

Nov. 26, 1963

W. J. HAYES

3,111,990

POSITION SELECTOR DEVICE FOR WELLS

Filed Nov. 7, 1960

3 Sheets-Sheet 1

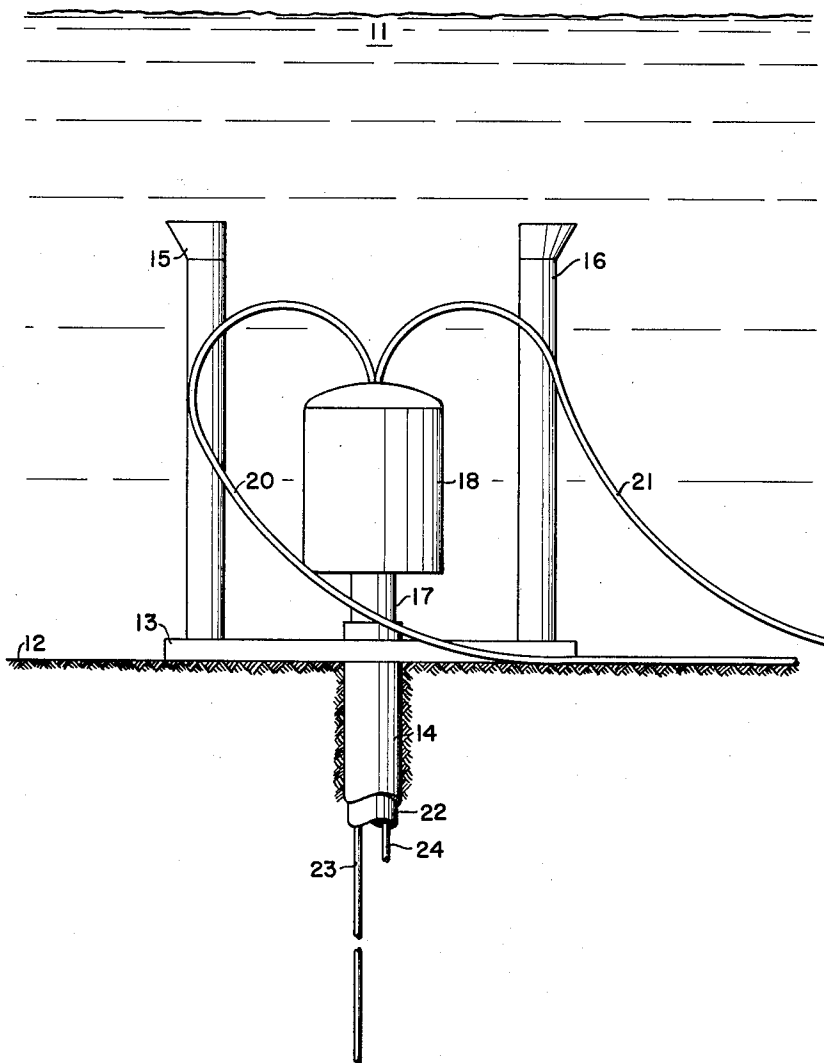


FIG. 1

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FIG. 9

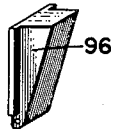


FIG. 5

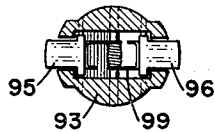


FIG. 6

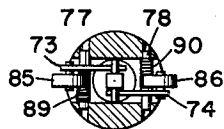


FIG. 7

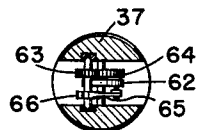


FIG. 8

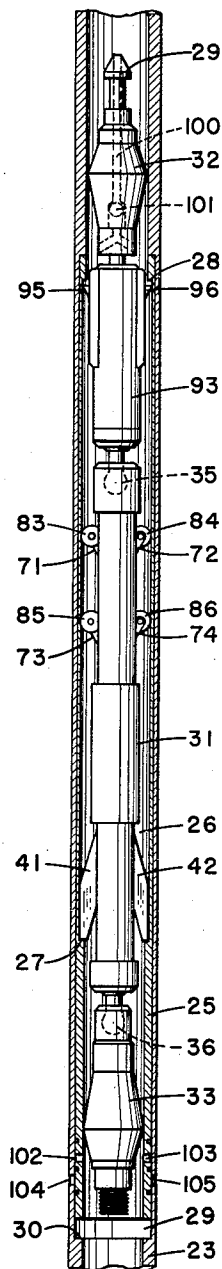
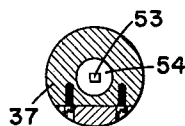


FIG. 2

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POSITION SELECTOR DEVICE FOR WELLS

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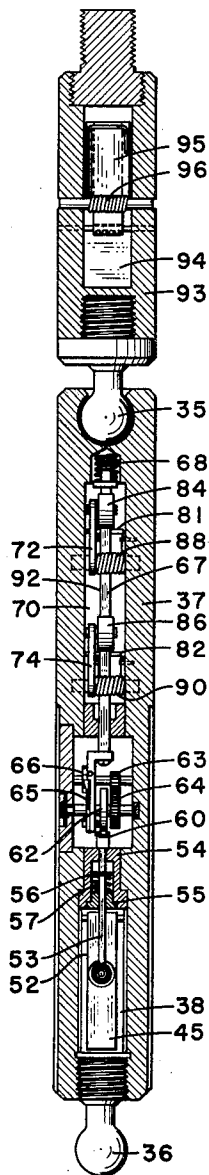


FIG. 4

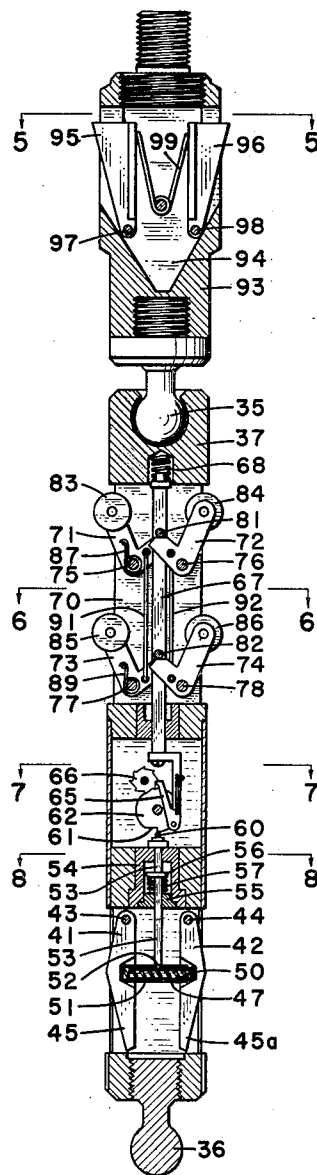


FIG. 3

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3,111,990

POSITION SELECTOR DEVICE FOR WELLS

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Filed Nov. 7, 1960, Ser. No. 67,647
8 Claims. (Cl. 166—64)

This invention relates to a well device adapted to be moved up or down a string of tubing positioned within a well and pertains more particularly to a device adapted to be pumped through a well tubing preferably together with a well tool connected thereto whereby the tool may be seated at a predetermined position within the well. In addition to positioning tools at a predetermined position within a well tubing, it is often desirable to position other well devices, instruments or equipment, for example, gas-lift valves, etc., or to carry out certain operations, for example, opening or closing a valve in the tubing.

A recent development in the oil industry is the drilling and completion of wells at an offshore location where the wellhead assembly and production control units are positioned beneath the surface of a body of water and preferably close to the bottom of the body of water. With wellhead assemblies positioned on an ocean floor, a hazard to the navigation of boats in offshore waters is removed. Additionally, considerable savings are realized in that it is not necessary to erect a protective stationary platform around the wellhead in the manner in which they are presently employed to protect well casing and well head assemblies extending above the surface of the water. It has also been found necessary to position a wellhead on the ocean floor in water depths where it is not feasible to erect a stationary platform around a wellhead assembly.

However, the placement of wellhead assemblies on the ocean floor raises a new set of problems with regard to carrying out workover operations, maintenance or other operations in a completed well. Major workover operations call for the use of a barge positioned on the surface of the water above the well together with equipment for going down and entering the wellhead assembly and the tubing or casing strings connected thereto, and in some circumstances may result in the entire removal of the wellhead assembly to the surface during workover operations. In order to carry out some of the more simple workover or maintenance operations, such as the perforation of well casing, the opening of a packer, the removal or insertion of a valve, the cleaning of paraffin from a tubing string, the opening or closing of a sleeve valve, etc., it has been necessary to develop an entirely new line of well tools which can be pumped through a production tubing string from some remote location, oftentimes a mile or more from the well, and enter the well, passing down the tubing string therein to be subsequently positioned therein for carrying out some preselected operation. After completing the operation, the tool in the tubing string within the well is subsequently removed, generally by reverse circulation.

While the problem of pumping a tool to the bottom of a well tubing string in order to carry out certain operations is fairly readily solved, the problem of pumping a certain tool, device or other apparatus to a certain predetermined position within a well tubing is far more difficult. This is especially true in the event that it is necessary to position the tool or other device in one of a series of identical locations within a well tubing. Thus, for example, a well tubing may be provided with a series of gas-lift valves spaced at various intervals along the length of the tubing. In replacing gas-lift valves in a well tubing it is necessary to be sure to get the newly positioned gas-lift valve in the proper side pocket of the well tubing.

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Likewise, a well tubing string may be provided with one or more sleeve valves at spaced intervals therealong or at various depths. At times it is desirable to open or close selectively one or more of these valves at certain designated levels while allowing any remaining valves to maintain their previous setting.

It is an object of the present invention to provide apparatus adapted to pass through a well tubing and automatically bypass a plurality of seating positions therein until arriving at and subsequently being seated in a preselected position.

Another object of the present invention is to provide an apparatus adapted to be pumped through a string of pipe in a well and around curved portions thereof which may be located in and/or outside a well, the apparatus being pumped together with a well device and subsequently being stopped at a preselected location in the pipe string.

A further object of the present invention is to provide apparatus adapted to pass through a well tubing and automatically seat itself in a preselected recess of a plurality of recesses spaced along a well tubing, and subsequently be energized to perform an operation such as opening or closing a valve.

These and other objects of this invention will be understood from the following description taken with reference to the drawing, wherein:

FIGURE 1 is a schematic view illustrating a wellhead assembly positioned on the ocean floor;

FIGURE 2 is a diagrammatic view taken in longitudinal cross-section of a tubing string with the apparatus of the present invention positioned therein;

FIGURE 3 is a longitudinal view taken in cross-section of the position selector device of the present invention;

FIGURE 4 is a longitudinal cross-sectional view of the position selector device of the present invention taken at 90 degrees to FIGURE 5;

FIGURES 5, 6, 7 and 8 are cross-sectional views taken along the lines 5—5, 6—6, 7—7, and 8—8 of FIGURE 3, respectively; and

FIGURE 9 is an isometric view of one of the upper latching dogs of the apparatus of FIGURE 3.

Referring to FIGURE 1 of the drawing, a wellhead assembly is shown as positioned below the surface 11 of a body of water and preferably on the ocean floor 12. The wellhead apparatus comprises a platform 13 secured to the top of a conductor pipe or surface casing 14 which in turn extends into the earth below the body of water and is preferably cemented therein in a conventional manner. The wellhead assembly may also be provided with two or more vertically positioned guide columns 15 and 16 which are fixedly secured at their lower ends to the platform 13. A well casing head 17 is mounted on the top of the conductor pipe 14 with a control equipment housing 18 closing the top of the casing head and/or any casing and tubing suspension equipment employed on the wellhead assembly, as well as the various control valves and other control equipment normally used on the top of a well of this type.

Emerging from the housing 18 are a pair of flow lines 20 and 21 which preferably bend in long sweeping curves from a vertical position down to a substantially horizontal position so that they can run along the ocean floor 12 to a remote location where fluid from the well, and normally from other wells, is collected and metered and treated. Such a collection station may be several miles away. During the production of the well, normally only one of the flow lines 20 or 21 is employed in transporting fluid away from the well. The well may be provided with one or more strings of well casing 22 suspended within the well. However, in other well installations wherein a single tubing string is utilized, the second flow-

line may be in communication with the annular space between the tubing string and the adjacent well casing. For purposes of illustrating the apparatus of the present invention, one of the tubing strings 23 in FIGURE 1 will be considered as being provided with a series of sleeve valves in spaced relationship along the tubing string.

Referring to FIGURE 2, it may be seen that the tubing string 23 is provided with suitable means for stopping a well tool or other device as it passes or is pumped through the tubing string. The stop means within the tubing string 23 may take the form of a sleeve valve 25 having a recessed portion 26, for example, which is shown as having an internal diameter greater than that of the internal diameter of the tubing string 23. In the particular recessed portion 26 illustrated, a seating or stop shoulder 27 is formed at the bottom thereof while another shoulder 28 is formed at the top thereof. In the event that no sleeve valve 25 is employed within the tubing string 23, the stop means within the tubing string may take the form of the recessed portion 26 in which the sleeve valve 25 is slidably mounted, with shoulder 30 forming the downward limiting stop.

Arranged for sliding movement through the tubing string 23 is the position selector device 31 of the present invention to which may be attached a well tool, device, instrument or other element (not shown), for example, a valve opening and/or closing device which is designed to be positioned at a predetermined location in the tubing string, such for example as in the recessed portion 26 of a particular sleeve valve 25 which it is desired to open or close. If it is desired that the instrument or tool and the position selector device be pumped into position through the tubing string 23, which would be the normal procedure, one or more rubber motor swab elements of a type described in copending application, Serial No. 45,036, filed July 25, 1960, is provided. The motor swab cups 32 and 33 may be directly connected to the instrument or tool or it may be connected to the position selector device 31 of the present invention which in turn is connected to the instrument or tool. The motor swab elements 32 and 33 may be arranged above and below the apparatus of the present invention, as illustrated in FIGURE 2, or both of them may be arranged above or both below the apparatus, or pairs of them may be carried above and below. In any pair of swabs, one is preferably arranged to expand when the apparatus is being pumped down the tubing while the other expands when the apparatus is pumped in the opposite direction. Alternatively, the apparatus may be provided with a fishing head 39 so that motor swabs could be circulated down to tubing to attach to the fishing head prior to pumping the apparatus up the tubing. Preferably, all connections, such as 35 and 36, are in the form of flexible joints such as a short section of hose or a ball-and-socket joint whereby the connected elements may pass readily through curved sections of the tubing string 23. It is to be understood that the tubing string 23 may be provided with a plurality of the recessed portions 29 or valves with recessed portions 26, which may be spaced, say, several hundred feet apart.

The position selector device shown in FIGURES 3 and 4 comprises a housing member 37 having a recess 38 formed therein near one end thereof in which a pair of latching dogs 41 and 42 are mounted on pivot pins 43 and 44 for radial expansion outwardly from the housing member 37 so as to contact the seating shoulder 27 of the recessed portion 26 of the sleeve valve 25 in the tubing string 23 (FIGURE 2). The outer faces of the lower portions 45 and 45a of the latching dogs 41 and 42 are preferably of a length and shaped at an angle so that when the latching dogs are in their extended position against the inner walls of a tubing string 23, the latching dogs 41 and 42 will readily pass over any joint formed between two sections of the tubing string without hanging up therein. A compression spring 47 is mounted between the latching dogs 41 and 42 for normally urging the latching

dogs 41 and 42 outwardly. The latching dogs 41 and 42 are normally retained in a retracted or inoperative position, as illustrated in FIGURE 3, by any suitable means as by a pair of telescoping sleeves 50 and 51 which surround the spring 47. When the sleeves 50 and 51 are in their shortest telescoped position, a pair of holes through the sleeves are in register with each other allowing a pin 52 at the lower end of a slidable arm 53 to pass through the holes. Since each sleeve 50 and 51 is secured at one end to one of the latching dogs 41 and 42, the latching dogs 41 and 42 are prevented from moving outwardly as long as the pin 52 remains positioned in the holes in the sleeves 50 and 51.

The arm 53 is slidably mounted for axial movement in bushings 54 and 55 centrally located within the housing member 37. A pin 56 through the arm 53 retains a compression spring 57 against lower bushing 55. A small-diameter pin 60 is formed at the end of the arm 53, the pin 60 being designed to fit into a slot 61 of an actuating wheel or releasing cam 62. The actuating wheel 62 in turn is coupled to and is actuated by a counting apparatus, such for example as a two-gear reducing train represented by gears 63 and 64, which operatively connect the wheel or cam 62 to a ratchet or indexing gear 66 which is actuated by a spring-loaded pawl 65.

The indexing gear or ratchet 66 engages and is actuated by the pawl 65 carried at the lower end of a linkage arm 67. The upper end of the linkage arm 67 is provided with a compression spring 68 which normally urges the arm 67 downwardly.

The housing member 37 of the position selector device is provided with a recess 70 in which one or more feeler elements are mounted for movement outwardly therefrom. Preferably, two pairs of feeler elements 71, 72, 73 and 74 are mounted on pivot pins 75, 76, 77 and 78 for movement in a plane parallel to the axis of the housing member 37. The feeler elements are of any suitable size and shape, preferably angular, as shown in FIGURE 3, with an arm of the elements 71, 72, 73 and 74 being operatively connected to the linkage arm 67, as by being in contact with a pin 81 or 82 extending through the arm 67. Rotatably mounted wheels 83, 84, 85 and 86 are preferably secured to the outwardly extending ends of the feeler elements 71, 72, 73 and 74 to reduce the friction and wear as the present apparatus moves slidably through a tubing string.

The feeler elements 71, 72, 73 and 74 are provided with suitable springs 87, 88, 89 and 90 arranged to urge the wheels 83, 84, 85 and 86 outwardly from the housing member 37 and against the inner wall of a tubing string 23 (FIGURE 2) as the position selector device passes therethrough. If two pairs of feeler elements 71, 72, 73 and 74 are employed, as illustrated in FIGURE 3, they are connected together by linkage arms 91 and 92 so that they operate together.

In the event that the position selector device of the present invention is to be employed to open a sleeve valve 25 (FIGURE 2) it may be provided with suitable means for subsequently closing the valve. One device for accomplishing this operation is shown in FIGURES 3 and 4 as a housing member 93 having a recess 94 therein in which a pair of upwardly directed, outwardly expandable, valve-engaging dogs 95 and 96 are movably mounted on a pair of shear pins 97 and 98. A spring 99 between the dogs 95 and 96 normally urges the shear pinned dogs outwardly. The housing member 93 is connected to housing member 37 by flexible joint 35 but it may be integrally formed thereon. The recessed portion 94 of the housing member 37 is shaped so as to hold and retain the dogs 95 and 96 in a retracted position when the pins 97 and 98 have been sheared. The upper motor swab element 32 (FIGURE 2) is preferably provided with an interior flow passage 100 and a check valve 101 therein arranged to permit fluid under substantial pressure to be pumped past the swab element 32.

Prior to running through a well tubing the position

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selector device of the present invention, a determination is made as to the depth to which the selector device 31 (FIGURE 2) is to be lowered. For example, it may be decided that the indicator device 31 should be actuated at a time so that it seats itself in the recessed portion 26 of the fourth valve 25 within the well tubing 23. In such a case, the ratchet 66 within the housing member 37 would be rotated backwards for the correct number of notches, in this case, four notches. The indicator device 31, together with any tool attached thereto, would be put in an open end of the tubing string 23 and passed therethrough until it had reached the fourth recessed portion in the tubing string. Preferably, a motor swab 32 is attached to the position selector device 31 so that the entire assemblage, including preferably another oppositely positioned motor swab 33 attached to the other end thereof, is put into a tubing string and the tubing string attached to a pump so that a fluid may be pumped down the tubing string 23 in back of the assembled elements. As the assembled tool passes down the tubing string 23, it passes the series of sleeve valves 25.

As the position selector device passes down through a tubing string 23 (FIGURE 2), the wheels 83, 84, 85 and 86 of the feeler elements 71, 72, 73 and 74 roll against the inner surface of the tubing string and expand into any recess that is of a length greater than the distance between the wheels 84 and 86 (FIGURE 3). Since the feeler elements 71, 72, 73 and 74 are connected in pairs by linkages 91 and 92 it is evident that both pairs of feeler elements 71-73 and 72-74 must move together. Thus, no single arm of a pair of arms can expand unless both expand. With this arrangement, no expansion of the feeler elements and hence no actuation of rod 67 and ratchet 66 takes place until the feeler elements have arrived at a recess 26 (FIGURE 2) long enough to accommodate both pairs of feeler arms at once.

When a recess 26 of sufficient length is reached both pairs of feeler elements 71, 72, 73 and 74 expand outwardly, which forces the linkage arm 67 upwardly. This movement causes the pawl 65 to rotate the ratchet 66 one notch. The ratchet 66 through the reduction gears 63 and 64, rotate the releasing cam 62 a fraction of a turn. The spring 68 causes the linkage arm 67 to follow the feeler element arms downwardly.

When the desired number of recesses or recessed portions of sleeve valves have been past so as to actuate the ratchet 66 the desired number of times to rotate the releasing cam 62 through the proper angle, as determined by setting the tool before it is run, the pin 60 moves into the slot 61, allowing the slidable arm 53 and the pin secured to the lower end thereof to travel upwardly. Upward movement of this arm 53, which is caused by the spring 57, pulls the pin 52 out of the telescoping sleeves 50 and 51 so that they are allowed to be expanded by means of spring 47 which also forces the latching dogs 41 and 42 outwardly. In the event that the recessed portion 26 of the sleeve valve 25 is long enough (as illustrated in FIGURE 2) to accommodate both of the feeler elements and the latching dogs within the recessed portion at the same time, the latching dogs 41 and 42 then move along the inner wall of the sleeve valve until they are stopped by the shoulder 27 therein. In the event that the recessed portion 26 of the sleeve valve 25 is not of a length great enough to accommodate the feeler elements and the latching dogs at the same time, release of the latching dogs 41 and 42 would cause the dogs to expand against the inner wall of the tubing string and ride along the wall of the tubing as the position selector device was propelled through the tubing to the next lower sleeve valve. During this operation the length and shape of the lower portions 45 and 45a of the latching dog would prevent the dogs from hanging up in the tubing collars or the space between two sections of the tubing string. It is

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because of these spaces that it is preferred to use two sets of feeler elements 84 and 86 spaced axially of each other to prevent actuation of the two in the event a feeler element expanded into one of the spaces. Alternatively, a single pair of feeler elements may be employed in some situations or even a single feeler element with a larger wheel carried at the end thereof.

With the latching dogs 41 and 42 seated on the shoulder 27 (FIGURE 2) of the sleeve valve 25, an increase in the hydraulic pressure above the two will cause the sleeve valve 25 to move downwardly so that its ports 102 and 103 are in register with ports 104 and 105 through the wall of the tubing 23.

In the event that it was planned to close the sleeve valve 25 a short time after it had been opened, the auxiliary housing member 93 with its upwardly directed latching dogs 95 and 96 would have been attached to the position selector device 31 at the time the position selector device was run downwardly through the tubing string 23. The dogs 95 and 96 are expanded when the device is first put in the tubing string 23 and they drag along the wall of the pipe as the device is pumped downwardly through the tubing string. In order to close the sleeve valve 25 and return the apparatus to the surface, circulation in the well is reversed so that the apparatus may be pumped upwardly through the tubing string. On upward movement of the apparatus through the well tubing 23, the dogs 95 and 96 engage the upper shoulder 28 of the sleeve valve 25, pushing it upwardly as far as it will go to the position shown in FIGURE 2. After the sleeve valve 25 has been closed, an increase in the hydraulic pressure within the tubing string 23 from below the tool causes the pins 97 and 98 (FIGURE 3) to shear, allowing the dogs 95 and 96 to be forced downwardly into the recess 94 within the housing member 93. Further expansion of the spring 99 holds the dogs 95 and 96 within the recess 94 and prevents them from later protruding and preventing recovery of the tool. With the dogs 95 and 96 retracted the apparatus may be circulated to the top of the well again. In the event that it is desired to leave the sleeve valve 25 open after the tool is retrieved, the upper dogs 95 and 96 would not be installed when the apparatus was originally run into the well.

In the above-described operation of the apparatus of the present invention, it is assumed that the motor swab cups 32 and 33 expand sufficiently during operation to engage the inner walls of the sleeve valve 25 in their operative position so as to provide a pressure differential across the apparatus sufficient so that it can be pumped through the tubing string 23. In some cases it may be found desirable to add additional motor swabs 32 above the presently illustrated motor swab 32 of FIGURE 2, or to send down independent motor swabs (not shown) to engage the fishing head 29 at the top of the apparatus.

I claim as my invention:

1. Apparatus for selectively limiting the downward travel of a well device through a pipe string depending vertically within a well, said apparatus comprising a vertical pipe string, a plurality of stop means formed within the pipe string at axially spaced locations therealong, a pumpable well device including a position selector device of a diameter sufficient to pass through said pipe string to stop selectively at one of said stop means, latching means carried by said position selector device and adapted to engage one of said stop means, and latch actuating means carried by said position selector device and operatively connected to said latching means, said latch actuating means including outwardly-extending feeler arm means actuatable by and responsive to movement past each of said stop means.

2. Apparatus for selectively limiting the downward travel of a well device through a pipe string depending vertically within a well, said apparatus comprising a vertical pipe string, a plurality of recessed stop means formed

within the pipe string at axially spaced locations therealong, a pumpable well device including a position selector device of a diameter sufficient to pass through said pipe string to stop selectively at one of said stop means, latching means carried by said position selector device and adapted to engage one of said stop means, latch actuating means carried by said position selector device and operatively connected to said latching means, said latch actuating means including outwardly-extending feeler arm means actuatable by and responsive to movement past each of said stop means, and adjustable release means operatively connected to said latch actuating means for delaying the operation of said latch actuating means until said position selector device is in a preselected portion of said pipe string.

3. Apparatus for selectively limiting the downward travel of a well device through a pipe string depending vertically within a well, said apparatus comprising a vertical pipe string, a plurality of recessed stop means formed within the pipe string at axially spaced locations therealong, a pumpable well device including a position selector device of a diameter sufficient to pass through said pipe string to stop selectively at one of said stop means, normally retracted, radially extensible latching means carried by said position selector device and adapted to engage one of said stop means, latch-actuating means carried by said position selector device and operatively connected to said latching means, said latch actuating means including outwardly-extending feeler arm means actuatable by and responsive to movement past each of said stop means, adjustable release means operatively connected to said latch-actuating means for delaying the operation of said latch-actuating means until said position selector device is in a preselected portion of said pipe string.

4. A position-selector device of a size adapted to pass through a pipe string in a well to a selected recessed portion thereof, said selector device comprising an elongated body member, radially extensible latching means carried within said body member, a counter mechanism operatively connected to said latching means for actuating said latching means on arrival at a preselected position in a pipe string, and counter-actuating means including outwardly extending feeler arm means carried by said body member and operatively connected to said counter mechanism for stepwise actuation of said counter mechanism, said counter-actuating means being responsive to movement of said feeler arm means past recessed portions in said string through which said selector device moves.

5. A position-selector device of a size adapted to pass through a pipe string in a well to a selected recessed portion thereof, said selector device comprising an elongated body member, spring loaded, normally retracted radially extensible latching means carried within said body member, arm means in said body member and operatively connected to said latching means to hold said latching means normally in a retracted position, adjustable counter mechanism connected to one end of said arm means to actuate said arm means when said gear mechanism has arrived at a preselected position, and actuating means including outwardly extending feeler arm means carried by

said body member and operatively connected to said counter mechanism for stepwise actuation of said mechanism.

6. A position-selector device of a size adapted to pass through a pipe string in a well to a selected recessed portion thereof, said selector device comprising an elongated body member having a chamber formed therein, flexible tool joint connector means carried on at least one end of said body member for connecting a well device thereto, spring-loaded normally retracted, radially extensible latching means carried within said body member, arm means in said body member and operatively connected to said latching means to hold said latching means normally in a retracted position, an adjustable ratchet-type counter mechanism connected to one end of said arm means to actuate said arm means when said counter mechanism has arrived at a preselected position, counter-actuating means including outwardly extending feeler arm means carried by said body member and operatively connected to said counter mechanism for stepwise actuation of said counter mechanism, said counter-actuating means being responsive to movement of said feeler arm means past recessed portions in the pipe string through which said selector device moves.

7. A position-selector device of a size adapted to pass through a pipe string in a well to a selected recessed portion thereof, said selector device comprising an elongated body member having a chamber formed therein, flexible tool joint connector means carried on at least one end of said body member for connecting a well device thereto, a pair of spring-loaded normally retracted, radially extensible latching means carried within said body member, arm means in said body member and operatively connected to said latching means to hold said latching means normally in a retracted position, an adjustable ratchet-type counter mechanism connected to one end of said arm means to actuate said arm means when said counter mechanism has arrived at a preselected position, counter-actuating means including at least two pair of outwardly extending feeler arm means carried by said body member in axial spaced relationship and operatively connected to said counter mechanism for stepwise actuation of said counter mechanism, said counter-actuating means being responsive to movement of said feeler arm means past recessed portions of the pipe string through which said selector device moves.

8. The apparatus of claim 7, including a second pair of spring-loaded latching means extending outwardly from said body member, and shear pins securing said latching means to said body member, said latching means being arranged on said body member for free movement in only one direction through a pipe string.

References Cited in the file of this patent

UNITED STATES PATENTS

2,292,938	Hennessy	Aug. 11, 1942
2,810,440	Kenneday et al.	Oct. 22, 1957
2,871,946	Bigelow	Feb. 3, 1959
2,871,947	Fredd	Feb. 3, 1959