

United States Patent

[11] 3,561,528

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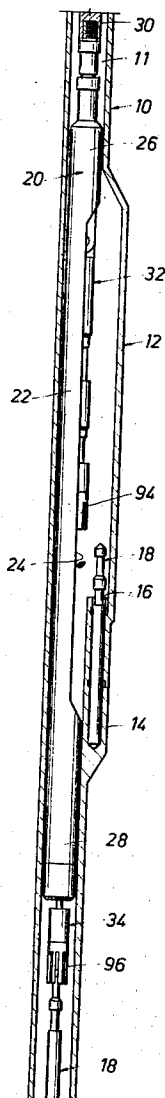
[54] **APPARATUS FOR SIMULTANEOUSLY GUIDING
 AT LEAST TWO INSERTABLE MECHANISMS IN A
 WELL TUBING**
 11 Claims, 9 Drawing Figs.

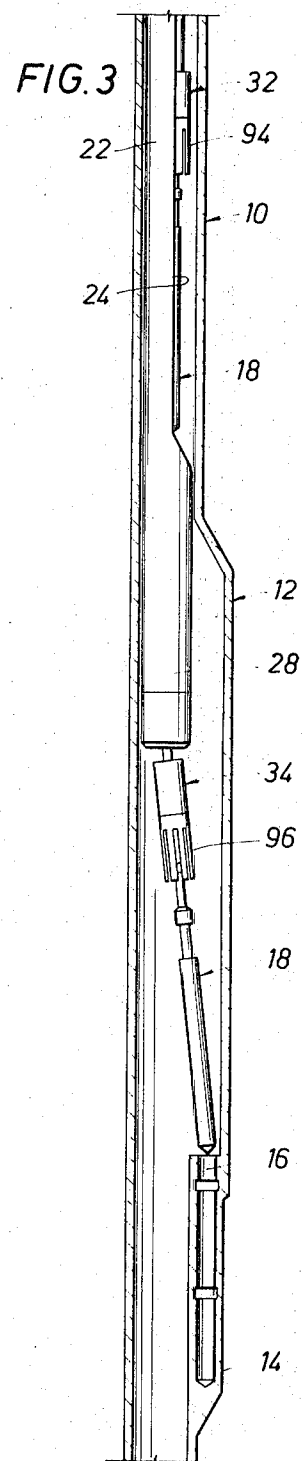
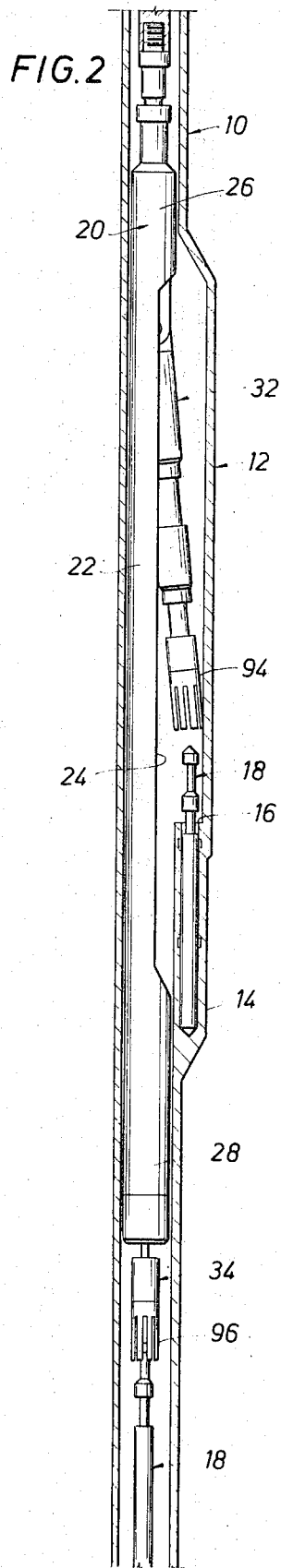
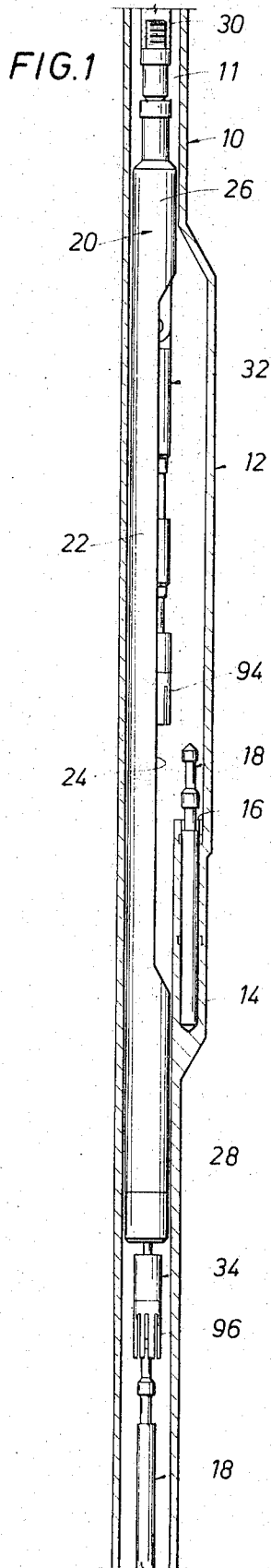
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[56] **References Cited**
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2,664,162 12/1953 Howard et al. 137/215X

ABSTRACT: An apparatus for installing and removing insertable elements, such as flow valves and the like, laterally of a well axis. The well has a plurality of laterally offset receiving stations. An elongated guide tool rotatably supports a top shifting tool and a bottom shifting tool. When the guide tool is lowered into the well, the top shifting tool is normally adapted to remove an element from a predetermined receiving station. The removed element upon becoming aligned with the axis of the well, releases the bottom shifting tool for lateral movement. The bottom shifting tool can then either install or remove another insertable element. Accordingly, in one apparatus aspect at least one insertable element can be removed and another element installed during a single run by the elongated tool through the well tubing; in another apparatus aspect at least two such elements can be removed during a single run.

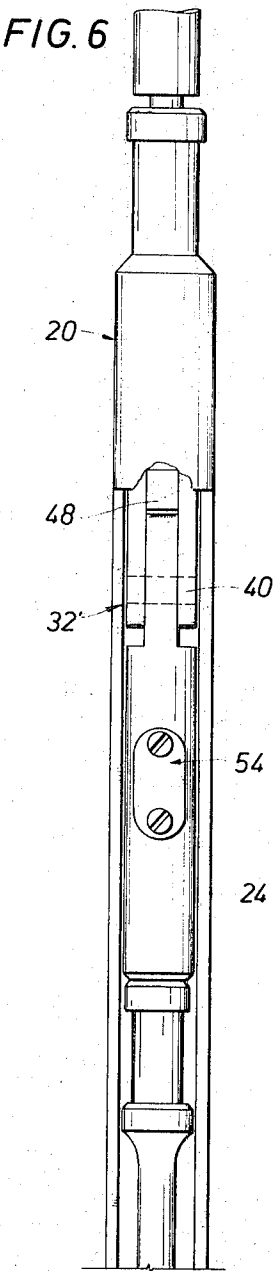
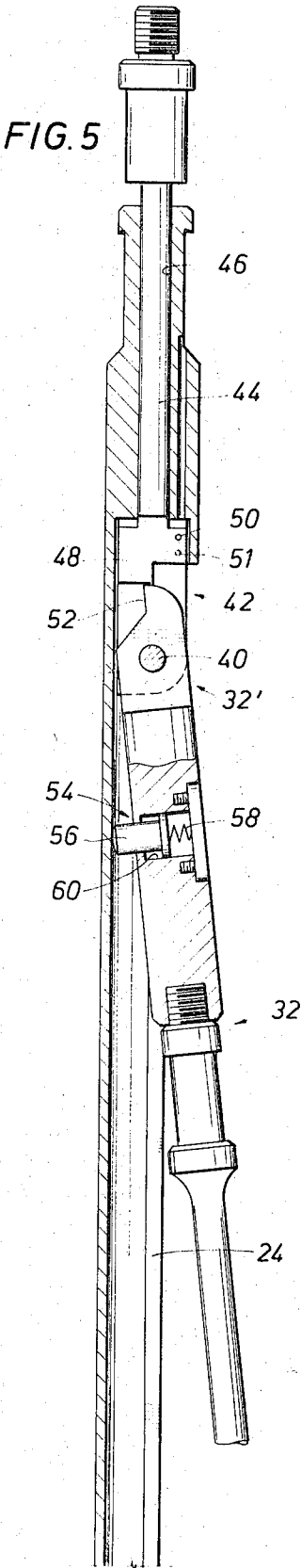
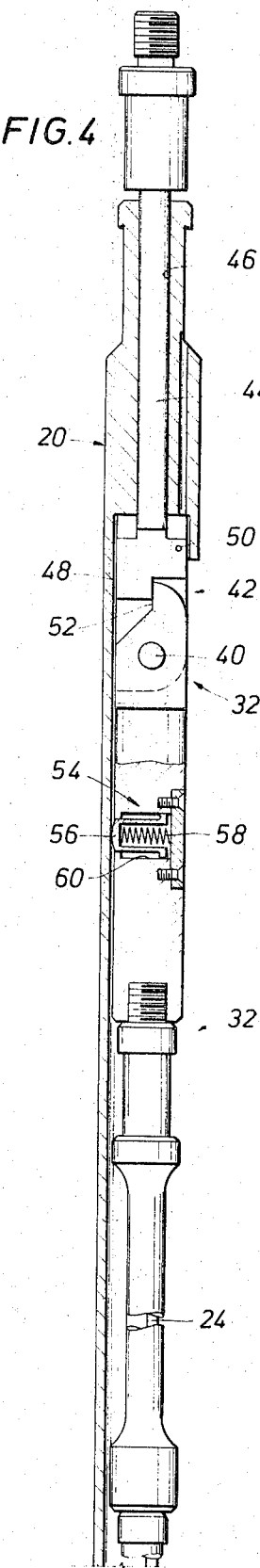




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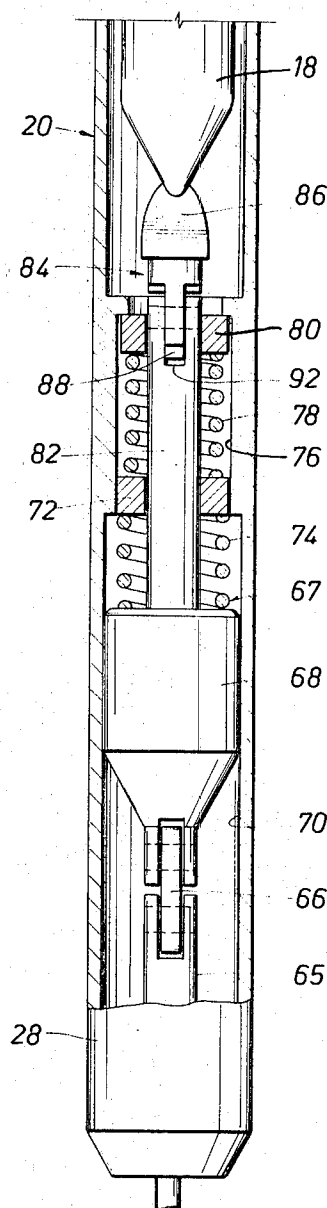
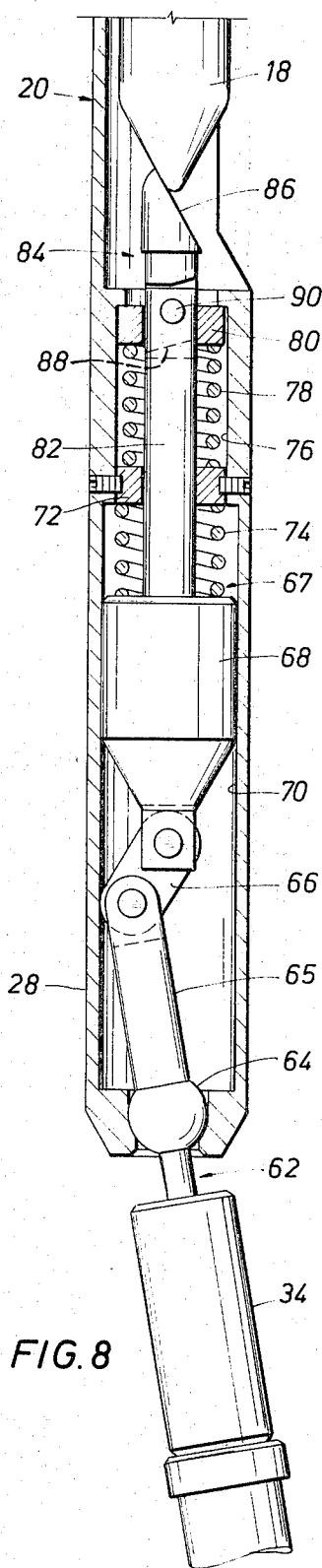
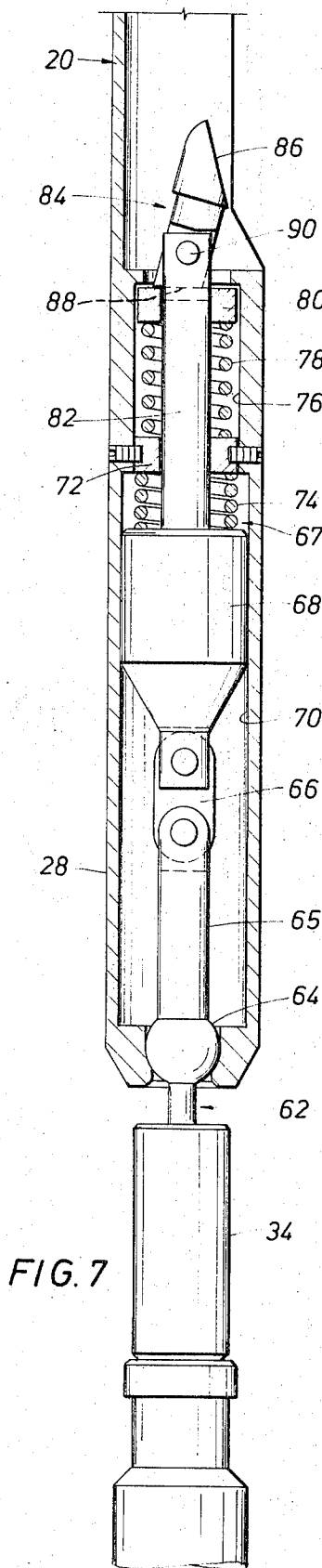
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APPARATUS FOR SIMULTANEOUSLY GUIDING AT LEAST TWO INSERTABLE MECHANISMS IN A WELL TUBING

CROSS-REFERENCES TO RELATED APPLICATIONS

A preferred method using the apparatus of this invention is described and claimed in copending Pat. application Ser. No. 872,944, filed Oct. 31, 1969 assigned to the same assignee.

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for guiding at least two insertable mechanisms or elements laterally of a well tubing axis, as for installing and removing such elements in and from laterally-offset, element-receiving stations.

Although the apparatus of this invention has application to insertable elements generally, it is described herein with particular reference to flow valves.

When the pressures in an oil reservoir have fallen to the point where the well not produce by natural energy, some means of artificial lift is used. One common technique is known as the gas-lift technique in which gas under pressure is used to lift the well fluids. A plurality of flow valves are installed in laterally-offset, flow-control receiving stations which are longitudinally spaced along the tubing string. Gas under pressure is injected into the annulus between the casing and the tubing and enters the tubing through the various flow valves. These flow valves regulate the transmission of the lift gas from the casing annulus into the well tubing. The high-pressure gas then lifts the fluids that stand inside the tubing in a well-known manner.

Single-function flow valve installing and removing devices are described in the technical and patent literature, as in U.S. Pat. Nos. 2,664,162, 2,679,904, and 3,353,608.

Generally, known devices includes an elongated, single-function tool which is lowered into the well tubing down to the level of a particular, laterally-offset, valve receiving station. By manipulating a wireline from the surface a pivotally mounted arm is guided laterally of the well axis for installing or removing a flow valve in or from the particular receiving station. After the single function is accomplished the tool is lifted to the surface.

For example, in U.S. Pat. No. 3,353,608 there is described an apparatus for installing or removing flow valves in and from a well tubing. The described apparatus includes an elongated guide body. A shifting tool is pivotally supported from the guide body. A releasable connecting means between the guide body and the shifting tool normally holds the shifting tool aligned with the axis of the guide body. The connecting means includes a spring between the guide and the shifting tool to laterally move the shifting tool away from the guide when the connecting means becomes disengaged. The lower end of the shifting tool is provided with a running or pulling adapter to either install or remove a flow valve in or from its seat. Then, the apparatus is pulled on a wireline to the surface of the well and prepared for another run through the tubing.

Accordingly, during each down-and-up run of the apparatus through the tubing, only one flow valve can be installed or removed.

There is therefore a great need for an apparatus which will allow the guiding through the well tubing of more than one flow valve during each down-and-up run through the tubing.

SUMMARY OF THE INVENTION

It is a general object of the invention to provide a new and improved apparatus for installing and removing laterally-offset, insertable elements in and from a well tubing.

It is a particular object of the invention to provide an apparatus for installing and removing flow valves in and from laterally-offset, receiving stations longitudinally displaced along the well axis.

It is a specific object to provide an apparatus for removing in a single run through the well tubing at least two flow valves.

It is likewise an object to provide such an apparatus for removing one flow valve and installing another flow valve during a single run through the well tubing.

It is a particular object of the invention to provide such an apparatus which is characterized by economy of operation in respect of cost of servicing wells and in respect of reducing the time during which the normal well operation is disrupted.

The above and other apparent objects of this invention are achieved in one preferred embodiment by a multifunction apparatus for installing and removing offset mechanisms such as flow valves in and from a tubing string on which are positioned a plurality of flow-control, offset receiving stations. The apparatus includes an elongated guide tool having an upper section and a lower section.

A top shifting tool is pivotally supported by and releasably connected to the upper section. Upon release, the top shifting tool moves toward a particular flow-control, receiving station to pull therefrom a flow valve. As the guide tool is next removed up through the tubing string, the removed flow valve becomes seated inside the guide tool.

The lower section of the guide tool rotatably supports a bottom shifting tool. The rotatable suspension of the bottom shifting tool coacts with a releasable force-producing mechanism. The mechanism is actuated when the tip of the removed flow valve enters inside the guide tool. The bottom shifting tool thereafter moves toward the particular flow control receiving station for installing or removing a flow valve, or toward any other receiving station above the particular receiving station.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in elevation, partly in cross section, illustrating the apparatus of the present invention as it is being lowered through a tubing adjacent to a particular flow-control, offset receiving station;

FIG. 2 is a view similar to FIG. 1 showing the top shifting tool released from the guide tool and moved toward the receiving station;

FIG. 3 is a view similar to FIG. 2 showing the guide tool lifted above the receiving station with the bottom shifting tool released from the guide tool and moved toward the receiving station for installing a flow valve;

FIG. 4 is an enlarged, cross-sectional view of the upper section of the guide tool showing the top shifting tool in its retracted position;

FIG. 5 is a view similar to FIG. 4 showing the top shifting tool in its released position;

FIG. 6 is a side view of the upper section of the guide tool shown in FIG. 4;

FIG. 7 is an elevational view, partly in cross section, showing the lower section of the guide tool with the bottom shifting tool in its retracted position;

FIG. 8 is a view similar to FIG. 7 but with the bottom shifting tool in its released position; and

FIG. 9 is a side view of the portion of the apparatus shown in FIG. 8.

Referring now to the drawings, and particularly to FIGS. 1-3, a string of tubing 10, which may be interconnected by collars (not shown) or by other means, is provided with a plurality of flow-control, offset receiving stations, generally designed as 12. Each station 12 is laterally offset from the bore 11 of tubing 10. The lower end 14 of each station 12 is provided with a valve seat 16 for housing an insertable element such as a flow valve, generally designated as 18. The receiving stations 12 are longitudinally spaced along the string of tubing 10, one above the other, for receiving production from the casing annulus at different levels. The above-described tubing structure is conventional. It is described, for example, in said U.S. Pat. No. 2,679,904.

The multifunction apparatus of the present invention is generally designated as 20. It includes an elongated guide tool 22 which is cylindrically shaped for ease in moving along the

wall of tubing 10. Guide tool 22 has an upper section 26, a lower section 28 and a recess or window 24 therebetween. Upper section 26 is threadably secured to a wireline socket 30 which supports the lower end of a wireline (not shown) in a conventional manner. Upper section 26 rotatably or pivotally supports a top shifting tool, generally designated as 32, and lower section 28 rotatably supports a bottom shifting tool, generally designated as 34.

Shifting tools 32 and 34 are normally held in their retracted positions, while apparatus 20 is lowered into tubing 10, so as to allow them to bypass the receiving stations 12 until a selected particular station 12 is reached.

Referring now to FIGS. 1—2 and 4—6, the upper and lower sections 26 and 28 of the guide tool 22 are sufficiently large in cross section relative to the inside diameter of tubing 10. The top shifting tool 32 is rotatably supported in the upper section 26, as by a pivot 40, and is connected to the guide tool 22 by a releasable connecting mechanism 42. Connector 42 may be any suitable type known in the art.

In the preferred embodiment, connector mechanism 42 includes a rod 44 slidably mounted in a cylinder 46 and terminating in an interlocking head 48 which is releasably secured by a shear pin 50. When the interlocking head 48 is fastened by pin 50, it engages an interlocking shoulder 52 defined by a releasing mechanism 32' at the head of the top shifting tool 32. Hence, pin 50 holds the top shifting tool 32 in its retracted position while the apparatus 20 is moved downwardly into tubing 10. The releasing mechanism 32' cooperates with a shifting mechanism 54 which includes a piston 56 loaded by a spring 58. Piston 56 is slidably mounted in a cylinder bore 60. Spring-loaded piston 56 pushes against the inner wall of guide tool 22.

Referring now to FIGS. 3 and 7—9, the bottom shifting tool 34 is rotatably supported by the lower section 28 of the guide tool 22, as by knuckle joint 62 having a bearing surface 64 connected to an arm 65. Arm 65 is connected through a linkage 66 to a suitable force-producing mechanism 67 which may include a spring-loaded piston 68.

Piston 68 slides in a cylinder bore 70 having a top end wall 72. A helical spring 74 is normally compressed between piston 68 and the lower face of wall 72, as shown in FIG. 7. On the upper side of wall 72 is another cylinder bore 76 housing a helical spring 78 and a sliding retainer ring 80.

A rod 82 is fixedly secured at one end to piston 68, and at the other end is pivotally connected to a hook-over latch 84. The latch 84 defines a retaining face 86 and a stop shoulder 88. Latch 84 is pivotally mounted on a pivot 90 in a recess 92 formed in the upper end of rod 82.

To the bottom of the top shifting tool 32 is releasably connected an adapter 94 (FIG. 2) which, depending on the function desired to accomplish, may be a running or pulling tool. Similarly, the bottom shifting tool 34 is provided with an adapter 96 (FIG. 1). Adapters 94 and 96 together with any flow valves 18 which it is desired to install are mounted in the apparatus 20 prior to lowering it into tubing 10.

In operation, the apparatus 20 is lowered into tubing 10 to a level slightly below a particular receiving station 12. Then, by imparting a quick down-and-up snap to the wireline jars and hence to socket 30, the shearing pin 50 will shear, as shown at 51 in FIG. 5. Sliding rod 44 will then move up in cylinder 46, thereby releasing shoulder 52 from engagement with head 48 and allowing piston 56, under the influence of spring 58, to shift laterally the top shifting tool 32 toward the particular receiving station, as best shown in FIGS. 2 and 5.

The axis of top shifting tool 32 need only rotate on pivot 40 a few degrees relative to the longitudinal axis of bore 11. This rotation is normally sufficient to allow the alignment and the engagement of the pulling adapter 94 with the flow valve 18.

In a manner well known in the art, the wireline is manipulated to pull out flow valve 18 from its seat 16. As the apparatus 20 is pulled up in bore 11, the top shifting tool 32 (together with the retrieved valve 18) then becomes seated in the guide tool 22 through the window 24. That is, the inner

diameter of bore 11 is such as to cause the top shifting tool 32 to rotate on pivot 40 against the pressure exerted by loaded piston 56.

As the upper section 26 of the guide tool 22 continues to be lifted into tubing 10, away from the particular offset receiving station 12, the retrieved valve 18 becomes fully seated in guide tool 22. The bottom conical tip of valve 18 pushes inwardly against face 86, thereby causing latch 84 to rotate on its pivot 90 and relieving the restraining shoulder 88 from engagement with the annular ring 80.

Compressed spring 74 is then released to push against the upper face of piston 68 causing piston 68 to slide down in cylinder 70. The linkage mechanism 66 translates the linear downward displacement of piston 68 into a rotation of the bottom shifting tool 34. The adapter 96 which can be a running or pulling tool on the bottom of shifting tool 34 is then brought into the position to install a replacement valve 18 in the seat 16 of the particular receiving station 12. The jarring required to disengage the running adapter 96 from its valve 18 is conventional and no further description thereof is believed necessary.

It will be appreciated that the bottom shifting tool 34 need not install a valve 18 in the particular receiving station 12 from which a valve 18 has been previously pulled by the top shifting tool 32. For example, the bottom shifting tool 34 can be fully raised into tubing 10 with its valve 18 sliding along the wall of tubing 10. Then, at any receiving station 12, positioned above the particular receiving station 12 from which a valve 18 has been removed, the bottom shifting tool 34 can be manipulated by the wireline to install its valve 18.

On the other hand, as previously mentioned, adapter 96 may be a pulling adapter instead of a running adapter, and a valve 18 can be pulled from any higher receiving station.

Consequently, the apparatus 20 of this invention is well adapted to perform more than one function during a single run through the tubing 10. It can, for example, during a single run, remove two valves, or remove one valve install one valve. It will also be appreciated that the principle of this invention may be extended to provide an apparatus having a plurality of sections wherein the actuation of one section triggers its adjacent section in the manner hereinabove described.

Although the present invention has been described in connection with details of a specific apparatus, it is understood that such details are not intended to limit the scope of the invention. The terms and expressions employed are used in a descriptive and not a limiting sense and there is no intention of excluding such equivalents in the invention described as fall within the scope of the appended claims. For example, the expression "shifting tool" 32 was generically employed herein. A more descriptive expression which is now referred to in the art is a "kick-over" tool.

We claim:

1. A multifunction apparatus for installing and removing offset mechanisms in and from a well tubing having a least one offset station, the apparatus including:
 - an elongated guide tool having an upper section and a lower section;
 - a top shifting tool rotatably and releasably connected to said upper section;
 - a bottom shifting tool rotatably and releasably connected to said lower section;
 - means releasing said top shifting tool for lateral movement toward a mechanism seated in a particular receiving station and for pulling said mechanism from its seat into said guide tool when said apparatus is raised in said tubing;
 - means releasing said bottom shifting tool for lateral movement toward said particular receiving station or to any receiving station positioned above said particular receiving station; and
 - said bottom shifting tool releasing means being actuable by said pulled mechanism upon becoming seated in said guide tool.
2. The apparatus of claim 1 wherein:
 - said offset mechanisms are flow control valves;

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said top shifting tool releasing means include first releasable connecting means normally maintaining said top shifting tool in alignment with said guide tool as the apparatus is lowered in said tubing; and

said bottom shifting tool releasing means include second releasable connecting means maintaining said bottom shifting tool in alignment with said guide tool as the apparatus is lowered in said tubing.

3. The apparatus of claim 2 wherein:

said first shifting tool coacts with a spring-loaded member; and

said member exerting a lateral force between the inner wall of said guide tool and said shifting tool to cause said lateral movement when said first connecting means are disconnected.

4. The apparatus of claim 3 wherein said member is a piston slidably mounted in a cylinder.

5. The apparatus of claim 4 wherein, said first connecting means include a member which is slidably mounted in an axial direction and which normally engages the head of said top shifting tool.

6. The apparatus of claim 5 wherein said member is selectively releasably secured in said guide tool by a shear pin.

7. The apparatus of claim 6 wherein:

said head is mounted on a pivot; and

said top shifting tool rotates about the pivot axis upon the shearing of said pin.

8. The apparatus of claim 2 wherein said second connecting means include a spring-loaded latch actuable by said pulled flow valve.

9. The apparatus of claim 8 wherein said second connecting means further include a force-producing mechanism con-

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nected between said latch and said bottom shifting tool to cause the rotation of said bottom shifting tool when said latch is actuated.

10. The apparatus of claim 9 wherein said force-producing mechanism includes:

a rod;

a spring-loaded piston;

a knuckle joint;

a linkage means;

one end of said rod being connected to said latch and the other end of said rod being connected to said piston;

said linkage means being connected between said piston and said knuckle joint;

said knuckle joint being connected to said bottom shifting tool; and

said knuckle joint being actuated by said linkage upon the movement of said spring-loaded piston.

11. The apparatus of claim 10 wherein:

said spring-loaded piston is slidably mounted in a cylinder formed in said lower section;

an end wall in said cylinder;

the free end of said rod extending through said end wall;

a helical spring between said piston and said end wall;

an annular clamping member slidably mounted on said rod and positioned between said spring and said end wall to clamp said latch; and

said latch being pivotally mounted in a slot formed in the free end of said rod and being slidable through said annular member when said latch is actuated by said pulled valve.

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