereto and including thrust bearing means supporting the weight of said first section from said second section so that said structure for holding said first section against rotation is not required to support said weight.

3. A well pipe spinner for use with a swivel having a rotating spindle; said spinner comprising a power actuated drive unit beneath said swivel connectible to said spindle in driving relation, said drive unit having a first section and having a second section which turns relative to the first section and drives the spindle, and including motor means for driving said second section, a structure for holding said first section against rotation and having substantial flexibility for enabling limited rotative motion thereof, and additional means for supporting the weight of said first section other than through said flexible structure so that said flexible structure is not required to support said weight.

4. A vane type fluid motor comprising a body containing a chamber, a rotor mounted in said chamber to rotate relative to the body, said rotor having a plurality of lobes projecting toward a wall of said chamber and having portions at the leading and trailing sides of the lobes which are spaced farther from said wall to vary the spacing between said rotor and said wall as the rotor turns, at least one vane movably carried by said body and projecting from said wall into said chamber and into engagement with said rotor and forming with said body and rotor at least one compartment which varies in size as the rotor turns, inlet means for conducting pressure fluid to said compartment in a relation driving the rotor, said inlet means including two fluid inlet passages in the rotor to which fluid may be supplied selectively to drive the rotor in opposite directions, and two inlet openings formed in and turning with the rotor through which said passages respectively communicate with the space between said rotor and said chamber wall, said openings being circularly between two successive lobes and near said two successive lobes respectively, and being positioned to drive said rotor in said opposite directions when pressure fluid is supplied to said two passages respectively, said openings being positioned to move past said vane and coact therewith in valving relation so that until one of said openings reaches said vane that opening communicates with a first side of the vane, and after said opening passes the vane the opening communicates with the opposite side of the vane, and said motor including a third passage in the rotor serving as a fluid outlet passage and communicating with the space between said rotor and said chamber wall at a location circularly between said two inlet openings, and also coacting with said vane in valving relation, each of said inlet openings being located circularly between one of said two successive lobes and the point of communication of said outlet passage with said space.

5. Well apparatus including a swivel, a spinner connected to said swivel, a rotary table, and a kelly which is to be turned selectively by either said spinner or said rotary table, said spinner including a vane type fluid motor having a first section and having a rotor section which is driven rotatably relative to said first section by pressure fluid and which turns with said kelly, at least one vane forming a partition between said sections defining a side of a compartment which changes progressively in size as the rotor section turns, said vane being mounted movably to one of said sections, and projecting into engagement with the other section and being shiftable relative to said one section in retracting and projecting directions in accordance with and in compensation for said change in size of said compartment, means operable when the rotor section is being driven by said pressure fluid to yieldingly urge said vane in said projecting direction and into engagement with said other section continuously as the rotor section turns through a series of complete revolutions, and means operable when said rotor section is driven by the rotary table to maintain said vane in a predetermined retracted position and out of engagement with the other section.

6. Well apparatus as recited in claim 5, in which said first mentioned means includes means operable, when the rotor section is being driven by the fluid, to urge the vane into engagement with said other section by the pressure of said fluid, and said second mentioned means includes a spring for maintaining the vane in said retracted position upon release of the pressure of said fluid.

7. Well apparatus as recited in claim 6, in which there are a plurality of said vanes mounted slidably to said first section and projecting radially inwardly into engagement with said rotor section and defining a series of said compartments, said rotor section having a plurality of circularly spaced radially outwardly projecting lobes engaging said vanes.

8. A well pipe spinner for use with a swivel and a kelly comprising a tubular body to extend generally vertically along an axis and having an upper threaded end for connection to the stem of a swivel and having a lower threaded end for connection to a kelly, said body containing a vertical passage for conducting circulating fluid from a swivel to a kelly, means forming a rotor structure about the outside of said tubular body adapted to turn about said axis with said tubular body and to drive it and a kelly rotatively about said axis, a housing structure disposed about said tubular body and about said rotor structure and containing a generally annular chamber extending about the tubular body and within which said rotor structure turns, at least one vane movably carried by one of said structures and projecting into sliding engagement with the other structure and defining a side of a fluid compartment which changes progressively in size as the rotor structure and kelly turn, means for retaining said housing structure against rotation about said axis, and inlet means for introducing pressure fluid into said compartment in a relation to drive the rotor structure about said axis.

9. Well apparatus comprising a swivel having a tubular stem, a kelly, and a spinner including a tubular body extending generally vertically along an axis and having an upper end connected to the swivel stem and a lower end connected to said kelly, said body containing a generally vertical passage for conducting circulating fluid from said swivel to the kelly, said spinner including means forming a rotor structure about the outside of said tubular body adapted to turn about said axis with said tubular body and to drive it and the kelly rotatively about said axis, a housing structure disposed about said tubular body and about said rotor structure and containing a generally annular chamber extending about the tubular body and within which said rotor structure turns, at least one vane movably carried by one of said structures and projecting into sliding engagement with the other structure and defining a side of a fluid compartment which changes progressively in size as the rotor structure and kelly turn, means for retaining said housing structure against rotation about said axis, and inlet means for introducing pressure fluid into said compartment in a relation to drive the rotor structure about said axis.

10. Well apparatus as recited in claim 9, in which said inlet means include two pressure fluid inlets operable to introduce pressure fluid into said housing structure at locations to drive the rotor structure and kelly in either of two opposite directions.

11. Well apparatus as recited in claim 9, in which said inlet means include a pressure fluid inlet passage formed in the rotor structure, and an opening formed in and

turning with the rotor structure for conducting fluid from said inlet passage to said compartment.

12. Well apparatus comprising a swivel having a tubular stem, a kelly, and a spinner including a tubular body extending generally vertically along an axis and having an upper end threadedly connected to the swivel stem and a lower end threadedly connected to said kelly, said body containing a generally vertical passage for conducting circulating fluid from said swivel to the kelly, and a vane type fluid motor disposed about said tubular body and including a hollow housing containing a generally annular chamber extending about said tubular body, a rotor disposed about said body and contained within said chamber and mounted to turn therein about said axis and to drive said body rotatively, said rotor having a plurality of radially outwardly projecting lobes and having portions of reduced radius therebetween, a plurality of vanes mounted to said housing and projecting generally radially inwardly into sliding engagement with the rotor and movable generally radially in retracting and projecting directions as the rotor turns, said vanes dividing said chamber into a series of compartments which vary in size as the rotor turns, means for retaining said housing against rotation, and means for introducing pressure fluid into said compartments at locations to drive the rotor and body rotatively.

13. Well apparatus as recited in claim 12, in which said pressure fluid introducing means include two inlet passages in the rotor, a first set of openings in the rotor for leading fluid from one of said inlet passages into said compartments at first sides of said lobes and in a relation driving the rotor in a first direction, and a second set of openings in the rotor for leading fluid from the other of said inlet passages into said compartments at second sides of the lobes and in a relation driving the rotor in the opposite direction.

14. A vane type fluid handling mechanism comprising a first section, a second section mounted to rotate about an axis relative to said first section, at least one vane forming a partition between the sections defining a side of a chamber which changes progressively in size as said second section rotates, means forming a guideway having spaced side walls and slidably receiving said vane and mounting it for sliding shifting movement between said side walls relative to one of said sections in accordance with and in compensation for said change in size of said chamber, said vane being free to retract within said guideway to a predetermined inactive position in which it no longer forms said partition between the sections, and being free to remain in that inactive position as said second section turns, said vane containing an opening extending entirely through the vane between said walls, two friction elements carried in said opening and yieldingly bearing against said two side walls respectively to frictionally retain said vane in said inactive position, and a spring between said two elements and urging them apart and against said side walls.

15. A vane type motor comprising a body containing a chamber, a rotor mounted in said chamber to rotate relative to the body, said rotor having a radially outer surface defining a plurality of radially outwardly projecting lobes extending into close proximity to an outer wall of said chamber, said rotor surface having portions circularly between the maximum radius portions of said lobes and which are spaced farther from said wall to vary the spacing between said rotor and said wall as the rotor turns, a plurality of circularly spaced vanes mounted to said body for generally radial movement relative thereto and projecting from said wall into said chamber and into engagement with said rotor surface and forming with said rotor and body a plurality of compartments which change in size as the rotor turns, two fluid inlet passages in the rotor to which pressure fluid may be supplied selectively to drive the rotor in opposite directions, a first set of inlet openings in the rotor at first sides of the lobes respectively for placing a first of said passages in communication with different ones of said compartments in a relation to drive the rotor in one of said directions, a second set of inlet openings in the rotor at the opposite sides of the lobes respectively for placing the second passage in communication with different ones of said compartments in a relation to drive the rotor in the opposite direction, and an outlet passage formed in and turning with said rotor and communicating with said compartments at locations between successive lobes and circularly between an opening of said first set of openings and an opening of said second set of openings and operable to discharge said fluid from the compartments.

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