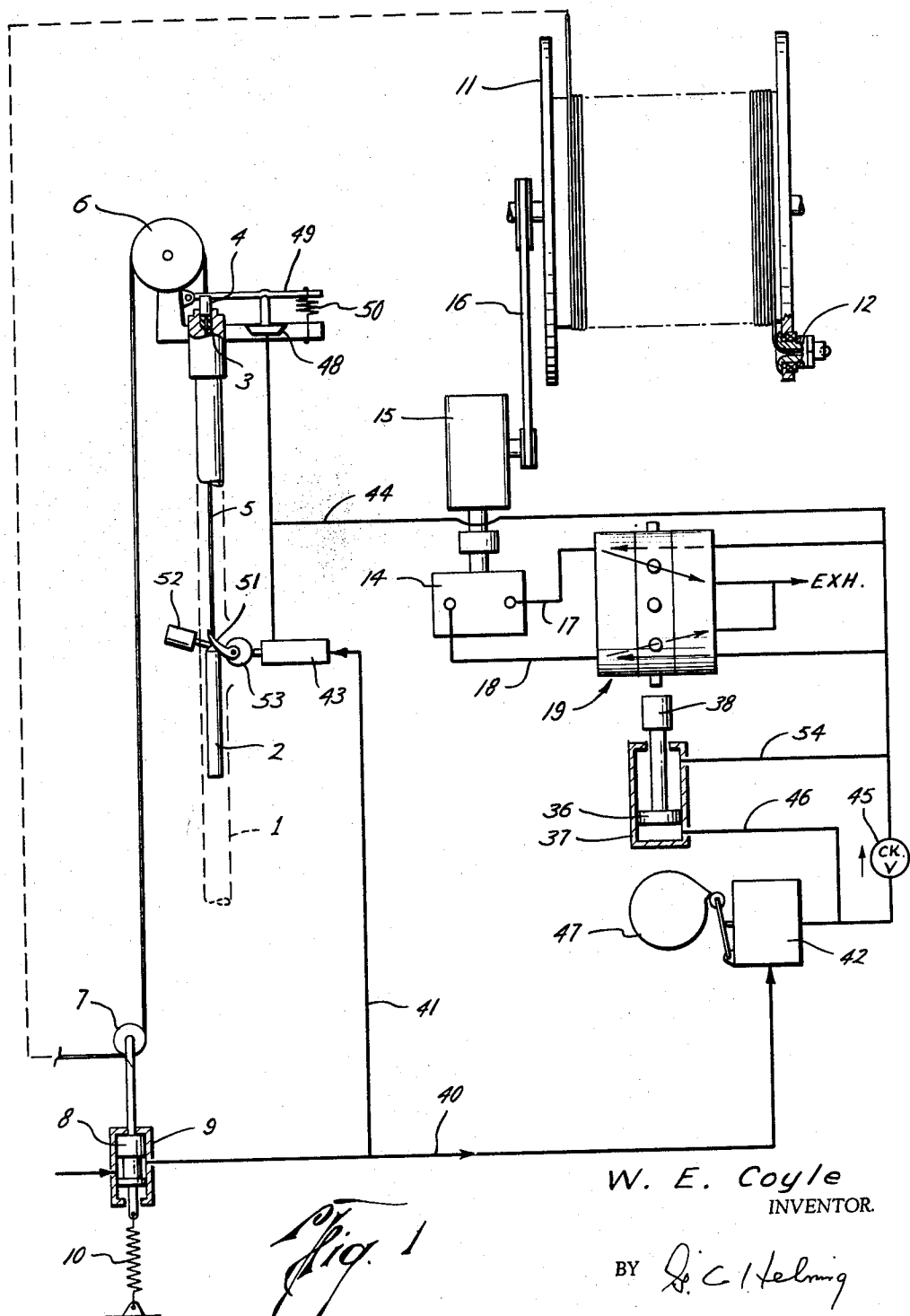


W. E. COYLE
WELL TUBING SCRAPER

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2 Sheets-Sheet 1



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Sept. 22, 1964

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2 Sheets-Sheet 2

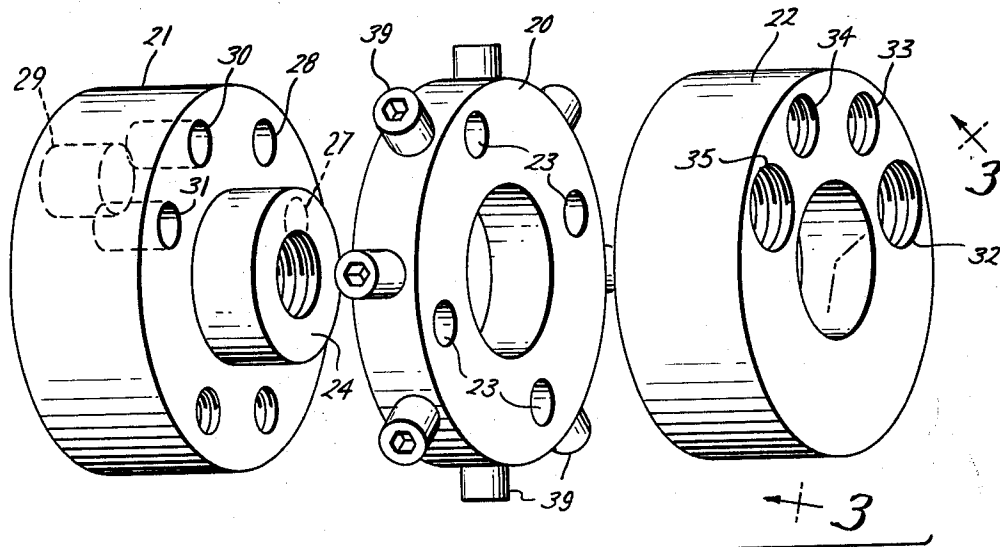


Fig. 2

Fig. 3

Fig. 4

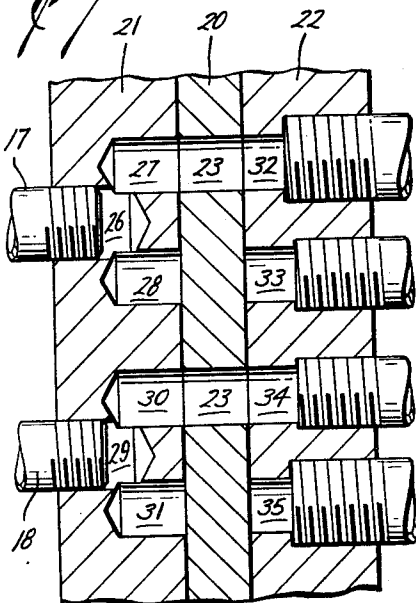
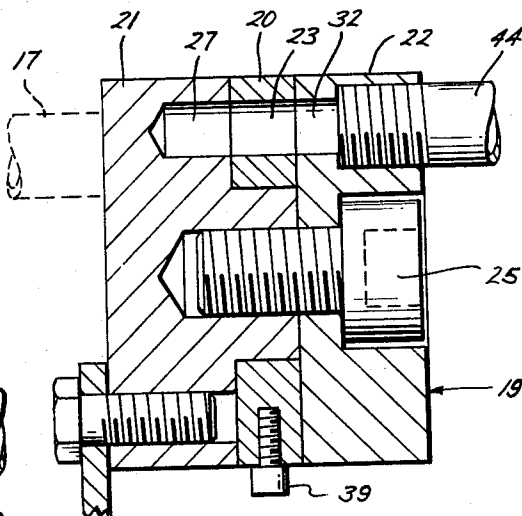
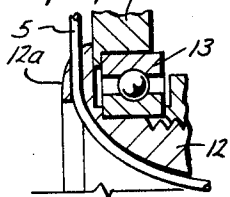


Fig. 5



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3,149,675

WELL TUBING SCRAPER

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12 Claims. (Cl. 166-64)

This invention relates to oil well working equipment which assists in maintaining production tubing against passage constricting build-up of paraffin deposits and in preserving good condition for large flow volume and more particularly to improved and simplified operating mechanism by which a scraper tool is run through a given length of well tubing periodically without attention and labor.

Depending on types of petroleum fluids being produced and on operating conditions including the flow temperature at different well hole levels and chilling with resulting wax solidification in upper reaches of well holes, there are some wells in which paraffin deposits coat and accumulate inside the tubing wall at a rate so fast as to justify clean-out at frequent intervals as by running a wall scraper through the tubing string. To meet the need there is here involved a simplified version of running equipment especially adapted for permanent installation at any wellhead for the automatic operation of initiating at selected time intervals and of completing a cycle of paying out a predetermined length of scraper tool suspension line and, after full pay-out, of returning the line and its wall scraper for a subsequent repetition of the cycle.

An object of the invention is to minimize manufacture and maintenance costs and complexities of such self acting equipment and to provide a power actuated unwinding-winding reel to which the upper end of a predetermined length of suspension line is fastened; along with a power supply system having but a few readily available controls combined for governing power application automatically and in patterned sequence for selecting the direction of reel unwinding rotation and driving the reel continuously in the same direction without change throughout a cycle of line unwinding to complete pay-out and immediate rewinding of the line until return of the wall scraper to its upper travel limit at the wellhead signals power cut-off.

A further object is to provide a reel direction control selector mechanism which in the idle interval between cycles remains set for reel rewinding rotation should power application be restored as will occur upon scraper tool downward slip from its upper limit due to line stretch or slack-off and malfunctioning and which control mechanism at the start of any cycle responds to initial power application and is thereby reset for reel rotation in the direction reversed and opposite from that which prevailed throughout the preceding cycle wherefore rotation will be in the direction for unreeling the line for a downstroke phase of the new cycle.

Another object of the invention is to provide an improved fastening to the rotatable reel of the upper end of a somewhat stiffly flexible suspension line by means of a swivel connection which relieves the line from severe bending stress by swinging through the wide angle of 180° during change in line direction from unreeling

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to rereeling as scraper tool travel passes through its lower limit while reel rotation proceeds without directional change.

Other objects and advantages will appear from the following specification having reference to the accompanying drawings wherein;

FIG. 1 is a schematic layout of the improved system;

FIG. 2 is an exploded perspective view of a multiple-way flow controller or reversing valve for a pneumatic system;

FIG. 3 is a vertical sectional view of the reversing valve assembly as on line 3-3 of FIG. 2;

FIG. 4 is a linearly developed view in section through the region of flow control porting of the selectively set valve; and

FIG. 5 is a fragmentary sectional view of the swivel assembly by which the upper end of the wire line is fastened to the reel.

In the drawings there is illustrated a portion of a well production tubing string assembly and more particularly an upward extension or lubricator section 1 above the usual out flow or gathering line connection at a wellhead. The lubricator section 1 above the flow path of production fluid houses a tubing wall scraper tool 2 at its upper travel limit and is sealed at the top by means of a stuffing box containing a compressible packing ring 3 and a pressure applying gland 4 through which extends a wire suspension line 5 fastened at its lower end to the scraper tool 2. Above the stuffing box the suspension line 5 is entrained on a guide wheel or pulley 6 rotatably supported by the tubing string assembly and the line then reaches downwardly and around a guide pulley 7 carried by a spool valve body 8 slidably mounted within a housing 9 and biased downwardly by a spring 10 toward valve closing position. Normally the valve is open for pressure fluid flow and its biasing spring 10 is overcome by ordinary tension in the suspension line 5 outside or beyond its wrappings on the rotatably mounted reel 11. Such normal line tension results from gravity pull on the scraper tool 2 and any applied weighting bars. The tool weight provides the lowering action as the suspension line is let out from the reel 11.

Wall coatings usually deposit in the upper, cooler reaches of well tubing strings and accordingly the depth above which these accumulations occur in any particular well can be ascertained for thereby determining the length of suspension line necessary to reach that depth when fully payed out thereby establishing the tool travel bottom limit at which point the tool descent phase ends and the tool elevation phase starts in its round trip circuit. Equating of the line length and the length of wall to be cleaned and securing the upper end of the established length of line to the reel enables the line to be first unwound to full pay-out and then rewound without change in direction of reel rotation. Alternation of reel rotation direction at the start of successive cycles provides for driving the reel in the direction for proper pay-out and rewinding. This in turn minimizes power delivery control problems and enables a cleaning operation to be performed and to be repeated at selected intervals related in any well to the rate of wax deposit, by starting the cycle in response to a clock operation which directs an initial delivery of power to effect reversal of the previous wind-up direction thereby unwinding the reel

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for the short distance necessary to drop the scraper tool below its upper limit whereupon an additional operating control for power delivery is initiated and continued until the tool has been returned to its upper limit.

The tool is suspended by a relatively stiff and smooth surfaced wire for fairly friction free slide passage through the tube sealing packing 3 when the packing is relieved of gland pressure 4. To protect the wire line against surface abrasion and scratches in the reel wrappings and from severe bending stress in its upper end at times of full pay-out and times of directional change for tool stroke reversal, a unique swivel connection joins the upper end portion of the wire to the reel and allows turning of the wire end portion through the necessary wide angle between opposite wrap directions.

As seen in FIGS. 1 and 5 one side flange of the reel 11 rotatably mounts the shank of a hollow stud 12 in a suitable bearing 13 on an axis substantially parallel to the axis of reel rotation and the suspension line 5 projects through a radial opening in the rotary stud head 12a and, after following an easy curve provided by the outwardly flaring central bore of the stud, is terminally anchored to the stud. The wire receiving radial opening in the head 12a swings with the swivelled stud to follow the wire line load during change in wrap directions whereby back and forth bending and buckling of the wire does not occur. The stud head 12a at its juncture with the stud shank is flat and bears against the flange inner surface and its head thickness in relation to its diameter is quite small for minimizing projection into the wire receiving drum region. Furthermore, the relatively thin head projection 12a is of tapered thickness to present a rounded face exposure and recedes toward a narrow peripheral rim immediately adjacent the inner face of the reel flange so that line wrappings will be free from undue crowding displacement as they bridge across the head without contact with abrupt surface breaks.

Preferably reel drive and its control is accomplished by means of a pneumatic pressure fluid system whereby rotation is transmitted to the reel from a reversible air motor 14 having its output shaft coupled with the reel through an irreversible drive transmission unit 15 comprising a conventional driving worm gear and driven worm wheel and an endless chain or belt connection 16. Pressure fluid flow connections to the air motor 14 include a pair of pipes or conduits 17 and 18 for alternate exhaust and pressure fluid delivery. Pressure fluid supplied through the line 17 and exhausted through the line 18 drives the motor in one direction and pressure fluid delivered through the line 18 and exhausted through the line 17 drives the motor in the opposite direction. Drive in either direction is transmitted from the motor 14 to the reel 11 but whenever the motor is out of action the irreversible drive unit 15 resists reel rotation under wire line load and acts as a brake and holds the reel stationary.

Alternate exhaust and pressurization of the two motor connected pipes 17 and 18 is under control of an adjustable reversing valve or flow port selector assembly 19 consisting of a shiftable valve plate or rotatable ring 20 interposed between a pair of complementary blocks 21 and 22 each having flow ports for controlled communication according to different settings of the shiftable valve plate 20. The rotatable centrally disposed valve plate 20 has a series of ports 23 extending therethrough parallel to the axis of rotation. As shown, there are four equally spaced apart parts 23 equally distanced radially from the central opening in the plate. By means of the central opening the plate 20 has rotatable bearing on an axially projecting boss 24 on the side block 21 and as seen in FIG. 3, a screw stud 25 is threaded into the boss 24 and rigidly holds the ported blocks 21 and 22 together and in face-to-face bearing with the opposite side faces of the rotatable valve plate 20. Carefully trued and closely fitted interfaces plus the use if desired

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of O-ring seals in the side block faces and in surrounding relation with respective flow ports and in slide bearing contact between faces of the central valve plate will resist leakage across the respective ports.

The motor connected pipe 17 as best seen in FIG. 4 communicates with a port 26 extending part way into the side block 21 from its outermost face and opening into both of a pair of adjoining ports 27 and 28 which extend inwardly and part way into block 21 from its innermost face. Additionally the block 21 contains a similar set of ports 29, 30 and 31 for communication with the other motor connected pipe 18. Both sets of ports are contained within the block 21 in the manner shown in FIG. 4 but, for clarity, in FIG. 2 the dotted line projection indicating the location of one set of ports is not duplicated at the ports of the other set. The several ports 27, 28, 30 and 31 are angularly spaced 45° between center lines of adjoining ports and in a group whose radial disposition corresponds with the ports 23 of the rotatable valve plate 20. In axial alignment respectively with the ports 27, 28, 30 and 31 are ports 32, 33, 34 and 35 extended through the block 22 and arranged in the overall system so that the ports 33 and 34 are for exhaust while the ports 32 and 35 are for connection with a pressure fluid source.

With the valve plate 20 set as indicated in the developed view FIG. 4 the flow direction valve assembly 19 is conditioned for exhausting one side of the air motor 14 by way of the ports 29, 30, 23 and 34 and for directing pressure fluid to the other side of the motor by way of the ports 32, 23, 27 and 26 and it will be noted that all other ports are blocked off at the central plate 20. A partial revolution of the valve plate 20 through 45° from the setting illustrated in FIG. 4 brings the flow directing ports 23—23 into a different setting in which the side of the motor connected with the ports 26 and 28 is exhausted to the port 33 and the port 35 is communicated through the ports 31 and 29 with the opposite side of the motor and the valving is conditioned for pressure fluid delivery in a direction to reverse the motor and reel drive. Similar alternation of delivery and exhaust flow paths occur with each successive resetting of the selector plate 20 in 45° increments or steps of angular movement.

Resettings of the reversing valve assembly occur periodically by transmission of progressive movement to the valve plate 20 imparted thereto upon timed intermittent operation of a suitable indexing motor which as shown comprises a piston 36 housed within a cylinder 37 for response to delivery of pressure fluid into the cylinder end portion on the side of the piston opposite to its outwardly projecting rod 38. The length of the piston power stroke is gauged to effect a 45° angular rotation of the valve plate 20 with the outward push being delivered by the piston rod 38 arranged to engage suitable peripheral formations on the plate 20. The direction of motion transmitting engagement will be tangentially with respect to plate circumference. The plate peripheral formations to receive the indexing force are conveniently afforded by the heads of a series of eight equally-spaced-apart studs 39 radially threaded into the plate 20 at the rim thereof. A piston power stroke occurs when pressure fluid is delivered at the aforementioned end of the motor cylinder 37 and piston return stroke takes place when the end is vented and in response to return pressure supplied as by a spring force or by fluid pressure routed into the other end portion of the cylinder. Opposite faces of the piston present differential areas to pressure fluid present on opposite sides of the piston and the unbalance favors piston projection.

The several system components seen to the right in FIG. 1 and including the reel with its drive train and selector control valve will be mounted in operative relation to one another on a suitable ground supported frame. The particular mounting means is of no consequence to

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the invention and is not shown except that the detail of the selector valve 19 in FIGS. 2 and 3 includes a pair of threaded bolt receiving holes near the bottom of the side plate 21 for attachment to a supporting bracket.

System actuating pressure gas or air from a source near the wellhead is supplied through the normally open valve 9 which serves as a safety shutdown upon failure of tension in the suspension line 5. Closure of the valve 9 against the supply of pressure gas preserves the system against damage and suspends operations until such time as line tension is restored and the reason for its failure has been remedied. From the safety valve 9 pressure fluid is fed into each of a pair of branch lines 40 and 41 which contain normally closed flow control valves 42 and 43, respectively, and merge or are rejoined downstream from the two valves 42 and 43 by a common pressure fluid supply line 44 leading to the valved ports 32 and 35 so that delivery of pressure beyond either valve 42 or 43 will extend to and pressurize the delivery ports 32 and 35 of the selector valve assembly 19.

The control valve 42 is a conventional unit which normally is closed against pressure fluid flow from the branch line 40 and vents the downstream side of the valve for bleed down of pressure in the pipe line leading from the valve. Within the pipe line downstream from the control valve 42 is a spring-closed check valve 45 which blocks back flow toward the valve 42 but passes forward flow downstream thereof at a restricted rate. Between the flow valve 42 and the check valve 45, a branch conduit 46 leads into the piston chamber of the cylinder 37 for delivery of pressure fluid to project the piston 36. A clock or other suitable timer mechanism 47 including a rotatable cam is provided to open the valve 42 for a short duration at regularly spaced apart intervals and which intervals can be varied or adjusted for timing repetitions of valve opening operation to fit the needs of any well installation.

Actuation of the intermittently operated flow control valve 42 for passing pressure fluid therethrough and as called for by the setting of the timer mechanism 47 initiates a cycle of reel rotation by pressurizing the system between the timer actuated valve 42 and the control valve 43 the latter of which during this initial stage is in its normally closed position. Flow resistance and restriction offered by the check valve 45 directs the initial shot of pressure fluid through the line 46 and delays pressure action in downstream relation to the check valve 45. Accordingly, the first response to pressure application beyond the valve 42 is a projection of the piston 36 and an instantaneous indexing of the selector valve 19 to a new setting which will cause motor drive in a reel unwinding direction of rotation. Thereafter pressure fluid passing into the line 44 beyond the check valve 45 can effect operation of the air motor 14 and simultaneously operate a diaphragm motor 48 which serves to relieve compression on the packing ring 3 for greater freedom of wire line slide travel through the packing ring. In this latter operation the diaphragm motor 48 acts on a lever 49 to raise the same and the gland 4 by overcoming downward bias on the lever normally provided by the spring connection 50. At times when the diaphragm motor 48 is inactive the spring 50 acts through the lever 49 to impose compression force on the packing and hold it deformed into snug bearing on the tool suspension line as an effective seal at the upper end of the well tubing string.

Response to initial delivery of pressure fluid passed by the valve 42 drives the motor 14 for a letting out of the suspension line 5 and after the tool 2 has dropped away from its upper limit and out of previous lifting engagement with a lever arm 51 pivotally located within the tubing section 1 in the travel path of the tool 2, the lever arm 51 will swing downwardly under suitable biasing means such as a weight 52 fixed to the arm. A lever motion transmitting connection, illustrated as a shaped

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cam 53, for engagement with an actuator rod of the flow control valve unit 43 transfers downward movement of the lever arm for opening the normally closed valve 43 and for holding the valve open so long as the tool 12 is below and out of contact with the lever arm 51. Following such sequential opening of the flow control valves 42 and 43, the timer responsive valve 42 has performed its function and is restored to normal flow closing position and the valve 43 becomes the sole or primary flow control to signal motor stoppage on cycle completion. The pressure fluid delivery line 41 serves as the main conductor of motor operating power and is supplemented by the line 40 for initialization of an operating cycle. Once the cycle has been initiated it will continue with the flow valve 43 held open while the flow control valve 42 goes to closed position under timer action. In other words, the timer 47 opens the valve 42 for only a short period sufficient merely to initiate a lowering of the scraper tool. Thereafter pressure fluid reaches the motor 14 by way of the open valve 43. Upon closure of the timer actuated flow control valve 42 it will also open and vent that part of the flow line between the valve 42 and check valve 45 whereupon the check valve closes against back pressure flow. The resulting bleed down through the valve 42 relieves pressure in the branch line 46 and its connected chamber portion within the piston cylinder 37 allowing piston retraction as by a response to pressure fluid directed from line 44 by its connection 54 to the cylinder 37 on the rod unbalancing side of the piston 36.

Until the piston 36 is again projected at the start of the next succeeding cycle the selector valve assembly 19 remains in its previously set position as does the direction of reel rotation. In each cycle, reel rotation continues without direction change for paying out the entire predetermined length of suspension line to the bottom limit of tool downstroke and for rewinding the line until the scraper tool returns to its upper limit and raises the swinging lever arm 51 to thereby close the control valve 43 and cut off further delivery of pressure fluid to the reel driving motor 14 and which cut off also re-establishes the sealing action of the packing ring 3.

In the absence of malfunctioning, the system remains idle until the timer again occasions a cycle and first resets the selector valve assembly 19 for reversing motor drive direction from previous reel-in to reel-out operation. Inasmuch as resetting of the selector valve unit 19 occurs only at the start of a new cycle the valve ports remain in previous settings throughout idle periods following line wind-in performances so that should the weighted tool for any reason settle downwardly away from the lever arm 51, then the flow control valve 43 reopens and the responsive motor drive will be in the winding direction and bring back the scraper tool. Pressure fluid delivery to the system will be cut off completely by closures of the safety valve 9 as a result of excessive suspension line slack and loss of line tension as can occur upon a malfunctioning inclusive of line breakage and entanglement.

The arrangement described is illustrative of a preferred embodiment and variations may be made without departure from the invention as set forth in the appended claims.

What is claimed is:

1. Automatic means for lowering a scraper tool through a well tubing to a lower limit and thereafter raising the tool to an upper limit and for repeating the cycle at spaced apart time intervals, including a scraper tool suspension line of given length equated to the length of tubing to be scraped, a line unwinding-winding reel having the upper terminal of said given length of the suspension line connected thereto and being rotatable to unwind the full length of the suspension line for complete pay-out thereof and to then rewind the suspension line without change in direction of reel rotation, drive mechanism connected with the reel to impart rotation in either of opposite directions, and means supplying power

to the drive mechanism for its drive in either direction selectively and without change of direction throughout a complete cycle of reel rotation and comprising a first power supply line and a second power supply line, each having a power supply connection with the drive mechanism, a first control device controlling the supply of power by the power supply connection of the first supply line, a second control device controlling the supply of power by the power supply connection of the second supply line, control means joining the drive mechanism with said power supply connections and having shiftable settings which successively effect responsive movements of the drive mechanism in a direction opposite to the direction of movement in a preceding cycle, an actuator responsive to power supplied when the first control device is effective and active on said control means to shift its setting, a timer operative on the first control device to render the same effective for a relatively short duration sufficient to initiate a cycle of reel rotation in the direction to lower the tool from its upper limit and means connected with the second control device and responsive to tool position at its upper limit to render the second control device effective while the tool is away from its upper limit and for continuing reel rotation in the last mentioned direction to the end of the entire cycle of unwinding and rewinding back to the tool upper limit position.

2. An automatic system for intermittently cycling the descent and return of a scraper tool between upper and lower limits within a well tubing, including a tool suspension line whose predetermined length establishes the lower limit of tool travel, a rotatable reel to which the upper end of the suspension line is fastened for a rereeling of the fully paid out suspension line on continued rotation of the reel in the direction of previous pay-out, a pressure fluid operated and reversible motor drive connected with the reel, a motor reversing valve having pressure fluid delivery connection with the drive motor and also having selective settings which control the reel rotation drive direction of the drive motor, a pressure fluid responsive device connected with the said motor reversing valve to change valve setting for a reversal of reel rotation upon supply of pressure fluid to said device, a main pressure fluid supply conduit leading to said motor reversing valve, a flow control valve in said conduit, means connected with said flow control valve and responsive to tool positions at and away from said upper limit to close and open respectively said flow control valve, a secondary pressure fluid supply conduit leading to both said device and said reverse valve, a normally closed flow control valve in the secondary pressure fluid supply conduit and a timer operating periodically upon the last mentioned valve to open the same for a relatively short duration sufficient to actuate said device and rotate the reel in a suspension line unreeling direction until tool position is away from said upper limit.

3. In the system of claim 2 in which the fastening of the upper end of the suspension line to the reel is a swivel connection and accommodates the free turning of the end portion of the line as reach direction of the fully paid out suspension line reverses from pay out to rewinding relation with the reel.

4. In the system of claim 2 in which the fastening of the upper end of the suspension line to the reel comprises a hollow headed stud pivotally mounted in one flange of the reel on a pivot axis substantially parallel to the reel axis with the pivoted stud head located inwardly of said flange, said head having a radial opening receiving the upper end portion of the line which is secured within the hollow stud and said head being of tapering thickness with its exposed end surface receding to a thin peripheral edge adjacent the inner face of said flange.

5. In the system of claim 2 wherein the fastening of the upper end of the suspension line to the reel comprises a member projected inwardly of the inner face of one

flange of the reel and means pivotally mounting said member on the flange for swiveling action about an axis substantially parallel with the reel axis, said member terminating in a convex face whose peripheral edge substantially merges into said inner face of the flange and said member having a radial guide opening for said upper end of the suspension line.

6. In a system for periodically lowering a scraper tool through a well tubing to a given depth limit and then returning the tool to an upper limit, a tool suspension line of selected length, a reel therefor to which the upper end of the line is fastened and whose rotation in either direction effects successive unreeling and rereeling of the suspension line for a round trip of the tool from and back to said upper limit, a reversible and pressure fluid actuated motor drive connected to said reel and provided with a pair of inlets for alternate delivery of pressure fluid and motor drive in one or the other of opposite directions, a selector valve having connection with and controlling delivery of pressure fluid to said inlets alternately and a pressure fluid supply connection leading to said selector valve and including a pair of branch supply lines, valve means in one of the branch lines controlling pressure fluid supply to the selector valve, an operating element for said valve means responsive to tool position at said upper limit for closing said valve means and responsive to tool position beyond said upper limit for opening said valve means, a selector valve indexing device connected with the other branch line and responsive to pressure fluid in the other branch line in conditioning said selector valve for reversing pressure fluid delivery to said inlets and periodically acting means supplying pressure fluid to said other branch line at spaced apart intervals each of a time duration sufficient to effect response to said indexing device and to initiate motor drive in the suspension line unreeling direction until said operating element has responded to tool travel beyond said upper limit.

7. In the system as in claim 6, said other branch line having a check valve therein in downstream relation beyond said indexing device, said check valve accommodating pressure fluid flow toward the selector valve and closing the branch line against back flow.

8. The system as in claim 6 together with means in said other branch line at the region downstream of said pressure fluid responsive indexing device to restrict pressure fluid passage toward said selector valve and to close against back flow and a vent valve in said other branch line in upstream relation to the last mentioned means and responsive to the operation of said periodically acting means in the times between said spaced apart intervals to bleed off pressure fluid to which said indexing device had responded.

9. The system as in claim 6 in which a check valve is positioned in said other branch line at a region downstream from the indexing device and in which said periodically acting means includes means operable to vent said other branch line and the indexing device connected therewith upstream of the check valve at those times between said spaced apart intervals.

10. In a system as in claim 6 wherein the drive between the motor and the reel includes an irreversible transmission.

11. In a system for periodically effecting an operating cycle of a well tubing scraper tool through successive lowering and elevating strokes of travel by rotating a reel to pay out all windings thereon of a tool suspension line and, without change in direction of reel rotation, to rewind the suspension line to an upper limit of tool travel, the improvement which comprises

- a reel driving reversible motor,
- a source of operating power therefor having power delivery connection with the motor,
- a reversing device constituting a part of said power delivery connection and having adjustable settings

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for selectively directing power to the motor for its operation in either of opposite directions,
 power actuated means operative on said reversing device to adjust the setting thereof for reversal of power delivery direction to the motor,
 an intermittent power flow controller having power delivery connection with said power actuated means to actuate the same and also with said reversing device for power delivery thereby to the motor and including timer mechanism timing power flow action of the controller at predetermined intervals, and tool position responsive and power flow controlling means having flow connection with said reversing

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device for power delivery thereby to the motor, said controlling means being responsive to tool position at said upper limit for blocking power delivery by said flow connection and being responsive to tool position away from said upper limit for power delivery by said flow connection.

12. In a system as in claim 11 in which an irreversible drive transmission is connected with the out-put side of said motor.

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