

[54] **MULTIPLE VALVE POCKET MANDREL AND APPARATUS FOR INSTALLING AND REMOVING FLOW CONTROL DEVICES THEREFROM**

3,802,503 4/1974 McGinn 166/117.5
3,807,498 4/1974 Terral et al. 166/117.5

Primary Examiner—James A. Leppink
Attorney, Agent, or Firm—Fulbright & Jaworski

[75] Inventor: Ben D. Terral, Houston, Tex.

[73] Assignee: Camco, Incorporated, Houston, Tex.

[22] Filed: Dec. 12, 1973

[21] Appl. No.: 423,923

[52] U.S. Cl. 166/117.5

[51] Int. Cl. E21b 23/02

[58] Field of Search 166/117.5, 117.6

[56] **References Cited**

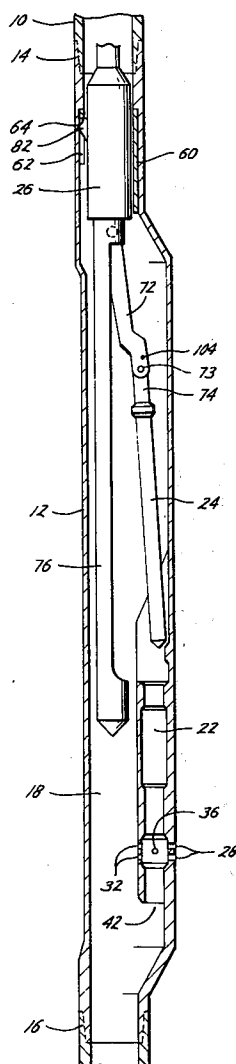
UNITED STATES PATENTS

3,732,928	5/1973	Sizer	166/117.5
3,752,231	8/1973	McGowen, Jr. et al.	166/117.5
3,788,397	1/1974	Terral et al.	166/117.5

[57] **ABSTRACT**

A sidepocket mandrel, for use in a well tubing, having more than one valve pocket. The valve pockets may include various positioned ports such as ports leading exteriorly of the mandrel, ports leading interiorly to the mandrel, ports extending between the valve pockets, and ports extending further downhole. The ports allow greater versatility so that the mandrel can provide various types of services for different types of downhole operations. An apparatus for selectively installing and removing various types of flow control devices into and from one of the valve pockets.

13 Claims, 5 Drawing Figures



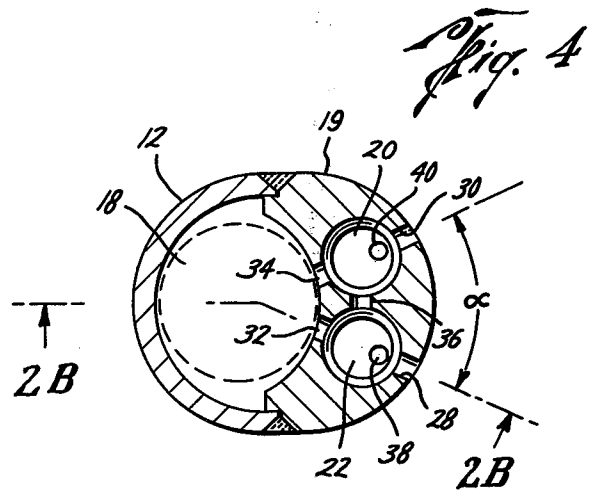
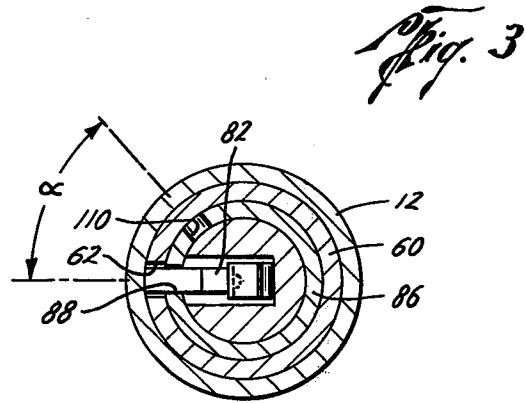
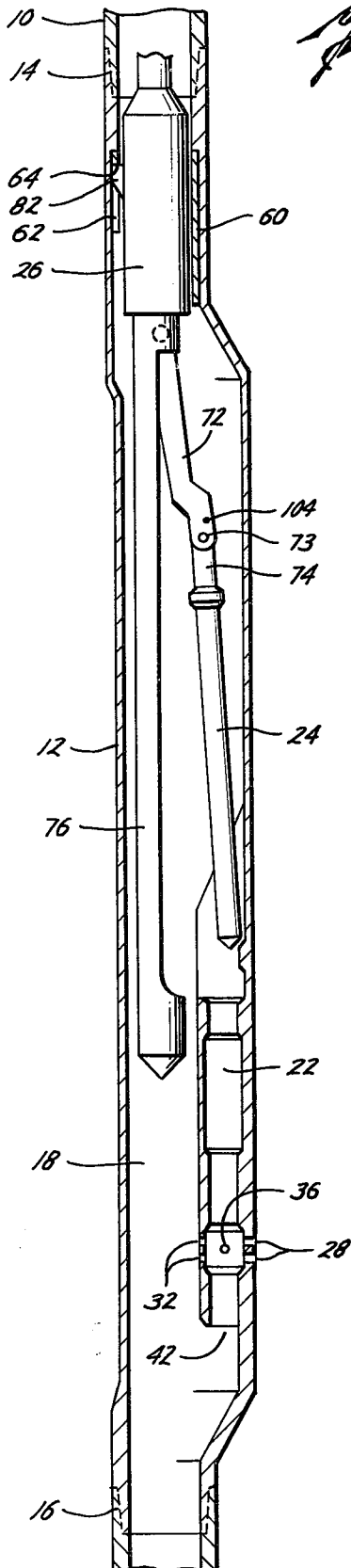
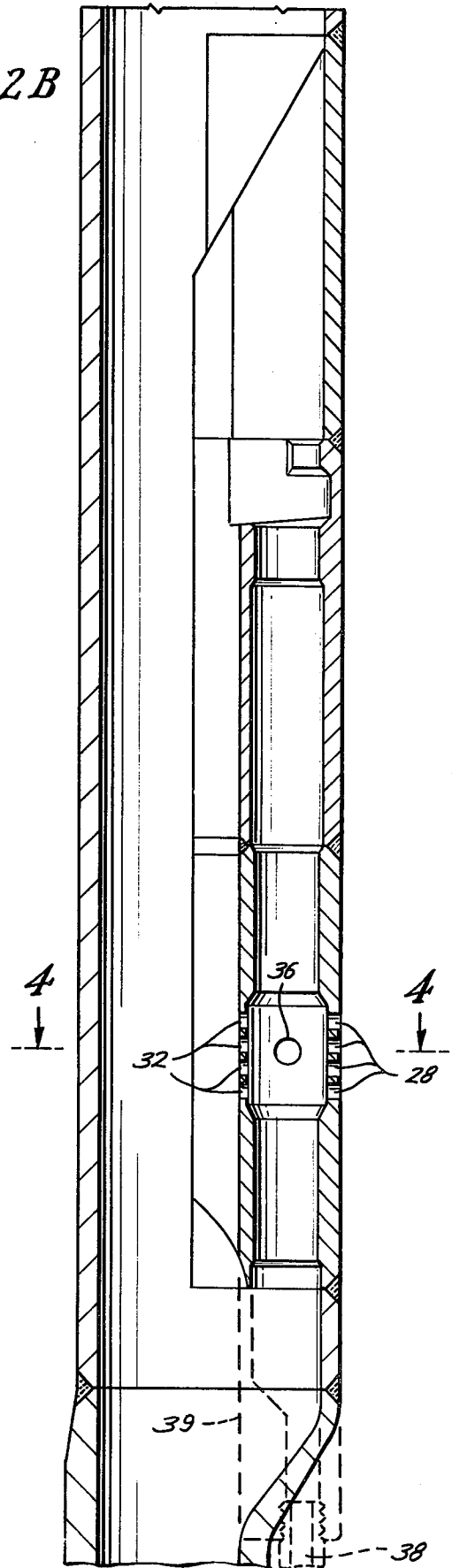
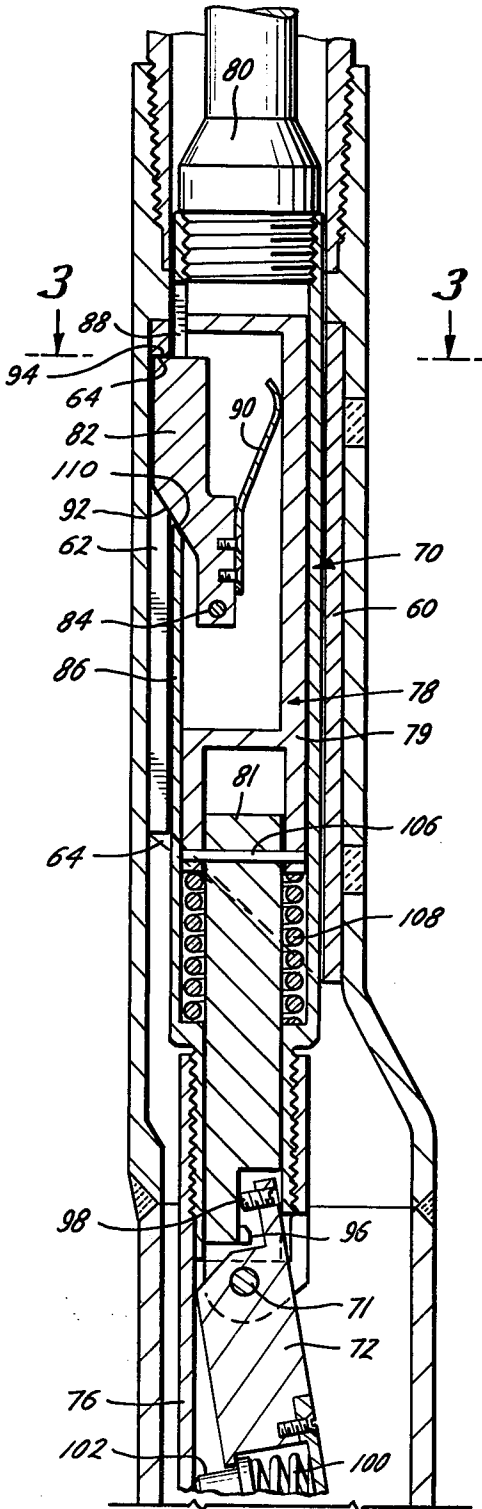


Fig. 2A

Fig. 2B



MULTIPLE VALVE POCKET MANDREL AND APPARATUS FOR INSTALLING AND REMOVING FLOW CONTROL DEVICES THEREFROM

BACKGROUND OF THE INVENTION

The present invention relates to a well mandrel having a plurality of valve pockets and apparatus for installing and removing flow control devices into and from the pockets.

Generally, it is old, as disclosed in patent application Ser. No. 95,408, filed Dec. 4, 1970 entitled "Apparatus for Installing and Removing Flow Valves," to provide a mandrel having an offset sidepocket and an apparatus for installing and removing flow control devices therein. The present invention is directed to an improved mandrel having a plurality of sidepockets through which a greater flow of fluid may be provided than a single pocket. In addition, the pockets may be ported in many different ways to provide greater versatility for performing different types of downhole well services. The present invention further provides a knickover tool having means for running and pulling flow control devices from a selected sidepocket.

SUMMARY

The present invention is directed to a sidepocket mandrel having more than one valve pocket. The valve pocket may include a plurality of ports extending to various locations to provide the mandrel with the capability of performing a variety of well operations. The sidepockets are adapted to accommodate various types of flow control devices such as gas lift valves, check valves, plugs, pilot valves and control valves for various functions.

A further object of the present invention is the provision of an apparatus for installing and removing flow control devices selectively from one of the plurality of sidepockets.

Yet a further object of the present invention is the provision of a well mandrel having a plurality of parallel cylindrical flow control devices receiving pockets having ports connecting the bores with the exterior of the mandrel and also being in communication with the mandrel bore for providing injection of gases or liquids from exterior of the mandrel to the interior of the mandrel and the tubing string or providing for reverse injection.

A still further object of the present invention is the provision of a sidepocket mandrel having a plurality of sidepockets in which the pockets include ports extending from the exterior of the mandrel for receiving gas or liquid and provided with ports extending exteriorly of the mandrel from the bottom of the sidepocket for injecting gases or liquids further downhole.

Yet a further object is the provision of a sidepocket mandrel having a plurality of sidepockets with interconnecting port means between the upper and lower ends of the sidepocket which are particularly adapted for pilot valve operations in which a pilot valve is provided in one of the sidepockets and a control valve in the second of the sidepocket which is particularly useful for injecting greater amounts of gas for lifting larger quantities of well production. The sidepockets may include port means for receiving gas and port means for injecting the gas to desired locations.

Yet a further feature of the present invention is the provision of a sidepocket mandrel having a plurality of

sidepockets in which the sidepockets include port means extending to the bore of the mandrel for receiving gas or liquid therefrom, and include port means extending from the bottom of the sidepockets to exteriorly of the mandrel for injecting gas or liquid into the casing annulus for providing casing flow gas lift operations.

Other and further features, and advantages will be apparent from the following description of the preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view, in cross section, illustrating the apparatus of the present invention installing a valve in one of the sidepockets of the mandrel of the present invention,

FIG. 2A is an enlarged elevational view, in cross section, of the top portion of the mandrel and apparatus for installing or removing a flow control device therefrom,

FIG. 2B is a continuation of FIG. 2A omitting the installing apparatus for clarity and is a cross-sectional view taken along the line 2B—2B of FIG. 4,

FIG. 3 is a cross-sectional view taken along the line 3—3 of FIG. 2A, and

FIG. 4 is a cross-sectional view taken along the line 4—4 of FIG. 2B.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and particularly to FIG. 1, a well tubing 10 is shown having connected thereto a mandrel 12 having upper 14 and lower 16 threaded connections for connection in the well tubing 10. The mandrel 12 includes a main bore 18 there-through generally having the same size and aligned with the bore of the well tubing 10, and further includes a plurality of sidepockets, here shown as sidepockets 20 and 22 (FIG. 4) which are cylindrical bores whose axes are offset from the main bore 18 for receiving various types of flow control units such as a conventional gas lift valve 24 (FIG. 1) therein. An apparatus, generally indicated by the reference numeral 26, is provided for installing or removing a flow control device into or from the sidepockets 20 and 22.

The outer dimensions of the cross-sectional area of the mandrel 12 is limited by the fact that the mandrel 12 is designed to be placed in a casing (not shown) in a well bore. In addition, the open bore 18 is required to be of a similar size to the bore of the tubing 10 in order to accommodate well tools moving through the well tubing 10. Therefore, the physical dimensions of the valve housing 19 are limited. By providing a plurality of sidepockets 20 and 22, instead of a single sidepocket, the necessary strength of the mandrel 12 may be maintained, but a larger control area may be provided by a plurality of sidepockets as compared with a single sidepocket. Therefore, the present invention provides a mandrel with a plurality of sidepockets which may provide a greater volume of control fluid for performing various downhole operations.

A further feature of the present invention is the provision of porting the plurality of sidepockets in a plurality of different ways to provide a greater versatility for performing various well functions. For example, as best seen in FIGS. 1, 2B and 4, suitable port means 28, such as three ports, may be provided intermediate the upper

and lower ends of the pocket 22 and extending from the sidepockets 22 to a point exteriorly of the mandrel 12. Similarly, port means 30 may be provided from sidepocket 20 extending exteriorly of the mandrel 12. Generally, port means 28 and 30 may provide for the ingress of fluids into the sidepockets 22 and 20, respectively, for gas lift installations as will be more fully described hereinafter.

Port means 32 (FIGS. 1, 2B and 4) are provided extending between the sidepockets 22 and the open bore 18 of the mandrel 12. Similarly, port means 34 are provided between the sidepocket 20 and the interior of the mandrel 12.

Interconnecting port means 36 are provided between the valve pockets 20 and 22 between the upper and lower ends of the pockets 20 and 22 generally for the purpose of pilot valving operations as will be more fully described hereinafter.

Additional port means are provided extending from the bottom of the sidepocket to a point exteriorly of the mandrel 12 such as port means 38 leading from the bottom of sidepocket 22 as shown in dotted outline in FIG. 2B, such as for the purpose of injecting gases or liquids further downhole and back into the interior tubing string 10. Similarly, sidepocket 20 may also include downwardly directed port means 40 (FIG. 4). And the partition 39 which forms part of the conduit for the lower ports 38 and 40 may be omitted along with the ports 38 and 40 to provide a fluid port 42, as best seen in FIG. 1, leading from the bottom of the pockets 20 and 22 to the interior of the mandrel 12 in communication with the open bore 18.

Thus, the valve pockets 20 and 22 may be provided with a plurality of ports for conducting various types of downhole operations. If for particular operations certain of the ports are not needed, they may be plugged up or omitted during construction. Which ports would be utilized would depend upon the operations to be performed and the types of flow control equipment inserted in the sidepockets 20 and 22.

One type of downhole operation that could be performed by the mandrel 12 is the function of receiving fluid externally of the mandrel through ports 28 and 30 and supply the liquid through port 42 into the open bore 18 and the bore of the tubing 10 for performing normal gas lift operations. For this use, conventional gas lift valves, such as the Camco R series valve, may be inserted in each of the pockets 20 and 22. Of course, the ports other than 28, 30, 42 would not be needed. Even for this gas lift operation, other types of flow control devices may be used such as dummies or Camco type DCR check valves.

The mandrel 12 will also provide the function of providing gas lift in a so-called chamber-lift operation by providing gas to force bottom hole liquid into the lower end of the well tubing 10 and lift the liquid through the tubing. For this operation, the ports 28, 30, 38 and 40 may be used with the gas lift fluid coming through the ports 28 and 30 and going out the bottom ports 38 and 40 downhole through packers (not shown) for pressurizing up the top of fluid surrounding the bottom end of well tubing 10 and forcing the fluid up into the bottom of the well tubing 10. Again, in such an operation, conventional gas lift valves may be used in the sidepockets 20 and 22.

Another type operation which the multiported multipocket mandrel 12 may perform is in operating a cas-

ing flow gas lift installation. For such use, lift gas would be pumped down the interior of well tubing 10 through the open bore 18 and into the ports 32 and 34 of the sidepockets 22 and 20, respectively, and conventional gas lift valves would be installed in the pockets 20 and 22 for controlling the passage of lift gas through the bottom ports 38 and 40 for supplying gas to the annulus between the well tubing 10 and the casing (not shown) for injecting gases or liquids to provide a casing flow gas lift installation.

In any of the uses described above, the interconnecting port 36 between the sidepockets 20 and 22 may be utilized for injecting greater amounts of gas for lifting larger quantities of products. The interconnecting port 36 allows a pilot valve to be inserted in one of the sidepockets, such as 20, and a control valve to be placed in the second sidepocket 22 and controlled by the pilot valve 20. Control fluid may be injected either into port 30 or port 34 to act on the pilot valve which in turn will actuate the control valve in the pocket 22 which admits gas lift fluids through either the ports 42 or 38. This type of arrangement has the advantage of being able to inject greater amounts of gas for lifting larger quantities of products than the usual gas lift valves. For example, with a pilot valve in pocket 20 and a controlled valve in pocket 22, gas flowing into port 30 would actuate the pilot valve and the controlled valve would control the lift gas flowing in ports 28 and out either port 42 or 38.

The present invention is also directed to an apparatus for installing and removing flow control devices from the sidepockets 20 and 22. Thus, referring to FIGS. 1 and 2A, a guide sleeve 60 is provided positioned aligned with the main bore 18 of mandrel 12 and preferably positioned above the sidepockets 20 and 22. The guide sleeve includes a longitudinal guide slot 62, a helical guide surface 64 positioned below the slot 62 and directed inwardly and upwardly toward the bottom of the slot 62 for guiding and orienting a key upwardly and into the slot 62, and an actuating shoulder 64 positioned at the top of the slot 62 for actuating the flow control device handling apparatus 26.

The slot 62 is radially spaced from the axis of one of the offset pockets, such as 22, a predetermined amount for rotating and orienting a valve handling apparatus relative to the sidepockets 20 and 22 for installing or removing a flow control device therefrom.

The flow control handling apparatus 26 generally includes a support body generally indicated by the reference numeral 70, a shifting tool 72 which is pivotally supported from the support body 70 by pivot 71, a flow control device handling support 74 which is pivotally carried by the shifting tool 72 about pivot 73, and an elongate guide case 76, and a longitudinal movable body generally indicated by numeral 78 and carried by the support body 70. The movable body 78 includes partitions 79 and 81. The support body 70 includes any suitable means for moving the apparatus 26 through the tubing 10 and mandrel 12, such as a hydraulic pump, or as shown for example only, a connection 80 for attachment to a wireline. An orientation key 82 is pivotally connected to the movable support body partition 79 at its lower end by shear pin 84. The support body 70 may also include an outer case 86 enclosing the movable body 78 and having an opening or window 88 through which the orientation key 82 is yieldably urged outwardly by a spring 90. The key 82 is yieldably urged outwardly at all times but because of the down-

ward facing tapering face 92 will readily pass downwardly over protruding shoulders inside of the well tubing. The key 82 also includes an upwardly directed actuating shoulder 94 which, when the key is below the guide surface 64, will contact the surface thereby rotating and aligning the flow control handling apparatus 26 in the well bore as the key 82 moves along the guide surface 64 and into the longitudinal guide slot 62 and into engagement with the actuating shoulder 64 thereby stopping further upward movement of the movable body 78.

Suitable engaging means, such as a shoulder 96, is connected to the lower end of the second part 81 of the movable body 78 for engaging a portion of the shifting tool such as pin 98, when the movable body 81 is initially in an upward position, to keep the tool 72 initially aligned within the guide case 76 and thus aligned with the main bore 18 in the well tubing 10 as the apparatus is initially moved down the well bore. However, when the apparatus 26 is moved into the mandrel 12 in which it is desired to install or remove a flow control device, and as best seen in FIG. 2A, when the orientating key is moved upwardly into the guide slot 62 and the key shoulder 94 engages the actuating shoulder 64 further upward movement of the movable body 78 is prevented. However, as best seen in FIG. 2A, further upward movement of the support body 70 will disengage the engaging means 96 as the pin 98 moves upwardly past the shoulder 96 allowing the shifting tool 72 to be actuated by one or more spring 100 actuated plungers 102 acting against the inside of the case 76. The shifting tool 72 and flow control device 24 is now in the position shown in FIG. 1. Further downward movement of the apparatus 26 moves the flow control device 24 into the valve seat 22 and further downward movement shears a shear pin 104 allowing the flow control device 24 and the valve handling support 74 to become aligned in the valve pocket 22 and further downward movement or jarring of the apparatus 26 seats the flow control device 24 securely in the sidepocket 22 and disconnects the running adapter 74 from the flow control device 24. Of course, the apparatus 26 may, by similar operation, using a pulling adapter in place of the running adapter 74, remove a flow control device 24 from the sidepocket 22.

Once a flow control device has been installed or removed, the apparatus 26 may be retracted upwardly. That is, the key 82 is raised in the mandrel 12, the shoulder 94 will again engage shoulder 64 in the sleeve 60 and the tool 26 can be jarred upwardly shearing shear pin 106 which has a lower shear point than emergency shear pin 84. With the shear pin 106 sheared, the support body 70 may be moved upwardly relative to the movable body 78 against the action of a resetting spring 108. It is also noted that the support body 70 has a retracting shoulder 110 which will engage the tapered surface 92 on the key 82 on upward movement of the support body 70 relative to the first part 79 of the movable body 78 thereby retracting the key 82 into the interior of the case 86 whereby the apparatus 26 may be moved uphole. The above description of the flow control handling device 26 is more fully described in co-pending patent application Ser. No. 95,408.

Of course, as previously mentioned, the longitudinal slot 62 is angularly spaced from the axis of one of the offset pockets, such as 22, a predetermined amount and will therefore install or remove flow control de-

vices only from the one sidepocket 22. As indicated in FIG. 4, the sidepockets 20 and 22 are radially displaced from each other a radial amount by an angle alpha. As indicated in FIG. 3, the key 82 extends through a window 88 when it is desired to install or remove a flow control device from the sidepocket 22. A second opening or window 110 is provided in the casing 86. The window 110 is radially spaced from the window 88 by an angle alpha. Therefore, if it is desired to install or remove a flow control device from the sidepocket 20, the movable body member 79 is rotated relative to the movable body 81 by angle alpha by the use of shear pin 106 through a second shear pin hold (not shown) in body 81 so as to extend through the window 110. The flow handling apparatus 26 is then operated in the same manner as before and in such operation will bring the flow control device 24 over and above the sidepocket 20. Therefore, the present flow control handling apparatus 26 may selectively install or remove flow control devices from either the sidepocket 20 or 22 depending in which of the windows 88 or 110 the orientation key 82 is positioned.

The present invention, therefore, is well adapted to carry out the objects and obtain the ends and advantages mentioned as well as others inherent therein. While a presently preferred embodiment of the invention is given for the purpose of disclosure, numerous changes in the details of construction and arrangement of parts may be made which will readily suggest themselves to those skilled in the art and which are encompassed within the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A mandrel for use in a well tubing comprising, a mandrel body including upper and lower connecting means for connecting the mandrel in a well tubing,

said body including an open bore therethrough for communication with the well tubing,

and

a plurality of flow control device receiving pockets offset relative to the open bore, said pockets positioned side by side to each other.

2. The apparatus of claim 1 including, port means in the side of the pockets extending of the mandrel, and

port means in the bottom of the pockets leading exteriorly of the mandrel.

3. The apparatus of claim 2 including, interconnecting port means between said pockets intermediate the ends of said pockets.

4. The apparatus of claim 1 including, interconnecting port means between said pockets intermediate the ends of said pockets.

5. The apparatus of claim 1 including, port means in the side of the pockets extending interiorly of the mandrel, and port means in the bottom of the pockets leading exteriorly of the mandrel.

6. The apparatus of claim 5 including, interconnecting port means between said pockets intermediate the ends of said pockets.

7. The apparatus of claim 1 including, port means in the side of the pockets extending exteriorly of the mandrel, port means in the bottom of the pockets extending interiorly of the mandrel, and

interconnecting port means between said pockets intermediate the ends of said pockets.

8. A mandrel for use in a well tubing comprising, a mandrel body including upper and lower connecting means for connecting the mandrel in a well tubing, said body including an open bore aligned with the connecting means for alignment with the well tubing, a plurality of flow control device receiving pockets offset from the open bore, said pockets positioned side by side to each other, and an orientation sleeve mounted in the bore having a longitudinal orientation slot.
9. The combination of claim 8 of a flow control handling apparatus adapted for use in placing a flow control device in or removing a flow control device from one of the pockets comprising, a support body adapted to be moved in the mandrel, a shifting tool pivotally supported from the support body and adapted to support a flow control device, an orientation key pivotally secured to the body, said key engagable with the orientation slot for radially orientating the body for directing the flow control handling device toward one of said pockets, means for selectively connecting the key to the body in a predetermined radially spaced relationship for selectively orientating the flow control device toward the desired pocket, releasing means on said body for initially holding the shifting tool aligned in the main bore, and shifting means connected to the shifting tool for shifting the shifting tool over the selected pocket when the releasing means is released.
10. The apparatus of claim 9 wherein the means for selectively connecting the key to said body includes a plurality of radially spaced windows in the outer periphery of the body through which the key may be selectively positioned.
11. A flow control handling apparatus adapted for use in placing a flow control device in or removing a flow control device from a well mandrel having a plurality of flow control device receiving pockets and including an orientation sleeve having a longitudinal orientation slot, positioned in a predetermined radially spaced relationship relative to said pockets, comprising,

- ing, a body adapted to support a flow control handling device, an orientating key adapted to be connected to the body and engagable with the orientation slot for radially orientating the body for directing the flow control handling device toward one of said pockets, means for selectively connecting the key to said body in a predetermined radially spaced relationship for selectively orientating the flow control handling device toward the desired pocket.
12. A flow control handling apparatus adapted for use in placing a flow control device in or removing a flow control device from a well mandrel having a plurality of flow control device receiving pockets and including an orientation sleeve having a longitudinal orientation slot positioned in a predetermined radially spaced relationship to said pockets comprising, a support body adapted to be used in the mandrel, a movable body carried by and longitudinally movable relative to the support body, an orientation key pivotally connected to the movable body, means for selectively connecting the key to the support body in a predetermined radially spaced relationship for selectively orientating the flow control device toward the desired pocket, a shifting tool pivotally supported from the support body and adapted to support a flow control handling device, releasing means on said movable body initially holding the shifting tool aligned in the bore but releasable on movement of the movable body relative to the support body, and shifting means connected to the shifting tool for shifting the shifting tool into the selected sidepocket when the releasing means is released.
13. The apparatus of claim 12 wherein the means for selectively connecting the key to the body includes a plurality of radially spaced windows in the outer periphery of the body through which the key may be selectively positioned.
- * * * * *

50

55

60

65