This invention relates to means for installing and removing flow control devices such as flow valves, chokes, and the like in the tubing of oil wells. The invention particularly has to do with the installation and removal of valves and the like which may be generically referred to as flow control units or devices and which are attached to the tubing wall outwardly of the axial center of the string of tubing. The invention has been found to be particularly useful in wells having two or more such valves installed in the wall of the tubing at different elevations. This application is a continuation in part of our copending application, Serial No. 34,954, filed June 25, 1949, now Patent No. 2,664,162.

Another object of the invention is to provide a means for the installation and removal of flow control devices such as flow valves, plugs having orifices therethrough, and the like for providing passage of oil or gas through the tubing of a well at different elevations in a manner whereby the removal of the tubing from the well is unnecessary, and thereby effecting a substantial saving in labor costs.

Another object of the invention is to provide a means for installing flow control devices such as flow valves, chokes, and the like in well tubing and for removing such flow control devices therefrom by providing a shifting tool for carrying out the foregoing object, which shifting tool is capable of detachable engagement with said valves or the like for expediting the installing and removing operations.

Another object of the invention is to provide a special tubing length constructed in such a manner that there will be substantially no pressure differential on the ends of the installed valve or the like for expediting the installing thereof.

These and other objects of the invention will become apparent from the following description and the accompanying drawings, wherein:

Figure 1 is a vertical sectional view of a well casing within an earth formation and showing units comprising the present invention installed at different elevations in the string of tubing.

Figure 2 is an enlarged elevation of one of the units illustrated in Figure 1.

Figure 3 is a vertical sectional view of the special section illustrated in Figure 2, and showing the invention arranged for bypassing the gas inlets.

Figure 4 is a view similar to Figure 3, but showing the invention just prior to the installation of a valve in the gas inlet of the special section of tubing.

Figure 5 is a vertical sectional view of the shifting mechanism of the preferred form of the invention.

Figure 6 is an elevation and broken section of a modified form of shifting tool.

Figure 7 is an elevation of a jar which may be employed in connection with the invention.

Figure 8 is an elevation of a flow valve and hold down assembly.

Figure 9 is a broken sectional view of the gas inlet of the special section and showing the valve hold down assembly in operating position.

Figure 10 is a broken elevation showing the engagement between a fishing tool and the upper end of the hold down assembly as employed when removing the valve.

Figure 11 is a vertical sectional view of the hold down assembly and running tool as employed when installing the valve, and

Figure 12 is a horizontal sectional view taken on lines 12-13 of Figure 11, and showing the location of a shear pin for engaging the running tool with the hold down assembly.

A typical installation of the present invention is shown in Figure 1 wherein the well casing 20 receives a string of tubing 21 connected by collars 22. At intervals and at different elevations there are special sections of tubing 23 for accommodating gas lift valves 24 or the like in such a manner that the inlet ports 25 of the valves are exposed to the interior of the casing 20. The gas lift valves 24 are commercial items and can be bought on the open market are not herein described in detail. It is also to be understood that a valve housing without an internal mechanism but having a small port, such as the inlet 25, can operate as a choke, and yet come within the scope of the present invention.

**Enlarged tubing section**

As shown, each tubing section 23 has an enlarged intermediate portion of greater internal cross sectional area than the internal cross sectional area at the ends of such section. An external recess is formed in a portion of each tubing section 23 intermediate its ends and aligned longitudinally extending openings are formed in the upper and lower walls of the external recesses providing seats for the reception of gas lift valves. There is thus formed within the overall dimensions of the enlarged intermediate portion of the tubing section what may be termed a laterally offset elongated internal tubular portion having upper and lower portions provided with aligned openings 27 and 28 which form seats for the flow...
control unit, which internal tubular portion is open to the exterior of the well tubing intermediate the flow control unit seats. To this end the special tubing section 23 includes a vertical enlarged portion or shell 26 which is integral with and extends downwardly along the side of said special section where said shell terminates, and where the same is provided with an opening 27 offset or eccentric to the main passageway through the string of tubing 21 for receiving the upper end of the valve 24. The lower end of the valve 24 is similarly received within another offset or eccentric opening 28 formed in the upper end of a lower projection or shell 29 beneath the first described shell 26. Ring seals 30 (Figs. 8, 9) are provided around the upper and lower ends of said valve within the openings 27 and 28 (see Fig. 9). The lower end of the valve 24 is provided with a conical guide 31 which, as will become apparent, is employed for guiding the valve through a hold down guide 32 (Figs. 3 and 4) above the opening 27 and integral with the inner surface of the upper shell 26. Valve outlets 23 are located in the valve 24 below the lower ring seals 20 (Fig. 8).

Hold-down assembly

There is a hold-down assembly 34, as shown in detail in Fig. 11, adapted to be threadedly connected with the upper end of the valve 24, which assembly includes a tubular body or connecting member 35 having a vertically disposed rod 36 slidably mounted in its upper end. A shouldered conical projection 37 adapted to be engaged by a suitable seating tool when the valve is to be removed is secured to the upper end of the rod 36 and is positioned above the upper end of the body 35. The lower end of the rod 36 is provided with an enlarged cylindrical catch member 38 having a step 39 formed in one-half of its lower surface. The vertical side or shoulder 40 of the step 39 provides an abutment extending across the center of the assembly and is arranged for engaging a side or shoulder portion of a recess 41 in a latch 42 carried by the body member 35. As shown, the latch 42 is rotatably mounted on a pin 43 horizontally positioned through opposing walls of the tubular body 35. The latch 42 includes a finger 44 which projects outwardly through one of a pair of opposing vertical slots 44 in the body 35. The upper end or head of the body 35 is downwardly and outwardly tapered, as at 45, to provide a cam surface to facilitate engagement with a suitable running tool. An annular recess 47 is provided beneath the tapered head portion of the body 35. A conventional running tool 48 connects with the tapered upper end or head of the body 35 when installing a valve 24, and is temporarily secured or connected to the body 35 by means of a shear pin 49 extending through the running tool 48 and through one side of an annular recess 47 formed beneath the head 45 of the body 35. The ends of the shear pin may be held in place by means of set screws 50 (Fig. 12) at each end thereof and threadedly engaged in the body 35, as shown in Fig. 12. The latch finger 44 is normally urged downwardly through one of the slots 44 in the tubular body 35 by a wire spring 51 attached to the step 39 about the pin 43, and having its remaining end positioned against the inner wall of the body 35. As will become apparent in the description of the operation, the engagement between the vertical side 40 of the step 39 with the side of the recess 41 in the latch 42 serves to hold the valve 24 within the openings 27 and 28 by reason of the engagement of the finger 44 against the lower edge of the hold-down ring 32 (Fig. 9). A second shear pin 52 of greater strength than the pin 49 is positioned through the body 35 and through the slidable rod 36 for maintaining the cylindrical catch member 38 in engagement with the latch 42. As will become apparent in the description of operation, upward movement of the rod 36 while the tubular member 35 is held fixed by the latch member 42 will shear the pin 52, and by reason of the action of the spring 51 the vertical side 40 of the cylindrical member 38 will disengage the side of the recess 41, and allow the finger 44 to be depressed through the vertical slot 45, thus disengaging the latch 42 from the ring 32. The shear pin 52 may be maintained against longitudinal displacement by set screws 53 at each end thereof threadedly engaged in the body 35.

Shifting tool

A shifting tool 54 (Figs. 3, 4 and 5) is adapted to be connected with the upper end of the running tool 48. The shifting tool is comprised of a rod 55 having a tubular mandrel or sleeve 56 slidably mounted thereon, together with centralizing elbows 51 mounted on said mandrel. As shown in detail in Fig. 5, the mandrel 55 has an enlarged upper end 52 in which there are vertical slots 59 pivotingly receiving the upper arms 60 of the elbows 51. A sleeve or collar 61 is slidably mounted on the mandrel 55 beneath the enlarged portion 55, which collar pivotally supports other arms 62 which are pivotally connected at their outer ends with the first described arms 60. A fixed latching collar 63 is secured to the lower end of the mandrel 55 and which slides upon the rod 55. A compression spring 64 is positioned around the mandrel 55 and between the slidable upper collar 61 and the fixed lower collar 63 whereby the elbows 51 are normally urged outwardly. The elbows are laterally disposed with respect to the length of the rod 55, and thus when the shifting tool 54 passes through the main portion of the well tubing 21 the diameter, the elbows 51 tend to centralize the assembly. A substantially cylindrical coupling 65 is connected with the lower end of the rod 55 and pivotally supports an upwardly extending latch 66 which is adapted to engage an annular recess 67 near the lower end of the latching collar 63. After engagement the latch 66 is maintained in the recess 61 by means of a small compression spring 68 between the lower end of the said latch and the surface of the recess 63 in which the latch 66 is received.

A modified form of shifting tool is illustrated in Fig. 6 and is generally designated by the numeral 70. This form of the invention includes the previously described rod 55 upon which a pair of collars 71 are slidably mounted. Vertically disposed and outwardly bowed springs 72 are connected at corresponding ends with the slidable collars 71. The lower end of the rod 55 is provided with an annular shoulder 73 and the upper end of said rod is provided with a shouldered coupling 74 for maintaining the collars 71 on the rod. There is a latch 75 pivotally mounted in a vertical slot 76 near the lower end of the rod 55 and arranged to engage the upper end of the lower collar 71 when the latter engages the lower shoulder 73. A spring 77 normally maintains
the lower end of the latch 15 in an outward position.

The upper end of the rod 55 of the shifting tool assembly 50 or 70 is connected with a swivel assembly 76 (Fig. 7), which in turn is connected with a jar 79. The swivel 78 and the jar 78 are of conventional construction and well known to the art, and are not, therefore, described in detail. The upper end of the jar 78 is connected with the lower end of a cable (not shown) which extends to the earth's surface, and by which the thus far described assembly is raised and lowered through the tubing 21.

Operation

To install a flow valve 24, the same is threadedly connected with the lower end of the hold-down assembly 34 which in turn is releasably connected with the running tool 40 in the manner previously described. The running tool 40 is threadedly connected with the latch supporting collar 65 at the lower end of the shifting tool 54. The entire assembly, including the swivel 78 and the jar 79, is then lowered from the earth's surface downwardly through the lengths of tubing 21. By reason of the slidable engagement of the mandrel or sleeve 56 on the rod 55, the shifting tool 54 is initially maintained at the upper end of said rod 55 by reason of the frictional engagement of the elbows 57 on the inner wall of the tubing 21. The distance from the lower end of the valve 24 to the elbows 57, when the shifting tool 54 is in its raised position on the rod 55, is such that the guide 31 on the lower end of the valve 24 will remain in axial alignment with the tubing 21, and thereby initially bypass the hold-down ring 32 in the shell 26. The last referred to arrangement and operation is illustrated in Fig. 3. Thus, the valve 24 may be lowered past any desired number of upper special sections 23 to any lower special section for either installing or removing the valve. To install the valve 24 in any desired special section 23, the assembly is first lowered therethrough, after which the cable is raised causing the rod 55 having at its lower end the latching collar 65 to move upwardly through the sleeve portion of the shifting tool 54 until the valve guide 31 is in a position above the hold-down ring 32. At this time the latch 68 carried by the collar 65 at the lower end of the rod 55 engages the latching collar 63 at the lower end of the sleeve or mandrel 56. The assembly is then lowered until the elbows 57 enter the enlarged portion 36 of the special section 23. By reason of the action of the elbows 57, which are relieved against lateral pressure at one side thereof by the cavity of the shell 26, the valve 24 is moved laterally over the hold-down ring 32. The assembly is then further lowered and jacked, thereby engaging the ring seats 50 in the respective annular openings 21 and 23 in the enlarged special section of tubing 23. In this position the valve inlet 25 is in communication with the interior of the casing 29 and the valve outlets 33 communicate with the interior of the tubing 21. The latch finger 44, through the action of the spring 51, is projected outwardly through slot 46 and engages the lower edge of the hold-down ring 32. The cable is then jacked and pulled upwardly, thus shearing the pin 49 in the running tool 40, permitting the running tool, together with the assemblies thereabove to be raised to the earth's surface, leaving the valve 24 seated and ready for operation.

To subsequently remove the valve 24 a conventional fishing tool 80 (Fig. 10), having a length approximately equal the length of the valve 24 and the hold-down assembly 34, is then connected to the lower end of the shifting tool 54 and lowered through the tubing 21. The valve 24 to be removed is initially bypassed, and the cable is then drawn upwardly, thus causing the latch 65 carried by the collar 65 at the lower end of the shaft 66 to engage the latching collar 63 of the shifting tool 54. While in this position the spring-pressured elbows 67 shift the assembly in the manner described above, and the fishing tool 80 is again lowered to engage the under portion of the conical projection 37 at the upper end of the hold-down assembly. By raising the cable and operating the jar 79, the pin 52 which connects slidable rod 36 to the body member 35 is sheared, and by reason of the resulting upward movement of the rod 36 in the body member 35 of the hold-down 34, the latch 42 is released from the catch member 38 and the finger 44 is retracted through the vertical slot 45 by the action of the spring 51. The entire assembly is then drawn to the earth's surface. It will be noted that the interior of the enlarged special section 23 communicates with both ends of the valve 24 so as to equalize the pressures on each end of the same, whereby the removal of the latter is facilitated since there is no material pressure differential to overcome.

The shifting tool illustrated in Fig. 6 operates in substantially the same manner as the shifting tool illustrated in Fig. 5. When the springs 72 enter the asymmetrical enlargement of the shell 26 the pressure on the radially arranged springs 72 becomes unequal and the rod 58 is shifted in the direction of the cavity. The other operations are the same as described in the foregoing, with the exceptions that the latch 78 passes through and engages the upper end of the lower collar 71 so as to relatively shorten the length of the assembly for shifting the valve 23 to a position above the hold down ring 32. As will be apparent an internally threaded coupler or the like (not shown) would be required to connect the threaded lower end of a shifting tool such as shown in Fig. 6 with the threaded upper end of a running tool such as indicated at 48 in Fig. 11.

The described form of the invention may be made in many ways within the scope of the appended claims.

What is claimed is:
1. A well tubing comprising a flow control unit receiving section having an enlarged intermediate portion of greater internal cross sectional area than the internal cross sectional area of the ends thereof, a laterally offset internal elongated tubular portion formed in the enlarged intermediate portion having upper and lower portions provided with aligned openings forming seats for said unit.
2. A well tubing comprising a flow control unit receiving section having an enlarged intermediate portion of greater internal cross sectional area than the internal cross sectional area of the ends thereof, a central recess formed in the enlarged intermediate portion, said recess having upper and lower wall portions provided with aligned longitudinally extending openings to provide seats for a flow control unit.
3. A well tubing comprising a special flow control unit receiving section having an enlarged intermediate portion of greater internal cross sectional area than the internal cross sectional area of the ends thereof, a transverse wall portion at the
lower end of the enlarged portion having an opening therethrough connecting the interior of the section with the exterior thereof and adapted to receive a flow control unit, and guide means for the flow control unit comprising an internal ring located within the enlarged portion of the section having its opening in alignment with the opening in the transverse wall portion.

4. Well tubing comprising a special section having an enlarged intermediate portion of greater internal cross sectional area than the internal cross sectional area of the ends thereof, an external recess formed in the enlarged intermediate portion, said recess having upper and lower wall portions provided with aligned longitudinally extending openings to provide seats for a flow control unit, and an internal ring within the enlarged portion having an opening above and in alignment with the aforesaid openings to provide means for guiding the flow control unit into said upper and lower wall openings.

5. For use with a well tubing having a laterally offset portion therein, a flow control unit handling tool comprising a main elongate body portion having spring-pressed outwardly expansible centralising means slidably positioned thereon, and co-engageable latching means on the forward portion of the main body of the tool and on the centralising means for latching the centralising means at the forward end of the body, said centralising means when latched serving to deflect the tool into the offset of the tubing.

6. For use in applying or removing flow control units to or from tubing equipped with one or more special flow control unit supporting sections each provided with a portion laterally offset from the vertical main bore of the well tubing; a flow control unit handling tool adapted to be lowered from the top of the well within the tubing to a selected special section, said flow control unit handling tool comprising an elongated body member having spring-pressed outwardly expansible guiding and control means slidable thereon, adapted to frictionally engage the inner wall of the well tubing during the lowering operation until a special selected section is reached, and latching means located on the body member at the lower or forward end of the valve handling tool adapted to engage and latch the lower portion of said slideable expansible guiding means at the forward end of the tool on raising the elongated body member relative to said guiding means when the tool is within the well tubing, said expansible guiding means, when latched, functioning to deflect the forward end of the tool into the offset portion of the special section to either seat the flow control unit or grasp a seated flow control unit in order to disconnect and retrieve the control unit.

7. A flow control unit handling tool as set forth in claim 6 having a flow control unit hold down assembly connected at the lower end thereof, said hold down assembly having spring-pressed catch means engageable with a portion of the wall of the special section for holding the assembly and attached control unit in seated position.

8. A flow control unit handling tool as set forth in claim 7, wherein the hold down assembly and handling tool are connected through the medium of a shear pin.

9. A flow control unit handling tool as set forth in claim 7, wherein the spring pressed catch is retained in latching position by means of a shear pin.

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