United States Patent [19]

Baugh

[11] **3,807,497**

[45] **Apr. 30, 1974**

[54] **ORIENTING TUBING HANGER APPARATUS THROUGH WHICH SIDE POCKET MANDRELS CAN PASS**

[75] Inventor: **Benton F. Baugh,** Houston, Tex.

[73] Assignee: **Vetco Offshore Industries, Inc.,** Ventura, Calif.

[22] Filed: **May 8, 1973**

[21] Appl. No.: **358,451**

[52] **U.S. Cl.** ..... **166/85,** 166/89, 285/18, 285/137 A

[51] **Int. Cl.** **E21b 33/03**

[58] **Field of Search** ..... 166/85, 89, 313; 285/18, 285/137 A

[56] **References Cited**

UNITED STATES PATENTS

3,340,932	9/1967	Bloudoff	285/137 A
3,020,069	2/1962	Word, Jr.	166/89
3,394,761	7/1968	Jackson, Jr. et al.	166/89
3,603,401	9/1971	Nelson et al.	166/89
3,661,206	5/1972	Putch	166/89
3,688,841	9/1972	Baugh	166/85
3,693,714	9/1972	Baugh	166/85

Primary Examiner—James A. Leppink

Attorney, Agent, or Firm—Bernard Kriegel

[57] **ABSTRACT**

A tubing hanger, from which multiple tubing strings are suspended, is seated in a subsea well head or casing hanger, being properly oriented with respect to a running tool by means of which the tubing hanger is lowered from a drilling vessel to seat in the casing hanger. The tubing hanger has an oval passage adapted to pass a tubing string with side pocket mandrels used for gas lift or other purposes, the tubing string being supported from an oval mandrel adapted to seat within the oval passage. The running tool is properly oriented relative to a guidance system as a reference point, the guidance system extending from the subsea floor to the drilling vessel, resulting in the multiple string tubing hanger and its several passages, including the oval passage, being properly oriented with respect to the guidance system. A locator assembly is then lowered to the tubing hanger and properly oriented with respect to its several passages, to subsequently guide the tubing string with the side pocket mandrels through the oval passage into the well bore, the oval hanger seating within the oval passage. The oval hanger has a fluid passage providing communication between regions above and below the tubing hanger.

25 Claims, 21 Drawing Figures

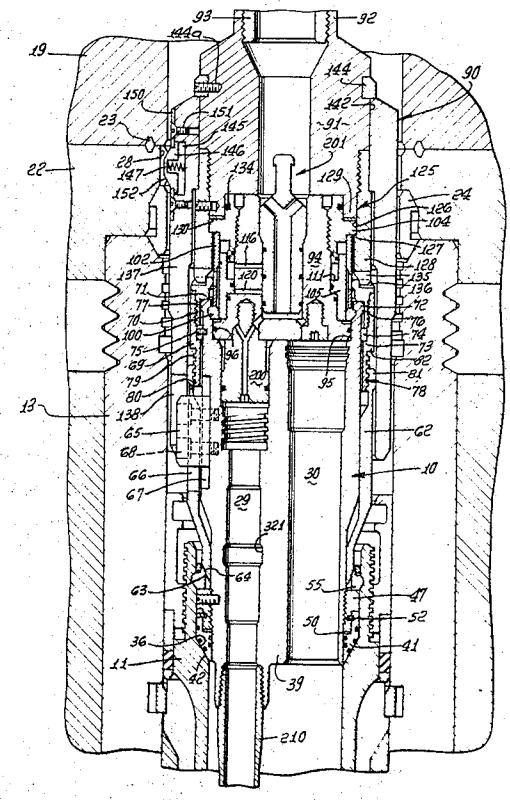


Fig. 1.

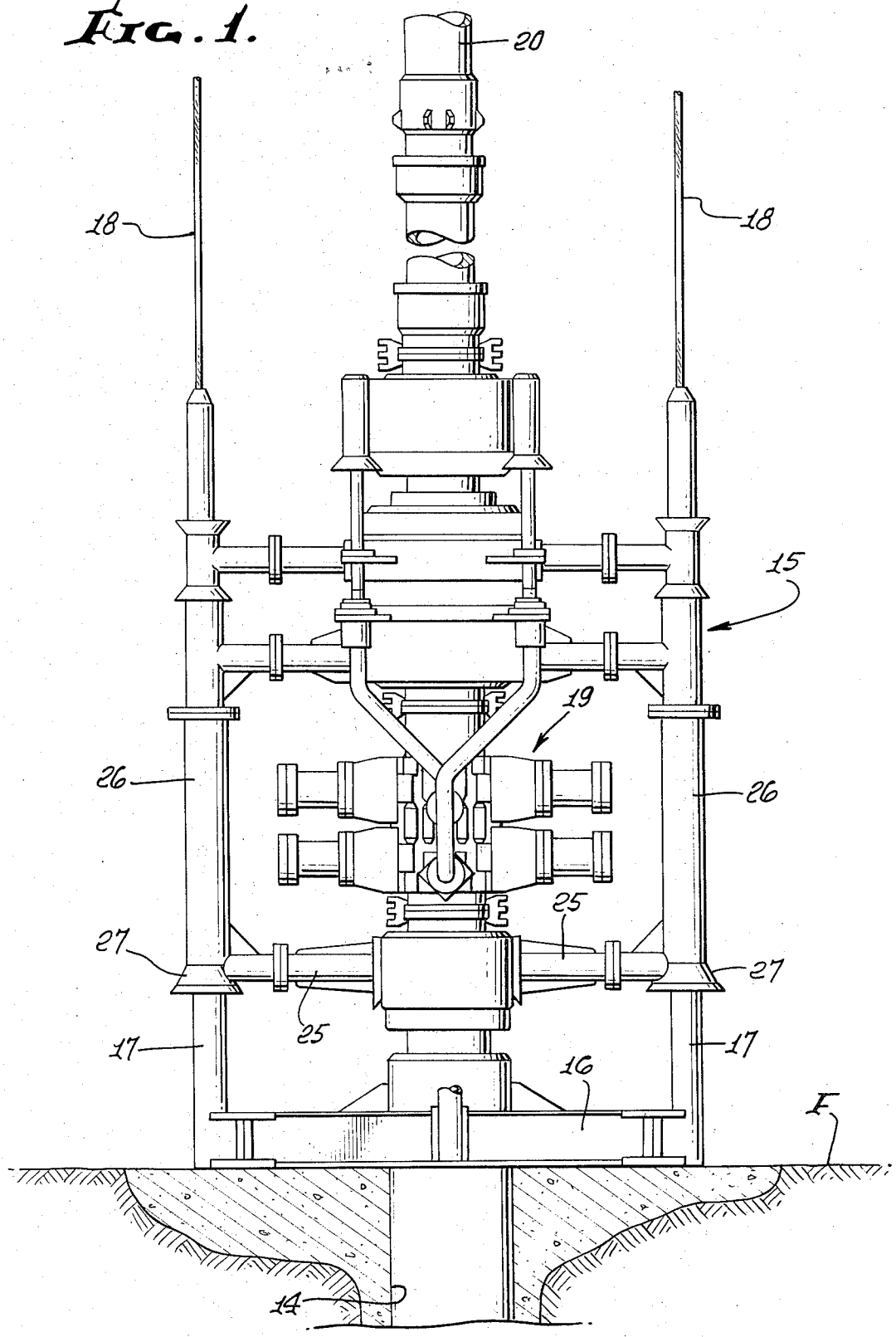


FIG. 2.

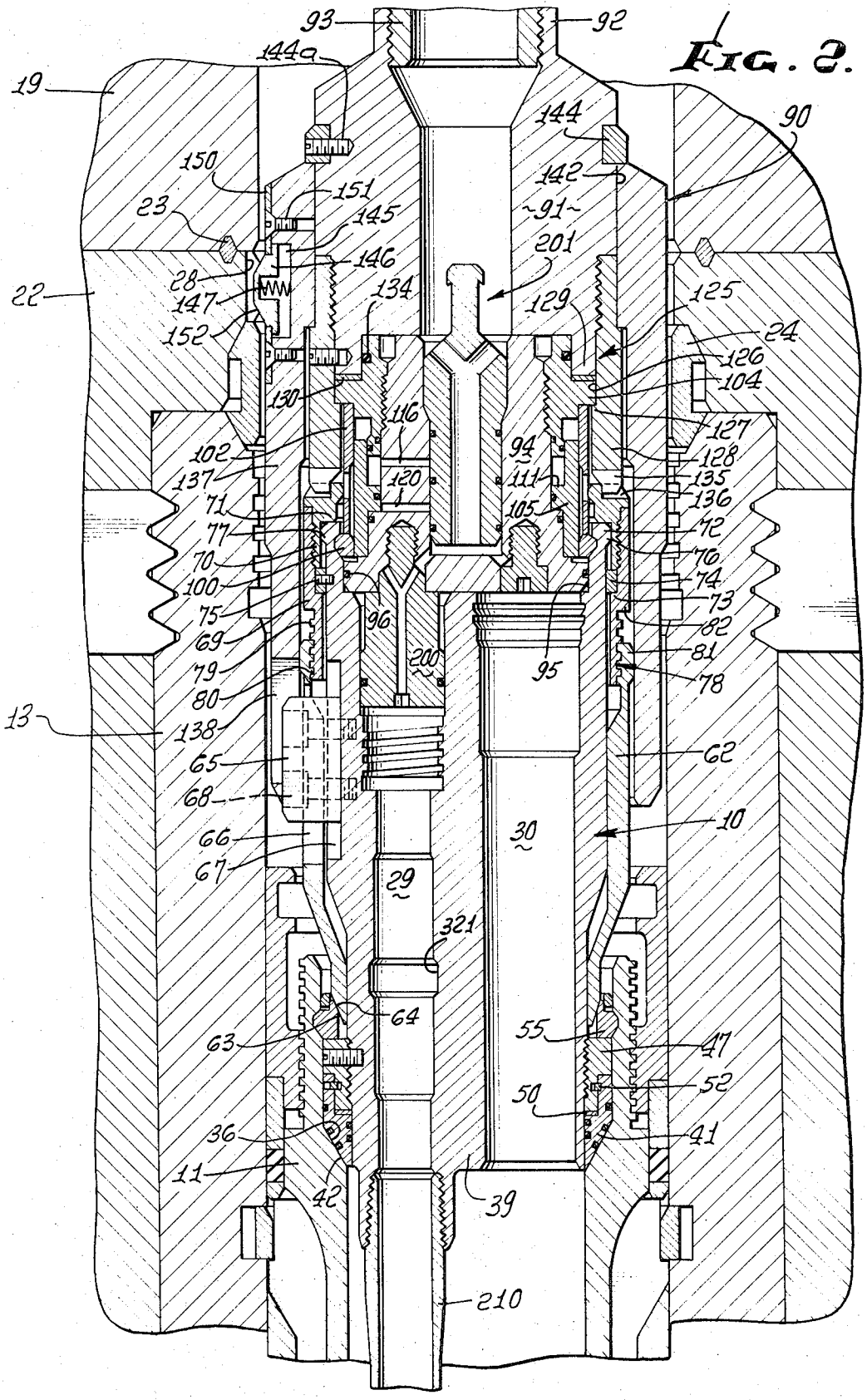

93
92
144a
19
144
90
150
142
151
23
145
91
201
146
28
147
134
129
125
22
152
24
126
130
104
116
127
102
94
128
137
111
135
120
136
71
105
72
77
76
70
74
100
73
75
82
96
69
81
200
95
79
78
80
13
138
62
65
68
10
66
30
67
29
321
64
55
47
63
52
50
36
41
11
42
39
210

FIG. 9.

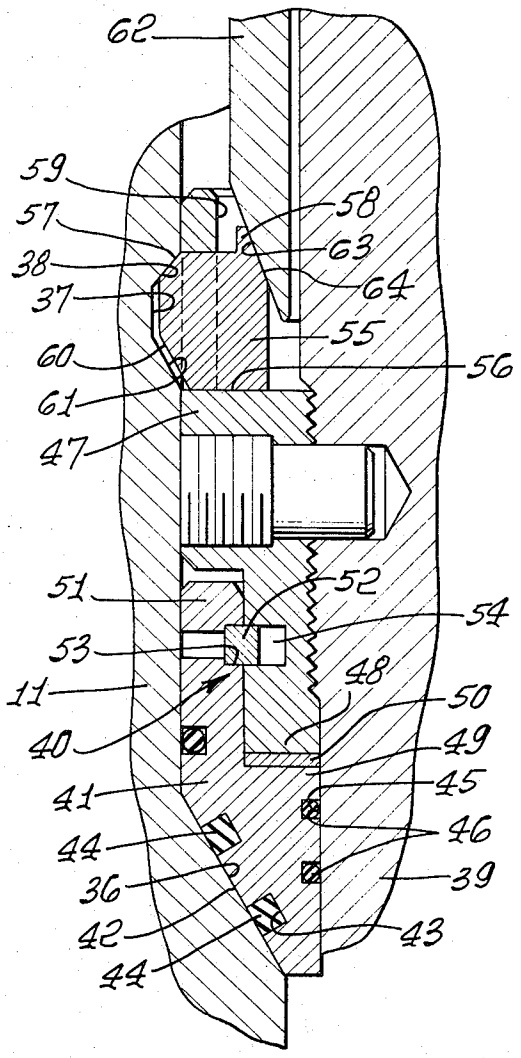

62
59
57
38
37
60
61
47
58
63
64
55
56
51
52
54
53
48
11
50
40
49
41
45
44
46
36
39
42
43
44

FIG. 3a.

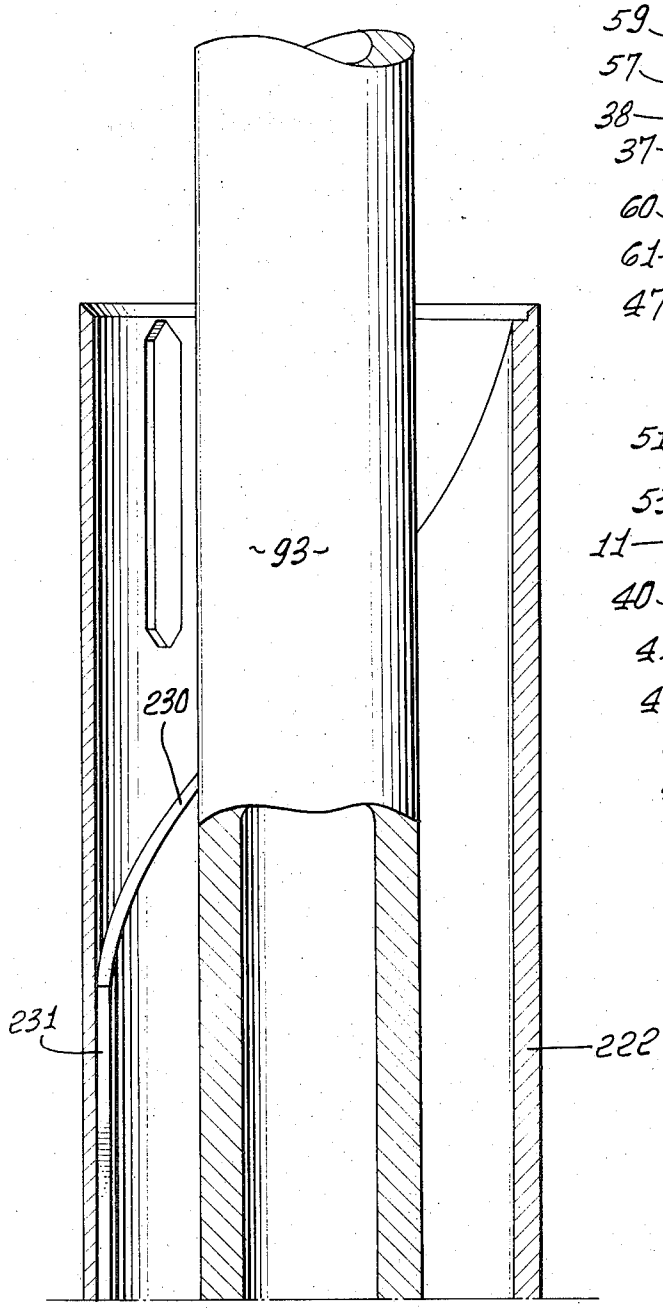

~93~
230
231
222

FIG. 3b.

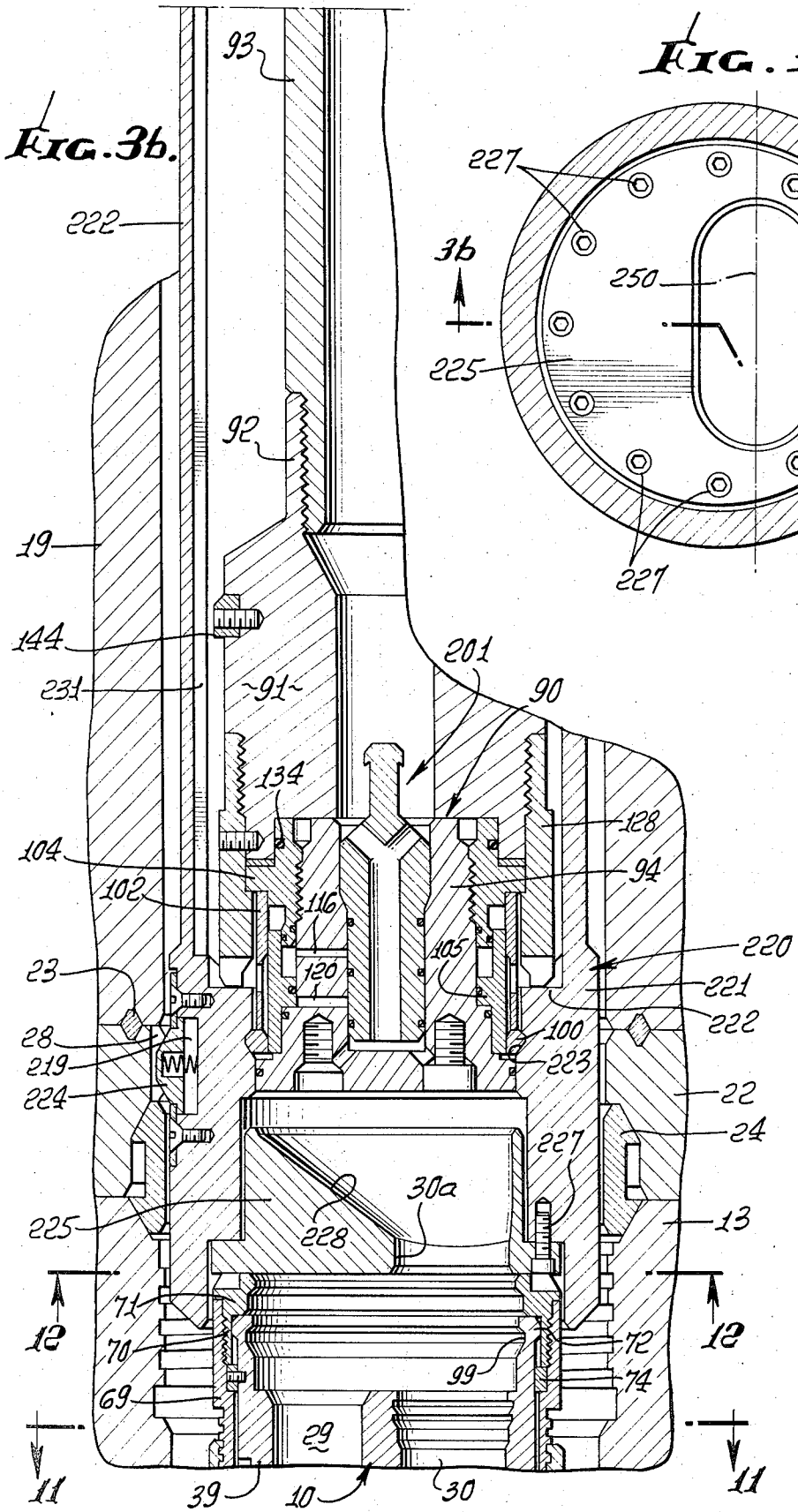

93
222
92
19
144
231
91
201
90
134
104
102
116
120
105
128
94
220
221
222
100
223
23
28
219
224
22
24
227
30a
225
228
13
71
70
69
72
74
99
29
12
12
11
11
39
10
30

FIG. 12.

220
227
3b
250
30a
225
227
3b

FIG. 4a.

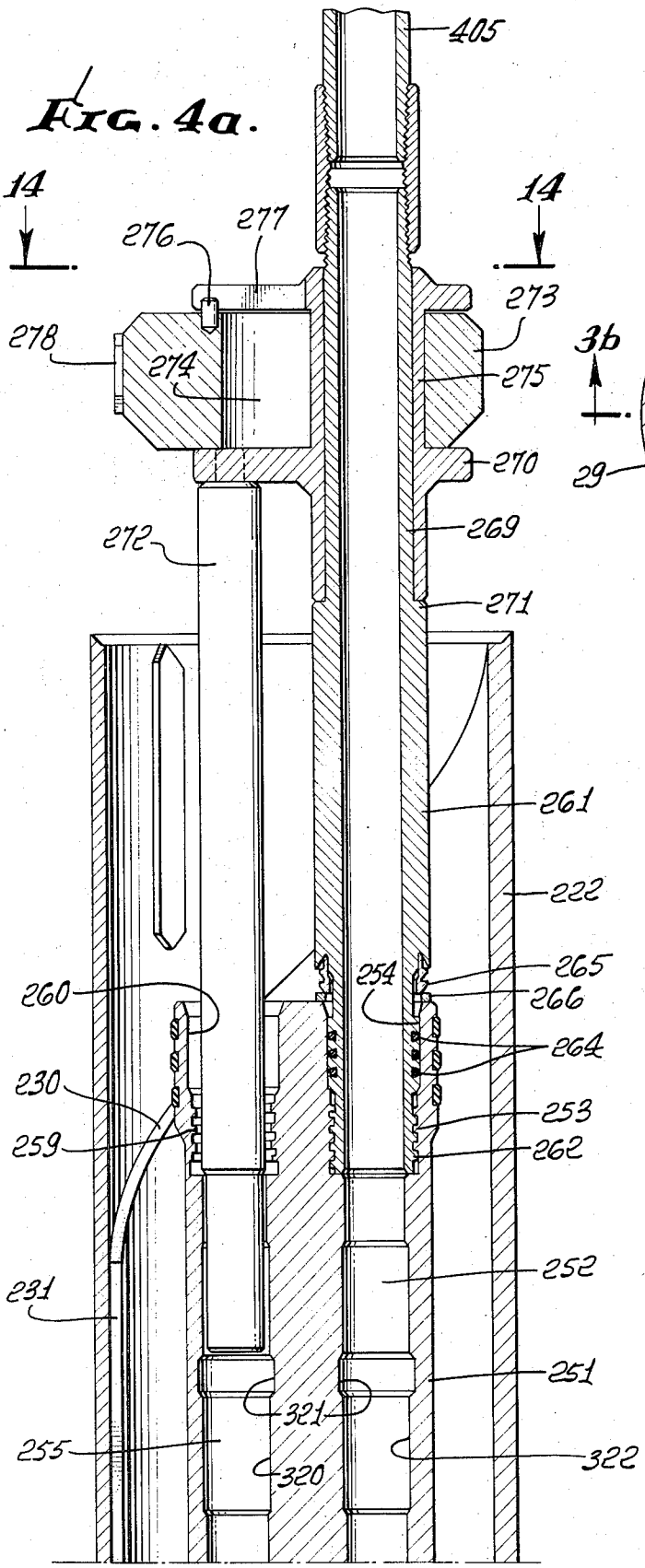


FIG. 11.

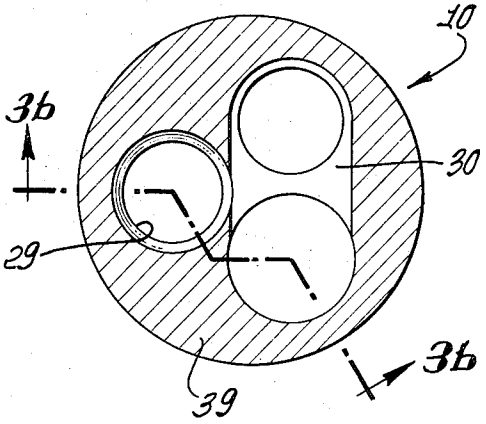


FIG. 13.

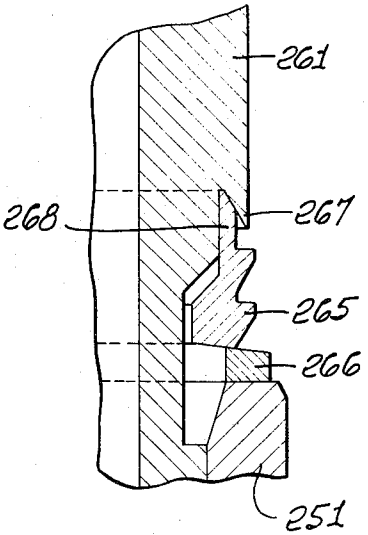


FIG. 4b.

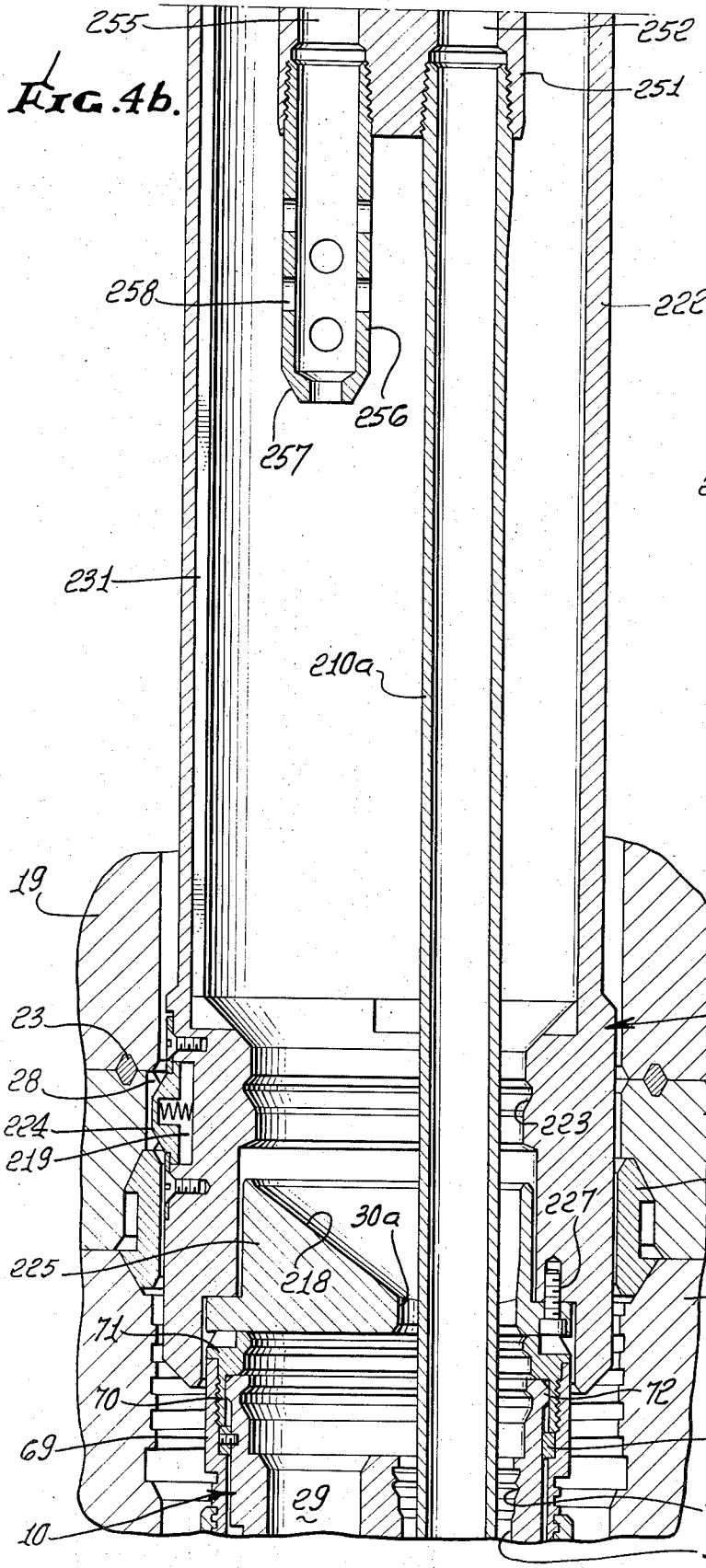

255
252
251
258
222
256
257
231
210a
19
220
23
28
224
219
223
22
24
227
30a
218
225
13
71
70
72
69
74
29
400
10
30

FIG. 15.

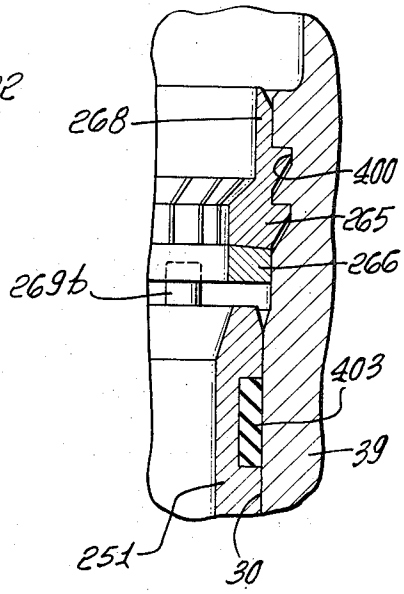

268
400
265
266
269b
403
39
251
30

FIG. 5a.

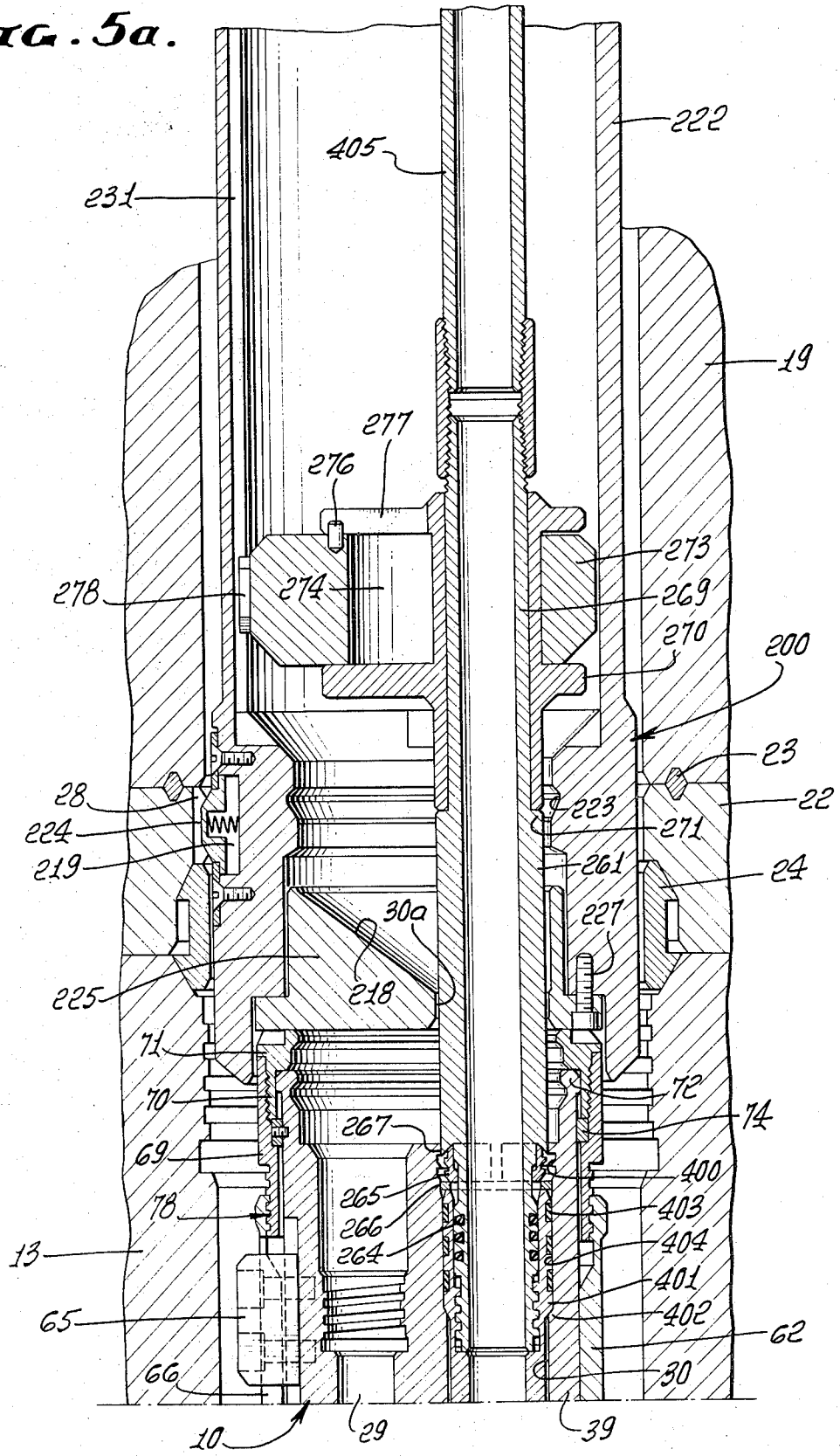

405
222
231
19
277
276
273
278
274
269
270
200
23
28
223
22
224
271
219
261
24
227
30a
225
218
71
72
70
74
267
69
400
265
403
78
266
404
264
13
401
65
402
62
66
30
10
29
39

Fig. 5b.

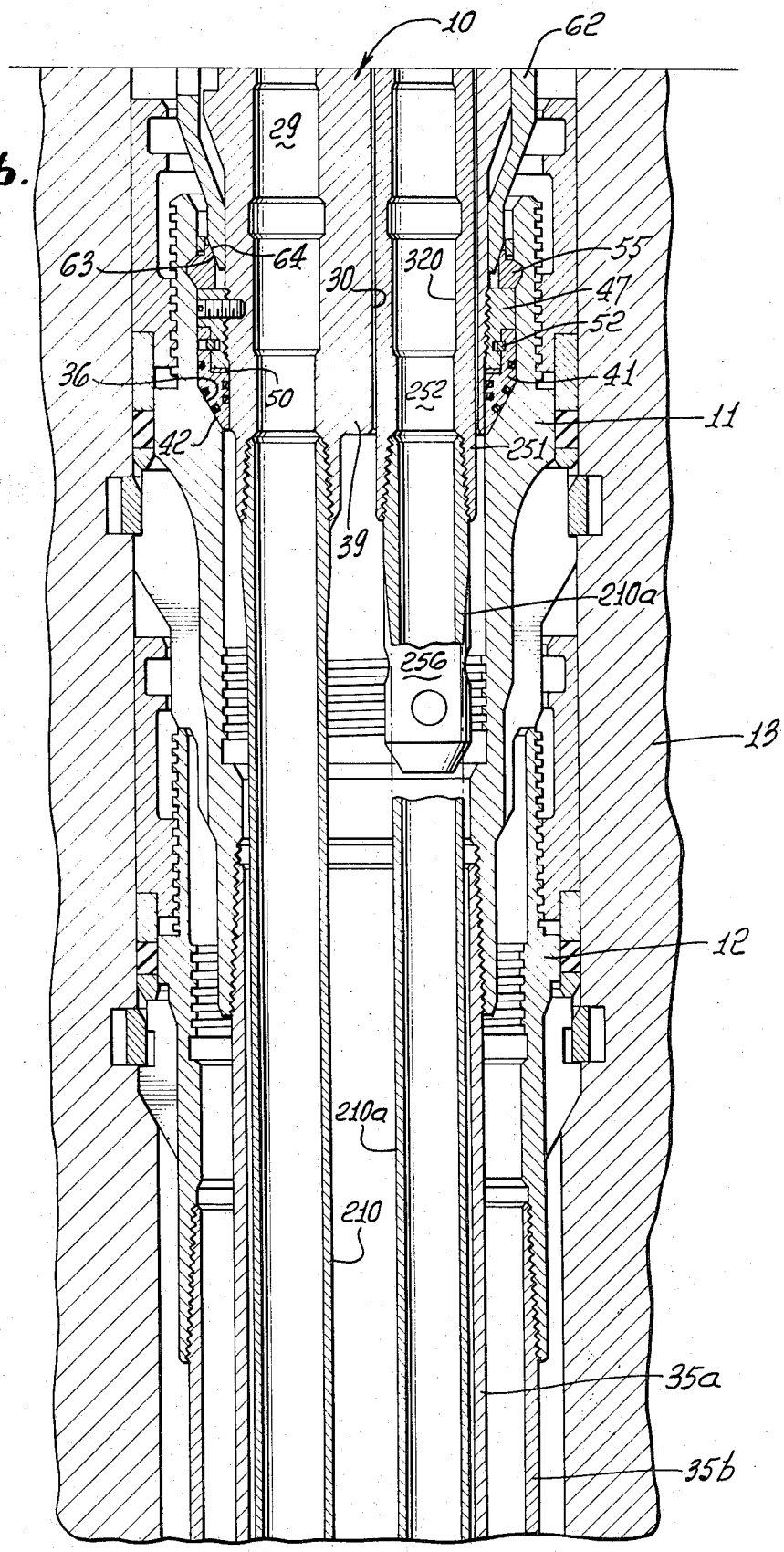

10
62
29
63
64
30
320
55
47
52
36
50
252
41
11
42
251
39
210a
256
13
12
210a
210
35a
35b

FIG. 6.

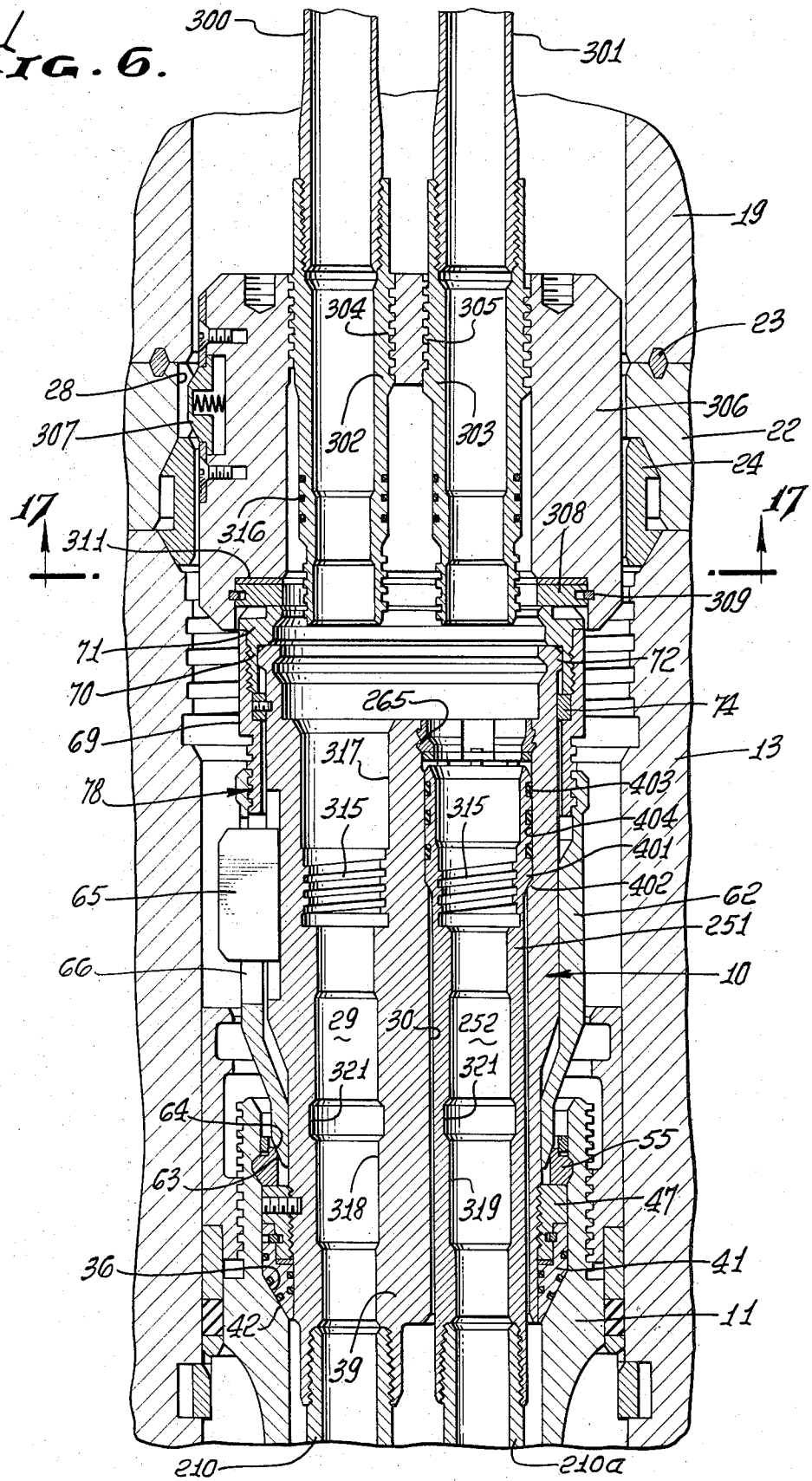
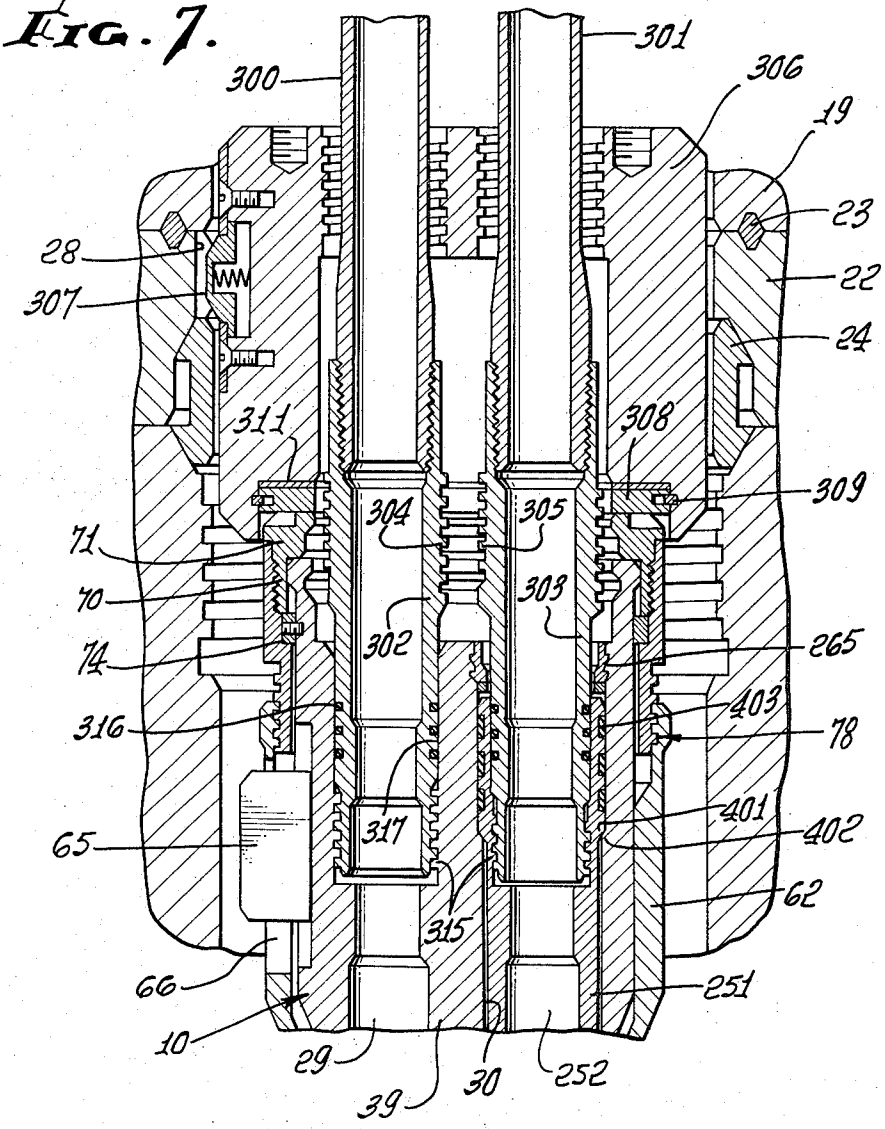

300
301
19
304
305
23
28
306
307
302
303
22
24
17
17
311
316
308
309
71
72
70
265
74
69
317
13
78
315
315
403
404
401
65
402
62
251
66
10
29
30
252
321
321
64
55
63
318
319
47
36
41
42
11
39
210
210a

FIG. 7.


300
301
306
19
23
22
24
28
307
311
308
309
304
305
303
71
70
74
302
265
403
316
78
317
401
402
65
62
315
66
251
10
29
39
30
252

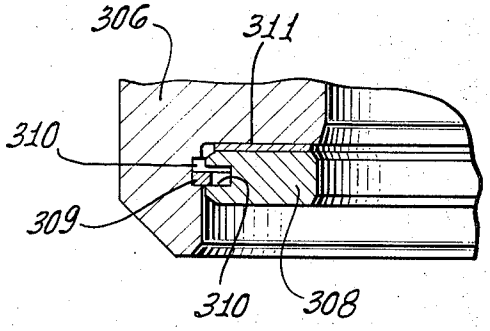

306
311
310
309
310
308

FIG. 16.

FIG. 8.

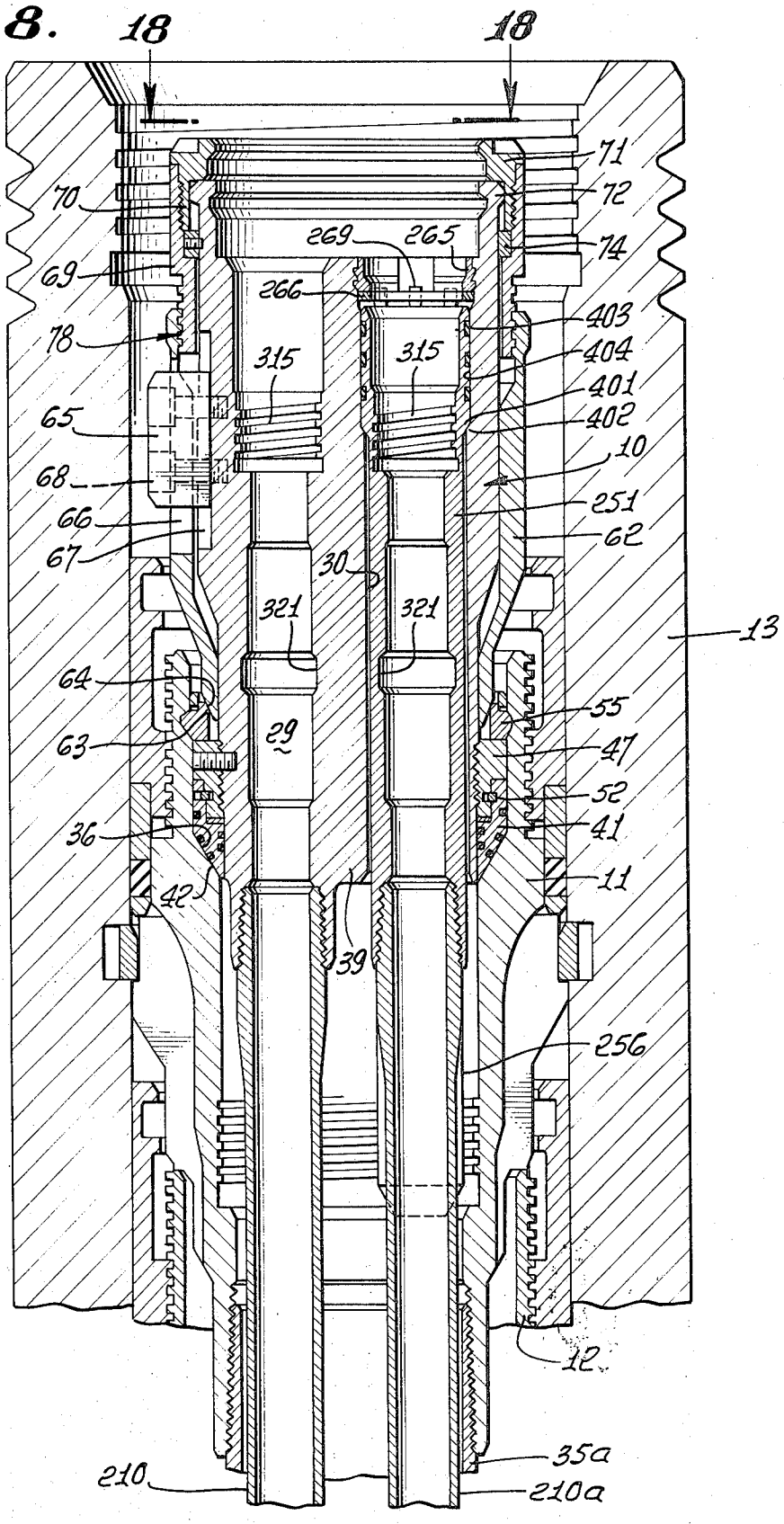

18
18
71
72
74
70
269
265
69
266
403
78
315
315
404
401
65
402
10
68
251
66
62
67
30
321
321
13
64
55
63
29
47
52
41
36
11
42
39
256
12
35a
210
210a

FIG. 10.

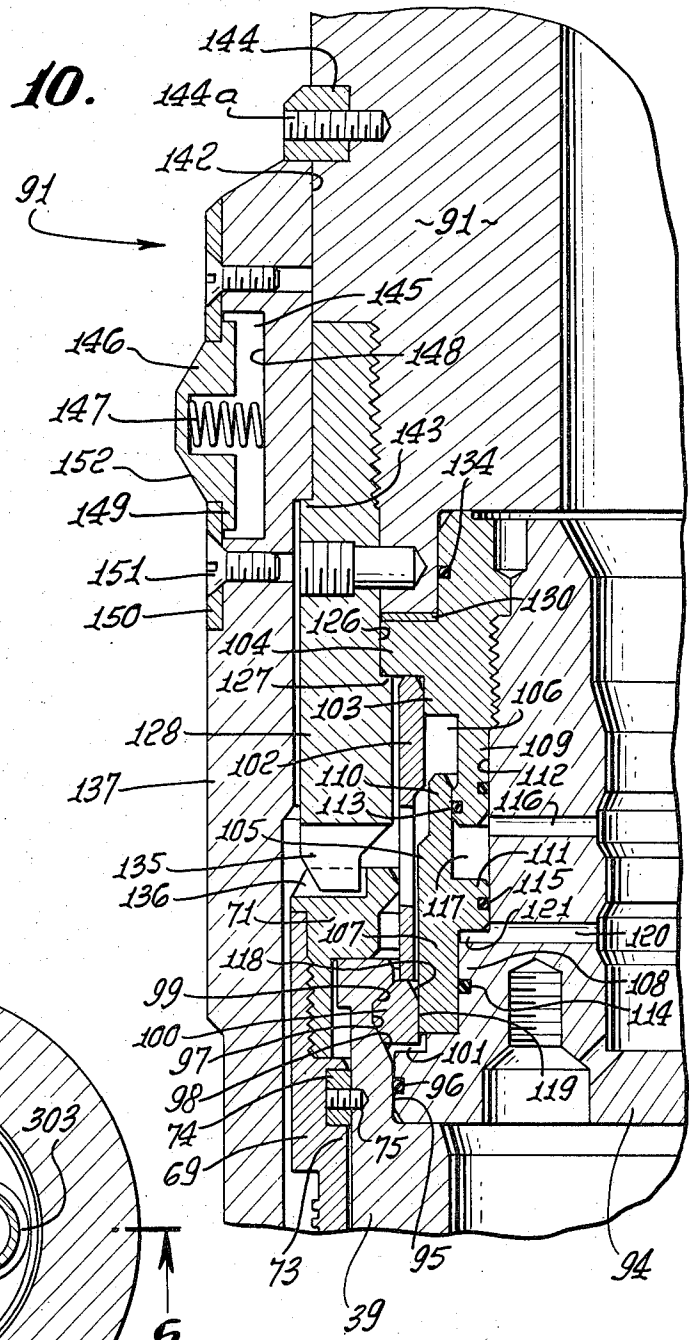

144
144a
142
91
~91~
145
146
148
147
143
134
152
149
151
150
130
126
104
127
103
106
128
102
109
110
112
137
113
116
105
111
135
115
136
71
117
121
107
120
118
108
99
114
100
97
101
98
96
119
74
75
69
73
39
95
94

FIG. 17.

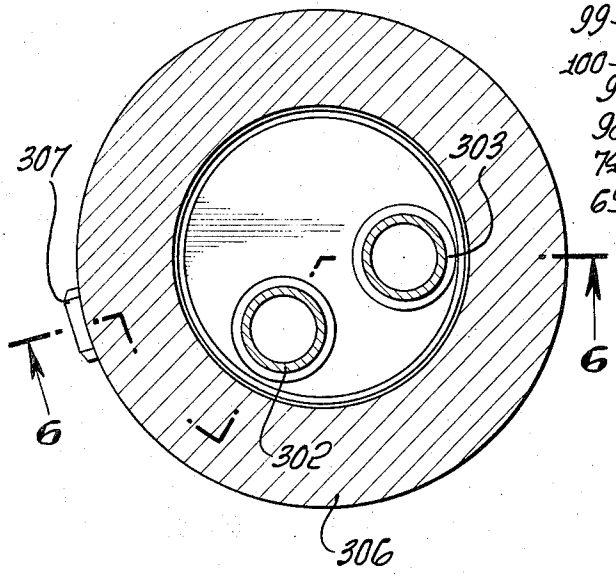

307
303
7
7
6
6
302
306

FIG. 14.

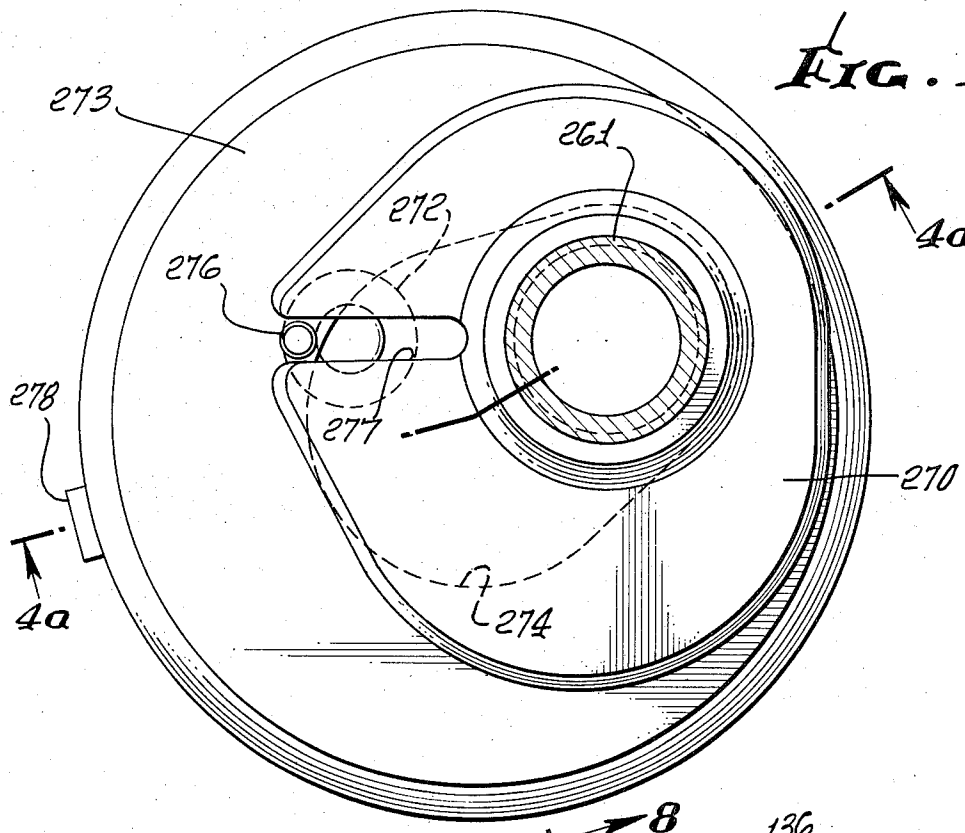
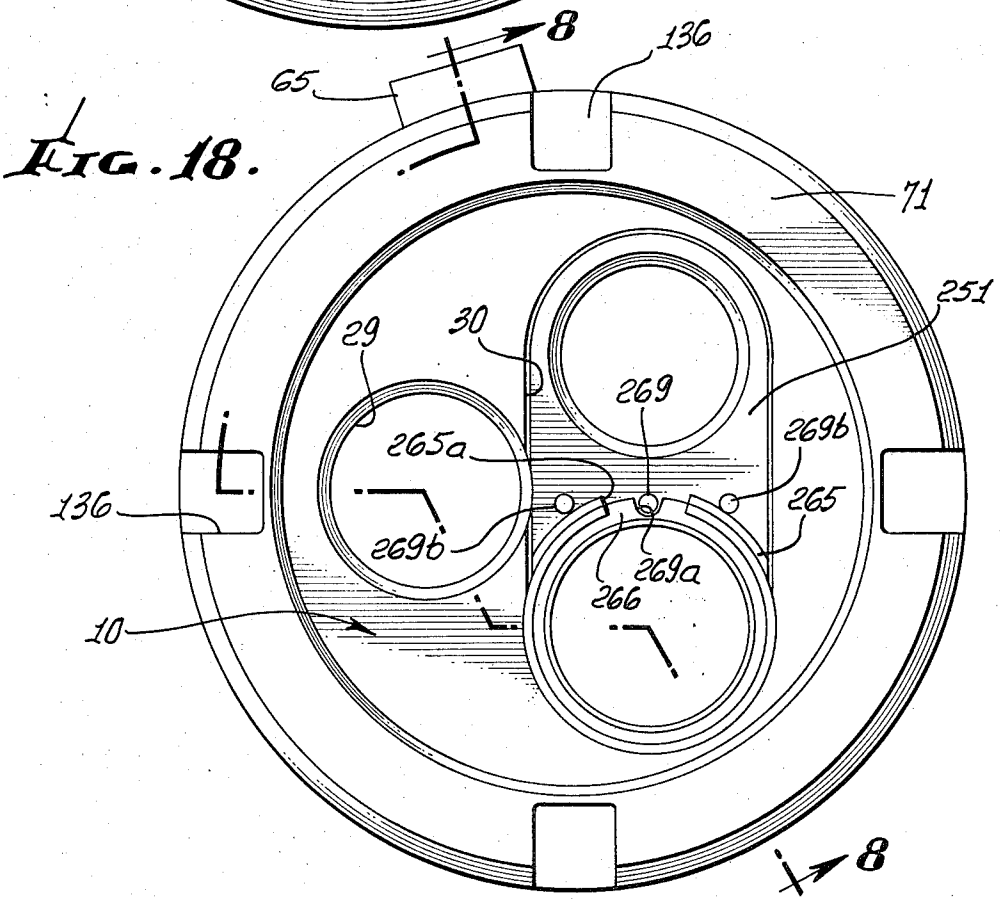

273
261
272
276
278
277
270
4a
4a
274

FIG. 18.


8
136
65
71
251
29
30
269
269b
265a
265
136
269b
269a
266
10
8

ORIENTING TUBING HANGER APPARATUS THROUGH WHICH SIDE POCKET MANDRELS CAN PASS

The present invention relates to subaqueous well bore apparatus, and more particularly to apparatus including a multiple string tubing hanger to be set and sealed in a well head or casing hanger.

Completion work in connection with oil and gas wells has required the provision of tubing hangers capable of passing large size gas lift and similar mandrels when a second tubing string is run in the well bore and supported from the tubing hanger. In completion work on land, extreme measures have been required to run the second string of tubing embodying one or more large size gas lift mandrels, such as providing completely segmented tubing hangers. When completing wells at offshore locations, the remote landing of the equipment at or near the subsea floor presents a still greater complication to the problem.

By virtue of the present invention, tubing hanger apparatus has been provided having a large passage of such shape and size as to permit easy passage of any usual variety of gas lift or other mandrels, such as side pocket mandrels, when the second tubing string is run therethrough. More specifically, the tubing hanger is provided with a large passage of oval shape through which a side pocket mandrel can pass and in which a supporting mandrel for the second tubing string is received. Such oval shape provides ample area through which the second tubing string with side pocket mandrels can move, as well as providing space for a fluid passage between a region above the tubing hanger and the region below the tubing hanger externally of the second tubing string.

Another object of the invention is to provide a locator adjacent to the tubing hanger properly oriented with respect thereto for guiding the second tubing string through the large passage and to orient the supporting mandrel with respect to the large passage to insure its movement into the latter and its appropriate seating in the tubing hanger. In a more limited sense, the large passage is of oval shape to receive a companion supporting mandrel of oval shape.

A further object of the invention is to provide apparatus embodying the locator, in which the locator can direct the second tubing string into the large passage.

After the second tubing string and supporting mandrel have been installed, the locator is removed, leaving the tubing hanger apparatus in condition for reception of the usual tubing strings sealingly engaged in the tubing hanger passages and communicating with the lower portion of a Christmas tree subsequently appropriately connected to the well head.

This invention possesses many other advantages, and has other purposes which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense.

Referring to the drawings:

FIG. 1 is a side elevational view of a subsea system used in connection with the drilling and completion of an underwater well bore;

FIG. 2 is an enlarged vertical section through the apparatus embodying the invention, and which is to be disposed in the well head casing hanger apparatus illustrated in FIG. 5*b*, including apparatus for setting a multiple string tubing hanger in a predetermined position, the tubing hanger itself being illustrated in its set condition;

FIGS. 3*a* and 3*b* together constitute a longitudinal section of a locator and a running tool therefor set on top of the tubing hanger, FIG. 3*b* being a lower continuation of FIG. 3*a*, FIG. 3*b* being taken along the lines 3*b*—3*b* on FIGS. 11 and 12;

FIGS. 4*a* and 4*b* together constitute a longitudinal section similar to FIGS. 3*a* and 3*b* of a second tubing string and supporting mandrel being lowered on a mandrel running tool into the locator, with a second string orienting guide assembly mounted on the mandrel running tool, FIG. 4*b* being a lower continuation of FIG. 4*a*;

FIGS. 5*a* and 5*b* are views similar to FIGS. 4*a* and 4*b* disclosing the mandrel seated in the tubing hanger after having been properly oriented with respect to the second string locator by the orienting guide assembly, FIG. 5*b* being a lower continuation of FIG. 5*a*;

FIG. 6 is a longitudinal section taken along the line 6—6 on FIG. 17 through the tubing hanger apparatus, illustrating first and second tubing strings disposed at the upper end of the tubing hanger prior to their connection to passages in the tubing hanger and the second string mandrel;

FIG. 7 is a view similar to FIG. 6 illustrating the first and second tubing strings threadedly connected in the first and second passages in the tubing hanger and the tubing hanger mandrel;

FIG. 8 is a longitudinal section through the apparatus illustrated in FIG. 18 with the first and second tubing strings removed;

FIG. 9 is a fragmentary longitudinal section through a portion of the tubing hanger, disclosing it latched to a surrounding casing hanger;

FIG. 10 is a fragmentary longitudinal section through the running tool for lowering the tubing hanger to the well housing, the running tool being latched to the tubing hanger;

FIG. 11 is a cross-section taken along the line 11—11 on FIG. 3*b*;

FIG. 12 is a cross-section taken along the line 12—12 on FIG. 3*b*;

FIG. 13 is an enlarged fragmentary section of the latch ring device for securing the second string mandrel to the tubing hanger;

FIG. 14 is an enlarged cross-section taken along the line 14—14 on FIG. 4*a*;

FIG. 15 is a view similar to FIG. 13 disclosing the latch ring expanded into locking relation to the tubing hanger;

FIG. 16 is a fragmentary section through a portion of the assembly disclosed in FIG. 6 used in orienting the first and second tubing strings relative to the passages in the tubing hanger and hanger mandrel;

FIG. 17 is a cross-section taken along the line 17—17 on FIG. 6;

FIG. 18 is an enlarged section taken along the line 18—18 on FIG. 8.

As illustrated in the drawings, a multiple tubing string hanger **10**, such as illustrated in U.S. Pat. No. 3,688,841, is to be set in sealed relation in a casing hanger **11** suitably supported, as through another casing hanger **12**, in a housing **13** at the top of a well bore **14** drilled into a formation underlying the floor F of an ocean, or other body of water. As is known in the art, the housing **13** and the various casing hangers **11, 12** supported thereby are secured to a guidance structure **15** of a guidance system, in a known manner. This guidance structure includes a base **16** having guide posts **17** extending upwardly from its corner portions and to which are secured cables or lines **18** extending upwardly through the water to a drilling vessel (not shown) floating in the water. A blowout preventer stack **19** is disposed at the lower end of a marine riser **20** extending upwardly to the drilling vessel, this blowout preventer stack being suitably secured to a connector **22** attached to the housing **13.** This connector may be of any suitable type, for example, being of the hydraulic type illustrated in U.S. Pat. No. 3,321,217. A suitable seal ring or gasket **23** effects a seal between the upper end of the connector and the lower end of the blowout preventer stack, another seal ring **24** effecting a seal between the casing hanger housing **13** and the connector **22.**

The connector **22** occupies a known position with respect to the guidance structure **15,** being moved downwardly with the blowout preventer stack **19** toward the housing **13** along the guide lines **18.** The connector has a guide frame **25** suitably secured thereto, the outer ends of which are attached to guide sleeves **26** having lower downwardly flaring funnels **27** secured thereto, and being slidable along the guide lines **18** and then over the guide posts. The connector has a longitudinal slot or groove **28** disposed therein which has a known orientation with respect to the guide posts **17.** It is with respect to this groove **28** that the tubing hanger **10** is to be oriented, so that the longitudinal passages **29, 30** extending through the tubing hanger body **39** will bear a known orientation or angular relation relative to the groove **28** in the connector, and consequently, with respect to the guide lines **18** and guide posts **17** of the guidance system **15,** the orientation being accomplished with the structure and in the manner described hereinbelow. It is to be noted that one of the passages **30** is of oval cross-section.

A plurality of concentric casing strings **35***a*, **35***b* (FIG. **5***b*) are connected at their upper ends to concentric casing hangers **12, 11** which are in stacked relation and appropriately sealed against the casing hanger housing **13.** The uppermost casing hanger **11** is the one on which the tubing hanger **10** is to seat and against which it is to be sealed, this casing hanger having a suitable downwardly tapering hanger seat **36** and an internal lock groove **37** thereabove, the upper side **38** of which tapers in a downward and outward direction.

The tubing hanger **10** includes the main body **39** having the plurality of longitudinal passages **29, 30** extending therethrough. The lower end of this body is connected by means of a swivel **40** to a landing ring **41** having a downwardly tapering seating surface **42** adapted to engage the companion seat **36** in the casing hanger **11.** The ring **41** has a plurality of circumferential grooves **43** therein receiving elastomer seal rings **44** adapted to bear and seal against the casing hanger seat **36.** It also includes circumferential internal grooves **45** containing seal rings **46** sealing against the periphery of the lower portion of the tubing hanger body **39.**

The swivel **40** interconnects the tubing hanger body **39** and landing ring **41,** permitting the hanger body to rotate relative to the landing ring. As specifically illustrated, the swivel includes a lower body member **47** threadedly secured to the body **39** and having a downwardly facing shoulder **48** opposed to an upwardly facing shoulder **49** in the landing ring, there being suitable antifriction bearing rings **50** between and engaging the opposed shoulders. The landing ring **41** has an upwardly extending skirt **51** encompassing the lower portion of the lower body member **47** and receiving the outer portion of an inherently expansible retainer ring **52** in an internal groove **53,** which also extends partially into an external groove **54** in the lower body member. It is apparent that the retainer ring **52** prevents the landing ring **41** from shifting longitudinally with respect to the hanger body **39** and its lower member **47,** while permitting rotation of the hanger body and lower member relative to the landing ring **41** when the latter is engaged with the casing hanger seat **36.**

The lower body member **47** also carries a plurality of circumferentially spaced lock dogs **55** extending through circumferentially spaced radial slots **56** in the lower body member and slidable radially therein. The outer portions of the dogs are receivable within the internal lock groove **37** in the casing hanger **11** and with the upper downwardly and outwardly inclined cam faces **57** on the dogs engageable with the companion upper cam face or side **38** of the groove. Outward movement of each dog is limited by engagement of its upwardly directed terminal member **58** with the inner surface **59** of the lower body member above the slots **56,** the dogs being shiftable radially inwardly to the extent limited by their engagement with the periphery of the tubing hanger body **39.** The dogs also have downwardly and inwardly inclined external tapered surfaces **60** engageable with an upper tapered surface **61** on the casing hanger to be cammed radially inwardly thereof during lowering of the tubing hanger body **39** with respect to the casing hanger **11,** as described hereinbelow.

The dogs **55** are expandable outwardly as a result of downward shifting of a cam actuator sleeve **62** surrounding the tubing hanger body, this actuator sleeve having a lower portion provided with a downwardly tapering expander surface **63** adapted to move behind the dogs or lock elements **55** and engage companion tapered expander surfaces **64** therein. The cam actuator sleeve **62** is longitudinally shiftable relative to the tubing hanger body **39,** but is non-rotatable with respect thereto by virtue of an orienting dog or key **65** extending through a slot **66** in the cam actuator sleeve and which is also received in a longitudinal groove or keyway **67** in the tubing hanger body, this key being secured to the body by one or more cap screws **68.** The orienting dog or key is secured to the tubing hanger body in a known and predetermined angular relationship relative to the longitudinal passages **29, 30** through the hanger body.

The cam actuator sleeve **62** is shiftable longitudinally of the tubing hanger body **39** by an actuator sleeve **69** that encompasses the upper portion of the hanger body **39** and which is threadedly secured to an upper actuator ring **70** having an inwardly extending portion or flange **71** overlying the upper end **72** of the hanger

body. Downward movement of this actuator sleeve **69** along the body **39** is prevented by the flange **71** engaging the upper end **72** of the tubing hanger body; whereas, its upward movement is prevented by engagement of an upwardly facing shoulder **73** on the actuator sleeve with a shear ring **74** encompassing the body and secured thereto by one or more shear pins or screws **75** extending through the ring and threaded into companion bores in the body. This shear ring is initially spaced downwardly from a downwardly facing shoulder **76** formed on and provided by an external flange **77** on the upper end of the tubing hanger body. Thus, the actuator sleeve **69** is prevented from shifting longitudinally in both upward and downward directions relative to the tubing hanger **39,** but is capable of rotating with respect thereto. Such rotation will effect longitudinal shifting of the cam actuator sleeve **62** along the tubing hanger body **39** by virtue of a threaded interconnection **78** between the lower portion of the actuator sleeve and the upper portion of the cam actuator sleeve. As noted, the actuator sleeve **69** has external right-hand threads **79** thereon meshing with companion internal right-hand threads **80** on the upper threaded head portion **81** of the cam actuator sleeve. Thus, right-hand rotation of the actuator sleeve **69** will shift the cam actuator sleeve **62** longitudinally upwardly along the body to a position in which the upper end of the cam actuator sleeve engages a downwardly facing shoulder **82** on the actuator sleeve, at which time the lower expander portion **63** is elevated above the dogs **55,** the latter being permitted to contract inwardly and be located completely out of the internal casing hanger groove **37.** On the other hand, left-hand rotation of the actuator sleeve **69** will effect downward movement of the cam actuator sleeve **62** along the tubing hanger body, shifting its expander portion **63** behind the dogs **55** and expanding the latter outwardly into the casing hanger groove **37.**

The tubing hanger **10** is lowered from the drilling vessel into its appropriate seating position within the casing hanger **11,** is firmly sealed thereagainst, and is appropriately oriented relative to the groove **28** in the connector **22,** and, therefore, with respect to the blowout preventer stack **19** and the guidance system **15** through use of a running tool **90** connected to the tubing hanger. The running tool includes an upper sub **91** having a threaded box **92** threadedly secured to the lower end of a running string **93** of drill pipe, or the like, extending upwardly through the marine riser **20** to the drilling vessel. The running tool (FIG. **10**) includes an inner body member **94** disposed in a counterbore **95** in the upper portion of the tubing hanger body **39** and having a suitable side seal ring **96** therein sealingly engaging against the inner cylindrical wall of the counterbore. The upper portion of the hanger body **39** includes a circumferential internal groove **97** above its cylindrical surface having a downwardly tapering lower side **98** and an upwardly tapering upper side **99,** this groove being adapted to receive a split lock ring **100** mounted in a groove **101** defined between the inner body member and an outer guide sleeve **102** thereabove, which is spaced from the lower side of the groove to provide upper and lower guide surfaces for the split lock ring **100.**

The upper portion of the outer guide sleeve **102** surrounds an upper guide member **103** constituting the upper portion of the inner body structure and threadedly secured to the inner body member **94,** this guide member having an outwardly directed flange **104** overlying the upper end of the outer guide sleeve **102** and extending laterally beyond its periphery. The lock ring **100** is expandable laterally outwardly hydraulically and is locked in its outward expanded position by an annular cylinder member **105** slidable along the inner body member **94.** Thus, the annular cylinder is located within an annular space **106** between the inner body member and the outer guide sleeve. It includes a lower cylinder sleeve portion **107** slidable along a lower piston portion **108** of the inner body member, the guide member **103** having a depending annular piston portion **109** along which an upper cylinder sleeve **110** is slidable. An inwardly directed cylinder head **111** is disposed in the space between the upper and lower pistons **109, 108,** being slidable along a reduced diameter peripheral portion **112** of the inner body member. The upper sleeve **110** slidably seals against a suitable seal ring **113** in the upper annular piston, the lower cylinder sleeve **107** slidably sealing against a suitable seal ring **114** in the lower piston **108,** there being a seal ring **115** in the cylinder head **111** slidably sealing against the periphery of the reduced diameter portion **112** of the inner body member **94.**

Fluid under pressure derived from the running string **93** can pass into a radial port **116** between the interior of the inner body member into an upper cylinder space **117** to shift the actuating cylinder **105** downwardly along the inner body member, for the purpose of engaging an upper inclined cam face **118** on the split lock ring **100** to expand the latter outwardly into the internal groove **97** in the upper portion of the tubing hanger body **39** and to then shift behind the inner cylindrical surface **119** of the lock ring to retain it within the hanger body groove **97** (FIG. **10**). On the other hand, when the lock ring **100** is to be released from the groove **97,** fluid under pressure is directed from the interior of the inner body member **94** through its side port **120** into the cylinder space **121** between the lower piston **108** and cylinder head **111** to shift the cylinder upwardly and out of engagement from the split latch ring **100,** allowing the latter to contract from the hanger body groove **97.**

The inner body member **94** is movable longitudinally with the top sub **91** of the running tool **90,** this top sub, however, being rotatable relative to the inner body member, because of the provision of a swivel **125** therebetween. This swivel is constituted by the external flange **104** on the guide member **103** projecting into an internal groove **126** defined between a lower upwardly facing shoulder **127** of a clutch member **128** surrounding the outer guide sleeve **102,** and threadedly secured to the top sub **91,** and a downwardly facing shoulder **129** provided by the end of the top sub. Rotation of the top sub **91** relative to the inner body member **94** is facilitated by an anti-friction bearing ring **130** provided between the top sub and the inner body structure. Leakage of fluid between the guide member **103** and the top sub **91** is prevented by a suitable side seal ring **134** in the guide member sealingly engaging the opposed inner wall of the lower portion of the top sub.

The rotary motion of the running string **93** and top sub **91** is transmitted to the actuator sleeve **69** for the purpose of locking the dogs **55** in the groove **37** in the casing hanger **11,** or to release the dogs from such groove. Such transmission of rotary motion is effected

by the interengagement of downwardly facing clutch teeth **135** at the lower end of the clutch member **128** with companion axially extending teeth **136** formed in the upper end of the upper actuator ring **71** secured to the actuator sleeve **69.**

An outer orienting sleeve **137** surrounds the clutch member **128,** actuator sleeve **69,** and the upper portion of the cam actuator sleeve **62,** having a lower slot **138** therethrough adapted to receive the outer portion of the orienting dog or key **65,** this slot terminating in a downwardly flaring mouth **139** to facilitate passage of the key into the slot. This orienting sleeve is movable longitudinally with the top sub **91** and upper clutch member **128** by being retained within a peripheral groove **142** defined between an upwardly extending shoulder **143** on the clutch member and a ring **144** secured to the top sub by screws **144***a*. The orienting sleeve has a narrow, vertical groove **145** therein in which an orienting key or dog **146** is radially shiftable, this key or dog being shiftable outwardly by a helical compression spring **147** bearing against the base **148** of the groove and against the central portion of the dog. The outward extent of movement of the dog is limited by engagement of its upper and lower terminals **149** with companion upper and lower stop plates **150** secured by screws **151** to the orienting sleeve **137,** the dog having upward and downward tapering external surfaces **152** to facilitate its longitudinal movement past obstructions that it might encounter. The dog **146** has a circumferential extent or width conforming to the width of the groove **28** in the connector **22,** to be forced by its spring **147** thereinto.

Because of the swivel connection between the outer orienting sleeve **137** and the sub **91** and clutch member **128,** the clutch member can transmit its rotary motion to the actuator sleeve **69,** after the orienting key **146** has expanded into the connector groove **28,** for the purpose of locking and unlocking the dogs **55** in the casing hanger groove **37.** However, prior to locking of the dogs in the groove, the rotary motion of the running string **93** and top sub **91** is transferable to the outer orienting sleeve **137** for the purpose of turning the latter within the connector **22** into a position in which its spring pressed key **146** expands outwardly into the connector groove **28.**

The running tool **90** and tubing hanger **10** carried thereby are specifically illustrated in various positions in U.S. Pat. No. 3,688,841. Accordingly, only the final set position of the hanger **10** is illustrated herein, although the different relative positions between the parts and the operation of the apparatus is described in detail below.

When the tubing hanger **10** is to be lowered and set in sealed off relation in the casing hanger **11,** its cam actuator sleeve **62** is first disposed in an upward position along the tubing hanger body **39,** with the upper end of the sleeve abutting the downwardly facing shoulder **82** on the actuator sleeve **69,** the lower end of the cam actuator sleeve being in its upper position with respect to the dogs **55.** The running tool **90** is secured to the tubing hanger **10,** the inner body member **94** being piloted within the upper end of the tubing hanger body, with a seal sub **200** secured to the body member being located in the round passage **29** of the hanger body **10,** the cylinder **105** being hydraulically actuated by fluid under pressure passing through the ports **116** to be shifted downwardly to expand and retain the lock ring **100** within the upper body groove **97.** At this time, the clutch teeth **135, 136** are engaged and the orienting key **65** is located within the orienting slot **138** in the lower portion of the outer orienting sleeve **137.** Accordingly, the tubing hanger **10** has a known angular relationship relative to the spring pressed orienting key or dog **146** mounted in the orienting sleeve.

A running dart **201** is then inserted in the body member **94** to seal off the ports **116, 120.** The running tool **90** and tubing hanger **10,** with a tubing string **210** secured thereto, are lowered by the running string **93** through the marine riser **20** and blowout preventer stack **19** and into the casing hanger body **11,** until the landing ring **41** engages the companion seat **36** in the casing hanger. The running string of drill pipe **93** and running tool **90** are then rotated, which will effect rotation of the actuator sleeve **69,** because of the engagement of the clutch elements **135, 136** with one another, and also rotation of the cam actuator sleeve **62** in view of the abutting of the upper end of the sleeve with the shoulder **82** on the actuator sleeve **69,** the rotation being in a right-hand direction. Accordingly, the entire tubing hanger **10** is rotated as a unit, this rotary motion being transmitted through the orienting key **65** to the orienting sleeve **137,** which turns the spring pressed dog **146** with it until the latter is opposite the connector orienting groove **28;** whereupon the spring **147** will shift the orienting key into the groove **28,** preventing further rotary motion from occurring. However, in view of the know relationship between the orienting dog **65** and the passages **29–31** through the tubing hanger body **39,** and of such orienting dog with the spring pressed orienting dog **146,** the engagement of the spring pressed key **146** in the connector groove **28** places the tubing hanger body **39** is a known angular relationship with respect to the connector **22,** and, therefore, with respect to the guidance system **15** along which the connector has been placed, the connector groove **28** bearing a known relationship to the guide posts **17** of the guidance structure.

Following landing of the landing ring **41** against its companion casing hanger seat **36,** and the positioning of the orienting key **146** in the connector groove **28,** the running string **93,** top sub **91** and clutch member **128** are rotated in a left-hand direction, which will rotate the actuator sleeve **69** in a left-hand direction. Since the cam actuator sleeve **62** cannot rotate, being fixed to the tubing hanger body **39** by the orienting key **65,** and to the connector **22** through the key **65,** orienting sleeve **137,** key **146** and groove **28,** the cam actuator sleeve **62** is shifted downwardly along the hanger body **39,** its lower expander portion **63** moving behind the dogs or latches **55** and shifting them laterally outwardly into the casing hanger lock groove **37** with which they are aligned, bringing the tapered cam surfaces **57** of the dogs into engagement with the companion cam face **38** defining the upper side of the casing hanger groove. As more left-hand torque is applied to the running string **93,** top sub **91,** clutch member **128** and actuator sleeve **69,** the cam actuator sleeve **62** is shifted downwardly to a further extend, the dogs being shifted radially outwardly to a further extent. In view of their tapered engagement with the upper side **38** of the casing hanger groove **37,** the lower body member **47** and the tubing hanger body **39** are urged downwardly, forcing the landing ring **41** downwardly and insuring firm leakproof sealing engagement between the seal

rings 44 and the casing hanger seat 36. The cam actuator sleeve 62 remains behind the dogs 55 and insures the retention of the tubing hanger body 39 in its downward position locked to and sealed against the casing hanger 11.

The running tool 90 can now be released from the set tubing hanger 10. The running dart 201 is retrieved by a wireline retrieving tool (not shown) and a releasing dart (not shown, see U.S. Pat. No. 3,688,841) is lowered through the running string, coming to rest within the inner body 94, directing fluid under pressure through the lower ports 120 into the lower cylinder space 121 to shift the cylinder 105 upwardly along the body 94 from its position behind the split lock ring, thereby releasing the running tool from the tubing hanger body 100. This allows the running string 93 to be elevated, elevating the running tool 90 therewith, the upper side of the lock ring 100 engaging the upper side 99 of the tubing hanger body groove 97 to shift the ring inwardly from the groove, the clutch teeth 137 on the clutch member becoming disconnected from the companion clutch teeth 136 on the actuator ring 70, and the outer orienting sleeve 137 sliding upwardly along the cam actuator sleeve 62 and completely off the fixed orienting dog or key 65. The upper inclined surface 152 on the spring pressed dog or key 146 will engage any obstructions thereabove, such as the upper end of the groove 28, and be cammed thereby inwardly completely from the connector 22 to move upwardly with the remainder of the running tool 90 through the blowout preventer stack 19 and marine conductor or riser 20 to the drilling vessel. The tubing hanger 10 remains secured in its oriented position within the casing hanger 11, with the tubing string 210 extending into the well bore to the desired depth.

After the tubing hanger 10 has been set with its passages appropriately oriented with respect to the orienting groove 28 in the connector, a locator (FIG. 3*a*, 3*b*) is lowered in place to subsequently guide a second string of tubing 210*a* into and through the second oval passage 30 in the tubing hanger (see FIG. 4*b*). As shown, a second string locator apparatus 220 is provided having a lower body portion 221 and an elongate locator sleeve portion 222 extending upwardly therefrom. This locator body has a longitudinal groove 219 therein receiving an orienting key 224 receivable within the orienting groove 28 of the connector, in the same manner as the key 146 is used in setting the tubing hanger 10 in its appropriate position within the casing hanger housing 13. Essentially the same running tool 90 is used with the exception that the outer orienting sleeve 137 is removed. The running tool 90 is connected to the locator body 221 in the same manner as it was connected to the tubing hanger 10. Thus, the inner body member 94 of the running tool is inserted within the locator body until the clutch member 128 engages the upper end 222 of the body. At this time, the latch ring 100 is disposed opposite the internal circumferential groove 223 in the body, permitting the cylinder sleeve 105 to be shifted downwardly hydraulically to force and retain the latch ring 100 outwardly in the body groove 223, and in that manner releasably securing the running tool 90 to the locator apparatus 220.

A locator guide member 225 is suitably secured to the lower portion of the body, as by means of screws 227, this locator member having a downwardly tapering guide surface 228 for guiding the second tubing string into its oval passage 30*a*, as described hereinbelow. The locator member 225 is secured to the body 221, such that the oval passage 30*a* is a predetermined angular distance from the orienting key 224, as for example, opposite the orienting key. Accordingly, the disposition of the orienting key 224 in the orienting groove 28 will place the oval body passage 30*a* in alignment with the oval passage 30 through the tubing hanger 10.

It is to be noted that the locator sleeve 222 has an inclined cam surface 230 therein extending from its upper end to a longitudinal groove 231, which, as described hereinbelow, has the purpose of guiding the second tubing string 210*a* into its appropriate position through the oval body passage 30*a*. The groove 231 and orienting key 224 lie in the same vertical plane.

The running tool 90 is secured to the lower end of a tubular running string 93, such as drill pipe, and is lowered into the locator sleeve 223 until the latch ring 100 is opposite the body groove 223, whereupon the cylinder sleeve 105 is subjected to fluid pressure and shifted downwardly behind the latch ring, shifting it outwardly into the groove 223 and thereby locking the locator apparatus 220 to the running tool. The running tool is then lowered through the marine riser 20 and into a position in which the lower surface of the locator member 225 engages the upper end of the tubing hanger 10. The running string 93 is then rotated until the orienting key 224 is forced by its spring 147 outwardly into the orienting groove 28 in the connector 22, which will then place the oval body passage 30*a* in appropriate alignment with the oval tubing hanger passage 30, and the groove 231 in the same vertical plane as the groove 28. To insure that the cylinder sleeve 105 will remain in its locked position behind the latch ring 100, a running dart 201 is inserted in the running tool to blank off the ports 116, 120 in the latter leading to the cylinder sleeve. After the second string locator apparatus 220 has been landed and properly oriented, the running dart 201 is retrieved by means of a suitable wireline tool (not shown) and a releasing dart, such as the dart shown in FIG. 4 of U.S. Pat. No. 3,688,841, is lowered through the running string and into the running tool, whereupon the fluid in the running string 93 can be subjected to pressure to effect an upward shifting of the cylinder sleeve 105 from its position behind the latch ring 100. An upward pull can now be taken on the running string 93 which will cause the latch ring 100 to be cammed inwardly from the groove 223, allowing the running tool 90 to be elevated by the running string 93 to the drilling vessel, leaving the second string locator apparatus 220 in its proper oriented position on top of the tubing hanger 10.

The second tubing string 210*a* (FIGS. 4*a*, 4*b*) is then run downwardly through the marine riser 20, the locator 220 and the oval passages 30*a*, 30 into the well bore. This second tubing string may have one or more side pocket mandrels (not shown) thereon, the maximum distance across the tubing string 210*a* and its side pocket mandrel being less than the major axis distance 250 across each of the oval passages. The upper end of the second tubing string 210*a* is threadedly secured to an oval mandrel 251, conforming in shape to the oval passages and with its dimensions slightly less than the corresponding dimensions of the oval passages. The tubing string 210*a* communicates with a mandrel pas-

sage **252** extending longitudinally through the mandrel at the one side thereof, this passage having an upper internal left hand thread **253** and a cylindrical sealing surface **254** above the thread. The mandrel also has a second bore **255** at the other side thereof provided with a lower nipple **256** threadedly secured thereto and having a tapered lower end **257.** This nipple has side ports **258** therethrough for the passage of fluid through the bore **255** and the side ports. The mandrel has a second internal left hand thread **259** in the upper portion of the bore and a sealing surface **260** above such thread.

A cylindrical mandrel running tool **261** has its lower portion inserted in the second string mandrel bore **252** and has an external left hand thread **262** meshing with the internal left hand thread **253,** as well as seal rings **264** sealingly engaging the cylindrical sealing surface **254** of the mandrel **251.** The mandrel running tool **261** also carries a split inherently expansible lock ring **265** engaging the upper surface of a ring **266** resting on the mandrel **251** and retained initially in retracted position by an encompassing mandrel skirt **267** surrounding the upper tapered portion **268** of the lock ring. The ring **266** is prevented from turning by a pin **269** secured to the top of the oval mandrel and extending upwardly through a notch **269***a* in the ring (FIG. **18**). The pin **269** is disposed between the ends of the lock ring **265** to limit the extent of its turning to a few degrees only, the open end **265***a* of the lock ring being prevented from shifting to any substantial extent laterally of the axis of the passage **252** by a pair of spaced vertical pins **269***b* secured to the upper end of the mandrel **251** and disposed externally of the lock ring to be engaged thereby, as disclosed in FIG. **18,** when the ring has been expanded outwardly into engagement with a companion arcuate lock groove **400** in the second oval passage **30** and which is disposed at one end portion of the oval passage.

The mandrel running tool **261** has an upper reduced diameter portion **269** extending through an orientation guide frame **270** that rests upon an upwardly facing shoulder **271** of the running tool, this guide frame having the upper end of an annulus pin or rod **272** firmly secured thereto and extending into the second bore **255** of the oval mandrel. The guide frame carries a guide member **273** having an enlarged opening **274** receiving the central hub part **275** of the guide frame (FIG. **14**) and which can shift laterally of the hub in several directions and pivot to a limited extent about the axis of a vertical pin **276** fixed to the guide member **273** and extending into a transverse slot **277** in the guide frame. The guide assembly has an orienting lug **278** at one side thereof opposite the mandrel running tool **261** for coaction with the cam surface **230** of the second string locator sleeve **222.** This lug can slide downwardly along the cam surface, and in so doing will turn the entire apparatus, including the running tool **261,** pin **272** and mandrel **251** within the locator sleeve **222** until the guide lug **278** slides down into the longitudinal groove **231** in the locator sleeve, at which time the oval mandrel **251** is in appropriate alignment with the oval passage **30***a* through the locator member **225.** Some lateral shifting can occur, and also relative turning, between the running tool **261,** diaphragm **270** and the rod **272** with respect to the guide member **273,** because of the enlarged opening **274** in the guide member and the transverse slot **277** receiving the pin **276** to permit the turning of the oval mandrel **251** into its position of alignment with the oval passage **30***a*. Such shifting insures that the oval mandrel **251** will be turned into the position of alignment with the oval passage **30***a* despite the fact that it may have reached the upper end of the locator sleeve **222** in a position in which the orienting lug **278** is disposed about 180° from the vertical orienting groove **231** in the locator sleeve **222.**

The oval mandrel **271** passes through the oval passage **30***a* in the locator member **225** and into the oval passage **30** of the tubing hanger, until a flange **401** on the oval mandrel comes to rest on a companion seat **402** in the tubing hanger, as disclosed in FIGS. **5***a* and **5***b*. At this time, the nipple **256** will be disposed below the passage **30,** and side seals **403** on the oval mandrel will be in sealing engagement with a sealing surface **404** in the passage **30** above its seat **402.** Rotation of the running string **405** secured to the upper end of the running tool **261** to the right to a small extent, such as a single turn, partially unthreads the lower portion **262** of the running tool from the left-hand thread **253** in the mandrel bore **252,** elevating the skirt **267** from the lock ring **264** and permitting it to expand outwardly inherently into the lock groove **400** in the tubing hanger. The open or split end **265***a* of the lock ring will face outwardly toward the opposite end of the oval passage **30,** with more than 180° of the lock ring disposed within the companion arcuate lock groove **400,** the lock ring **265** extending partially across the mandrel **251** to prevent its upward movement within the tubing hanger (FIGS. **6, 7, 8, 15, 18**). The running string **405** and running tool **261** are then turned to a further extent to the right to completely unthread the running mandrel **261** from the oval mandrel **251,** permitting the running tool and the orienting assembly carried thereby, as well as the rods **272,** to be elevated through the marine riser **20** to the drilling vessel.

A running tool **90** is then lowered on the running string **93** through the marine riser and into the locator **220,** with the cylinder sleeve **105** in its upper position, the latch ring **100** being retracted, until the clutch **128** engages the shoulder **222** on the upper end of the locator body **221.** An appropriate dart (not shown) is then run through the running string **93** and inserted in the running tool body **94,** for pressure to be applied through the upper ports **16,** forcing the cylinder sleeve **105** downwardly behind the latch ring **100** and expanding it outwardly into the groove **223,** thereby coupling the second string locator apparatus **220** to the running tool. The running string **93** is now elevated to elevate the running tool and the locator apparatus connected thereto through the marine riser **20** to the drilling vessel.

The second tubing string **210***a* with its side pocket mandrels thereon has thus been installed in the well bore, hanging appropriately from the tubing hanger **10** alongside the first tubing string **210** that was lowered in the well bore together with the tubing hanger itself.

First and second strings of tubing **300, 301** can now be lowered from the drilling vessel and appropriately related to the first and second passages **29, 30** through the hanger body **10** and through the hanger mandrel **251** (FIG. **6**). These tubing strings have lower portions **302, 303** threadedly secured, as by left hand threads **304, 305,** in parallel bores through an orienting member **306** having an orienting lug **307** related to the tubing strings **300, 301** in the same manner as the passage **29, 30** through the tubing hanger **10** are related to the

coupling orienting groove **208.** The member **306** carries a lower ring **308** adapted to bear upon the tubing hanger **10,** the member **306** being capable of turning around the ring **308** because of a swivel connection therewith provided by a split ring **309** received in opposed grooves **310** in the ring and member, a bearing **311** being disposed between the member **306** and ring **308.** The assembly of tubing **300, 301,** body member **306** and ring **308** is then lowered through the marine riser **20** until the ring **308** rests on top of the tubing hanger **10,** after which the tubing strings **300, 301** are turned, as to the right, until the orienting lug **307** snaps out into the orienting groove **28,** which will insure the appropriate alignment of the first tubing string **300** with the first passage **29,** and of the second tubing string **301** with the passage **252** through the oval mandrel **251.**

Each tubing string is then rotated to the right to unthread it from the orienting member **306,** thereby disconnecting the tubing strings from the member, whereupon each tubing string can be lowered until its lower threaded pin, which has the left hand thread thereon, is in threaded mesh with the internal threads **315** in the respective bores **29, 252,** whereupon continued left hand rotation fully secures the lower portion of each tubing string **300, 301** to the companion internally threaded box in the tubing hanger and in the oval bore, at which time suitable side seals **316** on the lower portions of each tubing string are engaged in the cylindrical seal bores **317** of the tubing hanger and mandrel, the parts then being in the position illustrated in FIG. **7.**

If the blowout preventer stack **19** is to be removed and a Christmas tree installed, suitable plugs (not shown) can be lowered through the tubing strings **300, 301** and set in the landing nipple portions **318, 319** of the first and second passages **29, 252,** as well as in the landing nipple portion **320** of the third passage **255** through the oval mandrel **251.** It is noted that each of these landing nipple portions has a groove **321** therein and a sealing surface **322** therebelow for receiving a suitable blanking plug that is releasably locked in the landing nipple portion, so as to close off the tubing string therebelow. These blanking plugs can be of the type manufactured by Baker Oil Tools, Inc. or by Otis Engineering Corporation, such plugs being well known in the industry. Upon installation of the plugs, the tubing strings **300, 301** can be rotated to the right and released from the tubing hanger **10** and the oval mandrel **251** and withdrawn, with the orienting member **306,** to the drilling vessel, whereupon the blowout preventer stack **19** can be disconnected and removed. A suitable Christmas tree (not shown) can be mounted in place in a known manner in appropriate relation to the tubing hanger **10** and its bores, the Christmas tree having provisions thereon for tubing sealing within the several passages **29, 252, 255.**

In the event that the well production is to be gas lifted through the second tubing string **210***a* and through the Christmas tree assembly, gas under pressure can be pumped down through the nipple **256** flowing out through its perforations **258** into the well casing, the gas passing through the gas lift valves in the side pocket mandrels for the purpose of elevating the production in the second tubing string **210***a* to the top of the well bore, all in a known manner.

I claim:

1. In apparatus to be located in a hanger disposed above a well bore: hanger body means adapted to be seated in the hanger and having a plurality of passages therein for tubing strings to be disposed in the well bore, a first of said passages being communicable with a first tubing string, a second of said passages being of oval cross-section; a mandrel of oval cross-section adapted to be seated in said second passage and adapted to support a second tubing string disposed in the well bore, said mandrel having a third passage communicating with said second tubing string and a fourth passage establishing communicating between a region above said mandrel and a region below said mandrel externally of said second tubing string.

2. In apparatus as defined in claim **1;** said second tubing string including a side pocket mandrel establishing communication between the interior and exterior of said second tubing string, the distance across said second tubing string and its side pocket mandrel being less than the major diameter of said oval passage to permit passage of said second tubing string through said oval passage.

3. In apparatus as defined in claim **1;** and means for orienting said oval mandrel relative to said oval passage for movement of said oval mandrel into said oval passage.

4. In apparatus as defined in claim **1;** and means for orienting said oval mandrel relative to said oval passage for movement of said oval mandrel into said oval passage; said orienting means including a locator adapted for lowering to a position above and adjacent to said hanger body means and oriented in a predetermined position with respect to said oval passage; a running tool secured to the upper portion of said mandrel for lowering said mandrel in said locator; and coengageable means on said running tool and locator for turning said mandrel in said locator, as said running tool lowers said mandrel in said locator, to a position of alignment of said mandrel with said oval passage for movement of said mandrel into said oval passage.

5. In apparatus as defined in claim **1;** and means for orienting said oval mandrel relative to said oval passage for movement of said oval mandrel into said oval passage; said orienting means including a locator adapted for lowering to a position above and adjacent to said hanger body means and oriented in a predetermined position with respect to said oval passage; a running tool secured to the upper portion of said mandrel for lowering said mandrel in said locator; and coengageable means on said running tool and locator for turning said mandrel in said locator, as said running tool lowers said mandrel in said locator, to a position of alignment of said mandrel with said oval passage for movement of said mandrel into said oval passage, said coengageable means on said running tool and locator comprising an orienting device on said running tool, and a downwardly inclined cam surface in said locator engaged by said orienting device to turn said mandrel to said position of alignment as said running tool lowers said orienting device and mandrel in said locator.

6. In apparatus as defined in claim **1;** and means for orienting said oval mandrel relative to said oval passage for movement of said oval mandrel into said oval passage; said orienting means including a locator adapted for lowering to a position above and adjacent to said hanger body means and oriented in a predetermined position with respect to said oval passage; a running

tool secured to the upper portion of said mandrel for lowering said mandrel in said locator; and coengageable means on said running tool and locator for turning said mandrel in said locator, as said running tool lowers said mandrel in said locator, to a position of alignment of said mandrel with said oval passage for movement of said mandrel into said oval passage, said coengageable means on said running tool and locator comprising an orienting device on said running tool, and a downwardly inclined cam surface in said locator engaged by said orienting device to turn said mandrel to said position of alignment as said running tool lowers said orienting device and mandrel in said locator, said orienting device including means extending into said fourth passage, whereby said running tool, mandrel and orienting device turn as a unit in said locator.

7. In apparatus as defined in claim **1**; and means for orienting said oval mandrel relative to said oval passage for movement of said oval mandrel into said oval passage; said orienting means including a locator adapted for lowering to a position above and adjacent to said hanger body means and oriented in a predetermined position with respect to said oval passage; a running tool secured to the upper portion of said mandrel for lowering said mandrel in said locator; and coengageable means on said running tool and locator for turning said mandrel in said locator, as said running tool lowers said mandrel in said locator, to a position of alignment of said mandrel with said oval passage for movement of said mandrel into said oval passage; said locator including guide means engaged by the second tubing string to direct the second tubing string into said second passage.

8. In apparatus as defined in claim **1**; and means for orienting said oval mandrel relative to said oval passage for movement of said oval mandrel into said oval passage; said orienting means including a locator adapted for lowering to a position above and adjacent to said hanger body means and oriented in a predetermined position with respect to said oval passage; a running tool secured to the upper portion of said mandrel for lowering said mandrel in said locator; and coengageable means on said running tool and locator for turning said mandrel in said locator, as said running tool lowers said mandrel in said locator, to a position of alignment of said mandrel with said oval passage for movement of said mandrel into said oval passage; said locator including guide means engaged by the second tubing string to direct the second tubing string into said second passage; said guide means having an oval passage aligned with said second passage and in which the second tubing string and mandrel pass for movement of the mandrel into said oval passage.

9. In apparatus to be disposed in a hanger located above a well bore and to be oriented in a predetermined angular position relative to a reference member above the well bore; hanger body means adapted to be seated in the hanger and having a plurality of passages therein for tubing strings to be disposed in the well bore, a first of said passages being communicable with a first tubing string, a second of said passages being of oval cross section; a running tool adapted to be secured to a running string, said running tool having a first orienting member engageable with the reference member to place said running tool in a predetermined angular position relative to the reference member; means releasably securing said running tool to said hanger body means for lowering said hanger body means into the hanger; means interconnecting said hanger body means and running tool for retaining said hanger body means in a predetermined angular position relative to said running tool, whereby to locate said hanger body means and its oval passage at a predetermined angular position relative to the reference member when said orienting member is engaged therewith; a mandrel of oval cross section adapted to be seated in said second passage and adapted to support a second tubing string disposed in the well bore, said mandrel having a third passage communicable with the second tubing string and a fourth passage establishing communicating between a region above said mandrel and a region below said mandrel externally of the second tubing string.

10. In apparatus as defined in claim **9**; a locator; a second running tool adapted to be secured to a running string and releasably secured to said locator for lowering said locator to a position above and adjacent to said hanger body means; said locator having a second orienting member engageable with the reference member to place said locator in a predetermined position with respect to said oval passage; a third running tool secured to the upper portion of said mandrel for lowering said mandrel in said locator; and coengageable means on said third running tool and locator for turning said mandrel in said locator, as said third running tool lowers said mandrel in said locator, to a position of alignment of said mandrel with said oval passage for movement of said mandrel into said oval passage.

11. In apparatus as defined in claim **9**; a locator; a second running tool adapted to be secured to a running string and releasably secured to said locator for lowering said locator to a position above and adjacent to said hanger body means; said locator having a second orienting member engageable with the reference member to place said locator in a predetermined position with respect to said oval passage; a third running tool secured to the upper portion of said mandrel for lowering said mandrel in said locator; and coengageable means on said third running tool and locator for turning said mandrel in said locator, as said third running tool lowers said mandrel in said locator, to a position of alignment of said mandrel with said oval passage for movement of said mandrel into said oval passage, said third running tool being releasably secured to said mandrel for release and removal from said mandrel after seating of said mandrel in said second passage.

12. In apparatus as defined in claim **9**; a locator; a second running tool adapted to be secured to a running string and releasably secured to said locator for lowering said locator to a position above and adjacent to said hanger body means; said locator having a second orienting member engageable with the reference member to place said locator in a predetermined position with respect to said oval passage; a third running tool secured to the upper portion of said mandrel for lowering said mandrel in said locator; and coengageable means on said third running tool and locator for turning said mandrel in said locator, as said third running tool lowers said mandrel in said locator, to a position of alignment of said mandrel with said oval passage for movement of said mandrel into said oval passage; said coengageable means on said third running tool and locator comprising an orienting device on said third running tool, and a downwardly inclined cam surface in said locator engaged by said orienting device to turn

said mandrel to said position of alignment as said third running tool lowers said orienting device and mandrel in said locator.

13. In apparatus as defined in claim 9; a locator; a second running tool adapted to be secured to a running string and releasably secured to said locator for lowering said locator to a position above and adjacent to said hanger body means; said locator having a second orienting member engageable with the reference member to place said locator in a predetermined position with respect to said oval passage; a third running tool secured to the upper portion of said mandrel for lowering said mandrel in said locator; and coengageable means on said third running tool and locator for turning said mandrel in said locator, as said third running tool lowers said mandrel in said locator, to a position of alignment of said mandrel with said oval passage for movement of said mandrel into said oval passage; said coengageable means on said third running tool and locator comprising an orienting device on said third running tool, and a downwardly inclined cam surface in said locator engaged by said orienting device to turn said mandrel to said position of alignment as said third running tool lowers said orienting device and mandrel in said locator, said orienting device including means extending into said fourth passage, whereby said third running tool, mandrel and orienting device turn as a unit in said locator.

14. In apparatus as defined in claim 9; a locator; a second running tool adapted to be secured to a running string and releasably secured to said locator for lowering said locator to a position above and adjacent to said hanger body means; said locator having a second orienting member engageable with the reference member to place said locator in a predetermined position with respect to said oval passage; a third running tool secured to the upper portion of said mandrel for lowering said mandrel in said locator; and coengageable means on said third running tool and locator for turning said mandrel in said locator, as said third running tool lowers said mandrel in said locator, to a position of alignment of said mandrel with said oval passage for movement of said mandrel into said oval passage; said locator including guide means engaged by the second tubing string to direct the second tubing string into said second passage.

15. In apparatus as defined in claim 9; a locator; a second running tool adapted to be secured to a running string and releasably secured to said locator for lowering said locator to a position above and adjacent to said hanger body means; said locator having a second orienting member engageable with the reference member to place said locator in a predetermined position with respect to said oval passage; a third running tool secured to the upper portion of said mandrel for lowering said mandrel in said locator; and coengageable means on said third running tool and locator for turning said mandrel in said locator, as said third running tool lowers said mandrel in said locator, to a position of alignment of said mandrel with said oval passage for movement of said mandrel into said oval passage; said locator including guide means engaged by the second tubing string to direct the second tubing string into said second passage, said guide means having an oval passage aligned with said second passage and through which the second tubing string and mandrel pass for movement of said mandrel into said oval passage.

16. In apparatus to be located in a hanger disposed above a well bore: hanger body means adapted to be seated in the hanger and having a plurality of passages therein for tubing strings to be disposed in the well bore, a first of said passages being communicable with a first tubing string; a mandrel adapted to be seated in a second of said passages and adapted to support a second tubing string disposed in the well bore, said mandrel having a third passage communicable with said second tubing string and a fourth passage establishing communication between a region above said mandrel and a region below said mandrel externally of said second tubing string; means for orienting said mandrel relative to said second passage for movement of said mandrel into said second passage; said orienting means including a locator adapted for lowering to a position above and adjacent to said hanger body means and oriented in a predetermined position with respect to said second passage; a running tool secured to the upper portion of said mandrel for lowering said mandrel in said locator; and coengageable means on said running tool and locator for turning said mandrel and said locator, as said running tool lowers said mandrel in said locator, to a position of alignment of said mandrel with said second passage for movement of said mandrel into said second passage.

17. In apparatus as defined in claim 16; said coengageable means on said running tool and locator comprising an orienting device on said running tool, and a downwardly inclined cam surface in said locator engaged by said orienting device to turn said mandrel to said position of alignment as said running tool lowers said orienting device and mandrel in said locator.

18. In apparatus as defined in claim 16; said coengageable means on said running tool and locator comprising an orienting device on said running tool, and a downwardly inclined cam surface in said locator engaged by said orienting device to turn said mandrel to said position of alignment as said running tool lowers said orienting device and mandrel in said locator, said orienting device including means extending into said fourth passage, whereby said running tool, mandrel and orienting device turn as a unit in said locator.

19. In apparatus as defined in claim 16; said locator including guide means engaged by the second tubing string to direct the second tubing string into said second passage.

20. In apparatus to be disposed in a hanger located above a well bore and to be oriented in a predetermined angular position relative to a reference member above the well bore: hanger body means adapted to be seated in the hanger and having a plurality of passages therein for tubing strings to be disposed in the well bore, a first of said passages being communicable with a first tubing string, a second of said passages being adapted to receive a second tubing string; a running tool adapted to be secured to a running string, said running tool having a first orienting member engageable with the reference member to place said running tool in a predetermined angular position relative to the reference member; means releasably securing said running tool to said hanger body means for lowering said hanger body means into the hanger; means interconnecting said hanger body means and running tool for retaining said hanger body means in a predetermined angular relation to said running toool, whereby to locate said hanger body means and its second passage at

a predetermined angular relation relative to the reference member when said orienting member is engaged therewith; a mandrel adapted to be seated in said second passage and adapted to support the second tubing string disposed in the well bore, said mandrel having a third passage communicable with the second tubing string and a fourth passage establishing communication between a region above said mandrel and a region below said mandrel externally of the second tubing string; a locator; a second running tool adapted to be secured to a running string and releasably secured to said locator for lowering said locator to a position above and adjacent to said hanger body means; said locator having a second orienting member engageable with the reference member to place said locator in a predetermined position with respect to said second passage; a third running tool secured to the upper portion of said mandrel for lowering said mandrel in said locator; and coengageable means on said third running tool and locator for turning said mandrel in said locator as said third running tool lowers said mandrel in said locator to a position of alignment of said mandrel with said second passage for movement of said mandrel into said second passage.

21. In apparatus as defined in claim **20**; said third running tool being releasably secured to said mandrel for release and removal from said mandrel after seating of said mandrel in said second passage.

22. In apparatus as defined in claim **20,** said third running tool being releasably secured to said mandrel for release and removal from said mandrel after seating of said mandrel in said second passage; said coengageable means on said third running tool and locator comprising an orienting device on said third running tool, and a downwardly inclined cam surface in said locator engaged by said orienting device to turn said mandrel to said position of alignment as said third running tool lowers said orienting device and mandrel in said locator.

23. In apparatus as defined in claim **20,** said third running tool being releasably secured to said mandrel for release and removal from said mandrel after seating of said mandrel in said second passage; said coengageable means on said third running tool and locator comprising an orienting device on said third running tool, and a downwardly inclined cam surface in said locator engaged by said orienting device to turn said mandrel to said position of alignment as said third running tool lowers said orienting device and mandrel in said locator, said orienting device including means extending into said fourth passage, whereby said third running tool, mandrel and orienting device turn as a unit in said locator.

24. In apparatus as defined in claim **20**; said locator including guide means engaged by the second tubing string to direct the second tubing string into said second passage.

25. In apparatus as defined in claim **20**; said locator including guide means engaged by the second tubing string to direct the second tubing string into said second passage; said coengageable means on said third running tool and locator comprising an orienting device on said third running tool, and a downwardly inclined cam surface in said locator engaged by said orienting device to turn said mandrel to said position of alignment as said third running tool lowers said orienting device and mandrel in said locator.

* * * * *