United States Patent [19]

Dufrene

[11] **3,867,984**

[45] **Feb. 25, 1975**

[54] **TUBING PLUG**

[76] Inventor: **Alex Dufrene,** P.O. Box 194, Des Allemands, La. 70030

[22] Filed: **Sept. 10, 1973**

[21] Appl. No.: **396,091**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 308,327, Nov. 21, 1972, Pat. No. 3,809,157.

[52] **U.S. Cl.** **166/188,** 166/196

[51] **Int. Cl.** **E21b 33/128**

[58] **Field of Search** 166/185, 188, 196, 202, 166/133; 277/116.2, 116.4

[56] **References Cited**

UNITED STATES PATENTS

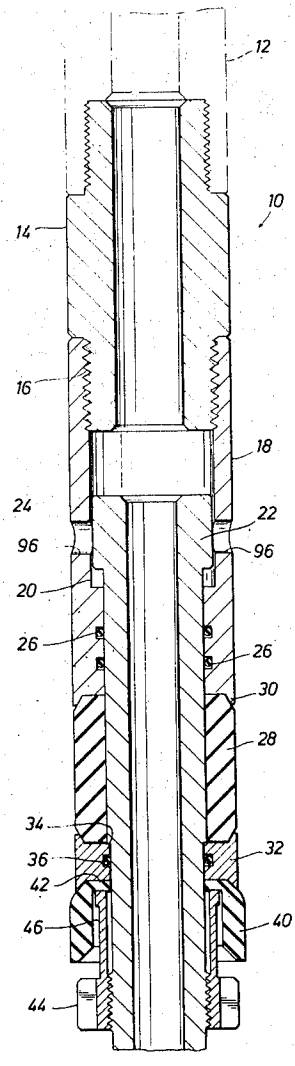
1,145,155	7/1915	Mack	166/196
1,972,791	9/1934	Otis	166/133
2,139,983	12/1938	Stone	166/133
2,230,447	2/1941	Bassinger	166/196
3,215,208	11/1965	Tamplen	166/196
3,283,823	11/1966	Warrington	166/196
3,433,303	3/1969	Clark, Jr. et al.	166/196

Primary Examiner—James A. Leppink
Attorney, Agent, or Firm—Donald Gunn

[57] **ABSTRACT**

A plug suitable for use in a tubing string which incorporates an elongate body formed of a slidable inner mandrel which moves a spacer ring mounted on the exterior, the spacer ring expanding a resilient pack-off element adjacent a fixed external mandrel. The apparatus is set by upward flow in the tubing string wherein upward flow forces the inner mandrel upward. A check valve arrangement is attached to the lower end of the inner mandrel. A lateral relief valve is included so that a release tool can reduce the pressure differential acting across the plug. An alternative embodiment of the plug is disclosed which includes a spring arranged between the inner and outer mandrels which spring enables the mandrels to set the plug without the necessity of downhole pressure which forces the inner mandrel upwardly in the first embodiment.

8 Claims, 8 Drawing Figures



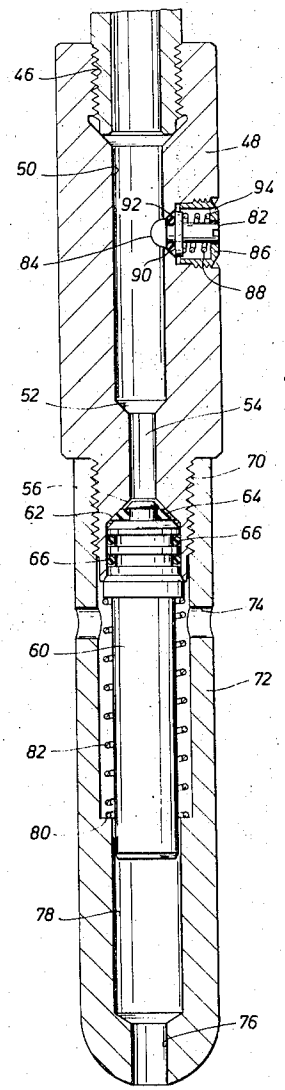


FIG. 1A

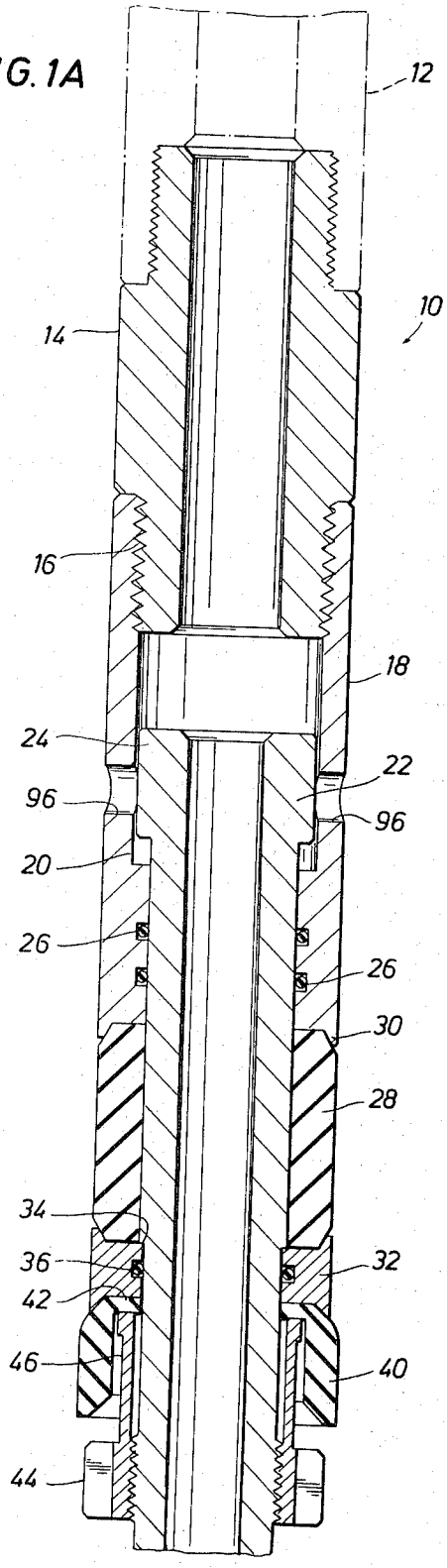
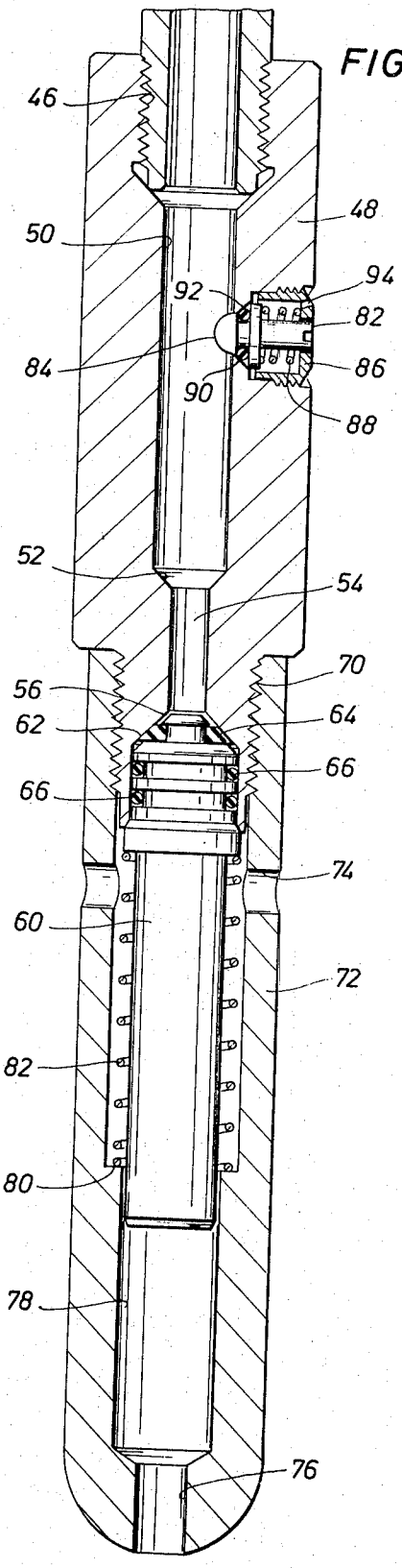

12
10
14
16
18
24
22
96
96
20
26
26
30
28
34
36
32
42
46
40
44

FIG. 1B


46
48
50
94
92
82
84
86
90
88
52
54
70
56
64
62
66
66
74
60
72
82
80
78
76

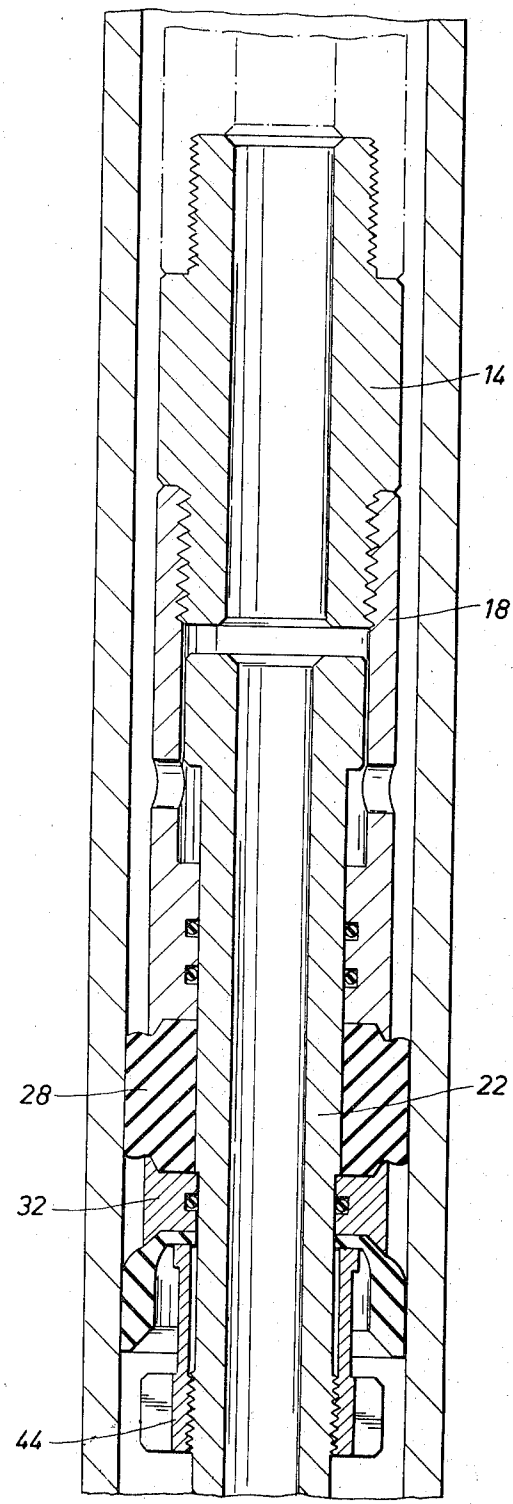


FIG. 2

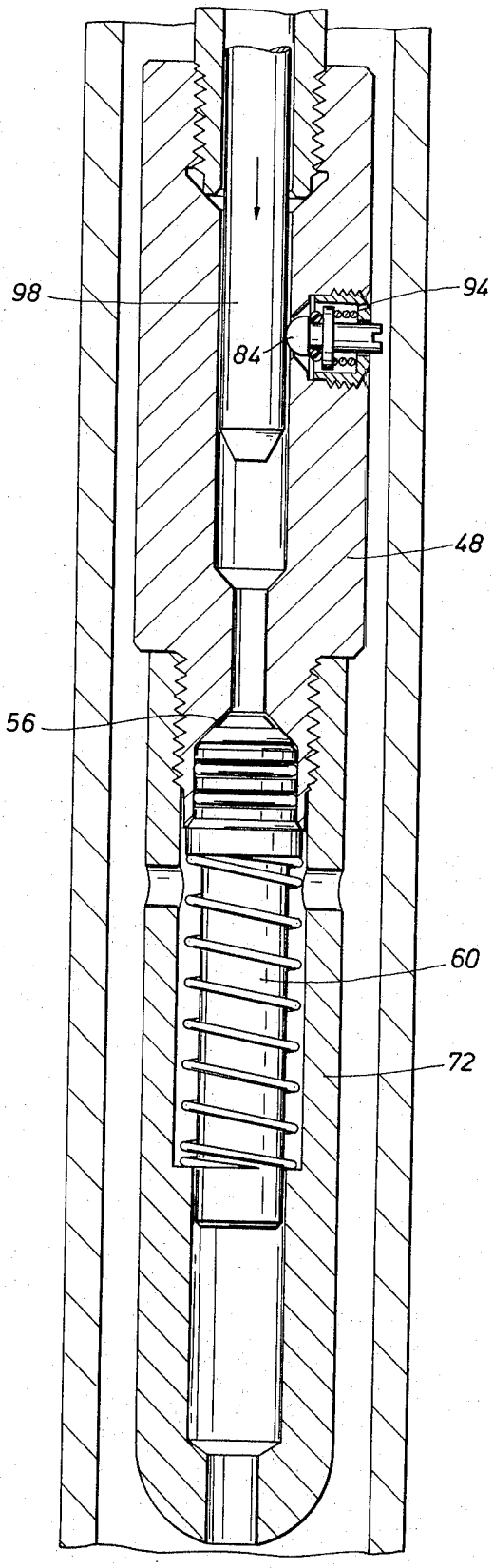


FIG. 3

FIG.4A

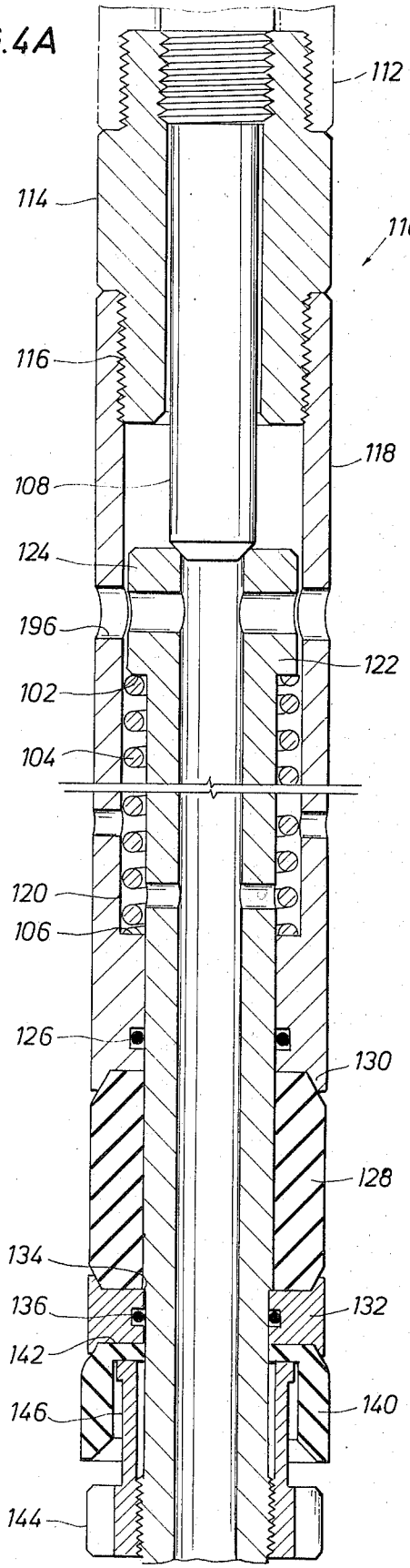

112
114
110
116
118
108
124
196
122
102
104
120
106
126
130
128
134
136
132
142
140
146
144

FIG.4B

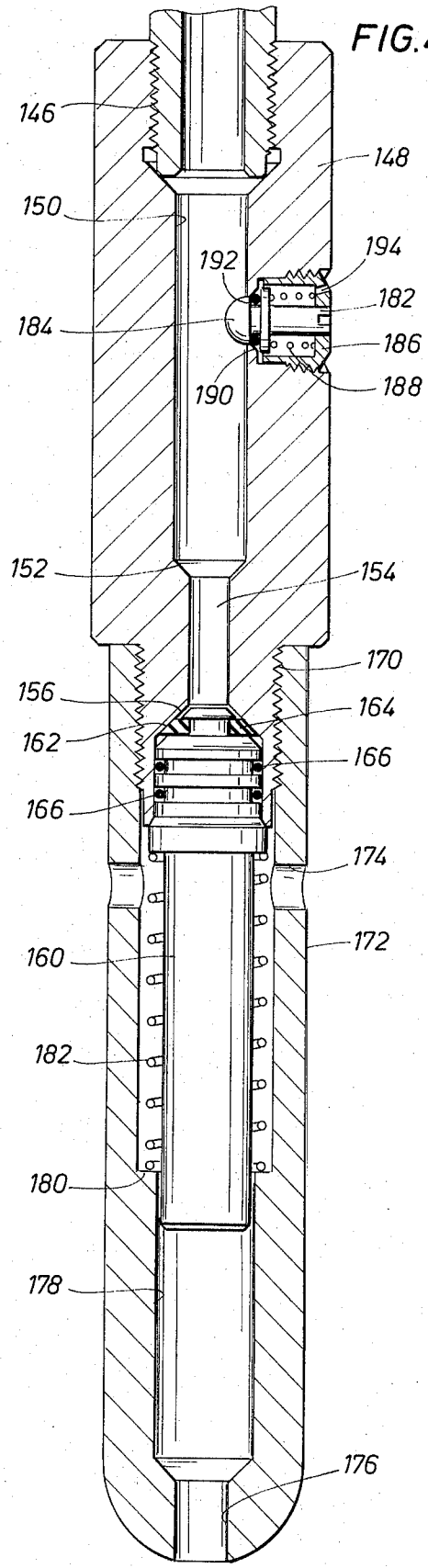

146
148
150
192
194
182
184
186
190
188
152
154
170
156
164
162
166
166
174
172
160
182
180
178
176

FIG.5

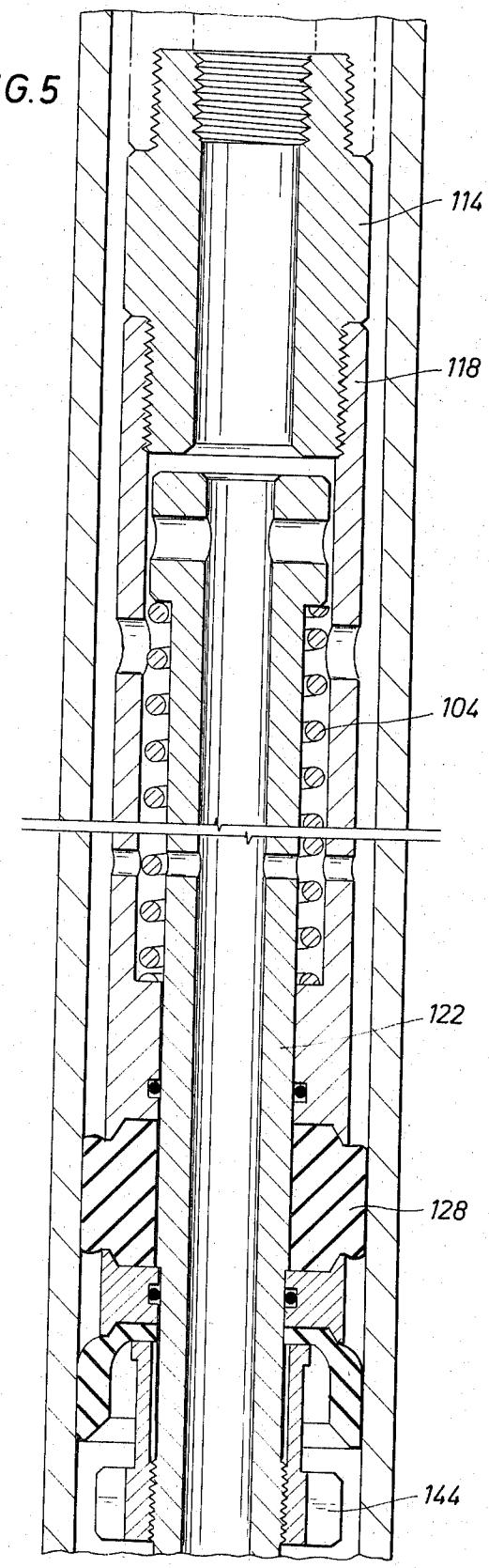
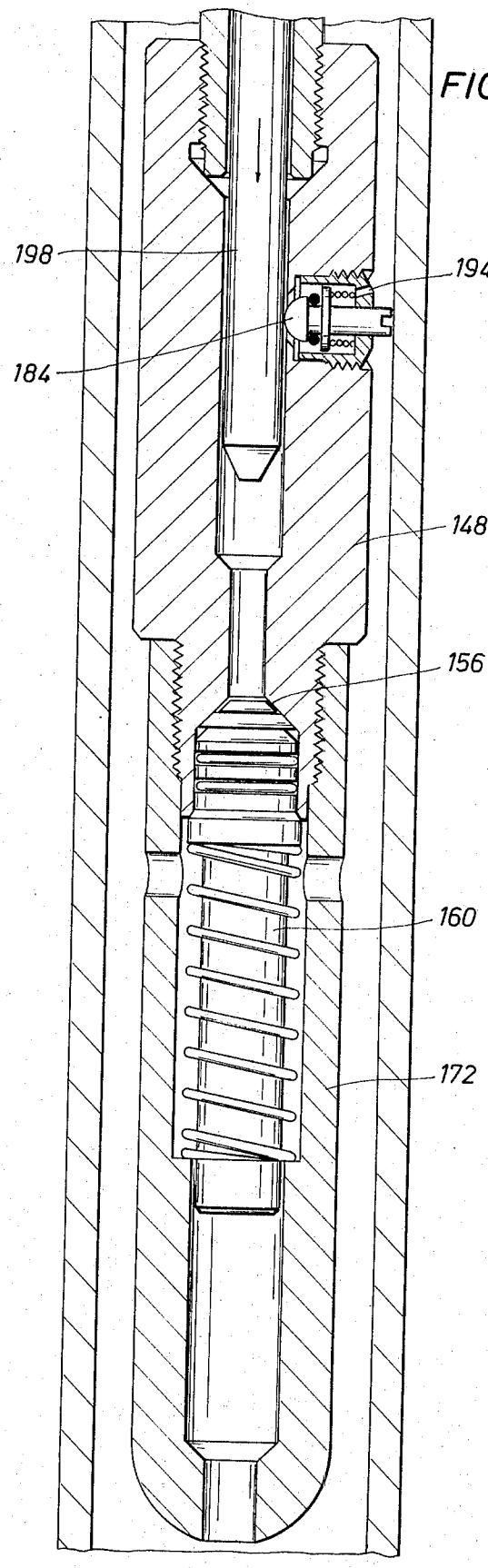


FIG.6



TUBING PLUG

This application is a continuation-in-part of Ser. No. 308,327, filed Nov. 21, 1972, now U.S. Pat. No. 3,809,157.

BACKGROUND OF THE INVENTION

In production of oil wells, it is sometimes necessary to place a plug in a tubing string. Plugging a tubing string is measurably different from placing a plug in an open bore or in a drill pipe. Normally, a tubing string is quite narrow in comparison with an open hole or cased hole, and it is generally undesirable to set metal slips in a tubing string in view of the potential for damaging the sidewall of the tubing.

Leakage past a plug is a critical factor. Often, a plug is placed in a tubing string to test for leaks at other places in the production equipment. Leakage past the plug in the tubing string is extremely undesirable because it will cloud the results of the test. Accordingly, the present invention has been provided as a means of plugging a tubing string with a minimum of leakage. The device is believed successful wherein previous attempts have failed.

SUMMARY OF THE PRESENT INVENTION

The present invention is summarized as incorporating a plug which is particularly adapted to be used in a tubing string. The plug incorporates a pair of telescoped mandrels. The outer mandrel is adapted to be connected by means of a crossover with a tubing lock to be run in a tubing string. The outer mandrel abuts at its lower end a rubber packing element. The packing element is in the form of a resilient cup which is fitted about an inner mandrel. The inner mandrel has a down or relaxed position and an up position which carries a spacer ring against the pack-off element to expand the cup. The lower mandrel is movable in response to bottom hole pressure. The lower mandrel incorporates a valve cage which surrounds a check valve mechanism. The check valve mechanism permits pumping down through the tool but not up through the plug. In addition, a lateral relief port is provided in the wall of the lower mandrel. This permits a release tool to be run into the plug of the present invention, actuating the lateral relief passage. An alternative embodiment is arranged between facing shoulders.on the inner mandrel and the outer mandrel. When released, the spring forces the shoulders apart, thereby compressing the rubber packing element and thereby expanding it to close the passage.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A and 1B jointly show the full length of the tubing plug of the present invention in sectional view, thereby illustrating the internal details of construction;

FIG. 2 is a view similar to FIG. 1A showing the tool of the present invention actuated and plugging the tubing string;

FIG. 3 is a view similar to FIG. 2 showing a release tool inserted into the plug of the present invention to release it from the plug position of FIG. 2;

FIG. 4A and 4B jointly show the full length of an alternative embodiment of the tubing plug in sectional view, thereby illustrating internal details of construction;

FIG. 5 is a view similar to FIG. 4A showing the alternative embodiment of the present invention actuated and plugging the tubing string; and

FIG. 6 is a view similar to FIG. 3 showing a release tool inserted into the plug of the present invention to release it from the plug position of FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the drawings, the numeral **10** generally indicates the plug of the present invention. It is adapted to be run in on a connector **12**, and is adapted to be placed in a tubing string. The tool of the present invention is preferably run in below a tubing joint or pre-set nipple, one suitable version thereof being manufactured by Baker Oil Tools and bearing the model designation "TS2" tubing joint lock. Camco also manufactures suitable lock or stop equipment for use with the present invention. The lock or stop apparatus is located above the tool of the present invention which constitutes the bottom most installation of the apparatus used for running it into the tubing string.

The plug **10** of the present invention incorporates a crossover **14** which is a double ended, threaded adapter for interconnection with the apparatus located thereabove. The lower portion of the crossover **14** threadedly connects at **16** to the outer mandrel **18.** The outer mandrel is threaded internally as illustrated in FIG. 1A. The outer mandrel is hollow through its center and includes an upwardly facing shoulder **20** which assists in assembly of the tool. The outer mandrel **18** surrounds an inner mandrel **22** which has an enlargement at **24** which cannot pass below the shoulder **20.** This is more amply illustrated in FIG. 1A. The enlargement **24** fits within the outer mandrel **18** in a manner to permit upward movement of the inner mandrel **22.**

The outer mandrel **18** fits snuggly about the inner mandrel **22** and a seal means **26** is found at two locations below the shoulder **20.** In the preferred embodiment, the seal means preferably incorporates an O-ring of resilient material placed in an encircling groove.

The inner mandrel **22** has a lower portion which supports a sliding, resilient cup or pack-off element **28.** The cup member **28** is tubular and is telescoped over the mandrel. The rubber or resilient cup abuts against the outer mandrel **18.** The outer mandrel **18** overlaps slightly at an overhanging shoulder **30** which tends to capture the cup member **28.** The cup **28** is abutted at its lower end by a spacer ring **32** which is held in position on the inner mandrel **22** at a small shoulder **34.** The shoulder **34** faces downwardly and secures the thimble **32** in position. The spacer ring **32** incorporates an internal annular groove which receives an O-ring seal member **36.**

A downwardly directed swab cup **40** is position below the thimble **32.** It has an internally directed lip **42.** A jam or keeper nut **44** is threaded on the exterior of the mandrel **22.** The jam nut **44** has a skirt **46** which extends upwardly into the cup **40** and abuts the internal lip **42.** It cooperates with the ring **32** to pinch the swab cup **40** and hold it in position. The jam nut **44** provides the relative upward force acting on the lower side of the resilient pack-off element **28** as will be described hereinafter.

The inner mandrel **22** is shown in FIG. 1B terminating at a threaded connection **46** into an equalizing sub **48.** The sub **48** has a central axial passage **50** which

narrows at a shoulder **52** in the lower portions of the sub **48.** The central passage is smaller below the shoulder **52.** The smaller passage is indicated by the numeral **54.** The passage **54** extends downwardly to a valve seat **56.** The valve seat **56** abuts against a valve element **60** which is carried on an elongate body and which has a contoured truncated conical face **62** at its upper edge. The conical face **62** is interrupted to receive a seal washer **64.** The valve body **60** has an appropriate number of seal members, preferably resilient O-rings received in annular grooves, as indicated at **66.**

The sub **48** includes the valve seat **56** which flares outwardly to a countersunk, enlarged passage which snuggly receives the upper end of the valve element **60.** The lower portions of the sub **48** include a threaded, interconnection **70** which enables joinder of a lower valve cage **72** to the sub **48.**

The valve cage **72** is a generally hollow, cylindrical body which is drilled at several locations such as **74** and **76** to receive fluid flow into an internal passage **78.** The passage **78** incorporates an upwardly facing shoulder **80** and a resilient coil spring **82** is positioned about the valve element **60** and bears on the shoulder **80** and the valve element **60** to force the element upwardly into contact with the valve seat **56.** As will be observed, fluid flow is permitted downwardly through the passage **50** and past the check valve arrangement shown in FIG. **1B.** Fluid flow exists from the valve cage **72** through the passages **74** and **76.** The fluid flow in that direction must overcome the bias of the spring **82.** However, flow in the opposite direction is prevented by the check valve arrangement illustrated.

The sub **48** incorporates a pressure relief valve which protrudes into the passage **50.** It incorporates a stem **82** which has a semicircular enlargement **84** protruding into the passage **50.** A hollow threaded nut **86** surrounds a compressed coil spring **88.** The spring **88** forces the shaft **82** to the left. The shaft supports a seal member **90** which is sealed against a tapered circular shoulder **92.** A flow path from the exterior is created when the shaft or stem **82** is forced to the right, opening the seal member **90** from the tapered shoulder and permitting the flow of pressure fluid through the hollow nut **88** and externally through a small port **94.**

The numeral **96** in FIG. **1A** identifies facing ports in the outer sub **18.** The ports **96** preferably align to enable insertion of a tool for purposes of assembly. The ports **96** do not function in the operation of the well plug.

Referring to FIG. **2,** the anchor tool relatively forces the outer mandrel **18** downwardly. The inner mandrel **22** moves upwardly carrying with it the keeper nut **44** which forces the ring **32** upwardly and against the resilient member **28.** The resilient member **28** expands and comes into sealing contact with the tubing string. The upward range of travel is limited by contact of the upper end of the inner mandrel **22** against the lower end of the crossover sub **14.** At this juncture, the tool had been expanded and has closed off the tubing string. It is maintained in this position by pressure from below in the tubing string. The running in tool can then be retrieved and removed.

Attention is directed to FIG. **3** where a retrievable tool **98** is shown. It incorporates a body which fits fairly sungly within the passage **50** in the sub **48.** It also carries an elongate probe which fits through the narrow passage **54** and contacts against the shoulder **52.** The retrieval tool **98** is preferably sized in dimension so that the bypass valve mechanism is first operated. The enlargement **84** is forced to the right as illustrated in FIG. **3,** clearing the check valve mechanism and permitting pressure to flow from the exterior to the interior of the tool. The small port **94** assures a relatively slow flow so that there is no sudden surge. At this juncture, the running in tool can be retrieved along with the plug inasmuch as the resilient member **28** has been disengaged with the tubing string wall. The inner mandrel **22** has been forced downwardly by the retrieval tool **98** and the resilient cup **28** has relaxed. This permits upward retrieval of the tool for subsequent use.

Attention is next directed to FIGS. **4A** and **4B** which disclose an alternative embodiment of the present invention. The embodiment differs slightly as will be described but has many similar parts. Accordingly, the reference numerals found on FIGS. **1A** and **1B** have been transferred to FIGS. **4A** and **4B** increased by **100** so that the foregoing description for the embodiment **10** can be adapted for the embodiment **100** with the exceptions noted below. The outer mandrel is identified as **118** while the inner mandrel is **122.** The mandrel **122** has a downwardly facing shoulder **102** on the exterior. The shoulder faces and is spaced from an upwardly facing shoulder **106** in the outer mandrel **118.** The shoulders are spaced apart in the unset position and a spring **104** is received between them. An annular space is defined between the two mandrels and is limited at the top and bottom by the two shoulders to receive the spring **104.** Preferably, the spring has several turns and is compressed in the view illustrated in FIG. **4A.**

The spring **104** is in its compressed state in FIG. **4A.** FIG. **5** shows it in an extended position after expansion. Expansion of the spring occurs at the time the tool is installed. Thus, FIG. **4A** discloses the packing element **128** in the relaxed condition. The packer **128** is expanded when the inner mandrel moves upwardly relative to the outer mandrel. This upward movement is achieved in the embodiment **10** through the use of downhole pressure. In the embodiment **110,** the relative movement of the two mandrels can be initiated by release of the inner mandrel to move upwardly relative to the outer mandrel. Thus, the packer **128** can be expanded without downhole pressure differential acting across the tool.

The inner mandrel **124** is held in the down position prior to installation by a tool **108** shown in FIG. **4A** which is inserted against the top portion of the inner mandrel **122.** In other words, the mandrel **122** is held in the down position in FIG. **4A** by the inserted tool **108.** When the tool is removed, the spring **104** is permitted to expand. This drives the inner mandrel upwardly in the same manner as described before. When it moves upwardly, the packing element **128** is expanded into the plugged position. When it plugs, the accummulation of downhole pressure thereafter aids and assists in maintaining the inner mandrel in the elevated position, keeping the tool set in the same manner as described with respect to the embodiment **10.**

The alternative embodiment **110** is released in the same manner as that shown in FIG. **3.** A release tool **198** is inserted and the inner mandrel **128** can be forced downwardly by downward manipulation of the tool **198.** It should be kept in mind that the tool **198** releases pressure through the lateral port in the manner described with respect to embodiment **10** and can also

be used to force the inner mandrel **122** downwardly, thereby relieving expansion of the packing element **128.** Thus downward movement compresses the spring **104,** restoring it to the state illustrated in FIG. 4A.

Except in the regards noted herein, the operation of the embodiment **110** is similar to that of the embodiment **10.**

The foregoing constitutes the description of preferred embodiment as well as alternative embodiments of the present invention, the scope of which is determined by the claims which are appended hereto.

I claim:

1. A plug for use in a tubing string comprising:
a hollow, elongate outer mandrel;
an elongate, hollow inner mandrel telescoped within said outer mandrel and movable relatively upwardly and downwardly thereof and having a portion extending therebelow;
an annular, radially outwardly expandable member received in telescoping arrangement about the lower portion of said inner mandrel and abutting the lower end of said outer mandrel;
means received on the exterior of the lower portion of said inner mandrel below said expandable member for abutting the lower portions thereof and capturing said expandable member for radial expansion on upward movement of said inner mandrel;
means for selectively closing the lower portion of said outer mandrel against the upward flow of fluid through the tubing string;
an axial passage communicating through said inner mandrel;
a valve cage of elongate external configuration connected with said passage;
check valve means in said valve cage including a valve element and a cooperative valve seat;
opening means in said valve cage to the exterior from said passage means with said valve means interposed therebetween to limit flow in one direction through said passage means; and,
a compressible spring operable between said outer and inner mandrels selectively moving them relatively to expand said expandable member.

2. A plug for use in a tubing string comprising:
a hollow, elongate outer mandrel;
an elongate, hollow inner mandrel telescoped within said outer mandrel and movable relatively upwardly and downwardly thereof and having a portion extending therebelow;
an annular, radially outwardly expandable member received in telescoping arrangement about the lower portion of said inner mandrel and abutting the lower end of said outer mandrel;
means received on the exterior of the lower portion of said inner mandrel below said expandable member for abutting the lower portions thereof and capturing said expandable member for radial expansion on upward movement of said inner mandrel;
means for selectively closing the lower portion of said outer mandrel against the upward flow of fluid through the tubing string;
an internal shoulder in a passage in said inner mandrel and adapted to receive therein an elongate releasing tool having an extending portion and adapted to land on said shoulder;
a laterally directed choke controlled valve means blocking flow from the exterior of said inner mandrel, said valve means being controlled by such a releasing tool and being located below said shoulder; and,
a compressible spring operable between said outer and inner mandrels selectively moving them relatively to expand said expandable member.

3. The apparatus of claim **2** wherein said valve means includes
a stem positioned at a point where such a releasing tool moves said stem;
a valve seat adjacent to said stem;
a cooperative valve element carried on said stem;
spring means urging said stem toward a closed position; and,
passage means having a restriction therein communicating from said valve seat to a point exterior of said inner mandrel.

4. The apparatus of claim **3** including a second check valve means communicating from the exterior of said inner mandrel constructed and arranged to be released by the same releasing tool after release of said first check valve means.

5. A plug for use in a tubing string comprising:
a hollow, elongate outer mandrel;
an elongate, hollow inner mandrel telesecoped within said outer mandrel and movable relatively upwardly and downwardly thereof and having a portion extending therebelow;
an annular, radially outwardly expandable member received in telescoping arrangement about the lower portion of said inner mandrel and abutting the lower end of said outer mandrel;
means received on the exterior of the lower portion of said inner mandrel below said expandable member for abutting the lower portions thereof and capturing said expandable member for radial expansion on upward movement of said inner mandrel;
means for selectively closing the lower portion of said outer mandrel against the upward flow of fluid through the tubing string;
an overlapping peripheral shoulder on said outer mandrel overhanging said expandable means to an extent sufficient to lock same on expansion;
a ring below said expandable means, said ring surrounding said inner mandrel and further positioned adjacent to a shoulder means thereon;
means for limiting the relative range of movement of said inner mandrel to said outer mandrel on expansion of said expandable means;
means for limiting fluid flow through said plug to the downward direction in the tubing string; and,
a compressible spring operable between said outer and inner mandrels selectively moving them relatively to expand said expandable member.

6. The apparatus of claim **5** wherein said expandable means includes an encircling resilient sleeve-shaped packer element, and said ring is contacted along its lower portions by an encircling swab cup, said swab cup including an inwardly directed lip adjacent to said thimble; and an encircling jam nut is positioned about said inner mandrel and forces said swab cup upwardly on relative upward motion of said inner mandrel.

7. The apparatus of claim **6** wherein said jam nut has a tubular extending upper portion bearing on the nether side of said swab cup.

8. The apparatus of claim **7** wherein a tubular valve cage joins to said inner mandrel below said keeper nut.

* * * * *