

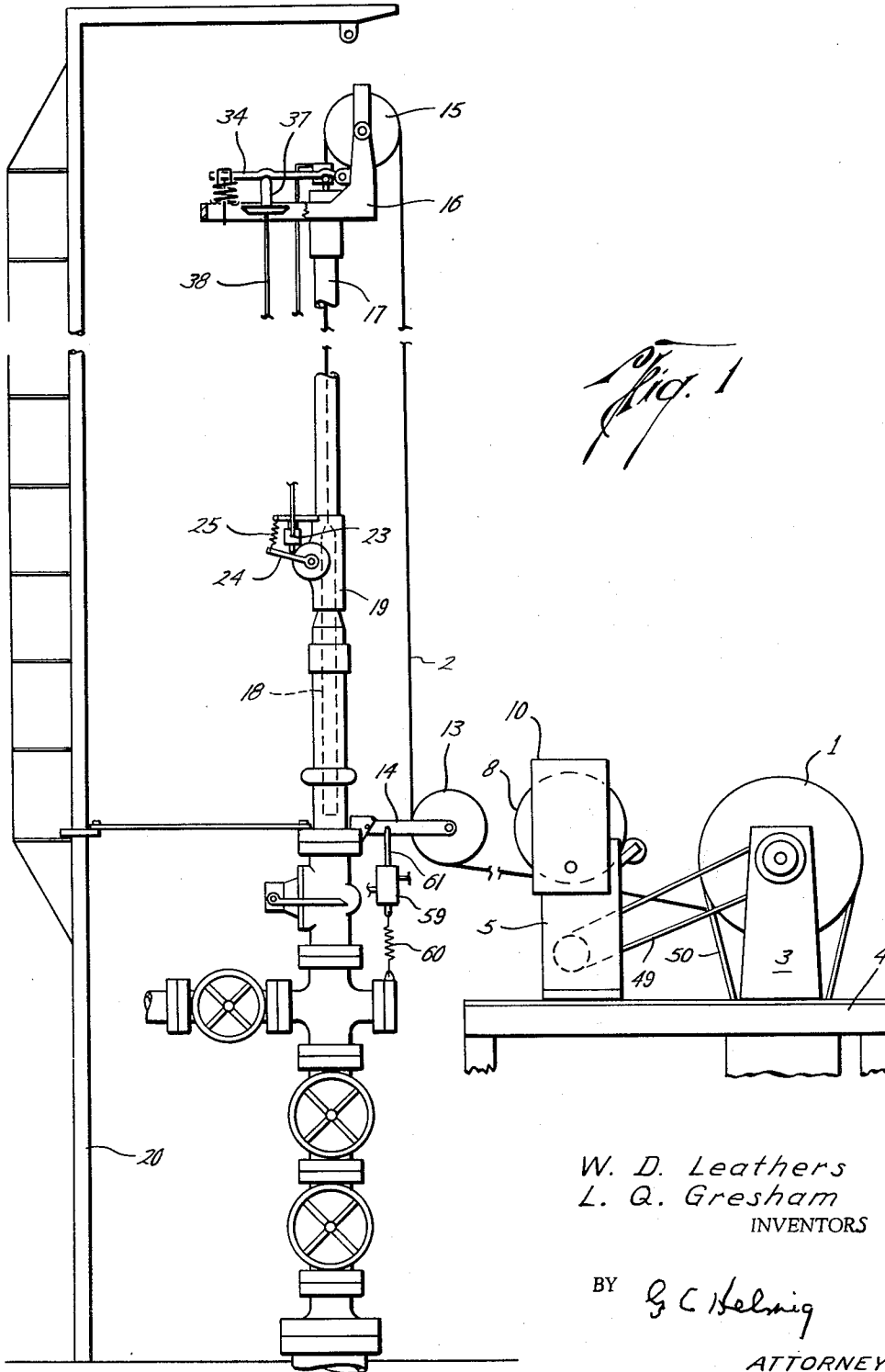
Jan. 12, 1965

W. D. LEATHERS ET AL
AUTOMATIC PARAFFIN SCRAPER

3,165,155

Filed Sept. 22, 1961

6 Sheets-Sheet 1



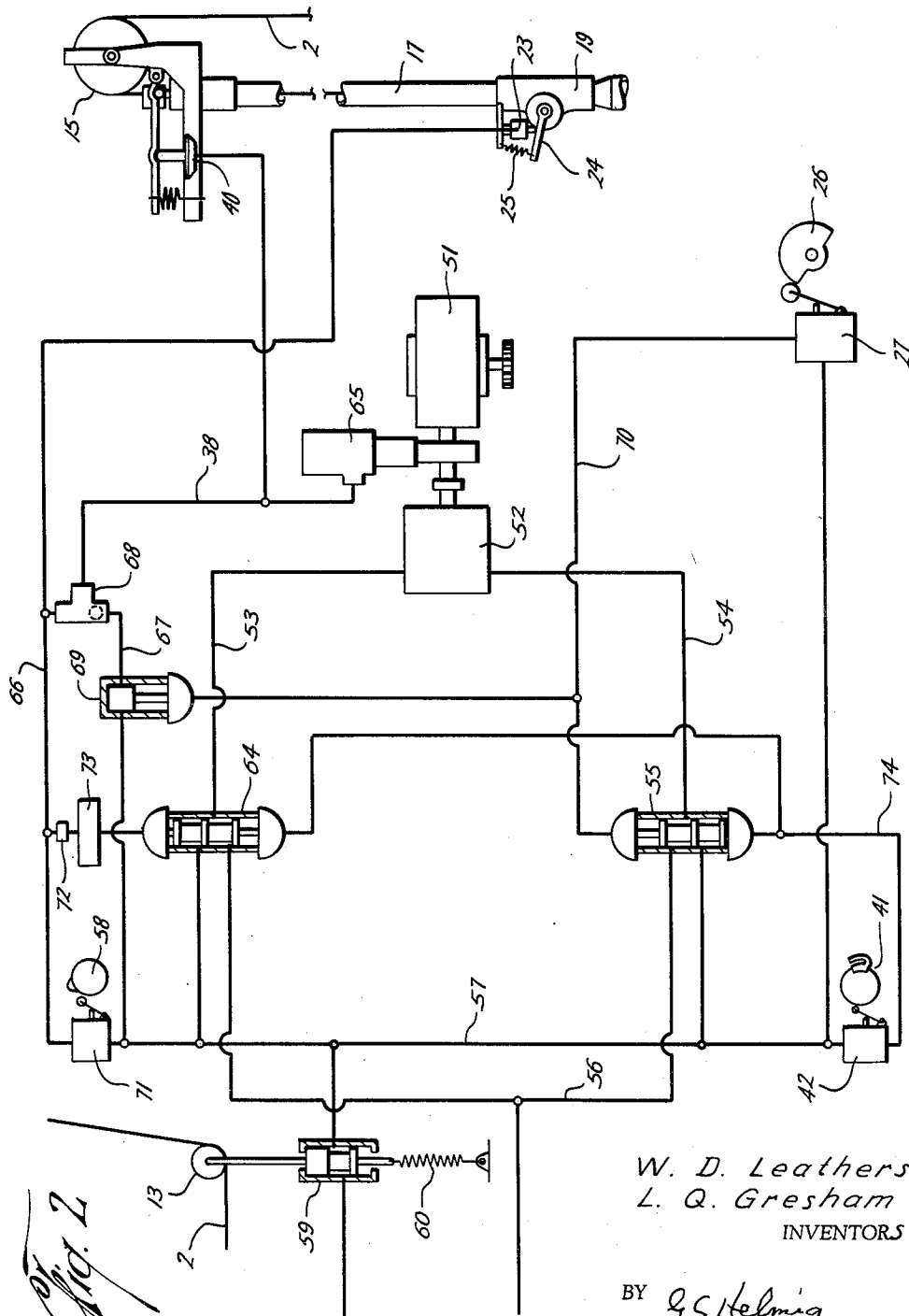
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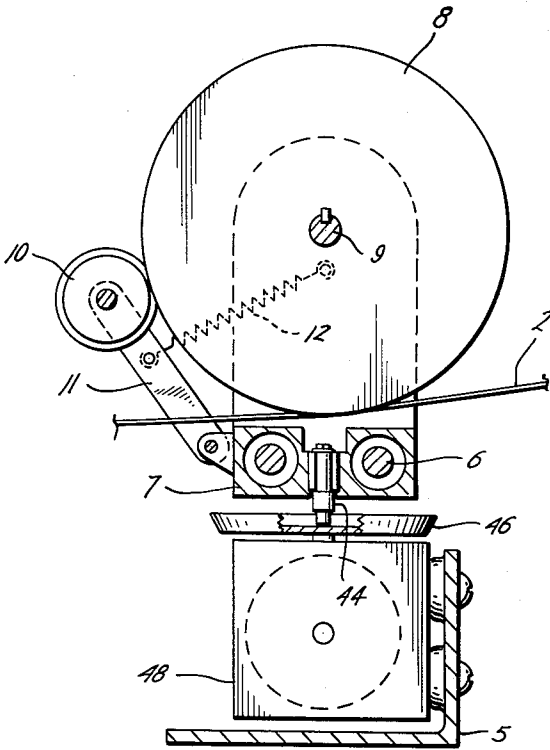


Fig. 6

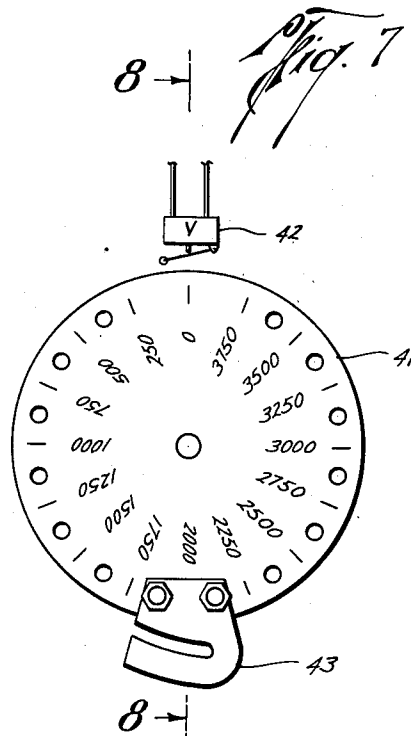


Fig. 7

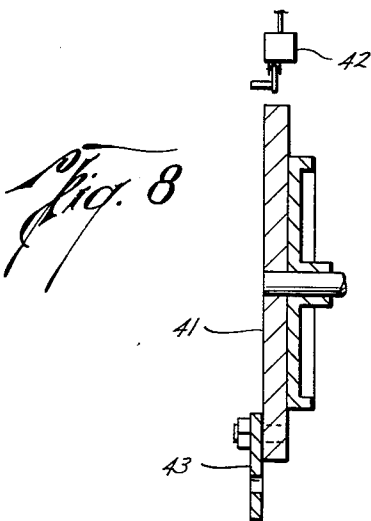


Fig. 8

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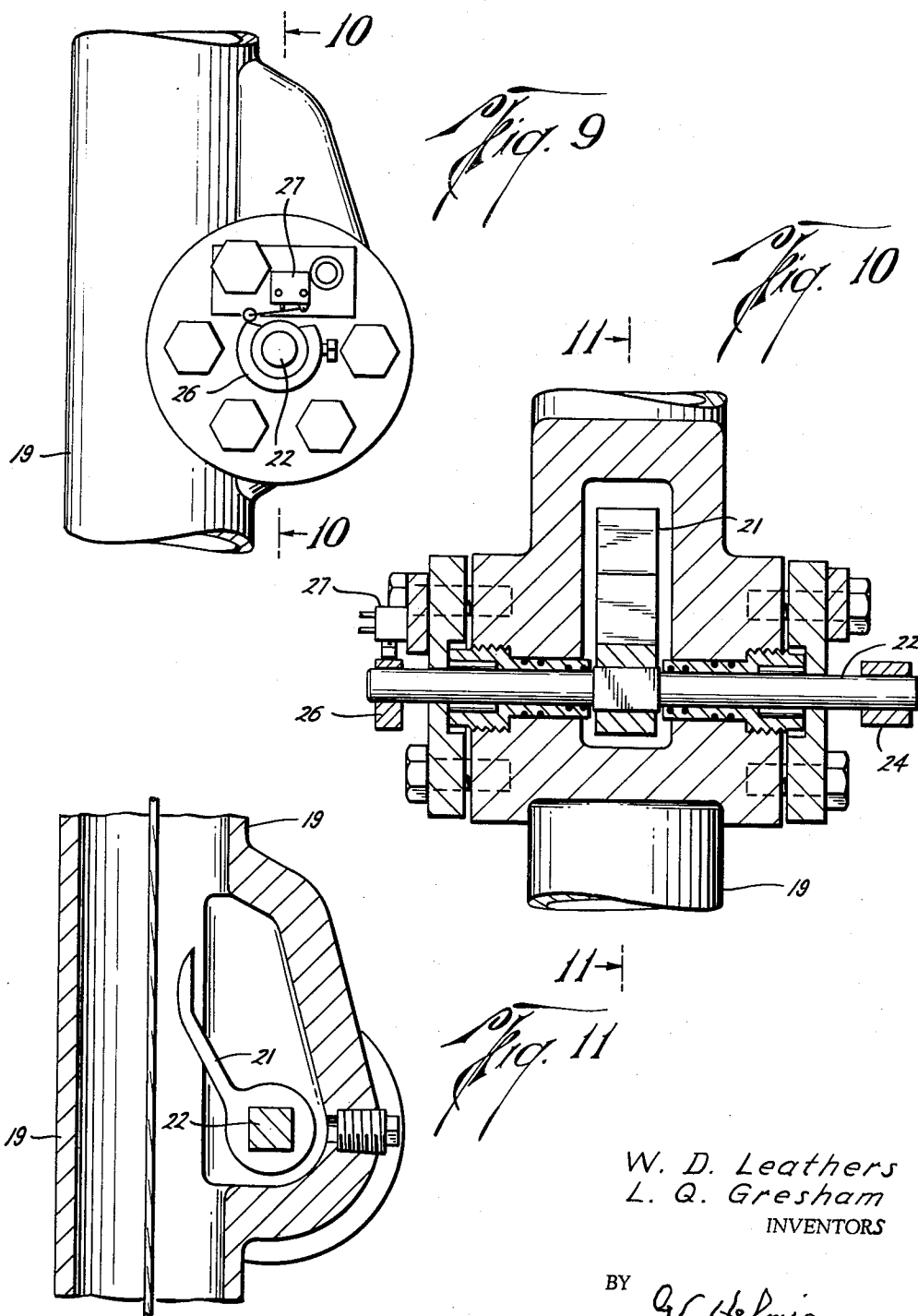
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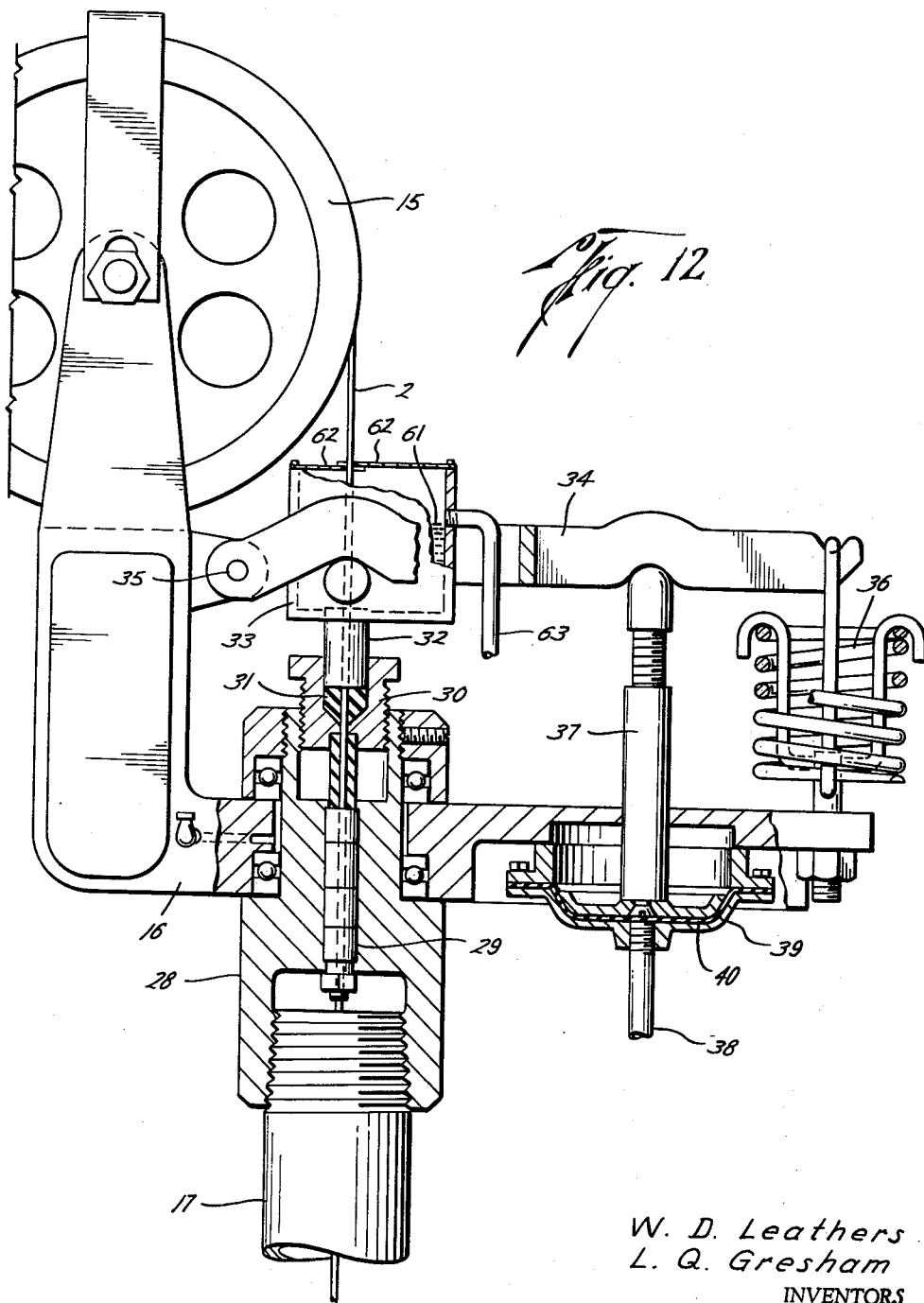
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Filed Sept. 22, 1961

6 Sheets-Sheet 6



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3,165,155

AUTOMATIC PARAFFIN SCRAPER

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Filed Sept. 22, 1961, Ser. No. 139,942

2 Claims. (Cl. 166-70)

This invention relates to equipment which periodically operates to scrape solid paraffin wax accumulation from the inside of the tubing string wall of a producing gas or oil well and more particularly to a system for automatically cycling the operation of lowering a tubing scraper tool from the wellhead to a selected depth and then elevating the tool for return to the surface, whereupon the operation stops and subsequently is repeated following a given interval which has been set according to the rate of wax coating build-up in the particular well.

Paraffin content of well fluids is usually in a state of fluid solution at elevated temperatures within the earth as exist below about four thousand feet in most areas but tends to lose fluidity with chilling and to deposit in viscous and solid form on movement through a production string and toward the surface. To prevent clogging and interference to full flow, such deposits must be cleaned and brought up as suspended solids in the well fluid once or more each day, depending on particular well conditions. Daily attention by a work crew and manual manipulation of scraper mechanisms can be costly and even impractical in some cases of lesser producing wells in more inaccessible locations. To provide efficient equipment which is inexpensive to build and use for the periodic scraping of well tubing without the need for frequent checkup, is a primary object of the present invention.

Another object of the invention is to provide an improved scraper operating control system powered by available pressure gas supply in a producing field and comprised of co-operating and interdependent signal responsive components which function for effecting scraper action in a desired pattern of sequential phases of each of successively timed cycles and also guard against costly restoration procedures in the event of parts failure or malfunctioning.

A further object is to provide an automated system in which lowering of a wire line suspended scraper is initiated through a timing controller for unreeling a wire line having a drive transmitting loop around a transversely shiftable and combined level winding and revolution counting wheel which, after a selected number of revolutions during wire line pay-out to a desired scraper depth, then transmits a signal for scraper elevation through a reversal or reel windup of the wire line until the returning scraper reaches the wellhead and its arrival is sensed for ending the cycle and conditioning the parts for subsequent repetition of the operation after a time lapse determined by the presetting of the timing controller.

A still further object of the invention is to provide a periodically active and self cycled scraper controlled assembly for unwinding and rewinding a suspension wire line through a tubing string having an upper terminal section which houses a retractable arm normally biased for projection into the path of the scraper tool for co-operation therewith, both as a catcher against uncontrolled tool descent and as an operational cutoff responsive to tool arrival at the upper end of tool return stroke and which terminal section also houses a packing ring normally under applied deforming pressure into tight gripping sealed relation with a wire line between running intervals but under lesser deforming pressure for a running seal embracement with the wire line during reel rotation in both directions.

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Other objects and advantages of the invention will become apparent upon inspection of the accompanying drawings wherein FIG. 1 is an elevation showing the general combination of components at a wellhead installation; FIG. 2 diagrams the pneumatic interconnections between the various components of the operating system; FIG. 3 is a side elevation of the wire line driving elements as viewed oppositely from the showing in FIG. 1; FIG. 4 is an end view of the apparatus shown in FIG. 3; FIG. 5 is an enlarged detail with parts in section as on line 5-5 of FIG. 4; FIG. 6 is a vertical section as on line 6-6 of FIG. 5; FIG. 7 is a side elevation of the reversing valve control disk driven from the wire line driven counting wheel and is viewed on line 7-7 of FIG. 4; FIG. 8 is a transverse section as on line 8-8 of FIG. 7; FIG. 9 is an elevation of a valve controlling structure which is responsive to the location of the scraping tool within the tubing at the wellhead as viewed from the side thereof opposite to FIG. 1; FIG. 10 is a vertical section as on line 10-10 of FIG. 9; FIG. 11 is a vertical section on line 11-11 of FIG. 10; and FIG. 12 is an enlarged view with parts in section of the closure packing for the top of the tubing and through which the suspension wire line is run.

Referring to the drawings, a power driven reel or winding drum 1 for the wire line 2 has its shaft rotatably mounted in a pair of side brackets 3 extending upwardly from a supporting frame or table 4. Also mounted on the table 4 and projecting upwardly is a supporting frame 5 carrying a pair of spaced apart rails 6 which extend parallel to the axis of the reel shaft. As best seen in FIG. 3, the rails 6 support and guide a transversely reciprocable bracket 7 which in end view, as seen in FIG. 4, is of U-shape and mounts between its upstanding side legs a rotatable counting and level winding wheel 8. This wheel is slidably splined or keyed on a rotatably mounted shaft 9 and is driven by a single wrapping or loop of the wire line 2 fitted within a peripheral groove in the counting wheel. For insuring a frictional drive fit, a tensioning wheel or roller 10 rides on the wire within the groove and is carried by a swinging lever 11 fulcrumed on the reciprocatory bracket 7 and resiliently biased inwardly by means of a compression coil spring 12 having one end joined to the lever 11 and its opposite end grounded on the supporting bracket adjacent the axis of the counting wheel.

As best seen in FIG. 1, the wire line 2 projects for some convenient distance beyond the counting wheel 8 to an idler pulley 13 mounted by a swing lever 14 pivoted on the wellhead. Above the pulley 13, the wire line runs vertically and is entrained on a pulley 15 mounted on a bracket 16 at the upper end of a tubing string extension 17. From the pulley 15 the wire line passes through a stuffing box which closes the upper end of the extension tube 17 and has connection with a scraper tool assembly indicated generally by the reference character 18 and shown in FIG. 1 in its usual storage and inoperative position as being housed within the upright extension 17 of the well production tubing.

The scraper tool here contemplated includes a knife or cutting member at the bottom of the tool assembly together with a series of weights above the knife and an upper terminal or wire line socket or coupling. In the normal raised position of the tool, the upper terminal is pocketed within a special tubing section 19 which is spaced below the upper tube packing closure a distance which is slightly greater than the over-all length of the scraper tool assembly 18 for a purpose later to be described.

For convenience of installation and adjustment, a gin pole and ladder assembly 20 is shown as installed as a permanent part of the wellhead construction.

The special tubing 19, just referred to, is shown in the enlarged views of FIGS. 9, 10 and 11 as having a bore aligned with the production tubing and lateral internal recesses for co-operation with a pivoted trigger arm 21 which is mounted on a rock shaft 22 pivotally supported in the side walls and projected therebeyond at opposite ends. The trigger arm 21 is shown outwardly projected from the side recess and into the path of the scraper tool. It can be swung out of the projected position and into fully retracted position within the lateral recess. Such reaction can be effected either by engagement of the trigger with the scraper tool or by supplying power to a piston and cylinder motor 23 bracketed to the housing 19 and having a projecting rod engageable with a rock lever 24 fixed on one end of the shaft 22. A coil spring 25 bears on the lever 24 for biasing the same in a direction for projecting the trigger arm 21. At its opposite end the rock shaft 22 has fixed thereon a cam 26 for co-operation with an operating arm of an air valve 27. In the trigger arm projected position of the parts, the valve 27 will be closed and in the retracted position of the lever arm 21 the valve 27 will be opened.

The detail of the wire line embracing closure for the upper end of the extension tube 17 is illustrated in FIG. 12. It involves an adapter fitting 28 screw threaded onto the extension tube 17 and pivotally mounting on a vertical axis the pulley mounting bracket 16. A central opening through the adapter 28 receives the wire line 2 and houses one or more cylindrical packing elements 29 in running seal engagement with the wire line. The packing elements 29 and their mounting are of conventional nature and in use they have been found to be fairly reliable for a running fit but tend to allow slight leakage of high pressure fluids after a period of use and while the line is not being run. For remedying that situation, a packing box 30 is here provided outwardly beyond the conventional packing rings 29 and it houses an elastic deformable packing ring 31 in embracing relation to the wire line. An adjustable gland 32 bears on the upper face of the packing 31 and terminates upwardly in an enlarged and cupped head 33 having lateral trunnion pins with which engage the transversely spaced apart arms of a lever assembly 34. One end of the lever 34 is hinged at 35 to the bracket 16 and the opposite lever arm is harnessed through a suitable spring device 36 to the opposite end of the bracket 16. The spring 36 transmits its force through the lever 34 to the gland 32 for depressing the same and thereby squeezing the packing 31 into tight sealing engagement with the wire line 2 in a manner to insure a good seal even after abnormal wear of the packing 31 incident to the slide fit engagement with the wire line. The spring 36 is active when the wire line is stationary. During movement of the wire line, the force of the biasing spring 36 can be overcome by suitable pressure fluid responsive motor shown in FIG. 12 as including a lever engageable ram 37 for transmitting the force of pressure fluid supplied through a pipe 38 to one side of a diaphragm chamber afforded by the bracket 16 and a cap 39 which clamps the rim of a movable diaphragm 40.

As the wire line tool leaves the tubing string during a reeling operation, the packing rings 29 and 31 will wipe the line clean of any excessive wax accumulation. To soften and wash off any remaining wax film, the cup 33 is provided to contain a solvent liquid 61 through which the wire passes. Additionally, the open top of the cup 33 may be closed as by means of a pair of flexible wiper flaps 62—62 having overlapping slitted portions for receiving the wire line with a close fit. Any wax will tend to go into solution in the solvent 61 and the solvent liquid will also tend to wash away any well fluid that may leak past the packings and which except for the cup would push out and deposit around the upper tube parts as messy and dirty accumulation. Cleanliness of the mechanism is permitted by trapping materials forced or carried out of the tube. The additions may tend to raise the liquid level within the cup and to carry away excess liquid,

a drip conduit or pipe 63 is fastened to a side wall of the cup near its upper end to receive liquid in excess of the desired level and carry such excess downwardly through the pipe 63 which will be of a length to extend to adjacent the ground and at one side of the wellhead equipment.

During pay-out of the wire line from its reel 1, the counting wheel 8 is driven by the line and the motion is transmitted from the counting wheel through its splined connection with the shaft 9 at a gear reduction drive unit 10 to a rotatable disk 41 whose predetermined rotation through less than a complete revolution effects the action of a valve 42 for transmitting a control signal which causes reversal of the direction of reel rotation. As seen in FIG. 7, the disk 41 is provided adjacent its outer edge with a series of openings for selective fitting of attachment bolts and an adjustable setting of a slotted cam plate 43. The bolts are spaced apart to correspond with given increments of well depth at which reversal of the run-in operation is desired and the drive reduction between the counting wheel and the disk 41 brings the slotted cam plate 43 into actuating relation with the valve 42 whenever the counting wheel 8 has turned through the distance of wire line pay-out selected as set up by the adjustable location of the cam slot bracket 43.

During both pay-out and reel winding of the wire line, the counting wheel and its supporting bracket 7 will have moved back and forth across the face of the winding reel for protective and uniform wrappings. For such purpose, the bracket 7 on its underside has a dependent pin 44 which rides in a heart-shaped cam groove 45 in the upper side of a rotatable cam plate 46 whose drive shaft 47 is connected to the output side of a gear reduction unit 48 mounted within the frame bracket 5. The input side of the gear reduction unit 48 is driven from the shaft of the drum through a chain and sprocket assembly 49 so that the rate of reciprocation of the counting wheel is properly related to the reel rotation and the wire line wrappings. In turn, the reel 1 is driven by a sprocket and chain transmission 50 from a gear reduction box 51 and air motor 52 mounted on the supporting frame 4. The air motor 52 is of the reversible type and has pipe connections 53 and 54 for delivery and exhaust of pressure fluids for forward and reverse motor drive. The supporting frame 4 also carries conventional shuttle valving for controlling the motor supply lines 53 and 54. The shuttle control valve shown at 55 is for connection with the line 54 and includes a shiftable spool within a housing for alternately communicating the line 54 with either an exhaust conduit 56 or a pressure fluid supply conduit 57. A pair of spoolshiftable motors which may be of a diaphragm type are carried by the housing and joined to opposite ends of the spool. The spool is so arranged that it will remain in any position to which it has been shifted and can be shifted in either direction by the application of pressure fluid to one or the other of the end motors. Such valving is conventional, as is also an adjustable clock or timing mechanism illustrated at 58 as being mounted in the main frame 4. The controller may be considered as being a clock driven cam which is preset so that at given spaced apart time intervals the cam will actuate a control valve for initiating action of the system, as will be described.

An additional control valve is shown at 59 in FIG. 1 as including a spring 60 for biasing the valve to closed position and a motion transmitting link 61 connected with the idler pulley arm 14. So long as the wire line 2 is under a predetermined tension, the bias of the spring 60 will be overcome for maintaining the valve 59 open but should slack occur in the line, the valve 59 will be closed.

This last mentioned valve, as seen in FIG. 2, is in the main line for delivering pressure gas to the operating system and normally it remains in open position. A shuttle valve 64, identical in structure to the shuttle valve 55 previously referred to, is for alternate con-

nection of the motor conduit 53 with a branch of the fluid pressure manifold supply line 57 and with a branch of the exhaust manifold 56. FIG. 2 additionally illustrates a spring applied brake assembly 65 co-operating with the motor drive shaft to maintain the same stationary when the motor is not in operation. The brake assembly 65 includes a fluid pressure actuated piston for releasing the brake. This brake release device as well as the motor for relieving pressure on the pack-off assembly at the top of the well tubing, are arranged to receive fluid pressure through the line 38 and from either of two pressure lines 66 and 67 as delivered through a directional valve 68. The directional valve 68 includes a pressure responsive valve element which is shiftable between seats at the inlet connections with the pressure lines 66 and 67 and will open whichever of the lines 66 and 67 is under the higher pressure and closes the lower pressure line. The line 67 is arranged to communicate with a branch of the pressure manifold line 57 through a valve assembly 69 which is spring pressed to open position and moved to closed position by a pressure fluid motor having pressure supply connection by a conduit 70 and which receives pressure fluid when the top limit valve 27 is open. The top limit switch has its inlet going to one of the branch supply lines of the pressure manifold 57 and its outgoing line 70, in addition to being joined with the valve unit 69, is joined to one of the end motors of the shuttle valve 55 so that pressure fluid supplied to actuate the shuttle valve 55 places the spool in position to exhaust the motor line 54. This is the condition which prevails whenever the wire line socket of the scraper tool is in engagement with the rock shaft trigger 21.

The line 66, leading to the directional valve 68, also leads to the trigger release cylinder 23 and is supplied with pressure fluid from the manifold 57 through a clock actuated valve 71. When the clock operated controller 58 calls for a scraping operation, its driven cam will effect an opening for a relatively short given duration, of the valve 71 whereupon pressure fluid moves through the line 66 to the cylinder 23 for applying retracting force on the trigger in opposition to the projecting spring 25; through the directional valve 68 and line 38 to the motor 40 for relieving pressure on the pack-off device and to the brake assembly 65 for releasing the motor shaft; and, additionally, pressure air will go through a branch containing a speed control or flow delay unit 72 ahead of a bottle or pressure fluid accumulation vessel 73 and the diaphragm motor at one end of the shuttle valve unit 64. After a given interval of pressure build-up, the shuttle valve will be shifted from its exhaust position illustrated, to the pressure flow position for delivery of pressure fluid through the line 53 to the motor for driving the motor in the forward and reel unwinding direction. The valve 71 will remain open for a period of time sufficient to insure that the scraper tool has passed downwardly and entirely below the trigger 21 and at the end of the time period the valve 71 will close. The instantaneous response of the trigger actuating spring 25 will be to project the trigger and rock the cam 26 for closing the top limit switch 27. Resultant bleed-down of pressure in the line 70 will result in an opening of the valve 69 for directing pressure through the directional valve 68 for maintaining the brake in release condition and the pack-off in pressure relief relationship. This lowering operation will continue until the predetermined length of wire line has been let out and has driven the counting wheel 8 and its geared-down connections with the indexing disk 41 for bringing the cam plate 43 into position for opening the valve 42. When this occurs, pressure from the manifold supply 57 passes the bottom limit valve 42 and is directed through the conduit 74 connected to reversing motors of each of the valves 55 and 64 and thereby shuttling both spools from the

initial position previously referred to, to exhaust the motor connecting conduit 53 and supply pressure through the motor conduit 54 for reversing the direction of motor rotation.

The scraper tool is pulled back up the tubing string until the upper wire line socket enters the tubing extension riser of the wellhead and strikes the trigger arm 21 for retracting the same. With trigger retraction, its rock shaft, through the cam 26, re-opens the top limit switch 27 which directs the signal to the valve 55 for shuttling its valve to exhaust position and to the valve 69 for closing the passage of pressure gas to the lines 67 and 38. Simultaneously, the motor 52 is stopped, the brake is applied to the motor drive shaft and spring pressure is effective for deforming the pack-off ring 31 around the stationary wire line at the upper end of the tubing string. The parts are now in the position of rest and remain so until the cycling controller again calls for scraper operation.

The various components of the system are arranged for co-operation and response to malfunctioning for preventing damage and the need for costly servicing operations. Thus the speed control unit 72 and the bottle 73 normally serve to introduce a lag between the time the motor starts to reel off the wire line and the time at which the packing around the wire line at the tubing string is released from its tight gripping action. This minimizes the likelihood of slack occurring in the wire line at the start of the lowering phase of the cycle. If, however, for any reason the frictional grip of the packing element resists free running of the wire line as to result in a lack of wire line tension at the valve 59, this valve under the bias of the spring 60 will close off the pressure supply for stopping further motor operation and for applying the brake 65. This prevents wire entanglements and enables remedial measures to be taken. Similarly, should the lowering of the scraper tool be obstructed within the tubing for any reason, the occurrence of wire line slack will result in closure of the valve 59. If for any reason the brake is ineffective and if the packing has become worn so as to allow line slippage under the load of the weighted scraper tool in the interval between operating cycles, the scraper tool may move downwardly and pull the wire line off the reel but also actuating the counting wheel so that after the predetermined amount of line has been run, the bottom limit switch 42 will then act to open the valve 55 for directing pressure fluid to drive the motor 52 in the rereeling direction until the trigger again is retracted for stopping the operation and without having caused any harm. Ordinarily, such downward creep of the wire line will not occur even though the packing ring may have become worn inasmuch as the brake cylinder is spring closed in the absence of the application of fluid pressure. While braking failure is unlikely to occur, its release action may possibly occur in the event of pressure fluid leakage at the valve 69 such as may, after a sufficient build-up period, supply pressure to the brake cylinder and to the pack-off release motor and in that event the tool may descend to the limit and be returned as beforementioned.

On the re-entry of the scraper tool into the region of the shutdown trigger 21, the wire line socket normally will not rise past the trigger before the motor stops. During the rest period, the trigger will be retracted and the top limit valve will remain open. Should some malfunction occur with the result that the scraper tool assembly rises past the trigger, the trigger actuating spring 25 will project it beneath the tool and block descent of the tool. If tool elevation ceases before the tool comes into stop abutment with the end of the tubing string without the imposition of breakage stress on the wire line, then at the beginning of the next operating cycle the shot of pressure gas delivered to the plunger cylinder 23 will retract the trigger for accommodating down pas-

sage of the tool assembly. On the other hand, if force exerted on the wire line causes it to break, the elevated tool can fall no further than permitted by the projected trigger and the trigger then acts as a catcher and eliminates the need of a fishing operation, as would be necessary if the tool assembly dropped to the bottom of the tubing string. Upon such wire line breakage, the lack of tension in the wire line will permit closure at the valve 59 of the main conduit line leading from the source of pressure fluid. The system will then remain inactive until necessary repairs are made.

The shuttle valves 55 and 64 are of the commonly available type and remain in either alternate position until reshifted by the application of a pressure fluid signal. Each of the control valves 27, 42 and 71, which function to pass pressure fluid signals, is arranged so that when closed, any line pressure therebeyond is bled down. It will be understood that the system actuating power can be other than controlled pneumatic pressures and that suitably arranged weights can be selected to supply bias force in any of the various components in place of springs, inclusive of those illustrated at 25, 36 and 60.

While only a specific embodiment of the invention has been referred to in this specification, it will be understood that such modifications and adaptations may be made as come within the scope of the appended claims.

What is claimed is:

1. Well tubing scraper control mechanism which is adapted to run a wire line suspended scraper tool through a well tubing string and from and return to an inactive location in a scraper housing section of the tubing string, including a wire line reel, a reversible fluid pressure motor drive connected with said wire line reel, a first pressure actuated valve shiftable to and from a setting which directs pressure fluid delivery to said motor for driving the same in wire line unreeling direction, a second pressure actuated valve shiftable to and from a setting which directs pressure fluid delivery to said motor for driving the same in wire line reeling direction, a periodically operating controller through which a pressure fluid signal is transmitted to the first pressure actuated valve for shifting the same to its pressure fluid delivery setting, pressure fluid signal transmitting means connected with both of the aforementioned valves and responsive to a predetermined amount of wire line unreeling for directing pressure fluid signals to actuate said valves for shifting the first pressure actuated valve from the abovementioned pressure fluid delivery setting and for shifting the second pressure actuated valve to its pressure fluid delivery setting, other valve means connected with said second pressure fluid actuated valve and movable to and from a setting which passes pressure fluid

to the second pressure fluid actuated valve for shifting the same from its said pressure fluid delivery setting and motion transfer means with said other valve means and including a movable device having mounting attachment to said housing section and being responsive to scraper tool arrival in said housing section to effect movement of said other valve means to said pressure fluid passing setting.

2. Well tubing scraper mechanism which is adapted to cycle the operation of lowering and then raising a wire line suspended scraper tool through a well tubing string and including a wire line reel having a pressure fluid actuated reversible drive motor, first and second fluid pressure responsive shuttle valves connected with the motor for controlling actuation thereof and each having an exhaust position and a pressure fluid delivery position, an intermittently operative fluid pressure controller connected with the first valve to set the first valve in pressure fluid delivery position while the second valve is in exhaust position for motor drive in reel unwinding direction, normally closed valve means having pressure fluid supply connection with both shuttle valves and being adapted when opened to supply pressure fluid to which both shuttle valves respond and reverse their relative positions for effecting motor drive in reel winding direction, a wire line driven counting wheel having a peripheral groove for frictional drive engagement by a wire line wrapping, a movable member having a motion transmitting and speed reducing connection with said counting wheel, a striker lug carried by said member and engageable with the normally closed valve means to open the same upon a predetermined extent of member movement as transmitted thereto with counting wheel rotation in the reel unwinding direction and an adjustable connection joining the lug and said movable member and fixing said predetermined extent of member movement.

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