United States Patent [19]

Taylor

[11] **3,747,682**

[45] **July 24, 1973**

[54] **WELL TOOLS**

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[73] Assignee: **Otis Engineering Corporation,** Dallas, Tex.

[22] Filed: **May 10, 1971**

[21] Appl. No.: **141,922**

[52] **U.S. Cl.** ..... **166/315,** 166/136, 166/224 S

[51] **Int. Cl.** **E21b 33/00,** E21b 43/14

[58] **Field of Search** 166/315, 67, 89, 166/224, 214, 136

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Primary Examiner—James A. Leppink
Attorney—H. Mathews Garland

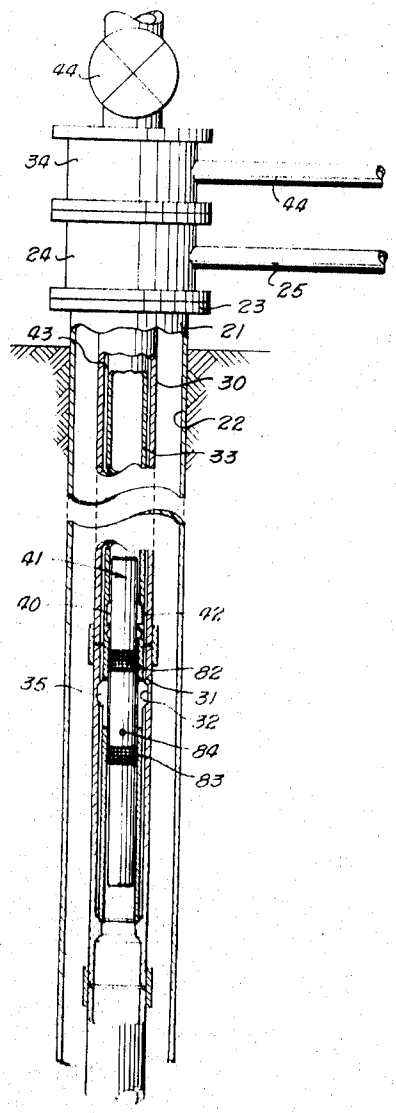
[57] **ABSTRACT**

A well safety valve system controllable from the surface and adapted for installation in a well to replace a malfunctioning existing system or for conversion of a well not having a safety system. The safety valve system includes a first outer tubing string extending from a well head to the desired production zone in the well and a second inner tubing string concentrically disposed within the outer tubing string and releasably locked at the lower end thereof with the outer tubing string whereby the inner tubing string is inserted and withdrawn by manipulation from the surface. A safety valve is supported at the lower end of the inner tubing string for shutting off fluid flow into the tubing string responsive to predetermined flow conditions. The safety valve is held in an open position by fluid pressure transmitted from the surface to the valve through the annulus between the outer and inner tubing strings. In one form of the invention the outer tubing string has a landing nipple incorporated in the string at the safety valve depth and the inner tubing string includes a locking collet engageable with the landing nipple recess for locking the lower end of the inner tubing string at the landing nipple within the outer string. The inner string also has a landing nipple for the releasable locking of a safety valve which holds the inner tubing string locking collet engaged with the outer tubing string. Another form of the invention includes a landing nipple assembly releasably lockable in the smooth bore of the outer tubing string with the removable landing nipple being engaged by the inner tubing string which also has landing nipple means for supporting the safety valve. The safety valve holds the locking collet of the inner tubing string locked with the releasable landing nipple. In a still further form of the invention a removable landing nipple for releasably locking the inner tubing string within the outer tubing string is releasably locked in a landing nipple provided in the outer tubing string at the desired depth. In each installation and the well procedure therefor a plug is used for shutting the well in at the safety valve depth while running and retrieving the inner tubing string.

25 Claims, 28 Drawing Figures

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[11] **3,747,682**
[45] **July 24, 1973**



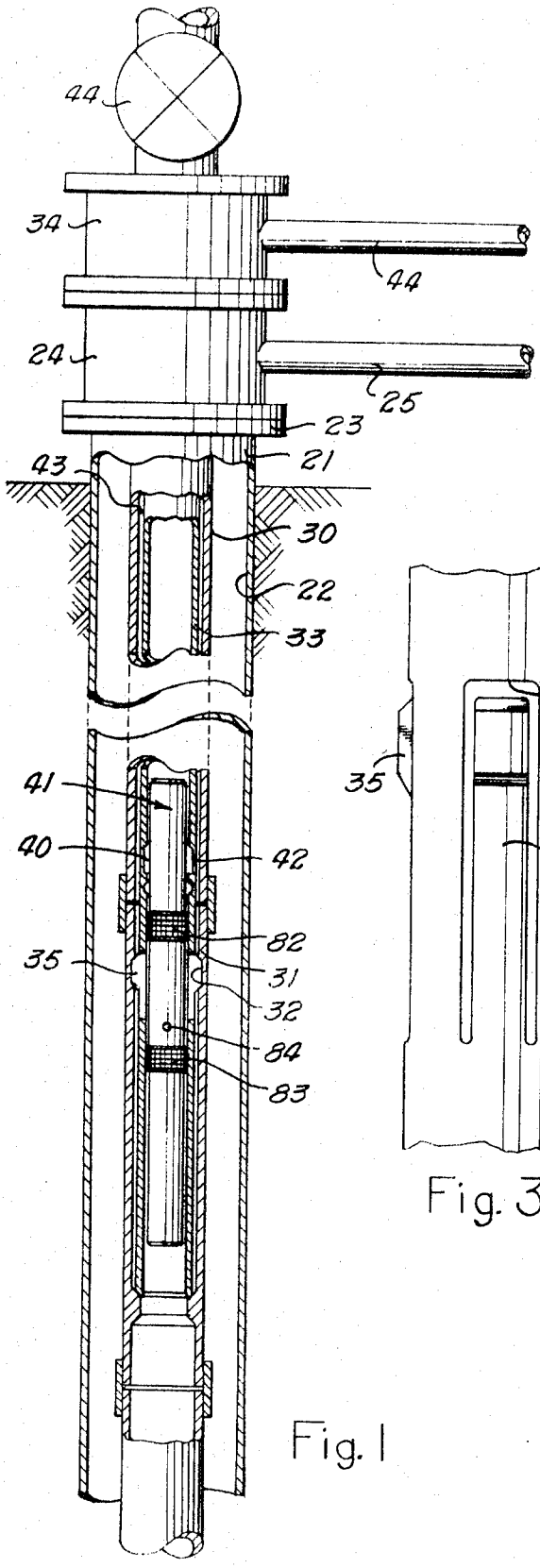


Fig. 1

Fig. 3

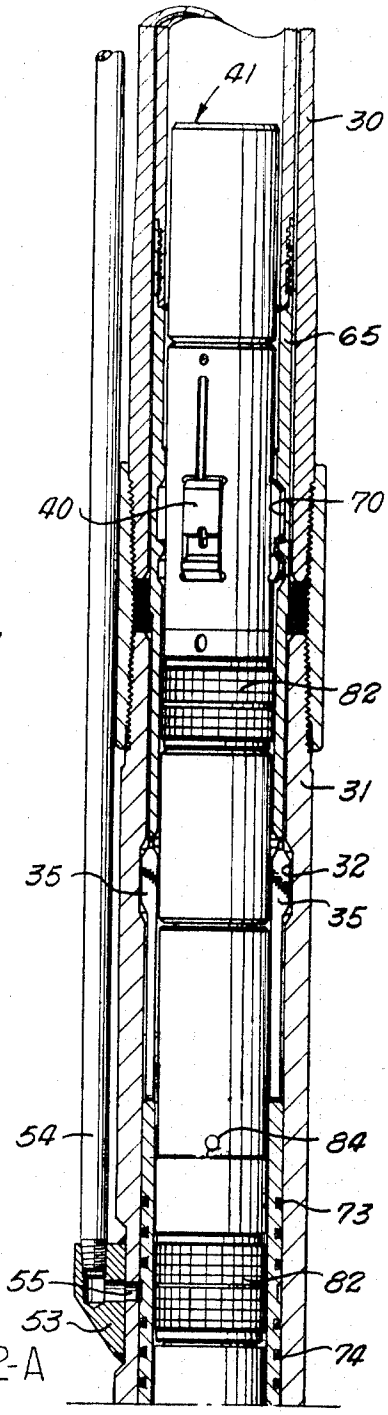


Fig. 2-A

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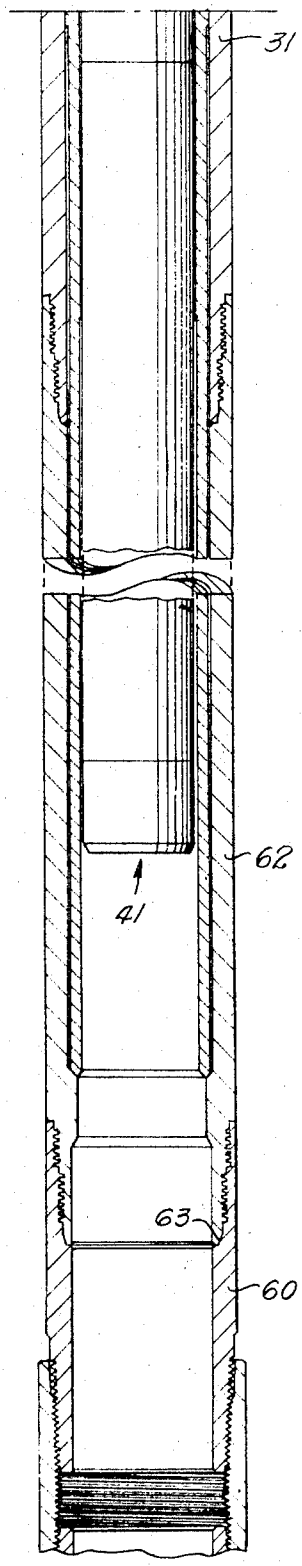


Fig. 2-B

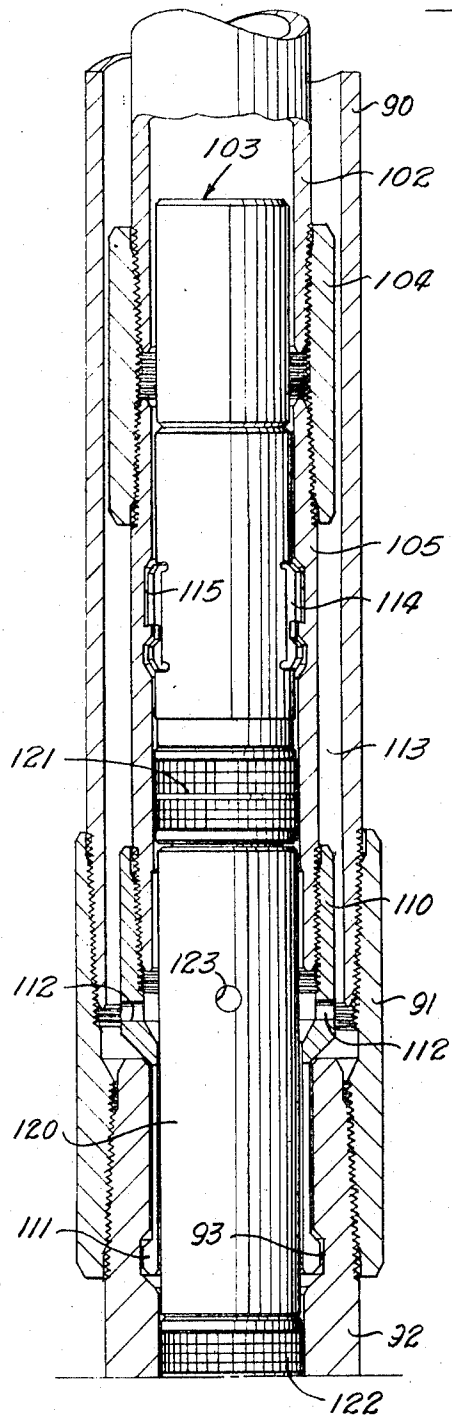


Fig. 4-A

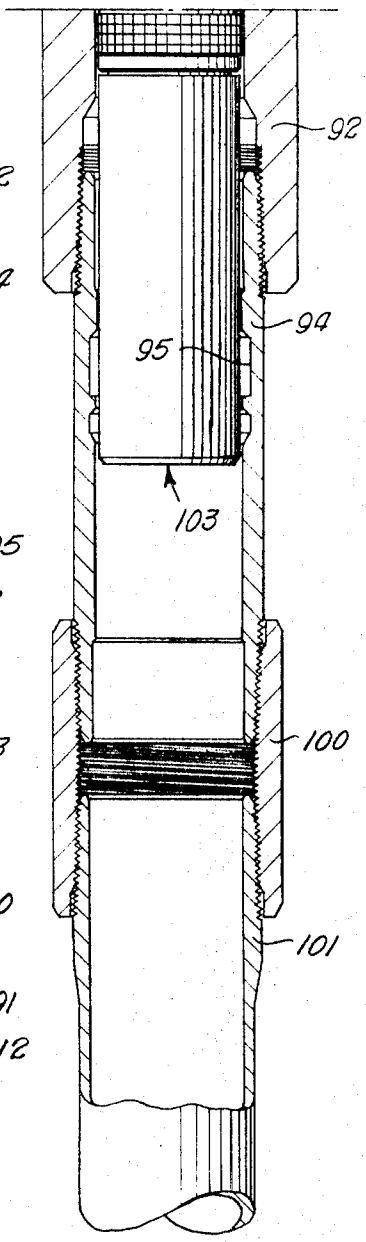


Fig. 4-B

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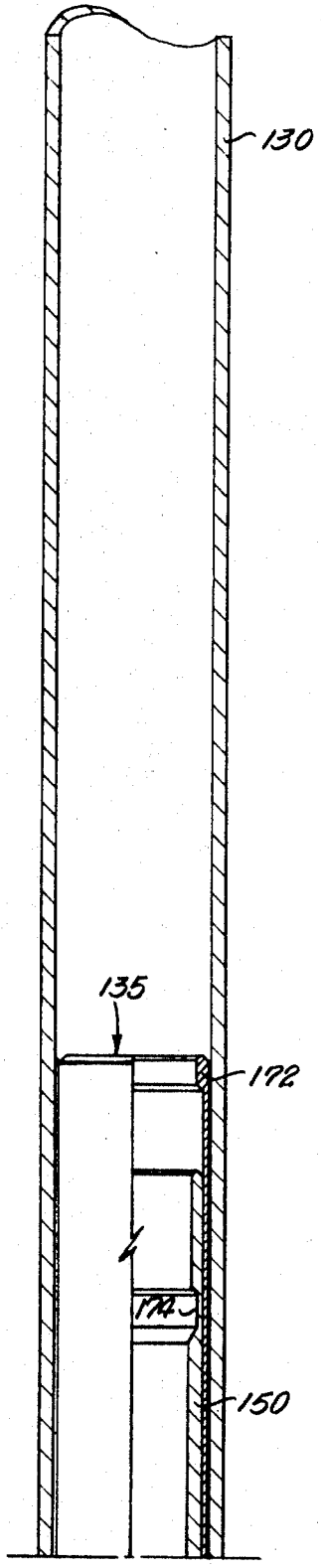


Fig. 5-A

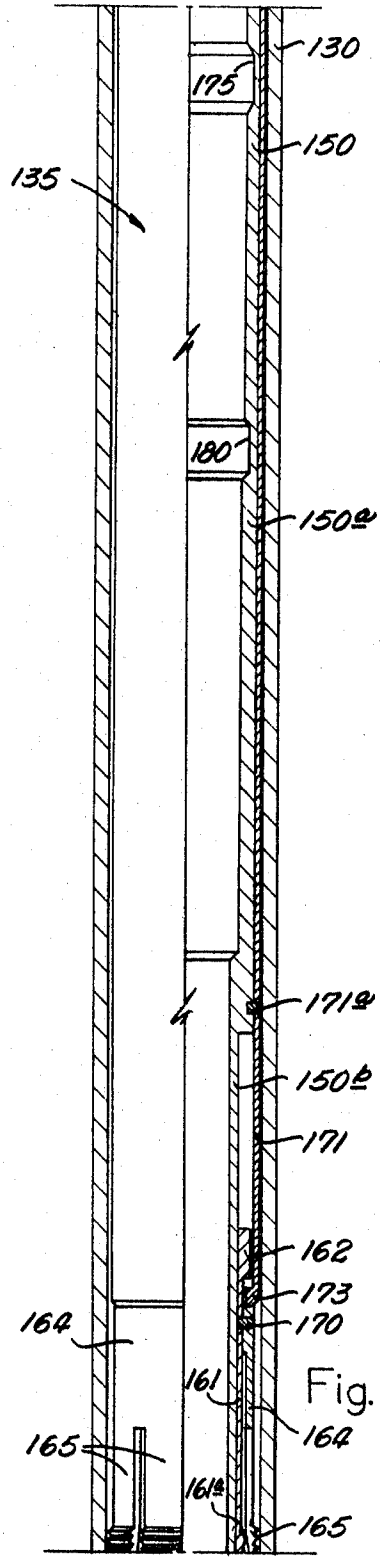


Fig. 5-B

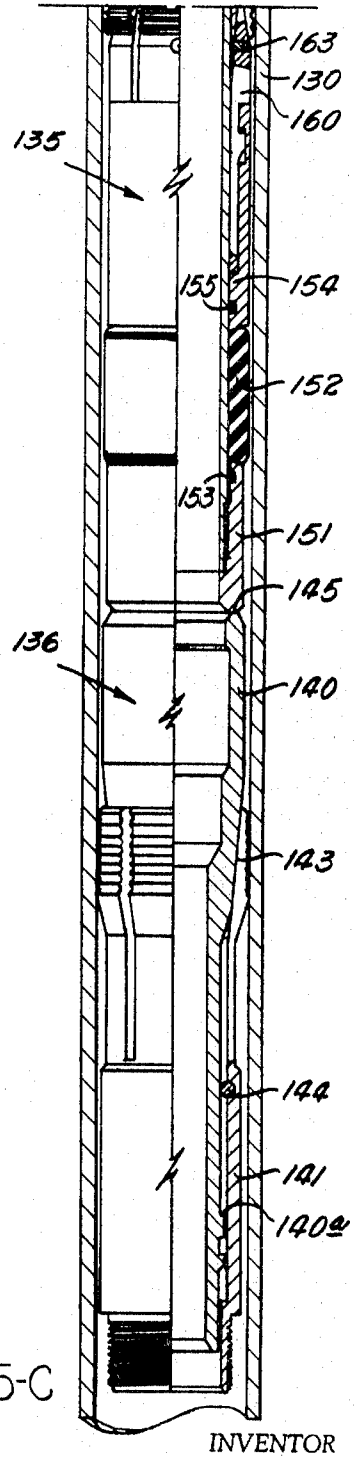


Fig. 5-C

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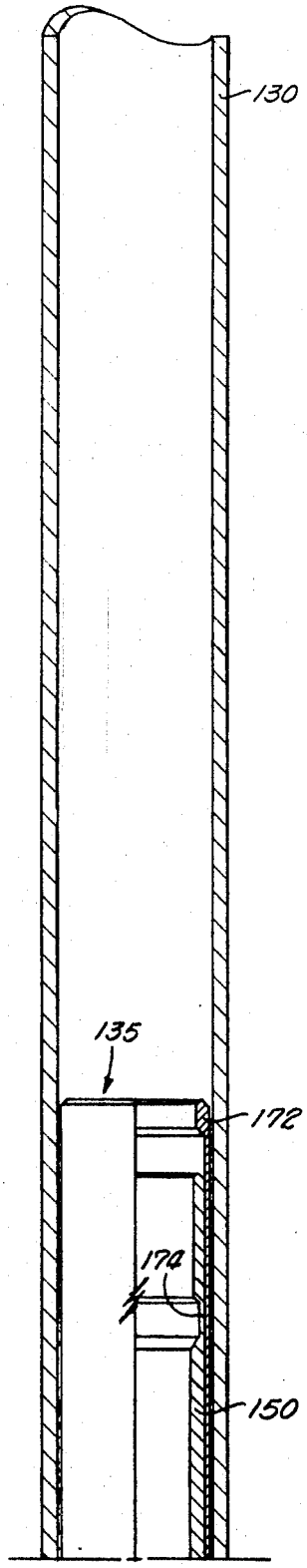


Fig. 6-A

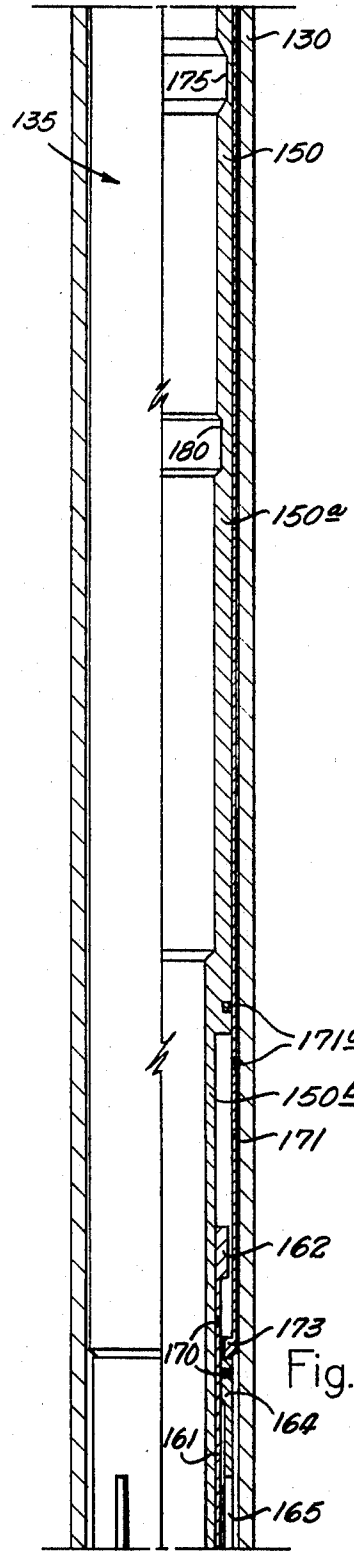


Fig. 6-B

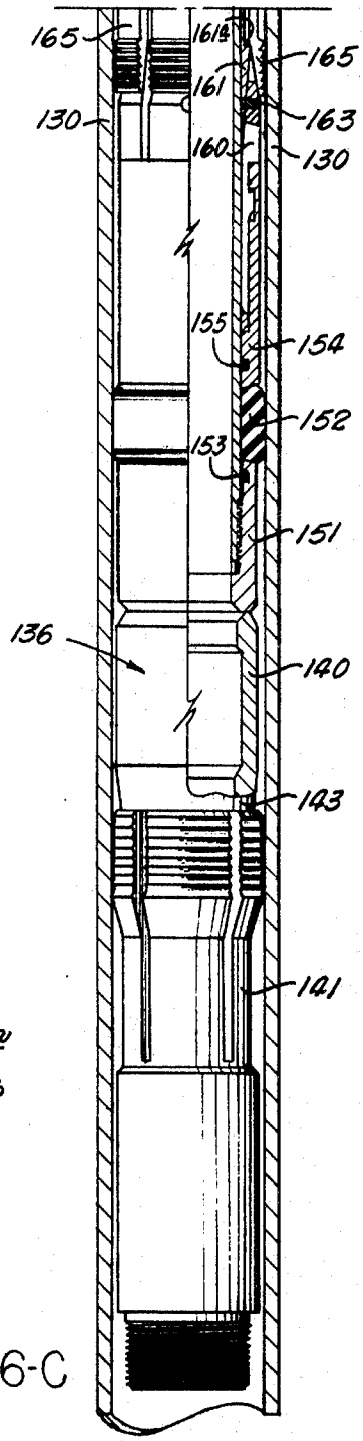


Fig. 6-C

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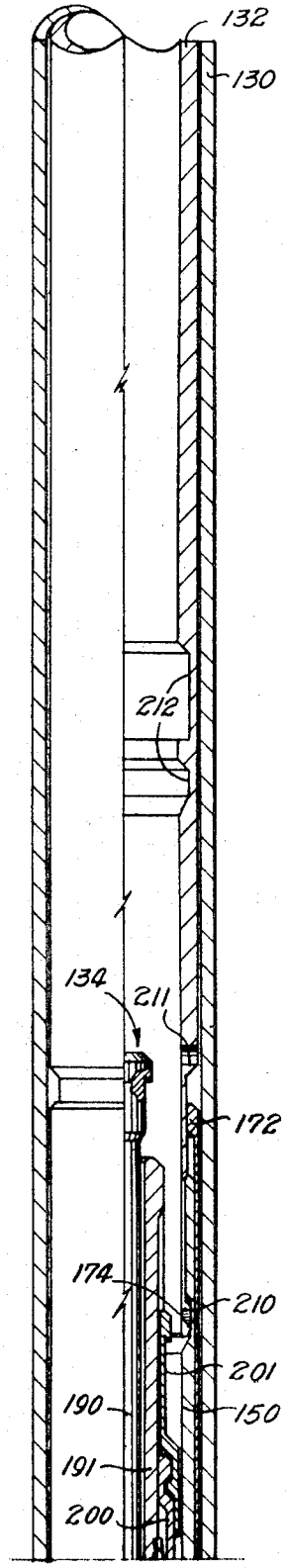


Fig. 7-A

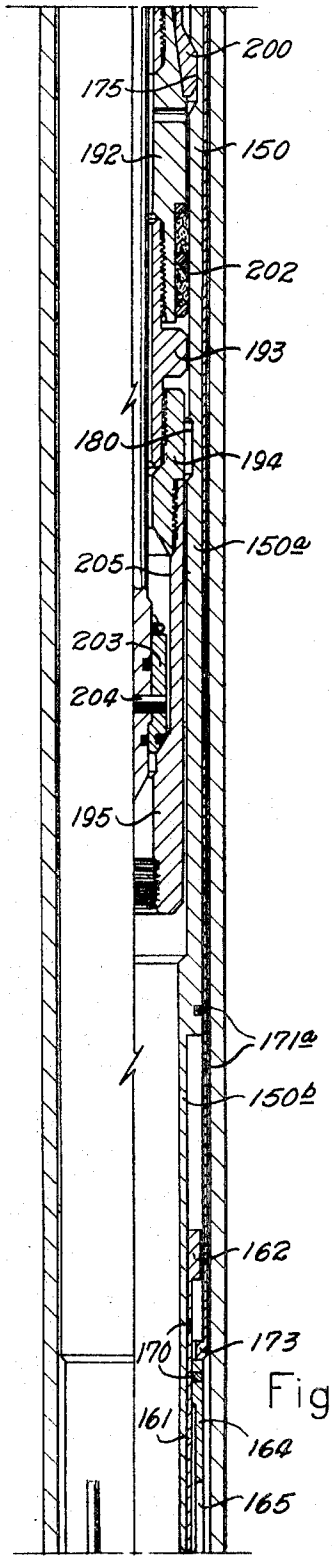


Fig. 7-B

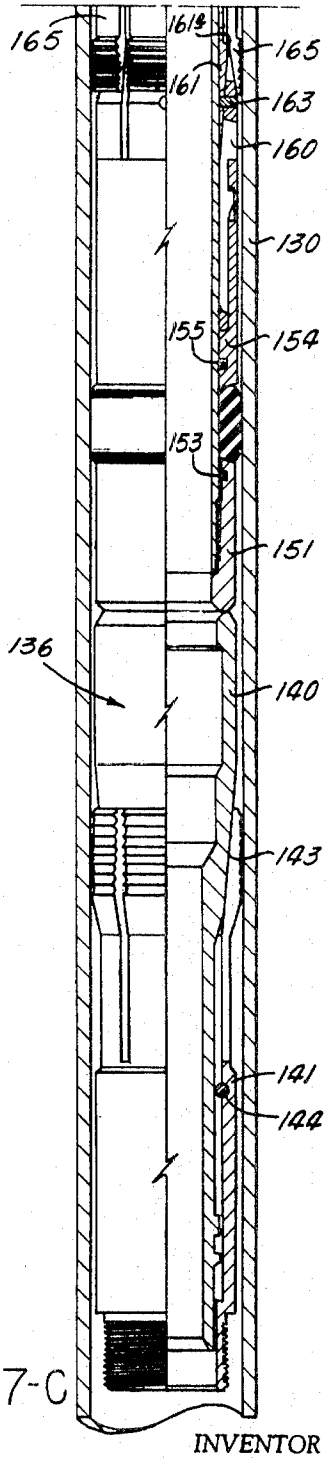


Fig 7-C

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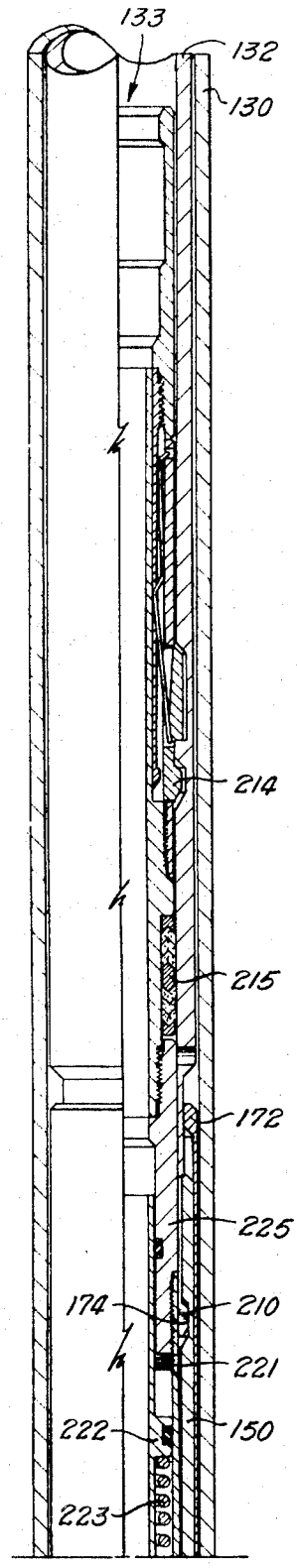


Fig. 8-A

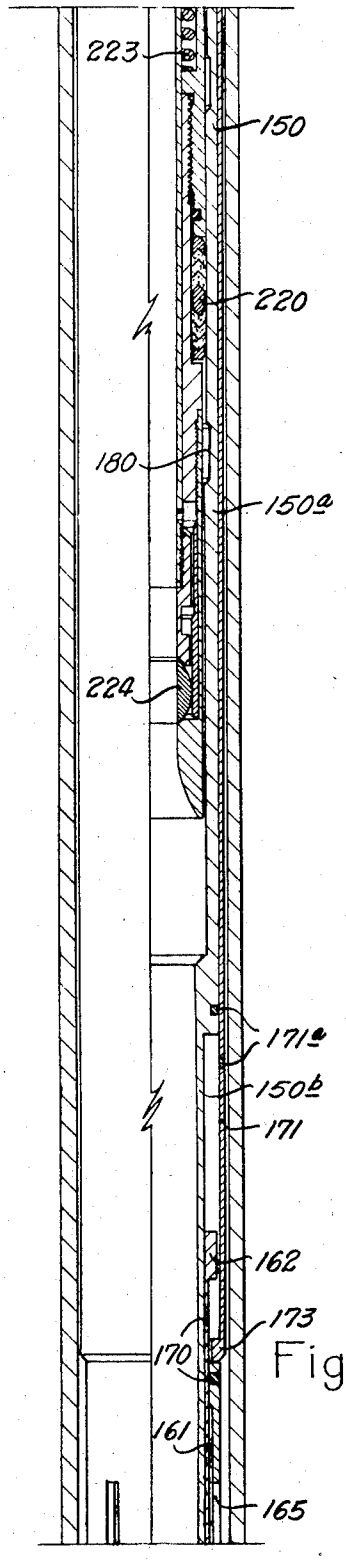


Fig. 8-B

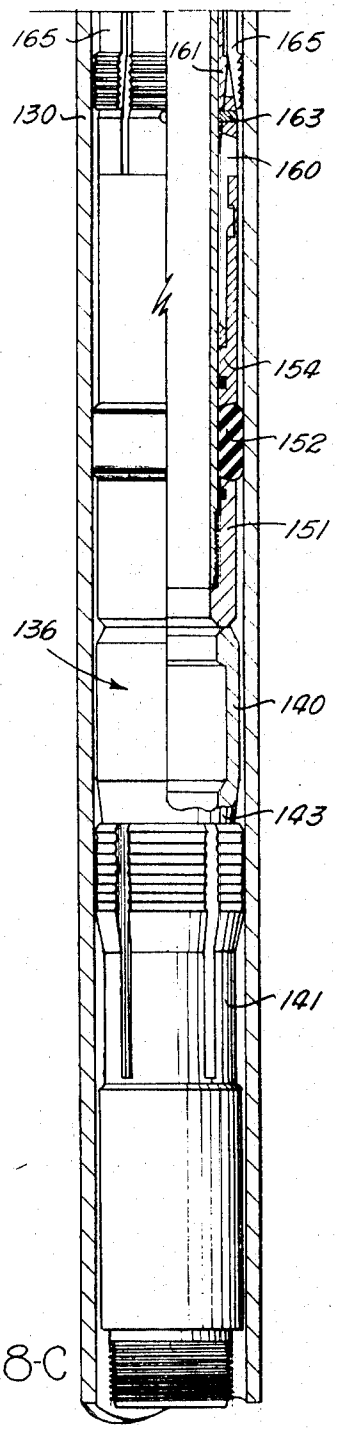


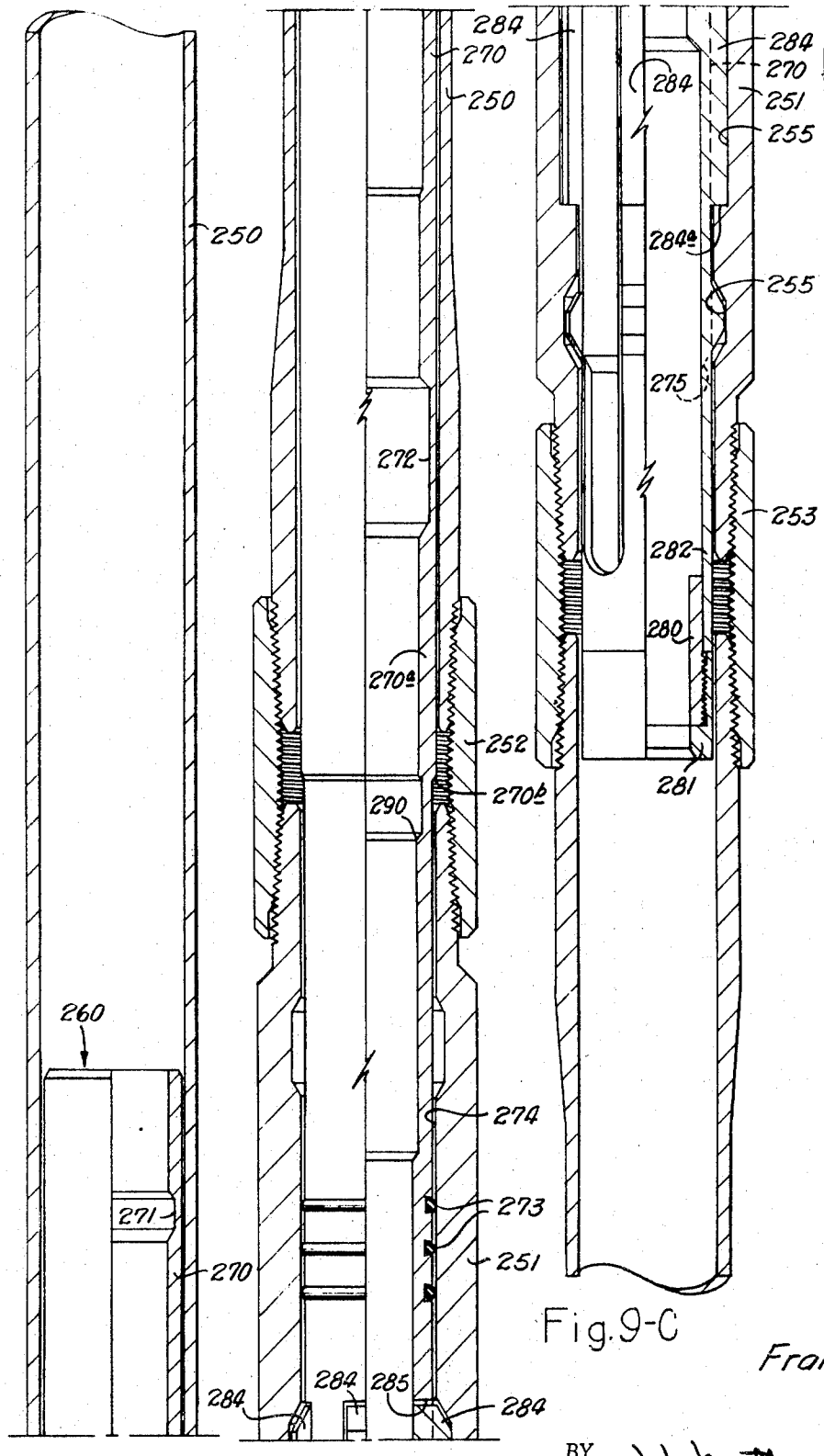
Fig. 8-C

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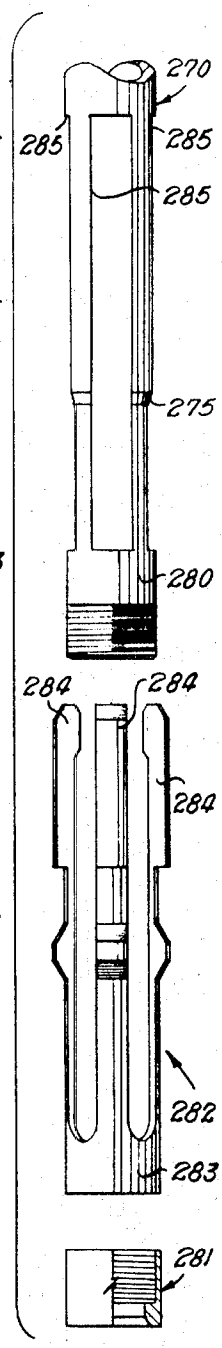


Fig. 12

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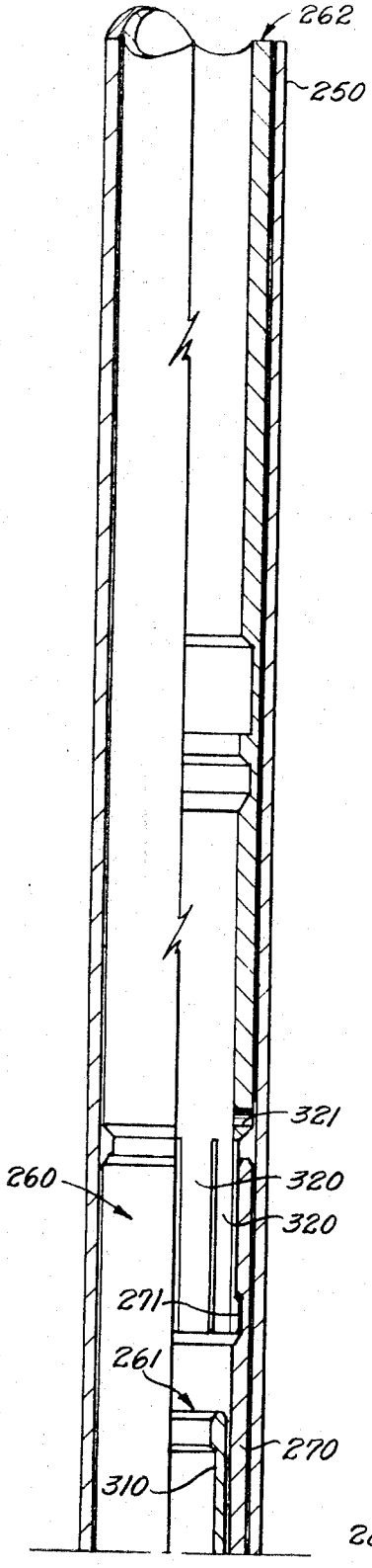


Fig. 10-A

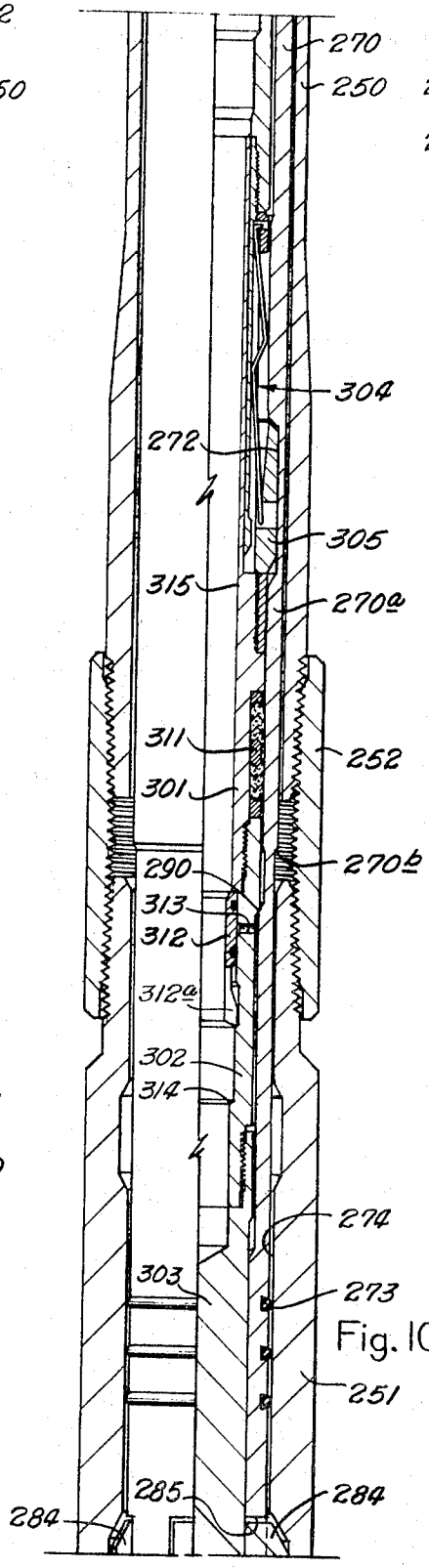


Fig. 10-B

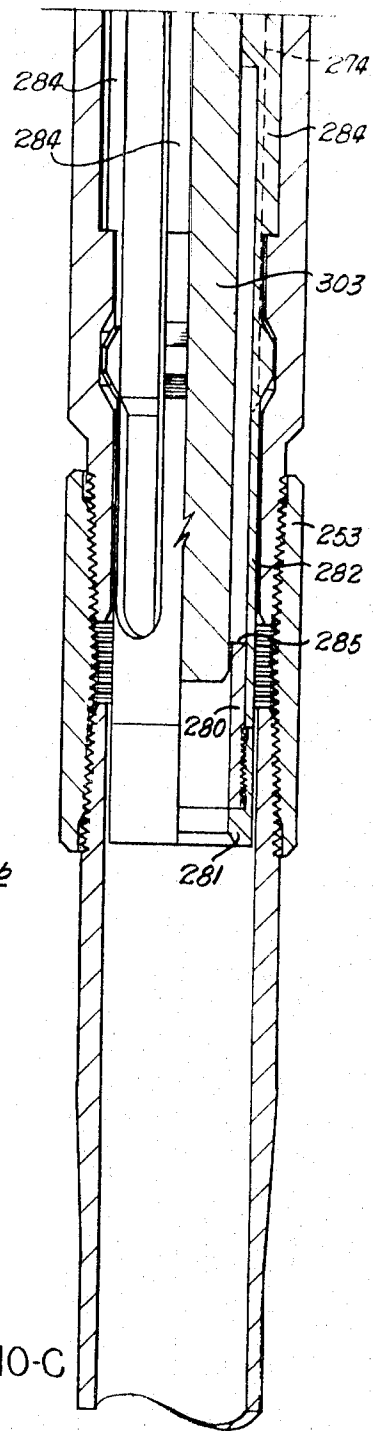


Fig. 10-C

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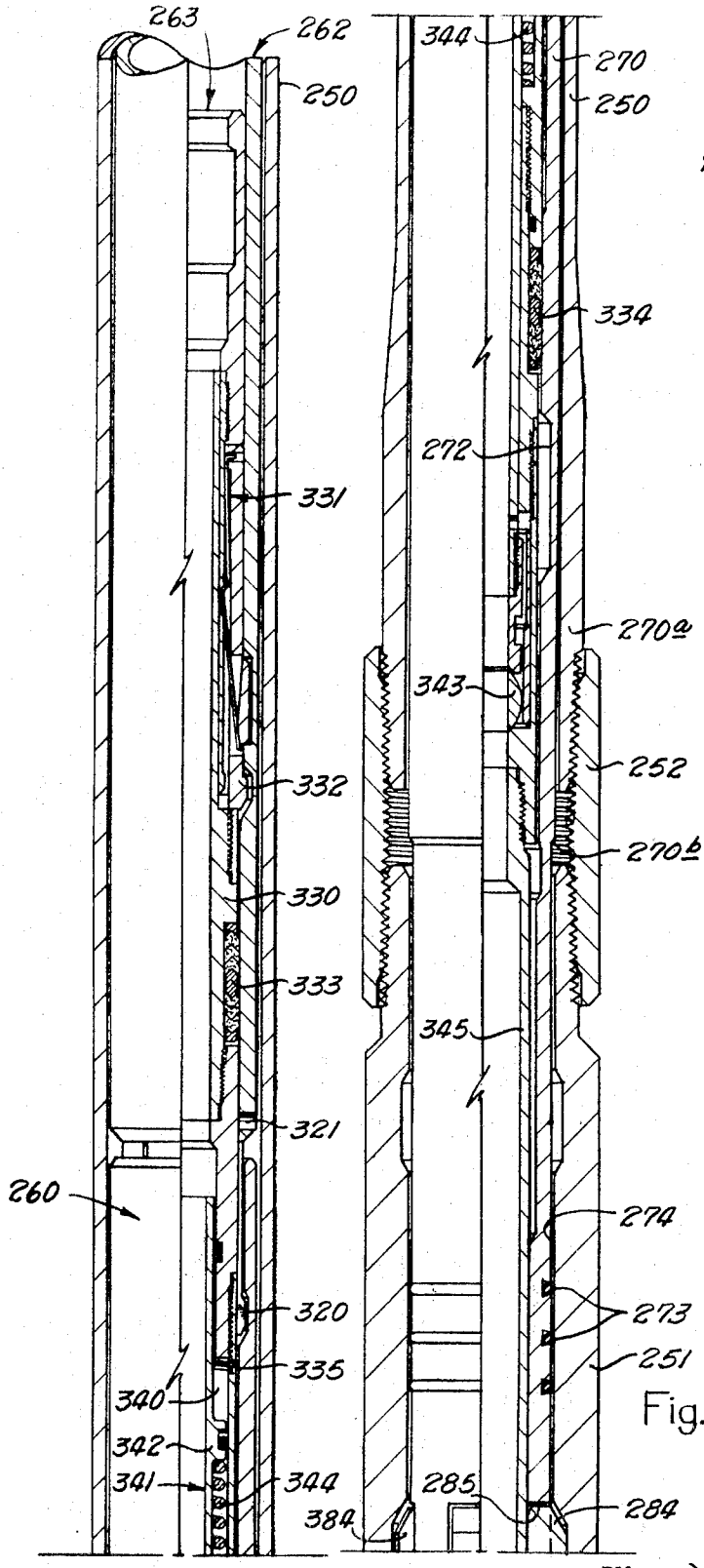


Fig. 11-A Fig. 11-B Fig. 11-C

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WELL TOOLS

This invention relates to well tools and more particularly relates to safety valve systems for wells.

In the past, well systems, particularly those adapted to the production of oil, have often been equipped with well safety valve systems which were installed at the time of the initial completion and fitting of the well. Such well systems can be very expensive in terms of both shut-down time and servicing requirements upon either failure or malfunction of the safety valve systems. The reworking of the well can be a major task when it is necessary to pull the tubing strings to replace the safety valve equipment. In one form of such safety valve system the fluid pressure required to maintain the valve in an open position is conducted to the valve through a small tubing extending alongside the main tubing string in which the safety valve is supported and through which the well is produced. A rupture of this control fluid line necessitates pulling the tubing string. In other situations wells may be completed without the installation of a safety valve and changing conditions subsequently require the use of a safety valve. Presently available systems, both for the repair of an existing safety valve arrangement or for the conversion of a well to safety equipment, requires a major workover of the well due to the absence of readily convertible or repairable components.

It is, therefore, a particulary important object of the invention to provide a new and improved well safety valve system. It is anothe object of the invention to provide a well safety valve system which is used for the conversion of both malfunctioning existing systems and also wells not initialy equipped with any form of safety valve system. It is a further object of the invention to provide a well safety valve system controllable from the surface by control fluid pressure communicated to a safety valve in the well through an annular space around the production tubing of the well. It is a still further object of the invention to provide a well safety valve system of the character described wherein the safety valve is releasably supported at the lower end of an inner production tubing string in an outer tubing string. It is still another object of the invention to provide a well safety valve of the character described wherein the safety valve is inserted and removed through a removable inner tubing string without removal of the inner tubing string. It is a still further object of the invention to provide a safety valve system of the character described which includes a removable inner tubing string for supporting the well safety valve usable in an outer tubing string equipped with landing nipple means. It is a still further object of the invention to provide a well safety valve system of the character described which includes a removable landing nipple releasably lockable in an outer tubing string and engageable by a releasable inner tubing string for supporting the safety valve at the desired depth. It is a still further object of the invention to provide a well safety valve system of the character described which includes a landing nipple releasably lockable along a smooth wall bore of an outer tubing string and engageable by a releasable inner tubing string for supporting the safety valve at the desired depth. It is a still further object of the invention to provide a method of fitting an existing well with a safety valve system.

In accordance with the invention there is provided a well safety valve system including an outer tubing string supported in a well casing, an inner tubing string releasably supported within the outer tubing string and defining an annular flow passage between such tubing strings, and a well safety valve releasably supported at the lower end of the inner tubing string and communicating with the annular space between the tubing strings for operating the safety valve responsive to fluid pressure in the annular space. The inner production tubing string supporting the safety valve is inserted and removed without handling the outer tubing string. The safety valve holds the inner tubing string locked in the outer tubing string. In one form of the invention the outer tubing string is initially equipped with a landing nipple engageable by locking means at the lower end of the inner tubing string. In another form of the invention a releasable landing nipple is secured with an outer tubing string landing nipple and engaged by locking means on the lower end of the inner tubing string which supports a removable safety valve at the lower end thereof. In a still further form of the invention a releasable landing nipple for holding the lower end of the removable inner tubing string is adapted to engage the smooth wall bore of the outer tubing string for installations where the outer tubing string was not initially equipped with a landing nipple.

The invention, together with its objects and advantages, will be more readily understood from reading the following description taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a broken longitudinal schematic drawing in section of a well including a system having safety valve apparatus embodying the invention;

FIGS. 2-A and 2-B, taken together, constitute a longitudinal view in section and elevation of an existing well safety valve system converted to a safety system embodying the invention;

FIG. 3 is a fragmentary view in elevation of the section of the inner tubing string of the system of FIG. 2-A showing the locking collet fingers formed in the inner tubing string;

FIGS. 4-A and 4-B together constitute a longitudinal view in section and elevation of another form of well safety valve system embodying the invention;

FIGS. 5-A, 5-B, and 5-C together comprise a longitudinal view in section and elevation of a still further form of well safety valve system embodying the invention and illustrating the lower stop in place and the removable landing nipple being set;

FIGS. 6-A, 6-B, and 6-C together are a view in section and elevation of the well system of FIGS. 5-A, 5-B, and 5-C with the landing nipple set;

FIGS. 7-A, 7-B, and 7-C together constitute a longitudinal view in section and elevation of the well system of FIGS. 5-A through 6-C with the well plug set in the landing nipple;

FIGS. 8-A, 8-B, and 8-C, taken together, constitute a longitudinal view in section and eleaation of the well system of FIGS. 5-A through 7-C, illustrating the well plug removed and the safety valve installed;

FIGS. 9-A, 9-B, and 9-C, taken together, constitute a view in section and elevation of another form of well landing valve system emboding the invention with only the removable landing nipple of the system set in the outer well tubing;

FIGS. 10-A, 10-B, and 10-C, taken together, comprise a longitudinal view in section and elevation of the well system of FIGS. 9-A through 9-C with the removable inner tubing and a well plug releasably engaged with the removable landin1 nipple of the system;

FIGS. 11-A, 11-B, and 11-C comprise a longitudinal view in section and elevation showing the well system of FIGS. 9-A through 10-C with the plug removed and the safety valve installed; and

FIG. 12 is an exploded view in elevation of the locking collet assembly on the removable landing nipple of the well system of FIGS. 9-A through 11-C.

Referring to the drawings FIG. 1 illustrates schematically the form of the invention shown in FIGS. 2-A and 2-B. The well system 20 shown in FIG. 1 includes a well casing 21 of suitable conventional design installed by standard methods in a well 22 and provided with a top closure flange 23. A tubing hanger 24 is supported on the flange 23 and provided with a fluid conduit 25 for communication into the casing of the well as desired during various procedures performed on the well. An outer tubing string 30 is supported in hanging relationship from the hanger 24 extending downwardly in the well casing to a desired depth therein. At the depth at which a well safety valve may be desired the outer tubing string 30 is provided with a landing nipple 31 having locking recesses 32. An inner tubing string 33 is supported within the outer tubing string from a hanger 34 mounte on the hanger 24. The inner tubing string has locking collet fingers 35 formed along a lower end portion releasably locking the lower end of the tubing string wih the locking recess 32 of the landing nipple 31 in the outer tubing string. The inner tubing string is insertable and withdrawable relative to the outer tubing string without disturbing the outer tubing string. The inner tubing string is provided with a locking recess 40 near the lower end thereof fr releasably locking a standard fluid-operated well safety valve 41 in the tubing string to control flow from below the safety valve into the inner tubing string through which well fluids are produced. The inner tubing stirng has a side port 42 communicating with the annulus 43 defined between the inner and outer tubing strings and extending to the surface into the hanger 34. A control fluid line 44 is connected through the hanger 34 into the annulus 43 for communicating control fluid under pressure from the surface through the annulus to the well safety valve 41. Most standd equipment and procedures require that this control fluid be used to hold the safety valve at an open position. The line 44 is connected to safety equipment, not shown, including an Otis Surface Control Manifold as illustrated and described at page 3,887 of the 1970–1971 issue of the "Composite Catalog of Oil Field Equipment and Services" published by World Oil, Houston, Tex. Such a control manifold may be operative responsive to a number of monitored operating conditions for shutting down the well in the event of a break in the line, a fire, and many other situations involving the need for closing in the well. A master valve 44 is supported on the inner casing hanger 34 for controlling flow of well fluids from the well. The safety valve 41 and the removable inner tubing string 33 are installed and retrieved utilizing equiment and procedures discussed in more detail in connection with the specific embodiments of the well safety valve systems illustrated in the drawings. While the system broadly illustrated schematically in FIG. 1 is exemplary of the system shown more specifically in FIGS. 2-A and 2-B, the broad concept represented in FIG. 1 of a well safety valve system is equally applcable to the other systems shown in the other figures of the drawings wherein removable landing nipples are employed for releasable engagement with the outer well tuing.

FIGS. 2-A, 2-B, and 3 illustrate a form of well safety valve system useful to convert an existing safety valve system to a system embody1ng the invention. The outer tubing string 30 is supported from the tubing head 24. The tubing string 30 includes the landing nipple 31 having the internal annular locking recess 32. The landing nipple has a side port fitting 53 which is connected with a control fluid line 54 extending in the original well installation to the surface to control fluid pressure equipment, not shown, for providing fluid pressure control of a safety valve, not shown, supported directly in the landing nipple 31. The present well system represents a conversion to one embodying the invention subsequent to some failure or malfunction of the original safety system wherein the control line 54 functioned. The control fluid in the original system was communicated to the safety valve used in that system through the landing nipple side port 55. Referring to FIG. 2-B, the tubing string 30 includes lower sections, not shown, connected by a coupling 60 into the tubing string with the lower sections being of a reduced diameter. A section 62 of the tubing string 30 threaded on the lower end of the landing nipple 31 includes an internal annular landing shoulder 63 which is engaged by the lower end of the internal tubing string 33. The inner tubing string includes a lower locking and landing nipple section 65 which comprises the lower end portion of the inner tubing string provided with internal locking recesses 70 and the laterally movable locking collet fingers 35 which are machined along the side wall of the tubing section integral with the tubing as evident in FIG. 3. The inner tubing section 65 is also provided with two sets of spaced external O-ring seals 72 and 73 positioned to seal above and below the side port 55 of the outer tubing string landing nipple 31 so that when the inner tubing section is in place the port 55 is effectively isolated from the bore of the outer tubing string, thus blocking off the inoperative original source of safety valve control fluid. The locking collet fingers 35 of the inner tubing string section are disposed longitudinally to move laterally to engage the internal locking recess 32 of the outer tubing string landing nipple when the lower end of the inner tubing string rests on the landing shoulder 63 of the outer tubing string.

The inner tubing string 33 is concentrically spaced within the outer tubing string 30 to define the control fluid annulus 43 which extends from the surface at the well head to communicate control fluid from the line 44 downwardly into the safety valve 41 supported within the landing nipple portion of the inner tubing string. The structure of the landing nipple portion of the inner tubing string whereby the locking collet fingers 35 are formed along the wall of the tubing string section provides circumferentially spaced inverted U-shaped openings 75 which permit the control fluid to communicate through the inner tubing string from the annulus for control of the safety valve 41 supported in the string. The wireline insertable and removable safety valve 41 has laterally expandable and contractible locking dogs or keys 41 releasably locked in the inner tubing string and controls well fluids through the bore

of the inner tubing string. The locking keys of the safety valve are received within the locking recesses **70** of the landing nipple portion **65** of the inner tubing string. The safety valve is provided with upper and lower external seal assemblies **82** and **83**, respectively, for sealing around the valve within the inner tubing string landing nipple portion above and below the slots **75** at the collet fingers **35** so that valve control fluid communicated through the annulus **43** and the slots **75** is confined within the inner tubing string between the seals **82** and **83** for communication through the side port **84** in the safety valve for remote fluid control of the valve. The safety valve body along a central portion **85** is disposed in alignment with the heads of the collet fingers **35** preventing inward contraction of the collet fingers and thereby locking the fingers at the recess **32** so that the inner tubing string is locked within the outer tubing string when the safety valve is in place within the inner tubing string.

A well installation of the nature of that shown in FIGS. **2-A** and **2-B**, generally, initially includes a safety valve, not shown, installed within the landing nipple **31** of the outer tubing string and controlled by fluid conducted through the line **44** and the side port **55** to the safety valve. When failure of this well system, such as rupture of the line **54**, occurs, the well system is readily converted to a safety valve arrangement embodying the present invention. The original safety valve is removed by suitable means and a standard tubing plug, not shown, is installed in the outer tubing section below the coupling **60** of FIG. **2-B** by standard wireline procedures. As previously explained, this lower portion of the outer tubing string is of a smaller diameter and thus accommodates a plug which ultimately can be removed by wireline through the bore of the inner tubing string. With the well plug set in the outer tubing string below the coupling **60**, the well is, of course, shut in above the plug and the pressure is bled off at the well head to permit the well to be opened for the insertion of the inner tubing string **64**, which, preferably, is not run in through a stuffing box because it is substantial in diameter and may be quite long for such an insertion procedure. With the well thus shut-in, the well head is opened and the inner tubing string **64** is lowered into the well until its lower end engages the landing shoulder **63** in the outer tubing section **62**. The collet fingers **35** are aligned with and spring outwardly into locking relationship in the recess **32** of the outer tubing string landing nipple **51**. the seals **72** and **73** of the inner tubing string seal above and below the port **55** to prevent communication through the ruptured control line **54** into the bore of the outer tubing string. The pressure is then equalized across the well plug so that the well is again under pressure to the surface. Wireline procedures are then used to remove the plug through the inner tubing string. The safety valve **41** is then run by wireline into the inner tubing string until it is properly positioned at and the locking keys **40** of the valve expand into the locking recesses **70** of he landing nipple **31** of the inner tubing string. Control fluid is then introduced into the annulus **43** through the line **44** at the well head. The fluid flows downwardly in the annulus and radially inwardly through the slots **75** around the collet fingers. The fluid under pressure is communicated around the safety valve between its seals **82** and **83** into the valve through the side port **84**. When the pressure is raised to a sufficient level, the safety valve opens to permit production through the inner tubing string. When the pressure of the control fluid drops below a predetermined level because of such factors as a fire, a blowout, or other malfunction at the surface, the reduced pressure permits the safety valve to close.

In removal of the safety valve system of the present invention, the valve **41** is first retrieved by wireline from the inner tubing string. A well plug is again run into the well and locked in the outer tubing string below the lower end of the inner tubing string. With the well shut in, the well head is opened and the inner tubing string is withdrawn. Upward force on the inner tubing string cams the collet fingers **35** inwardly, releasing the inner tubing string from the recess **32** permitting it to be lifted to the surface. During the presence of the safety valve within the inner tubing string landing nipple the valve body portion **85** holds the inner tubing string collet fingers expanded in the outer tubing string locking recess **32** so that the inner tubing string cannot be released and lifted to the surface. The safety valve is thus locked within the lower end portion of the inner tubing string while the inner tubing string is locked within the outer tubing string so that when the safety valve closes effecting a large pressure differential across the valve tending to lift the valve and the inner tubing string within the outer tubing string, the valve and inner tubing string are locked in position by virtue of the collet fingers **35** and the valve locking keys **40**.

FIGS. **4-A** and **4-B** illustrate another form of well safety valve system embodying the invention which permits the conversion of a well system not originally equipped with a safety valve. The original well installation includes an outer tubing string **90** including a coupling **91** into which is threaded a landing nipple **92** having an internal locking recess **93** and secured at its lower end on a reduced landing nipple **94** having an internal locking recess **95**. Additional portions of the outer tubing string include a coupling **100** threaded on the landing nipple **94** and a tubing section **101** connected with the coupling.

In accordance with the present invention, an inner tubing string **102** is releasably locked within the outer tubing string held by a standard safety valve **103** which is releasably locked within the inner tubing string. The safety valve is adapted for fluid control and wireline handling. The inner tubing string includes a coupling **104** threaded on another section **105** which is threaded into a tubular locking fitting **110** having a plurality of circumferentially spaced dependent locking fingers **111** which are releasably engageable in the locking recess **93** of the outer tubing string landing nipple **92**. The fitting **110** has a pair of lateral ports **112** to admit control fluid to the safety valve from an annulus **113** defined between inner and outer tubing strings and communicating at the surface with the control fluid line **44**. The safety valve **103** includes circumferentially spaced radially movable locking dogs **114** engageable in an internal locking recess **115** of the inner tubing landing nipple section **105**. A central body section **120** of the safety valve holds the inner tubing string locking collets **111** against inward movement, thereby locking the inner tubing string within the outer tubing string landing nipple **92** when the safety valve is locked in position within the inner tubing string so that a pressure differential across the safety valve, when closed, will not lift the safety valve and the inner tubing string relative to the outer tubing string. The safety valve has upper and

lower external seal assemblies **121** and **122**, respectively, sealing around the valve with the bore walls of the inner tubing string so that control fluid communicated through the annulus **113** and the side ports **112** is directed to a side port **123** in the safety valve for controlling the opening and closing of the valve from the surface.

A well system, as represented by FIGS. **4-A** and **4-B**, may originally include only the outer tubing string which, when desired, is fitted with a well safety valve system embodying the invention. A suitable standard plug, not shown, is run by wireline into the outer tubing string and locked at the recesses **95** for shutting in the well above the plug. The well is then opened at the well head and the inner tubing string is run into the well until the collet fingers **111** expand into the outer tubing string landing nipple locking recess **93.** The well pressure is then equalized across the plug, and the plug is removed by wireline techniques. The safety valve **103** is then run by wireline into the inner tubing string and locked at the lower end of the string by expanding the keys **114** into the locking recesses **115.** The central body portion **120** of the safety valve **103** holds the outer tubing string locking collets **111** expanded in the recess **93.** The seals **121** and **122** seal above the side ports **112** so that control fluid pressure is communicated from the surface through the annulus **113** to the safety valve holding the valve at an open position.

When removal of the safety valve system in FIGS. **4-A** and **4-B** is desired, the valve **113** is first removed by wireline and a standard well plug, not shown, is run through the inner tubing string into the landing nipple **94** of the outer tubing string. With the well thus shut in, the well head is opened and the inner tubing string is lifted disengaging the locking fingers **111** from the locking recess **93** o the landing nipple **92** of the outer tubing string. With the collet fingers disengaged, the inner tubing string is removed from the outer tubing string through the well head. Thus, the well system shown in FIGS. **4-A** and **4-B** permits the outer tubing string to be fitted with a removable inner tubing string which is held in place by a safety valve releasably locked within the lower end of the inner tubing string so that an existing well having a tubing string with a landing nipple is readily converted to a safety valve system.

A still further form of well safety valve system embodying the invention is illustrated in FIGS. **5-A** through **8-C** wherein an outer tubing string **130** having a smooth wall bore **131** is converted to a safety valve system by the installation of an inner tubing string **132** and a safety valve **133.** A well plug **134** is used in carrying out the precedure of installing this particular safety valve system in a well. Referring particularly to FIGS. **5-A, 5-B,** and **5-C,** the well as initially equpped and produced has the outer tubing string **130** supported from the well head hanger **24** as in FIG. **1.** A suitable standard Otis Type G Stop or Pack-off Anchor Stop **135** is run with wireline equipment and techniques to a desired depth at which it is locked with the wall of the bore of the outer tubing string. The stop **135** includes an inner locking member **140** and an outer locking collet **141** having a plurality of circumferentially spaced collet fingers **142** which are shown expanded along the expander surface **143** of the inner member for locking the stop with the tubing wall. A locking wire **144** holds the inner and outer members together when withdrawing the stop, as described hereinafter. The upper end edge **145** of the stop provides a supporting surface for the wireline installable and removable landing nipple **135.** After setting the bottom stop, the removable landing nipple **135** is installed by wireline and set on the stop **136.**

The landing nipple **135** is shown in FIGS. **5-A, 5-B,** and **5-C** positioned on the stop **136** but not locked with the tubing string wall. The landing nipple comprises a tubular body **150** having an upper portion **150*a*** and a reduced lower portion **150*b*** for supporting the locking and sealing assemblies of the landing nipple. An annular retainer **151** is threaded on the lower end of the reduced portion **150*b*** of the landing nipple body for holding an expandable seal **152.** An internal O-ring **153** seals between the body and the retainer. A seal expander sleeve **154** is slidably disposed on the body above the seal **152.** An O-ring **155** is positioned within an internal annular recess of the expander for sealing between the expander and the body. An expander collet **160** is interlocked with the seal expander **154** and slidable along the body. A collet locking sleeve **161** having an upper external annular flange portion **162** is slidably disposed along the body interconnected by a shear pin **163** with the expander **160.** A locking collet **164** having locking collet finger heads **165** is slidable on the sleeve **161** and connected thereto by a shear pin **170.** An elongated external operator sleeve **171** is slidably disposed over the body **150** and locked thereon by a shear pin **171*a*** for expanding the seal **152** and the locking collet finger heads **165.** The sleeve **171** has an upper internal annular flange **172** and a lower internal annular flange **173** which overlaps the collet expander sleeve flange **162** positioned between the flange **162** and the upper end of the locking collet **164.**

The body **150** of the removable landing nipple **135** has an upper internal annular locking recess **174,** an intermediate internal annular locking recess **175,** and a lower internal annular locking recess **180.** The removable landing nipple is installed in the outer tubing **130** on the stop **136** with standard wireline equipment. The landing nipple is run into the tubing **130** with the seal **152** relaxed and contracted and the locking collet fingers **165** at upper non-locking positions as shown in FIGS **5-A, 5-B,** and **5-C.** When the landing nipple comes to rest on the upper end **145** of the stop, the outer sleeve **171** is jarred downwardly forcing the locking and seal expander assembly held together by the shear pins **163** and **170** comprising the seal assembly expander **154,** the collet finger expander **160,** the collet assembly **164,** and the sleeve collet expander **161** downwardly against the seal **152** expanding the seal until the resistance against further expansion effects the shearing of the pin **170.** Initially, in order to release and jar the sleeve **171** downwardly, the pin **171*a*** is sheared releasing the outer sleeve **171** on the body **150** for downward movement. When the pin **170** is sheared, the flange **173** of the outer sleeve **171** forces the collet **164** downwardly against the expander **160** which is held by the previously expanded seal assembly **152** so that the collet fingers **165** are wedged along the expander **160** against the wall bore of the outer tubing locking the landing nipple against upward movement in the outer tubing string.

After the wireline installation of the removable landing nipple **135** on the stop **136,** the well is shut in by the wireline installation of the plug **134.** The plug is a suit-

able standard well tubing plug assembly having a central mandrel **190** disposed within a tubular body comprising an upper member **191**, central members **192, 193**, and **194**, and a lower outer member **195**. plurality of locking dogs **200** are supported on the body operated by a sleeve **201**. A seal assembly **202** is supported on the body between the members **192** and **193** for sealing around the plug within the landing nipple **135**. An annular closure member **203** is secured by a shear pin **204** within the bore **205** of the lower body member **195**.

The plug **134** is designed to seal against a pressure differential in either an upwardly or a downwardly direction. After the plug **134** is lowered into the landing nipple, the plug locking dogs **200** are expanded into the landing nipple locking recess **175** locking the plug in place within the landing nipple. The pressure is then bled off the well by relieving the pressure at the well head in the outer tubing string so that the well may be opened with the pressure differential being sustained by the plug **134**. The locking collets **165** on the landing nipple prevent upward movement of the landing nipple while the seal **202** around the plug and the seal **203** within the plug prevent well flow upwardly past the plug.

The inner tubing string **132** is then run into the well. The inner tubing string has a collet assembly along the lower end section of the string comprising a plurality of circumferentially spaced collet fingers **210** below a side port **211** in the tubing string. The string is provided with locking recesses **212** for locking the well safety valve **133** in place within the inner tubing string. The inner tubing string is lowered in the outer string until the collet fingers **210** move into the upper end of the landing nipple body **150** and expand into the annular locking recess **174** of the body. The inner tubing string is spaced concentrically within the outer tubing string defining a control fluid annular passage **213** from te surface into the landing nipple **135**. The use of the plug **134** within the removable landing nipple permits the tubing string, which may be of substantial length such as 1,000 feet or more, to be inserted into the outer tubing string without the use of a stuffing box, which is not particularly satisfactory for the insertion of such a long string of tubing.

After the inner tubing string **132** is installed in the outer tubing string, wireline tools are run through the inner tubing string to the plug **134** which is jarred upwardly shearing the pin **204** withdrawing the central rod **190** permitting pressure equalization across the plug so that well pressure is again communicated through the tubing strings to the surface. The plug is then removed by standard wireline procedures whch effect the disengagement of the locking dogs **200** from the recess **175** of the landing nipple followed by removal of the complete plug from the tubing strings through the well head. The safety valve **133** is then run with wireline tools through the inner tubing string **132** into the landing nipple **135** and locked at the recess **212** in the lower end of the inner tubing string. The valve **133** is a standard valve assembly adapted to be set and retrieved by wireline methods. The valve includes locking dogs **214** which are expandable into the inner tubing string locking recesses **212** for locking the safety valve within the lower end portion of the inner tubing string **132**. The valve body has upper and lower seal assemblies **215** and **220**, respectively, for sealing with the lower end of the bore of the inner tubing string and the bore of the landing nipple above and below a valve side port **221** leading to the fluid control mechanism of the safety valve. The safety valve has an annular piston **222** which is forced downwardly against a spring **223** by control fluid pressure communicated through the port **221** to hold the ball element **224** of the valve in an open position. Release of the fluid pressure against the piston **222** allows the spring to lift the valve control mechanism upwardly closing the ball **224** to prevent flow through the bore of the safety valve. The body of the safety valve along a central portion **225** is aligned within the inner tubing string collet fingers **210** holding the collet fingers in locked relationship with the locking recess **174**. Thus, the safety valve is locked within the lower end portion of the inner tubing string and holds the tubing string locked with the landing nipple **135**, which, in turn, is locked with the smooth wall bore of the outer tubing string **130**. Control fluid is communicated from the surface to the safety valve through the annular space **213** between the inner and outer tubing strings.

When removal of the well saftty valve system, as shown in tts complete form in FIGS. **8**-A through **8**-C, is desired, the safety valve **133** is first removed by release of the locking dogs **214** to permit the valve to be pulled through the inner tubing string to the surface. The well plug **134** is then reinstalled in the well through the inner tubing string and locked within the landing nipple **135** by expansion of the dogs **200** into the locking recess **175**. The pressure is then bled from the well at the surface and the inner tubing string is withdrawn. Since the plug **134** has no structure aligned with and against the collet fingers **210** on the lower end of the inner tubing string, the collet fingers are cammed inwardly out of the locking recess **174** responsive to a lifting force on the tubing string from the surface. When the collet fingers release from the landing nipple, the inner tubing string is lifted from the well through the well head. After removal of the inner tubing string, the central member **190** of the plug **134** is removed equalizing the pressure across the bottom plug and the remainder of the plug is removed by wireline. The landing nipple is secured by a pulling tool at the upper end thereof lifting the outer sleeve **171** until the flange **173** engages the slip expander flange **162**. The sleeve is jarred upwardly severing the pin **163** so that the slip expander sleeve **161** is pulled upwardly allowing the slip expander **160** to contract. When the sleeve **161** is lifted a sufficient distance, the flange **161a** engages the internal flange **164a** within the slip assembly head withdrawing the slips **165** from the slip expander, thereby releasing the landing nipple **135** which is then withdrawn from the outer tubing string. The stop **163** then may be similarly released and retrieved. The inner expander member **142** is lifted from within the outer member **141** so that the slips **143** move downwardly on the expander surface of the member **140**, releasing the slips from the outer tubing string wall. When the slips are released and the stop is further lifted, the retainer wire **144** engages the shoulder **140*a*** on the inner member so that the slip assembly is lifted with the inner member and the complete stop is removed by wireline from the outer tubing string.

Thus, an outer tubing string provided with a smooth inner wall, and thus no pre-installed landing nipple, is readily fitted with a well safety valve system embodying

the invention. It will be recognized that this particular safety valve system includes a wireline operable landing nipple for locking the inner tubing string which then is held in place by the safety valve which is locked within the lower end of the inner tubing string.

A still further form of well safety valve system including a removable landing nipple lockable at an outer tube landing string nipple included in the original well installation is shown in FIGS. **9-A** through **12** of the drawings. In this particular form of the invention, the well in which the safety valve system is installed is one in which an outer tubing string **250** was initially run and set in the well. The tubing string **250** includes an Otis Type S landing nipple **251** connected in the outer string by pipe couplings **252** and **253**. The inclusion of such a landing nipple in a tubing string at selected depths at which well tools may in the future be installed in the well is often standard practice. The landing nipple includes an upper internal recess **254** and lower locking recesses **255**. The safety valve system includes a removable landing nipple **260**, a well plug **261**, an inner tubing string **262**, and a safety valve **263**.

Starting with the well equipped with only the outer tubing string **250** and the landing nipple **251** empty, the first step in the procedure is the wireline installation of the removable landing nipple **260**. The landing nipple **260** has a tubular body mandrel **270** provided near the upper end thereof with an internal annular locking recess **271** for the releasable locking of the inner tubing string with the landing nipple. The nipple **260** has an intermediate locking recess **272** for the locking of the plug **261** within the landing nipple. A plurality of O-ring seals **273** are disposed within external annular recesses along the central portion of the landing nipple body mandrel for sealing around the landing nipple with the wall surface **274** defining the bore through the outer tubing landing nipple **251**. Below the O-ring seals **273** the body mandrel **270** is reduced in diameter at **275** and threaded externally along a lower end section **280** for engagement of an annular retainer **281** which holds a locking collet **282** on the lower end portion of the body mandrel. The locking collet has a base annular ring portion **283** and a plurality of circumferentially spaced locking collet fingers **284** extending from the ring upwardly along and around the body mandrel. The locking fingers have outer boss configurations adapted to fit the landing nipple locking recesses **255** of the outer tubing string landing nipple **251**. The body mandrel **270** has a plurality of circumferentially spaced longitudinal windows **285** best illustrated in FIG. **12** which shows in exploded relationship the lower end portion of the body mandrel **270** along with the collet **282** and the retainer **281**. The windows **285** extend from the lower end portion of the full diameter of the body mandrel **270** into the reduced diameter portion of the body mandrel and are spaced to receive the locking collet fingers **284**. When the locking collet **282** is telescopically disposed on the body mandrel held by the retainer **281**, the collet fingers project radially partially inwardly into the windows **285** and the bosses of the fingers project radially outwardly beyond the full diameter of the body mandrel so that at the normal relaxed positions of the collet fingers they are receivable in the locking nipple recesses **255**.

When the collet **282** is assembled on the body mandrel, the base ends of the collet fingers **284** are slightly within the lower ends **285***a* of the windows **285** so that the collet fingers **284** may be compressed inwardly into the bore of the body mandrel **270** during insertion and withdrawal of the landing nipple **260** at the outer tubing string landing nipple **251**. An internal supporting shoulder **290** is provided around the bore through the landing nipple body mandrel **270** to limit the downward movement of the plug **261** in the landing nipple **270**.

The landing nipple **270** is installed by standard wireline procedures by a wireline running tool of suitable design engaged at the internal recess **271** of the landing nipple body mandrel **270**. The landing nipple is lowered through the outer tubing string **250** to the landing nipple **251** in the outer tubing string. During the downward travel of the landing nipple **260** the collet fingers **284** are held compressed inwardly into the body mandrel windows **285** by the bore wall of the outer tubing string. The landing nipple **260** moves into the tubing string landing nipple **251** until the collet fingers **284** are aligned with the locking recesses **255** which permit the collet fingers to spring radially outwardly into locking relationship in the recesses. The shoulders **284***a* on the collet fingers provide an abrupt stop means for the collet fingers and thus the landing nipple **260**. A further precaution against movement of the landing nipple **260** below the tubing string landing nipple **251** is provided by the larger diameter portion **270***a* of the body mandrel **270** which terminates at a shoulder **270***b* which is larger in diameter than the bore through the landing nipple **251** so that a malfunction of the collet fingers **284** will not result in the landing nipple **260** going below the tubing string landing nipple **251**.

Following the setting of the removable landing nipple **260** within the outer tubing string **250**, the wireline-type plug **261** is run into the well and locked in the landing nipple **260** for shutting in the well preparatory to the running of the inner tubing string **262**. The plug **261** is of a suitable standard design including a tubular body assembly **300** comprising central tubular members **301** and **302**, a lower solid locking rod member **303** and upper handling and locking structure including a standard Otis X-type locking mandrel **304** having locking dogs **305** and an internal annular handling recess **310** for connecting the tool with a wireline running tool. An external seal assembly **311** is supported on the plug body for sealing around the plug with the bore surface of the removable landing nipple **260**. An internal sleeve valve **312** is slidably disposed within the bore of the body member **302** for movement between an upper closed position and a lower open position within the bore for covering and uncovering a side port **313** in the plug body member **302**. The fit of the plug body within the removable landing nipple body **270** below the seal assembly **311** on the plug body is sufficiently loose that well pressure is readily communicated within the removable landing nipple around the plug body to the side port **313**. Thus, movement of the valve **312** downwardly to a lower position at which the locking collet fingers **312***a* of the valve engage the internal shoulder **314** uncovers the side port **313** allowing equalization of well pressure across the plug and communicating into the bore **315** of the plug which opens upwardly into the tubing string above the plug. The valve **312** is movable by suitable standard wireline tools.

With the removable landing nipple **260** installed as previously described, the plug **261** is run in on a wireline into the landing nipple body mandrel **270** against the stop shoulder **290**. The locking dogs **305** of the plug

expand into the locking recess **272** locking the plug within the removable landing nipple. The solid rod portion **303** of the plug body projects within the removable landing nipple collet fingers **284** preventing inward movement of the collet fingers and thereby holding them at their normal locking relationship in the locking recesses **255** so that as the pressure is bled from the well at the well head applying upward well pressure to the plug, the rod **303** holds the removable landing nipple locked within the outer tubing string landing nipple **251.** The upward well pressure differential across the plug cannot force the plug and the removable landing nipple upwardly in the outer tubing string. The O-ring seals **273** around the removable landing nipple prevent flow around the body mandrel **270** while the seal assembly **311** on the plug prevents fluid flow within the body mandrel **270** around the plug.

With the plug **261** set in the landing nipple **260,** the well is bled down and opened at the well head for insertion of the inner tubing string **262.** The lower end portion of the inner tubing string has a set of circumferentially spaced locking collet fingers **320** which are receivable in the locking recess **271** of the removable landing nipple **260.** Additionally, the inner tubing string has a side port **321** above the collet fingers **320.** Above the side port **321** the lower end portion of the inner tubing string is provided with locking recesses **322** for the releasable locking of the safety valve **263** within the lower end of the inner tubing string. The inner tubing string is run into the outer tubing string until the collet fingers **320** enter the upper end of the removable landing nipple body mandrel **270** and spring outwardly into locking relationship with the locking recess **271** of the landing nipple body. A wireline tool is then run into the inner tubing string through the string to the plug **261** engaging the internal sleeve valve **312** which is forced downwardly until the collet fingers **312***a* engage the stop shoulder **314** uncovering the side port **313** of the plug body. The pressure is equalized across the plug through the side port **313** to permit removal of the plug. The plug is then retrieved by engagement of a suitable wireline pulling tool with the handling recess **310** of the plug body releas1ng the mandrel locking dogs **305** and withdrawing the plug from the removable landing nipple bore.

The well safety valve **263** is then run with wireline equipment into the inner tubing string where it is releasably locked within the lower end of the tubing string and the removable landing nipple **260.** The safety valve is of suitable standard design having a tubular body mandrel **330** on which is secured a locking mandrel **331** having a set of locking dogs **332** provided with outer bosses which fit the inner tubing string locking recesses **322.** The safety valve has an external seal assembly **333** for sealing around the safety valve with the bore wall of the inner tubing string below the locking recesses **322.** The safety valve body also has a lower seal assembly **334** for sealing with the bore wall of the removable landing nipple body mandrel **270.** Between the upper and lower seal assemblies of the safety valve, the body of the valve has a side port **335** leading to an annular piston chamber **340** in which is disposed an annular valve operator **341** having an annular piston **342** movable responsible to control fluid pressure communicated through the side port **335.** The valve operator rotates a ball valve **343** for closing and opening the bore through the safety valve. The valve operator is biased upwardly toward a valve-open position by a spring **344.** The lower end portion of the safety valve body comprises a tubular locking member **345** which, when the valve is locked in place in the removable landing nipple, extends in locking relationship through the collet fingers **284** so that the landing nipple collet fingers are prevented from inward movement. Thus, the lower end portion of the safety valve holds the removable landing nipple in locked relationship in the outer tubing string landing nipple **251** so long as the safety valve is in place within the landing nipple. The body of the safety valve along the upper central portion of the valve above the side port **335** is sized to fit within and along the inner tubing string locking collet fingers **320** holding the fingers in locked relationship in the locking recess of the body mandrel **270** of the removable landing nipple **260** so that so long as the safety valve is held within the removable landing nipple in the position shown, the inner tubing string is maintained locked with the removable landing nipple. Thus, the lower end portion of the safety valve locks the removable landing nipple in the fixed landing nipple of the outer tubing string while the upper central portion of the safety valve body locks the inner tubing string with the removable landing nipple and the safety valve is locked by the dogs **332** in the recesses **322** of theinner tubing string.

The inner tubing string **262** is concentrically spaced within the outer tubing string **250** defining an annular control fluid flow passage **350** extending from the surface to the valve **263** for communicating control fluid to the valve to hold the valve in an open position. The pressure is ommunicated along the annular flow passage to the tubing side port **321** and also along the collet fingers **320** to the side port **335** of the safety valve between its upper and lower seal assemblies **333** and **334.** The control fluid pressure is communicated through the side port into the piston chamber **340** for holding the piston **342** downwardly at a valve-open position. So long as the well is produced, the ball valve **343** is held open by the control fluid communicated from the surface. When a predetermined condition develops responsive to which the valve is arranged to close, the control fluid pressure is reduced permitting the spring **344** to lift the piston **342** rotating the valve **343** to a closed position. The application of a pressure differential across the valve tends to lift the valve in the inner tubing string applying an upward force to the string through the locking dogs **332.** This upward force is communicated through the inner tubing string locking fingers **320** to the mandrel of the removable landing nipple **260.** The fingers **320** are held locked by the presence of the safety valve through the fingers in the bore of the removable landing nipple. Additionally, the upward force communicated through the locking fingers **320** tends to lift the removable landing nipple which also is held locked in place by the collet fingers **284** which are prevented from inward movement by the tubular member **345** of the safety valve extending through the collet fingers.

When removal of the safety valve system from the well is desired, the safety valve **263** is first retrieved by wireline methods with the well under pressure. Release of the locking dogs **332** with a suitable wireline retrieving tool permits the safety valve to be lifted through the inner tubing string to the surface. After removal of the valve, the removable locking nipple **260** remains locked in the outer tubing string locking nipple **251** be-

cause no pressure differential now exists across the removable landing nipple. The well plug **261** is again run in the inner tubing string and locked within the removable landing nipple at the position shown in FIGS. **9**-A, **9**-B, and **9**-C, and the well pressure is bled off at the well head so that the well head is opened for retrieval of the inner tubing string **262.** With a pressure differential again across the removable landing nipple, the nipple is held in place by the rod portion **303** of the plug. The inner tubing string is lifted camming the collet fingers **320** inwardly from the locking recess **271** releasing the inner tubing string from the landing nipple body **270.** After the inner tubing string is fully withdrawn, the pressure is equalized across the end plug by using wireline techniques to shift the sleeve valve **312** to the open position, subsequent to which the plug is retrieved from the well through the outer tubing string. The landing nipple **260** is then recovered by use of a wireline operated pulling tool applying an upward force to the upper end of the landing nipple at the recess **310.** The upward force cams the locking collet fingers **284** inwardly into the lateral windows **285** releasing the collet fingers from the recesses **255** permitting the landing npple to be withdrawn from the outer tubing string.

Thus, the well safety valve system of FIGS. **9**-A through **12** permits the conversion of an existing well having a tubing string provided with a landing nipple, such as the nipple **251,** to a safety valve system. The system includes a removable landing nipple lockable within the tubing string landing nipple and a removable inner tubing string with both the removable landing nipple and the inner tubing string being locked within the outer tubing string by the well safety valve. The removable landing nipple and the well safety valve and plug are all set and retrieved by wireline techniques.

It will be recognized that each of the illustrated and described forms of well safety valve systems includes mechanism for converting various types of well systems to include a safety valve controllable from the surface through an annular control fluid flow passage. In each form of the invention the annular flow passages are defined by concentrically disposed inner and outer tubing strings; the inner tubing string is releasably locked at a lower end thereof with structure secured to the outer tubing string at the safety valve depth; and the inner string is held in such locked relationship by the presence of the well safety valve. The well safety valve is biased open by control fluid pressure and closes to shut off communication into the inner tubing string responsive to the occurrence of a predetermined condition. The control fluid is communicated from the surface and responds to any one or more of a number of desired opeating conditions. With the exception of the running of the inner tubing string, the other procedures carried out in the well bore may be handled by wireline techniques. In one form of the invention, an original well installation includes a landing nipple into which the inner tubing string is coupled and held by the safety valve which is releasably locked within the lower end of the inner tubing string. In another form of the invention a removable landing nipple is releasably locked at a landing nipple provided in the outer tubing string with the inner tubing string then being coupled into the removable landing nipple and held by a safety valve supported in the lower end of the inner tubing string. In a still further form of the invention a removable landing nipple is supported and locked at a desired depth along a smooth wall bore of the outer tubing string with the inner tubing string being coupled into the removable landing nipple and held by a safety valve supported at the lower end of the inner tubing string. In a still further form of the invention a removable landing nipple is releasably locked at an outer tubing string landing nipple and supported in locked relationship by the removable well plug and safety valve utilized. The plug is supported in the removable landing nipple, and the safety valve, when in operation, is supported in the lower end of the inner tubing string extending through the removable landing nipple locking both the tubing string in the removable landing nipple and the removable landing nipple in the outer tubing string landing nipple.

What is claimed and desired to be secured by Letters Patent is:

1. A well safety valve system comprising: a first outer tubing string supported in a well; first locking means associated with said first tubing string at a predetermined depth along said string; a second inner tubing string supported in spaced concentric relationship within said first tubing string defining an annular control fluid flow passage between said tubing strings from a surface end thereof along said strings; said second tubing string including second locking means for releasably locking said string with said first locking mean, said second locking means being held in locked relationship with said first locking means by a safety valve positioned within said tubing string communicating with said annular flow passage between said strings, said safety valve being insertable and removable through said second tubing from the surface.

2. A well safety valve system in accordance with claim **1** wherein said locking means coupled with said first tubing includes an internal annular locking recess and said second tubing string is provided with locking collet fingers receivable in said locking recess of first tubing string and held in said recess by said safety valve.

3. A well safety valve system in accordance with claim **2** including a safety valve releasably locked in said tubing strings holding said inner tubing string in locked relationship with said outer tubing string.

4. A well safety valve system in accordance with claim **2** wherein said locking means coupled with said first tubing string comprises a conduit section connected in said first tubing string and having an annular locking recess therein for releasable connection of said second tubing string with said first tubing string.

5. A well safety valve system in accordance with claim **4** including a safety valve releasably locked in said tubing strin holding said inner tubing string locked with said outer tubing string.

6. A well safety valve system in accordance with claim **4** wherein said second tubing string is provided with external seal means spaced from said locking fingers and adapted to seal around said second tubing string within said first tubing string on opposite sides of a side port in said first tubing string leading to a control fluid line connected with said first tubing string and communcating with said side port.

7. A well safety valve system in accordance with claim **2** wherein said locking means coupled with said first tubing string comprises a bottom stop releasably locked along a smooth wall bore section of said first tubing string and a landing nipple supported on said bottom stop and releasably locked with said smooth

wall bore section of said first tubing string; and said internal locking recess for said locking fingers of said second tubing string is provided in said landing nipple for releasably locking said second tubing string with said landing nipple; said safety valve being supportable at the lower end of said second tubing string and aligned with said locking fingers for holding said fingers in locked relationship with said landing nipple when said safety valve is locked with said second tubing string.

8. A well safety valve system in accordacne with claim **7** wherein said removable landing nipple is provided with expandable and contractible locking dogs and an external annular seal for sealing around said nipple with the wall surface of the bore of said first tubing string.

9. A well safety valve system in accordance with claim **7** including a removable well plug for closing a bore through said landing nipple when said second tubing string is being run in and retrieved from said first tubing string and a well safety valve for support in said second tubing string when said second tubing string is releasably locked with said landing nipple within said first tubing string.

10. A well safety valve system in accordance with claim **2** wherein said locking means coupled with said first tubing string includes a first landing nipple comprising a section of said first tubing string and a releasably lockable second landing nipple having locking dogs for locking said second landing nipple with said first landing nipple in said first tubing string, said internal annular locking recess being provided in said second landing nipple for releasably locking said second tubing string with said second landing nipple, said locking dogs of said second landing nipple being held in locked relationship with said first landing nipple by a well plug when said well plug is releasably locked in said second landing nipple and by a safety valve when said safety valve is releasably locked in said second landing nipple, said safety valve having a locking surface aligned with said locking fingers of said second tubing string for holding said tubing string releasably locked with said second landing nipple when said safety valve is locked in place along said second tubing string and said second landing nipple.

11. A well safety valve system in accordance with claim **10** including a well plug releasably lockable in said second landing nipple below said locking recess in said nipple and having a locking member disposed along said locking dogs of said second landing nipple holding said dogs in locked relationship in said locking recess in sadi first landing nipple and a well safety valve lockable in said second tubing string and having a locking surface alignable with said locking fingers of said second tubing string for holding said fingers in locked relationship with said locking recess of said second landing nipple and having a locking member disposed through said locking dogs of said second landing nipple for holding said locking dogs in said locking recess of said first landing nipple when said safety valve is releasably locked along said first tubing string, second tubing string, and said second landing nipple.

12. A method of fitting a well with a well safety valve controlled by fluid pressure communicated from a surface end of said well comprising the steps of: positioning a well plug in a first production tubing string of said well substantially at a depth at which said safety valve is to be set in said well; bleeding the pressure down in said first tubing string above said well plug; inserting a second inner tubing string in said first tubing string and running said second tubing string to safety valve depth in said first tubing string; releasably locking said second tubing string with said first tubing string at said safety valve depth; increasing the pressure in said tubing strings above said well plug for equalizing the pressure across said well plug; removing said well plug from said tubing string through said second tubing string; and installing a safety valve in said second tubing string at a predetermined depth therein and aligned to releasably hold said second tubing string in locked relationship with said first tubing string so long as said safety valve is locked in said tubing string.

13. A method in accordance with claim **12** wherein said inner tubing string is releasably locked with a locking recess provided along said outer first tubing string.

14. A method of fitting a well in accordance with claim **12** wherein a removable landing nipple is releasably locked in said first tubing string and provided with a locking recess and said second tubing string is releasably locked with said removable landing nipple in said first tubing string.

15. A method of fitting and operating a well in accordance with claim **14** wherein said removable landing nipple is supported on a bottom stop adapted to releasably lock with a smooth wall bore section of said first tubing string.

16. A method of fitting and operating a well in accordance with claim **14** wherein said first tubing string includes a landing nipple having a locking recess therein and said removable landing nipple is locked in said first tubing string at said locking recess therein and held in locking relationship with said first tubing string by a member on a well plug when supported in said removable landing nipple and a member on a safety valve when supported in said removable landing nipple and said safety valve additionally is aligned to lock said second tubing string with said removable landing nipple.

17. A well safety valve system comprising: a first tubing string supported in a well bore, said first tubing string including a landing nipple forming a portion thereof at a depth in said well for installation of a safety valve, said landing nipple having a side port for communication of control fluid pressure from a control line leading to said landing nipple; said landing nipple having an internal annular locking recess spaced from said side port for locking a well tool in said landing nipple; a second inner tubing string concentrically spaced within said first outer tubing string defining an annular control fluid flow passage from the surface along said tubing strings to said landing nipple in said first outer tubing string, said inner tubing string having locking collet fingers formed along said tubing string in the side wall thereof for releasably locking said second inner tubing string with said locking recess at said landing nipple of said first outer tubing string; seal means disposed around said second inner tubing string for sealing above and below said side port in said landing nipple of said first tubing string whereby said side port is isolated from the bore of said first tubing string when said second tubing string is disposed in and locked with said first tubing string; and said second tubing string having internal annular locking recess means spaced from said locking collet fingers for supporting a well safety valve in said second tubing string along said locking collet fingers holding said collet fingers in said locking recess

of said landing nipple of said first tubing string when said safety valve is locked in said second tubing string whereby said safety valve communicates with said annular flow passage between said tubing strings for controlling fluid flow into said second tubing string and holding said second tubing string in locked relationship with said first tubing string.

18. A well safety valve system in accordance with claim **17** including a safety valve releasably locked i1 said second tubing string at said locking recess therein, said safety valve 0aving spaced seal means for sealing around said valve with the inner wall defining the bore of said second tubing string above and below said collet fingers in said second tubing string.

19. A well safety valve system for controlling flow in a well through a safety valve communicating with the surface end of said well through a concentric control fluid flow passage comprising: a first outer tubing string supported in said well for producing well fluids therefrom, said first tubing string including a landing nipple having an internal annular locking recess therein for releasably locking well tools in said first tubing string at a depth adapted for use of a well safety valve in said tubing string; a second tubing string concentrically spaced within said first tubing string and extending to said landing nipple in said first tubing string, said second tubing string having a plurality of circumferentially spaced locking collet fingers receivable in said locking recess of said landing nipple of said first tubing string for releasably locking said second tubing string with said landing nipple of said first tubing string; and said second tubing string having internal locking recess means spaced from said locking collet fingers for supporting a safety valve in said second tubing string, said safety valve having a body surface portion aligned with said locking collet fingers of said second tubing string for holding said second tubing string in locked relationship with said first tubing string when said safety valve is releasably locked in said second tubing string.

20. A well safety valve system in accordance with claim **19** including a well safety valve releasably locked in said second tubing string at said locknng recess thereof, said safety valve having external seal means for sealing around said valve within said second tubing string above said locking collet fingers thereon and for sealing within said landing nipple of said first tubing string below said collet fingers on said second tubing string whereby control fluid pressure is directed from an annular space around said second tubing string within said first tubing string to fluid pressure responsive means within said safety valve for controlling said safety valve by control fluid pressure communicated to said valve from the surface.

21. A well safety valve system for controlling a safety valve by control fluid pressure communicated to said valve through an annular fluid flow passage extending from a surface end of a well comprising: a first outer tubing string disposed in said well extending to a production depth therein; a bottom stop releasably locked with a smooth wall bore section of said first tubing string; a releasably locked landing nipple supported on said bottom stop in said first tubing string, said landing nipple having first and second spaced internal locking recesses therein for releasably locking a well plug in said landing nipple and releasably locking a second inner tubing string with said landing nipple, said landing nipple having locking means thereon for locking said landing nipple with said smooth wall bore section of said first tubing string against said bottom stop; a second inner tubing string supported in concentric spaced relationship within said first tubing string, said second tubing string having a plurality of spaced longitudinal locking collet fingers at the lower end thereof for releasably locking said tubing string with said second of said locking recesses in said removable landing nipple; and said second tubing string having locking recesses therein spaced from said locking collet fingers for releasably supporting a well safety valve at the lower end of said second tubing string at a position at which said safety valve is aligned within said locking collet fingers on said second tubing string holding said collet fingers in locked relationship with said second locking recess of said landing nipple when said safety valve is locked in said second tubing string and said second tubing string is interlocked with said landing nipple.

22. A well safety valve system in accordance with claim **21** including a well safety valve releasably locked at said locking recess in said second tubing string and having an external wall portion of said valve extending along said locking collet fingers holding said collet fingers of said second tubing string locked with said removable landing nipple, said safety valve having external seal means spaced along a body portion thereof sealing with said second tubing string above said locking collet fingers and with said landing npple below said collet fingers for directing control fluid pressure from said annular control fluid flow passage between said tubing strings into a side port in said safety valve for controlling said safety valve responsive to fluid pressure from the surface end of said well.

23. A well safety valve system in accordance with claim **21** wherein said removable landing nipple is provided with expandable and contractible locking fingers for locking said landing nipple with said smooth wall bore section of said first tubing string and said landing nipple is provided with an external annular seal for sealing around said nipple with said bore wall of said first tubing string.

24. A well safety valve system for controlling a well safety valve by control fluid pressure communicated to said valve through an annular control fluid flow passage extending from the surface end of a well to said valve, comprising: a first outer tubing string supported in said well, said tubing string including a landing nipple disposed at safety valve depth in said well along said first tubing string, said first landing nipple having an internal locking recess therein; a removable second landing nipple having locking dogs engageable in said locking recess of said first landing nipple of said first tubing string, said second landing nipple having a first locking recess therein for releasably locking a second inner tubing string therewith and a second locking recess for releasably locking a well plug in said landing nipple, said locking dogs on said second landing nipple being lockable with said locking recess of said first landing nipple in said first tubing string by means on a well plug supported in said removable landing nipple when said well plug is in operating position in said landing nipple and by means on a well safety valve when said safety valve is supported in operating position through said second landing nipple; and a second inner tubing string supported concentrically spaced within said first tubing string defining a fluid flow passage between said first

and second tubing strings to the lower end of said second tubing string, said second tubing string having locking collet fingers extending from the lower end thereof circumferentially spaced around said second tubing string and receivable in said first locking recess of said removable landing nipple, and said second tubing string having locking recess means therein near the lower end thereof spaced from said locking collet fingers for supporting a well safety valve within said second tubing string at a position at which a body portion of said safety valve extends through said locking collet fingers of said second tubing string holding said collet fingers in locked relationship with said removable landing nipple.

25. A well safety valve system in accordance with claim **24** including a well plug releasably lockable with said second locking recess of said second landing nipple and having a locking rod thereon for holding said locking dogs of said removable landing nipple in locked relationship in said locking recess of said first landing nipple of said outer first tubing string when said plug is releasably locked in said removable landing nipple and a safety valve releasably lockable with said locking recess means of said second tubing string, said safety valve being aligned along a body portion thereof within said locking collet fingers on said second tubing string for holding said fingers in locked relationship with said second landing nipple and said safety valve having a locking member along a lower end thereof disposed within said locking dogs of said second landing nipple for holding said dogs in locked relationship with said locking recess of said first landing nipple of said first tubing string when said safety valve is locked in position in said second tubing string, and said safety valve having spaced seals thereon for sealing with said second tubing string above said locking collet fingers thereon and with said second landing nipple below said locking collet fingers for directing control fluid from said annular flow passage between said tubing strings to a side port in said safety valve for controlling said safety valve responsive to said control fluid.

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