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SIDE POCKET MANDREL

This invention relates to gas lift apparatus and more particularly to side pocket mandrel for use in wells produced by gas lift techniques.

Side pocket mandrels typically have an elongate
5 body with a main bore extending longitudinally there-
through and a receptacle bore extending alongside the
main bore, a belly portion above the receptacle bore to
provide space for the operation of a kickover tool with
which a flow control device is installed in or removed
10 from the receptacle bore. The receptacle bore in most
cases is provided with lateral ports which communicate
the receptacle bore with the exterior of the side
pocket mandrel so that a flow control device placed in
the receptacle bore will control the passage of lift
15 gas between the interior of the tubing string in which

the side pocket mandrel is connected and the tubing-casing annulus surrounding the tubing string. For some time now, many side pocket mandrels have been equipped with deflectors for protecting the upper end of the

5 receptacle bore and any flow control device disposed therein from damage which could arise from being impacted by well tools passing through the tubing string. The deflectors will cause large ordinary well tools to be deflected back into the main bore of the side pocket

10 mandrel while the smaller diameter tools which are intended to enter the receptacle bore will be guided into the latter by such deflectors. Examples of side pocket mandrels having deflectors are illustrated in the following United States patents:

15 3268006 3891032 4031954 4106564 4333527
 3741299 3874445 4034806 4197909 4407362
 3796259 4002203 4066128 4201255 4462465
 3802503 4030543 4106563 4239082 4480686
 3807498

20 Deflectors have normally been manufactured separately from the side pocket mandrel body, being subsequently welded therein as a part of a receptacle unit or being welded directly to the side pocket mandrel body.

United States Patent No. 3268006 discloses side pocket mandrels having therein deflectors extending upwardly from the upper end of the receptacle bore for some appreciable distance. The deflectors provide a channel which is narrower than the main bore but is sufficiently wide to guide a flow control device or the like into the receptacle bore therebelow. Tools which are too wide to enter the channel provided by the deflector will be kept clear of the receptacle bore and will be deflected back into the main passage through the side pocket mandrel.

United States Patent No. 3741299 discloses a type of deflector which is welded into the body of the side pocket mandrel just above the receptacle but adjacent thereto. The receptacle and the deflectors are made separately and are then welded into a window in the wall of the side pocket mandrel body. The deflector provides a channel which will guide smaller tools into the receptacle bore and is provided with an upwardly and outwardly sloping surface for deflecting larger tools away from the receptacle bore and into the main bore. Many other patents show deflectors of the type which have been disclosed in United States Patent No. 3741299, and among these are the following United States Patents:

3796259	3802503	3807498	3874445	3891032
4002203	4030543	4031954	4034806	4106563
4106564	4197909	4201265	4239082	4480686

United States Patent No. 4066128 discloses:
5 deflectors which are welded into the side pocket mandrel
just above the receptacle bore to deflect larger tools
away from the receptacle bore while guiding smaller
tools into the receptacle bore. Similar deflectors are
shown in United States Patents Nos. 4407362 and
10 4462465.

United States Patent No. 4197909 illustrates
deflectors which are very similar to those in Patent No.
3741299 mentioned earlier, and in addition to this, the
mandrel body immediately above the upper ends of the
15 deflectors has been provided with a pair of internal
button-like projections which will prevent tools from
interfering with or lodging atop the upper ends of the
deflectors. Sometimes deflectors can be spaced slightly
from the inner wall of the mandrel leaving a crack or
20 a crevice therebetween in which tools or wire may
become fouled. The internal buttons taught in Patent
No. 4197909 are provided to prevent this from happening.
One form of these buttons is illustrated in Fig. 3 of
Patent No. 4197909 and shows that these buttons are
25 formed by making an external indentation in the wall of

the mandrel body and causing a corresponding inward projection or button.

United States Patent No. 4333527 discloses deflectors which are welded in place within the upper
5 body section of the side pocket mandrel which is then welded by a circumferential weld to the upper end of the lower body section.

Deflectors for side pocket mandrels are of a shape which is costly to manufacture and welding them
10 in place within the mandrel is generally expensive. Sometimes the deflectors have their upper ends spaced slightly from the inner wall of the mandrel, thus leaving a crevice in which tools or wire can lodge and cause trouble. If the deflectors are welded into
15 the mandrel using plug welds. these plug welds can become a source of mandrel failure since they may crack due to flexure resulting from differential pressures which may act in one direction or the other, inwardly or outwardly.

20 None of the prior art patents shows a side pocket mandrel having deflectors formed in the wall thereof above the receptacle bore providing a channel

between them which is narrower than the main bore but wider than the receptacle bore for guiding a flow control device into the receptacle bore and providing upwardly facing inclined deflecting surfaces for
5 deflecting other larger well tools toward the main bore and away from the receptacle bore and any flow control device which may be disposed therein.

The present invention is directed to a side pocket mandrel having means at its opposite ends for
10 connection into a string of well tubing and having a main flow passage extending longitudinally there- through, a receptacle bore extending alongside the main bore, a belly extending upwardly from the upper end of the receptacle bore and providing space for
15 operation of a kickover tool used to instal a flow control device in or to remove such a device from the receptacle bore, the mandrel body being formed, in the wall thereof above the upper end of the receptacle bore, with deflectors spaced apart a distance which
20 will permit flow control devices to be guided there- between into the upper end of the receptacle bore and yet spaced close enough together to prevent larger tools from passing therebetween, the deflectors having guide surfaces thereon which serve to deflect
25 the larger tools away from the receptacle bore and

back into the main bore of the side pocket material.

According to the invention, there is provided a side pocket mandrel, comprising an elongate body connectable in a string of well tubing and having a main bore therethrough and an offset belly portion intermediate its ends; and
5 receptacle means providing a receptacle bore in the elongate body and opening upwardly into the belly portion, said receptacle means being adapted to receive a flow control device therein in locking and sealing engagement
10 therewith; and the body being formed with a pair of indentations in the external surface of the belly portion and providing a corresponding pair of internal deflectors extending upwardly from a point near the upper end of the receptacle bore and being spaced apart to form a keyway-
15 like channel therebetween in alignment with the receptacle bore and being at least as wide as said receptacle bore but narrower than the main bore.

Further features of the invention will become apparent from the description which follows of some examples and in which reference is made to the accompanying drawings, wherein:

5 Fig. 1 is an elevational view of a side pocket mandrel, partly in section, showing the body thereof formed with deflectors in accordance with the present invention;

10 Fig. 2 is a cross-sectional plan view taken along the line 2-2 of Fig. 1;

Fig. 3 is a view similar to Fig. 2 but illustrating a comparable mandrel of circular section;

15 Fig. 4 is a sectional elevation illustrating a further embodiment of the side pocket mandrel of the invention;

Fig. 5 is a cross-sectional plan view taken along the line 5-5 of Fig. 4;

Fig. 6 is a view similar to Fig. 5 but illustrating a comparable round mandrel;

Fig. 7 is a sectional elevation illustrating yet a further embodiment of the side pocket mandrel of the invention;

Fig. 8 is a cross-sectional plan view taken
5 along the line 8-8 of Fig. 7; and

Fig. 9 is a view similar to Fig. 8 but illustrating a comparable round mandrel.

Referring firstly to Figs. 1, 2 and 3, side pocket mandrel 20 has an elongate body 21 having a main
10 bore running longitudinally therethrough from end to end. This main bore is indicated by the arrow and the reference numeral 22 applied thereto. It will be seen also that each end of the side pocket mandrel 20 is provided with suitable connecting means, such as
15 threads 23, by which the mandrel 20 may be connected into a string of well tubing (not shown) so that the main bore 22 through the mandrel 20 is continuous with the bore of the tubing. The side pocket mandrel 20 is bulged outwardly at the right hand side as seen in
20 Fig. 1 to provide a belly 28, and provided therein is receptacle bore 30, as shown, which is offset from the main bore 22 and which extends alongside thereof and

is adapted to receive a suitable flow control device (not shown) in sealing and locking engagement therewith. Lateral ports 32 are provided in the wall defining the receptacle bore 30 to communicate
5 the interior of the side pocket mandrel 20 with the exterior thereof. Any flow through the ports 32 is controlled by a flow control device (not shown) when such device is in position in the receptacle bore 30. The upper end of the bore 30 communicates with the
10 interior of the side pocket mandrel 20 as does its lower end although the latter is not visible. Patents Nos. 3741299, 4066128, 4197909 and 4333527 are hereby incorporated herein for all purposes by reference thereto.

15 A well flow control device (not shown) is generally installed in the receptacle bore 30 through use of a suitable kickover tool (not shown) lowered into the well on a string of tools such as wireline tools, or pumpdown tools, and the kickover tool is
20 actuated to move the flow control device laterally into alignment with the receptacle bore 30, after which the tools are lowered in order to place the flow control device in the bore 30. This operation is well

known in the art.

Deflectors also are well known in the art. They are usually placed immediately above the receptacle bore 30 and generally serve two purposes.

5 One purpose is to deflect larger well tools from the receptacle bore so that they will not lodge thereon or damage the receptacle, or any flow control device positioned therein, and another purpose is to guide
10 flow control devices into the receptacle bore 30 after having been aligned therewith by the kickover tool.

The mandrel 20 is provided with deflectors such as deflectors 34, there being one provided on each side of the receptacle bore 30, thus providing a
15 channel therebetween which is narrower than the main bore 22 but at least as wide as the receptacle bore 30.

The deflectors 34 are better illustrated in Fig. 2 from which it will be appreciated that each deflector 34 is provided by a respective ridge-like
20 internal protrusion which is formed by an external indentation 36 formed in the wall of the elongate body 21 as shown. A channel 38 is formed between the opposed faces 39 of the deflectors 34, and this channel 38 is narrower than the main bore 22 but wider than

the receptacle bore 30. The opposed faces 39 of the deflectors 34 may be formed flat or non-flat, as desired. The bends at the edges of the deflectors 34, both on the internal and external surfaces of the mandrel body 21, are preferably radiused to avoid concentration of stresses. The upper end of each deflector 34, as seen in Fig. 1, is formed with an upwardly facing shoulder 40 which is inclined upwardly and outwardly so that large tools engaging the deflectors 34 from above will be deflected back into the main bore 22 and away from the receptacle bore 30. The lower end 42 of each deflector 34 is located a short distance above the upper end of the receptacle bore 30, as shown. The upper end of each deflector 34 may be spaced above the upper end of the receptacle bore 30 by any suitable distance and could extend to the upper end of the belly 28, if desired.

The deflectors 34 may be created by forming external indentations such as the indentations 36 in the exterior of the mandrel body 21 by any suitable means such as forging which includes forming such indentations with or without heat and with or without dies. Preferably, the indentations 36 are forged through use of a suitable press, such as a hydraulic or mechanical press, while holding the mandrel 20 at a

suitably high temperature to facilitate such forming operation. Also it may be preferable to perform this operation with dies of suitable shape in order to provide deflectors 34 of suitable dimension and shape.

5 In addition, it may be preferable to form the deflectors 34 using a shaped core or former (not shown) inside the side pocket mandrel body 21 in order to obtain the proper internal shape and dimension of the deflectors 34 and the proper size of the channel 38

10 between the deflectors:.

In Fig. 2, the side pocket mandrel 20 is shown to be oval in cross-section. The side pocket mandrel may, if desired, be formed of circular cross-section material as is shown in Fig. 3.

15 In Fig. 3, a round side pocket mandrel is shown and is indicated generally by the reference numeral 20a. The mandrel 20a has a body 21a having deflectors 34a formed one on each side of its receptacle bore 30a and forming a channel 38a therebetween, which channel

20 38a is narrower than main bore 22a but wider than the receptacle bore 30a. The deflectors 34a are provided by forming external indentations 36a in the wall of the side pocket mandrel 20a, as shown. The deflectors 34a and the channel 38a perform the same functions as

the deflectors 34 and channel 38 in the side pocket mandrel 20 previously described with reference to Figs. 1 and 2.

The body 21 of the side pocket mandrel 20 or the
5 body 21a of the side pocket mandrel 20a may be formed in any suitable manner. For instance, the body 21 may, if desired, be constructed in two pieces welded together as at 48. Lower body section 50 may be fashioned from a solid block of material and the upper
10 body section 52 may be made from a piece of round or oval tubing, for instance as taught in United States Patent No. 4333527. Upper body 52 section preferably has the deflectors 34 formed therein before the upper and lower body sections 52 and 50 are welded together
15 by the circumferential weld indicated by the numeral 48. The thread 23 at the upper end of the side pocket mandrel 20 could be provided by forging the upper end of the upper body section 52 to suitable size and shape, and then cutting the thread therein. Alternativ-
20 ely, an upper transition piece 52a can be formed separately and welded, as at 56, to the upper end of the upper body section 52. The thread 23 at the upper end of the mandrel 20 may preferably be cut after welding is completed. Similarly, the extreme lower
25 portion of the side pocket mandrel 20 could be provided

by a lower transition piece 50a which may be similar to the upper transition piece 52a and is welded to the lower end of the lower body section 50 as at 58. The lower threaded connection 23 would
5 then be formed after assembly of the side pocket mandrel 20 has been completed. If desired, the side pocket mandrel 20 could have its body constructed from a single piece of round or oval tubing with its ends swedged down as shown, these ends then being
10 provided with threaded connections such as the threads 23. In this case, the receptacle bore 30 would be provided by a separately formed receptacle member which would be positioned inside of the body 21 and welded into a window in the wall of the side
15 pocket mandrel.

Another form of side pocket mandrel embodying the invention is shown in figs. 4, 5, and 6 wherein the side pocket mandrel is indicated generally by the numeral 120. The mandrel has body 121 having a main
20 bore 122 extending therethrough from end to end and having threaded connections 123 at its opposite ends whereby the side pocket mandrel 120 is connectable into a string of well tubing. The mandrel 120 is provided with a receptacle bore 130 which is offset

from and extends alongside the main bore 122. Upper body section 152 may, if desired, be made separately from lower body section 150 and the two body members then welded together with a circumferential weld
5 such as weld 148 after deflectors 134, which may be exactly like the deflectors 34 of the mandrel 20, have been formed in the wall of the upper body section 152 by forming external indentations 136, as shown in Fig. 5. The deflectors 134 provide between them a
10 channel 138 which may be exactly like the channel 38 of the mandrel 20. The side pocket mandrel 20 differs from the side pocket mandrel 20 previously described principally in that the receptacle bore 130 of the side pocket mandrel 120 opens at its lower end to the
15 exterior of the side pocket mandrel 120. This opening is indicated by the numeral 160 and may be threaded as at 162 for attachment of a pipe (not shown) which may extend downwardly therefrom as needed. It will be noted that the receptacle bore 130 is provided with
20 internal lateral flow ports 132 which, in this case, communicate the receptacle bore 130 with the main bore 122 as shown. Thus the side pocket mandrel 120 is equipped for casing flow gas lift operations. In such operations, for instance, a suitable gas lift
25 valve (not shown) is installed in the receptacle bore 130 and lift gas, which is injected into the tubing

(not shown) at the surface, passes downwardly to the mandrel 120 and through the ports 132 into the receptacle bore 130. The lift gas then passes through the gas lift valve and is directed through the opening 5 160 at the lower end of the receptacle bore 130 into the tubing-casing annulus to aerate the column of well production fluids between the tubing and casing and thus aid in lifting such fluid to the surface.

If desired, the side pocket mandrel 120 may be 10 provided with external ports (not shown) instead of the internal ports 132. The external ports would then be like the ports 32 of the mandrel 20 and would communicate the receptacle bore 130 with the tubing-casing annulus externally of the mandrel 120. The side pocket 15 mandrel 120 provided with external ports as just described would be useful in chamber-lift operations in which the lift gas would be injected into the tubing-casing annulus at the surface and would flow down to the external ports (not shown) in the side pocket 20 mandrel 120, enter therein, and flow through the gas lift valve (not shown) in the receptacle bore 130 to be directed outwardly through the opening 160 at the bottom thereof. A tube or pipe (not shown) attached by the thread 162 of the port 60 and extending downwardly 25 through a packer would conduct the gas into a chamber

therebelow in which well fluids would collect. Gas injected into the chamber in the manner just described would depress the column of well fluids therein and force such fluids upwardly into the tubing string (not shown) and past the side pocket mandrel 120. Well fluids would then be aerated by lift gas entering the tubing from the annulus through separate gas lift valves (not shown) placed in the tubing string at spaced intervals above the side pocket mandrel 120 and thus be lifted to the surface.

If desired, the side pocket mandrel 120 can be constructed in much the same manner as was the side pocket mandrel 20, that is to say by forming it as separate sections which are then welded together by circumferential welds.

In Fig. 5, the side pocket mandrel 120 is shown to be oval in cross-section. However, the mandrel may, if desired, be formed with a circular cross-section as shown in Fig. 6.

20 In Fig. 6, a round side pocket mandrel is shown and is indicated generally by the reference numeral 120a. Mandrel 120a comprises body 121a having deflectors 134a formed one on each side of its receptacle bore

130a and forming a channel 138a therebetween, which
channel 138a is narrower than main bore 122a but is
wider than the receptacle bore 130a. The deflectors
134a are provided by forming external indentations
5 136a in the wall of the side pocket mandrel 120a as
shown. The deflectors 134a and the channel 138a
perform the same functions as the deflectors 34 and
the channel 38 of the side pocket mandrel 20
previously described.

10 Another embodiment of the invention is shown
in Figs. 7, 8, and 9 wherein the side pocket mandrel
is indicated generally by the numeral 220. This side
pocket mandrel 220 may be constructed with a one-
piece body 221 which may be round or oval in section
15 (see Figs. 8 and 9) and which has its opposite ends
forged to reduce its size to a suitable dimension
preparatory to forming threaded connections 223 there-
in at its opposite ends, as shown, Before the
opposite ends of the mandrel body 221 are reduced
20 in size, however, two external indentations 236 are
formed in the exterior surface of the body to provide
a pair of internal protuberances 234 which act as
deflectors as has explained in relation to the previous-
ly-described embodiments and which provide a channel
25 238 between them. In case of side pocket mandrel 220

however, the protuberances or deflectors 234 extend from a suitable distance above side pocket receptacle 224 to a distance somewhat below the upper end of receptacle bore 230. In Fig. 8, the body 221 is
5 shown to be oval in shape.

The side pocket receptacle 224 of the mandrel 220 is formed separately from the mandrel body 221. As shown, the receptacle 224 is formed with a lateral boss 225 having one or more lateral ports 226 in the
10 wall thereof which ports 226 communicate the receptacle bore 230 with the exterior of the mandrel 220, as shown. The receptacle 224 is positioned with its boss 225 in a window 227 formed in the mandrel body 221 and is welded in place as by a weld 228 extending completely
15 around the window. Thus, the receptacle 224 becomes an integral part of the side pocket mandrel 220. The receptacle bore 230 formed in the receptacle 224 is adapted to receive a flow control device (not shown) therein in locked and sealed relation therewith. The
20 lateral port 226 communicates the interior of the mandrel 220 with the exterior thereof as is common in side pocket mandrels.

Lift gas for gas lift operations is injected into the well annulus at the surface, flows down the well

between the tubing and casing, passes through the port 226 and through the gas lift valve (not shown) in the receptacle bore 230. Upon leaving the gas lift valve, the gas is directed into the tubing through
5 the open lower end 231 of receptacle bore 230 to aerate a column of well fluids rising in the tubing and assists in lifting such well fluids to the surface.

If desired, transition pieces, such as transition pieces 223a may be welded, as by circumferential
10 welds 223b, to the mandrel body 221 as shown, thereby avoiding the necessity for forging the ends of the mandrel body 220 to adapt them for providing the threads 223 in its opposite ends.

In Fig. 8, the sidepocket mandrel 220 is shown to
15 be oval in cross-section. However, the side pocket mandrel may, if desired, be formed with a circular cross-section as shown in Fig. 9.

In Fig. 9, a round side pocket mandrel is shown and is indicated generally by the reference numeral
20 220a. The mandrel 220a comprises a body 221a having deflectors 234a formed one on each side of its receptacle bore 230a and forming a channel 238a therebetween, which channel 238a is narrower than main bore 222a but

wider than the receptacle bore 230a. The deflectors 234a are provided by forming external indentations 236a in the wall of the side pocket mandrel 220a as shown. The deflectors 234a and the channel 238a 5 perform the same functions as the deflectors 34 and the channel 38 in the side pocket mandrel 20 previously described.

If desired, any of the mandrels described hereinabove could be made with orienting means therein 10 such as, for instance, that taught in United States Patent No. 4333527. Understandably, an orienting sleeve (not shown) could be secured within the mandrel near to the upper end thereof for orienting a wireline-type kickover tool (not shown) lowered into the tubing 15 string by wireline tools for the purpose of installing a flow control device in the receptacle bore of retrieving such a device therefrom. On the other hand, if the mandrel is to be used in pumpdown operations, the orienting sleeve would preferably be placed below 20 the upper end of the receptacle bore for orienting a pumpdown kickover tool (not shown), and, additionally, the mandrel would further be provided with an internal annular shoulder near its upper end providing a downwardly facing annular shoulder to be engaged by the 25 pumpdown kickover tool for activating the same after it

has first been oriented by the orienting sleeve just mentioned.

The deflectors 34, 34a of the mandrels 20, 20a, or the deflectors 134, 134a of the mandrels 120, 120a, 5 or the deflectors 234, 234a of the mandrels 220, 220a, and the channel formed between them in each case have been shown to serve the same functions as do the deflectors which are provided by other means, but can be provided at low cost. Such deflectors may be readily 10 formed, especially by forging. Such deflectors, being formed by deforming the wall of the mandrel body, do not create cracks or crevices in which tools or wire can become fouled or broken.

The body of the mandrel can, of course, be of 15 non-round or non-circular cross-section other than oval. It will be understood that variations may be made to the sizes and arrangement of the features and details of the illustrated embodiments of the side pocket mandrels, as also may changes be made in materials and 20 processes used for forming them, without departing from the scope of the invention.

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CLAIMS

1. A side pocket mandrel, comprising:

(a) an elongate body connectable in a string of well tubing and having a main bore there-through and an offset belly portion intermediate its ends; and

(b) receptacle means providing a receptacle bore in the elongate body and opening upwardly into the belly portion, said receptacle means being adapted to receive a flow control device therein in locking and sealing engagement therewith;

(c) the body being formed with a pair of indentations in the external surface of the belly portion and providing a corresponding pair of internal deflectors extending upwardly from a point near the upper end of the receptacle bore and being spaced apart to form a keyway-like channel therebetween in alignment with the receptacle bore and being at least as wide as said receptacle bore but narrower than the main bore.

2. A side pocket mandrel according to claim 1 wherein the body is made in at least two sections which are welded together after the external indentations have been formed.

3. A side pocket mandrel according to claim 1 wherein:



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(a) the indentations extend downwardly below the upper end of the receptacle means; and
(b) the receptacle means is a separately-made element welded into the elongate body.

- 5 4. A side pocket mandrel according to claim 1, 2, or 3, wherein the elongate body is of generally circular cross-section.
5. A side pocket mandrel according to claim 4, wherein the indentations are formed in the exterior of the
10 elongate body as by forging.
6. A side pocket mandrel according to claim 1, 2, or 3, wherein the elongate body is generally of non-circular cross-section.
7. A side pocket mandrel according to claim 6, wherein
15 the indentations are formed in the exterior of the elongate body as by forging.
8. A side pocket mandrel according to claim 1, 2, or 3, wherein the elongate body is of generally oval cross-section.
- 20 9. A side pocket mandrel according to claim 8, wherein the indentations are formed in the exterior of the elongate body as by forging.

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10. A side pocket mandrel according to claim 1, 2, or 3, wherein the indentations are formed in the exterior of the elongate body as by forging.

11. A side pocket mandrel, comprising:

- 5 (a) a lower body section having a main bore there-
through, a receptacle bore extending alongside
said main bore, and lateral port means in the
wall of said receptacle bore, said lower body
section having means for connecting its lower
10 end to a tubing string; and
- (b) an upper body section welded to the upper end
of said lower body section, said upper body
section having a main passage therethrough in
alignment with said main bore of said lower
15 body section and having an offset belly therein
in alignment with said receptacle bore, said
upper body section being formed with a pair of
indentations in its external surface providing
a pair of corresponding internal deflectors
20 extending upwardly from a point near the upper
end of said receptacle bore and being spaced
apart to form a keyway-like channel there-
between in alignment with said receptacle bore
and being at least as wide as said receptacle
25 bore but narrower than said main bore, said
upper body section having means for connecting



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its upper end to a tubing string.

12. A side pocket mandrel according to claim 11 wherein the deflectors are formed in the upper body section before said upper body section is welded to said lower body
5 section.

13. A side pocket mandrel according to claim 11 or 12 wherein said deflectors are formed as by forging.

14. A side pocket mandrel substantially as hereinbefore described with reference to and as illustrated in Figs.
10 1 and 2, in Figs. 1 and 3, in Figs. 4 and 5, in Figs. 4 and 6, in figs. 7 and 8, or in figs. 7 and 9 of the accompanying drawings.
