Dec. 5, 1961 A. F. RHODES ET AL 3,011,552

APPARATUS FOR SETTING PIPES IN TENSION

Filed Sept. 26, 1957 4 Sheets-Sheet 1

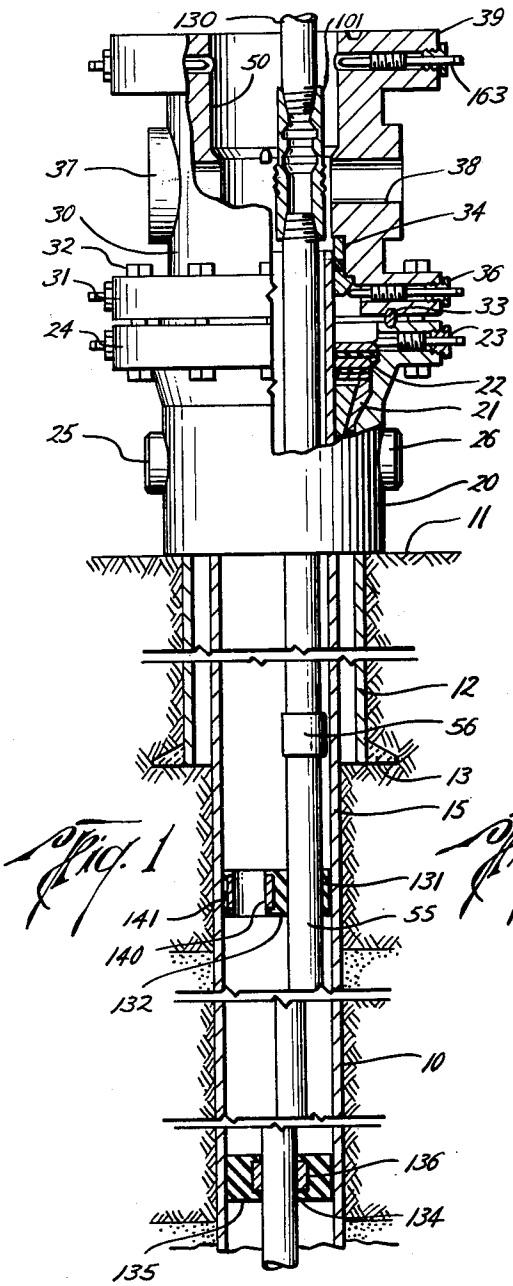


Fig. 1

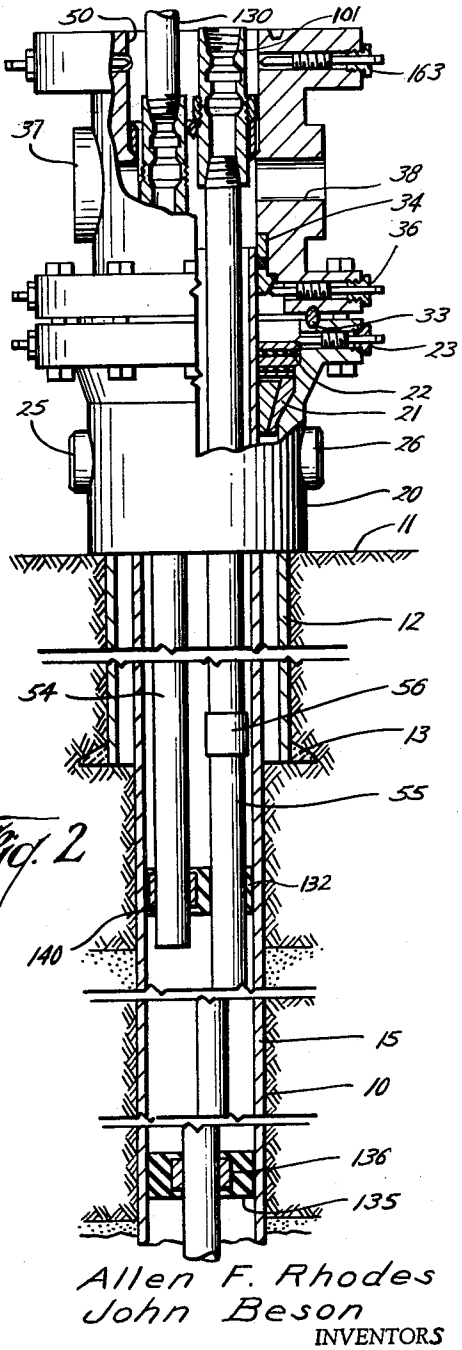


Fig. 2

Allen F. Rhodes
John Beson
INVENTORS

BY Carl B. Fox, Jr.

ATTORNEY

Dec. 5, 1961 A. F. RHODES ET AL 3,011,552

APPARATUS FOR SETTING PIPES IN TENSION

Filed Sept. 26, 1957 4 Sheets-Sheet 2

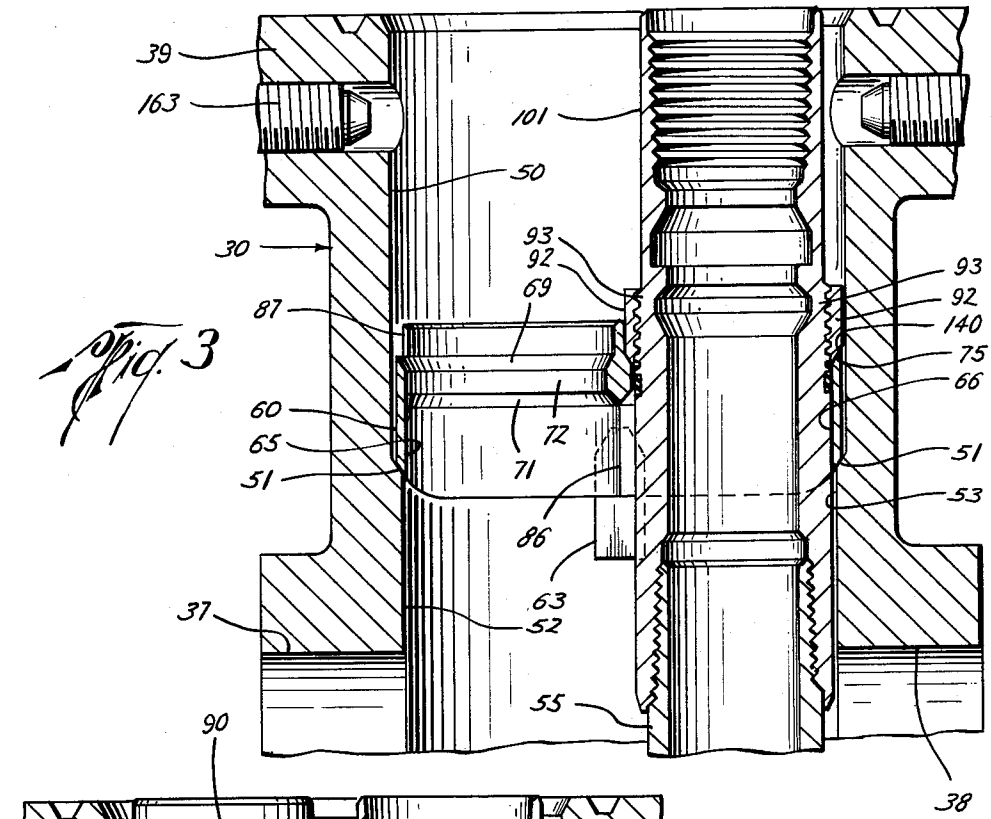


Fig. 3

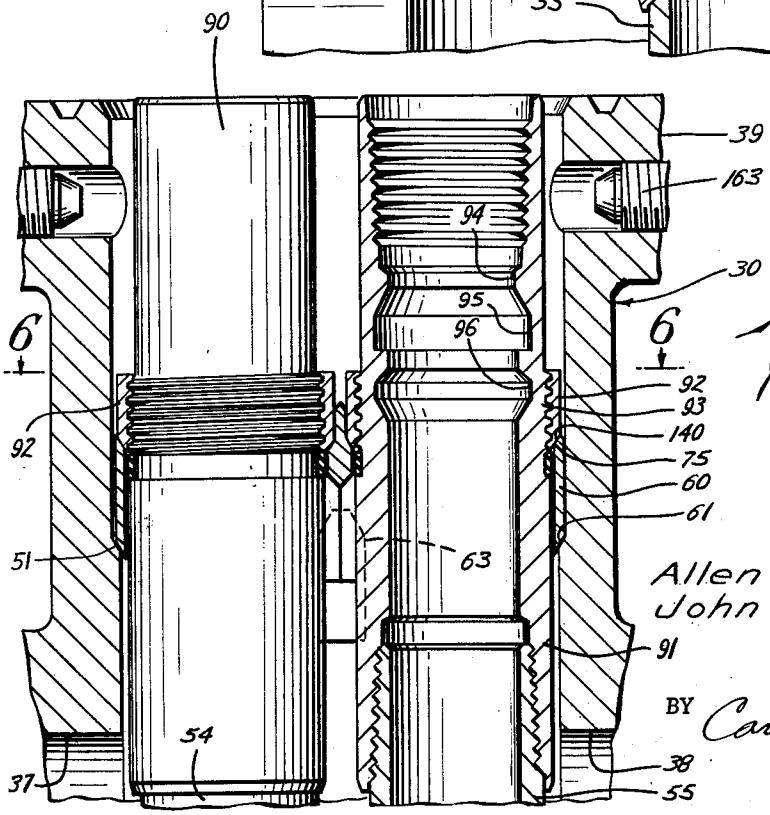


Fig. 4

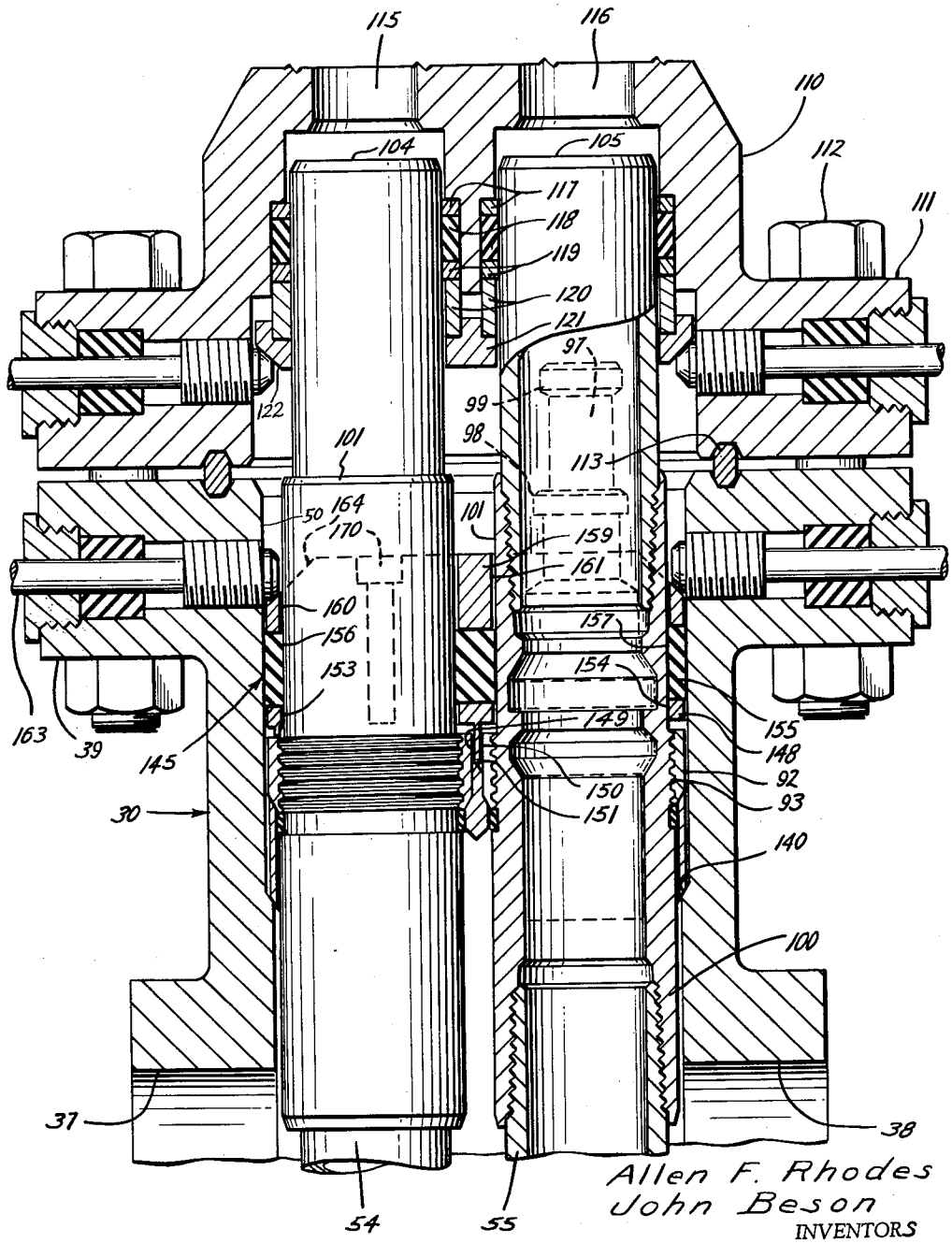
Allen F. Rhodes
John Beson
INVENTORS

BY Carl B. Fox, Jr.
ATTORNEY

Dec. 5, 1961 A. F. RHODES ET AL 3,011,552

APPARATUS FOR SETTING PIPES IN TENSION

Filed Sept. 26, 1957 4 Sheets-Sheet 3



Allen F. Rhodes
John Beson
INVENTORS

Fig. 5

BY Carl B. Fox, Jr.
ATTORNEY

Dec. 5, 1961 A. F. RHODES ET AL 3,011,552

APPARATUS FOR SETTING PIPES IN TENSION

Filed Sept. 26, 1957 4 Sheets-Sheet 4

Fig. 6

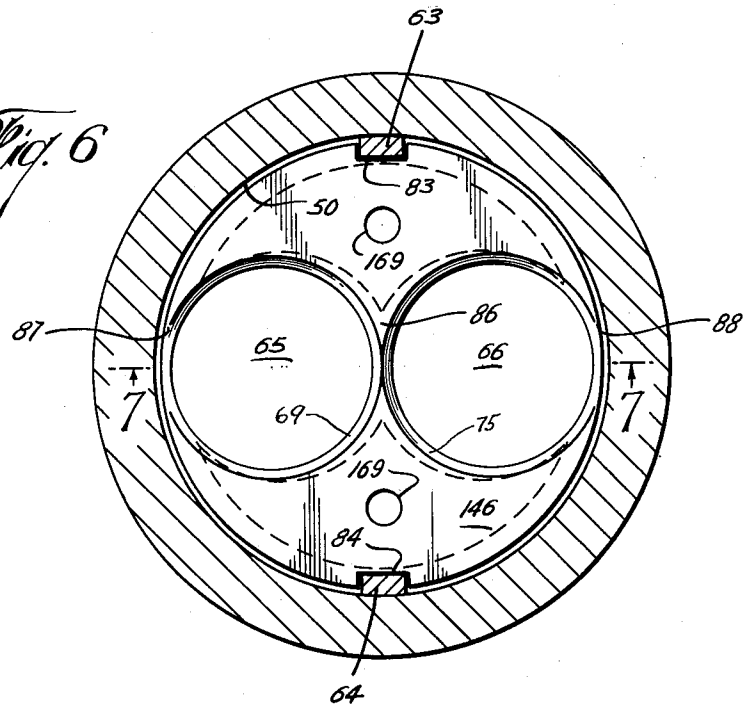
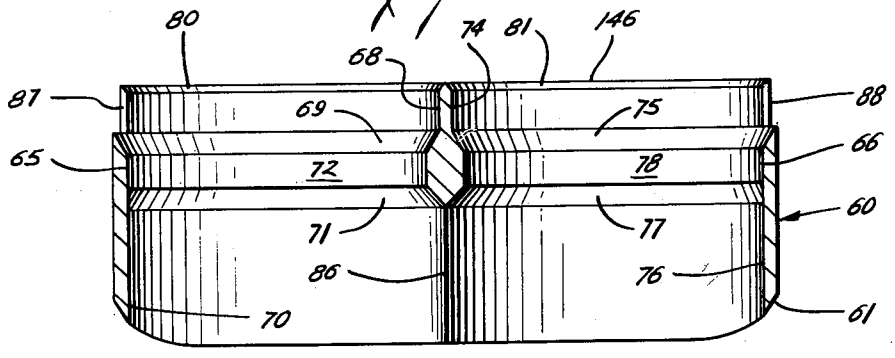


Fig. 7



Allen F. Rhodes
John Beson
INVENTORS

BY Carl B. Fox, Jr.
ATTORNEY

United States Patent Office 3,011,552 Patented Dec. 5, 1961

3,011,552

APPARATUS FOR SETTING PIPES IN TENSION

Allen F. Rhodes and John Beson, Houston, Tex., assignors, by mesne assignments, to McEvoy Company, Houston, Tex., a corporation of Texas

Filed Sept. 26, 1957, Ser. No. 686,460
7 Claims. (Cl. 166—67)

This invention pertains to pipe hanging equipment, and more specifically to tubing hangers for multiply completed wells. This invention also pertains to means for hanging pipe in longitudinal tension, and more specifically to so hanging multiple tubing strings in a well adapted for plural production. While the invention will obviously be most valuable in connection with multiple production wells, it is not intended to be limited thereto, since equipment for suspending a pipe in longitudinal tension will have many applications where the multiplicity of pipes is of no importance, including wells having only one production tubing. For purposes of illustrating the invention is one of its manifestations, and for making clear the application of the invention to a problem, the invention is herein disclosed with reference only to a dual well completion application, thereby also indicating the manner of applying the invention in any suitable applications thereof. It is a principal object of the invention to provide equipment for supporting a pipe or pipes in longitudinal tension.

Another object of the invention is to provide apparatus for separately supporting in tension a plurality of parallel pipes in a common passageway, such as, for example, a well hole.

A further object of the invention is to provide such means permitting suspension in tension of each of the pipes to be achieved independently, and permitting separate suspension and removal of each of the pipes.

Another object of the invention is to provide such apparatus whereby each pipe may be given tension in any desired degree independently of the other pipe or pipes.

Other objects and advantages of the invention will appear from the following description of a preferred embodiment, reference being made to the accompanying drawings, of which:

FIGURE 1 is an elevation, partly in vertical section, of the preferred form of apparatus, illustrating a step of the method;

FIGURE 2 is similar to FIGURE 1, illustrating another step of the method;

FIGURE 3 is an enlarged partial vertical section, showing the preferred apparatus with one production tubing run into the well;

FIGURE 4 is similar to FIGURE 3, showing the apparatus with both production tubings in place;

FIGURE 5 is a sectional view similar to FIGURES 3 and 4, showing the pack off means in place;

FIGURE 6 is a horizontal section taken as indicated by line 6—6 in FIGURE 4, only with both tubing strings absent from the hanger; and,

FIGURE 7 is a vertical section taken at line 7—7 of FIGURE 6, showing only the hanger body of the preferred embodiment.

FIGURES 1–5, besides showing the apparatus according to the invention, also show the apparatus in various stages of assembly to illustrate the method of the invention.

Referring first to FIGURES 1 and 2, there is shown a well **10** which has been drilled into the earth from the surface **11** thereof. A surface casing **12** surrounds the upper part of the well and is cemented in place at **13** at its lower end. A second casing **15** of smaller diameter extends concentrically down through surface casing **12**

and therebelow to the bottom (not shown) of the well where it is usually also cemented in place similarly as the surface casing. There may be several such concentric casings in the well, depending on factors known in the art, and known to persons skilled therein, and the particular arrangement is shown in FIGURES 1–2 only to illustrate the invention; the numbers and arrangement of the casings in no way affects the invention. At any rate, at a lower part of well **10**, there will be a single casing not surrounded by other casings, situated as is the portion of casing **15** below the lower end of surface casing **12** in FIGURES 1 and 2.

A casing head **20** is surmountingly connected to the upper end of casing **12**, as is customary. Casing **15** is suspended by a slip hanger means **21** seated in the casing head **20**, and the annulus around casing **15** in the casing head is sealed by a pack off means **22** which is urged downwardly by a plurality of the lockscrews **23** disposed radially through upper flange **24** of casing head **20**. Casing head **20** has side outlets **25**, **26** to permit access to the annular space between casings **12**, **15**.

A tubing head **30** surmounts casing head **20** and is bolted at its lower flange **31** to upper flange **24** of the casing head by a plurality of the bolts **32**. A steel ring gasket **33** provides a fluid-tight seal at this connection. Another pack off means **34** in the lower opening of tubing **30** is urged upward by a plurality of the lockscrews **36** radially through flange **31** to form a seal around the upper end of casing **15** which extends thereinto.

Tubing head **30** has side outlets **37**, **38** through which access may be had to the interior of the tubing head and casing **15**. A flange **39** is provided around the upper end of the tubing head for connection of other equipment surmounting the tubing head thereto (not shown in FIGURES 1 and 2).

Tubing head **30** (see also FIGURES 3–6) has an axial opening **50** vertically therethrough around which is formed the downwardly converging conical shoulder **51**. Shoulder **51** is recessed arcuately at opposite sides **52**, **53** to permit the well tubing strings **54**, **55**, and the couplings **56** therealong to pass through the tubing head. Tubing head **30** and casing **15** form a passageway into the well.

A hanger body **60**, best shown in FIGURES 3–7, is seated upon shoulder **51**, a shoulder **61** around the bottom edge of the body and of the same conical taper as shoulder **51** providing the seating surface of the body. Shoulder **61** is also arcuately recessed at opposite sides in conformity with recesses **52**, **53** of shoulder **51**. A pair of locator pins **63**, **64**, each 90° around the tubing head from the recesses, are each snugly received in slots (not shown) downwardly of shoulder **51** at opposite sides thereof and are welded in place. The pins project above shoulder **51** along the sides of opening **50** and are beveled at their sides and inner surfaces so as not to act to prevent sliding of the hanger body, tubings and tubing couplings therepast.

Hanger body **60** has two non-concentric tubing openings **65**, **66** vertically therethrough, each of which are generally cylindrical in shape. Opening **65** is formed by a counterbore **68** from the top of the body which extends downwardly to downwardly converging annular conical seat **69**, and by a counterbore **70** from the bottom of the body which extends upwardly to upwardly converging conically beveled surface **71**. Between these counterbores the opening is formed by bore **72**. Identically, opening **66** is formed by upper counterbore **74** which terminates downwardly at seat **75**, by lower counterbore **76** which terminates upwardly at beveled surface **77**, and by intermediate bore **78**. The lower counterbores are indicated (in part) by dashed lines in FIGURE 6. The square edges formed by the upper counterbores are bev-

eled at 80, 81 in order to provide smooth paths through the openings for introduction and withdrawal of equipment therethrough. Lower counterbores 70 and 76 are centered radially inwardly of upper counterbores 68 and 74, respectively, to permit the slight inward bending of tubings 54 and 55 which occurs lower down in the well.

The wall thicknesses of the hanger body at the outer sides of bores 72, 78 and lower counterbores 70, 76 are very thin. Body 60 has oppositely disposed vertical slots 83, 84 in its outer surface which are each positioned 90° around the body from a vertical plane through the axes of the bores and counterbores. Slots 83, 84 are of a form to each closely receive one of the pins 63, 64 extending above shoulder 51 to provide means for azimuthly aligning hanger body 60 when it is set set in the tubing head. Thus the counterbore portions which form the thin side walls of body 60 are each aligned with one of the arcuately cutaway recesses 52 or 53 of shoulder 51.

The lower counterbores 70, 76 overlap at the center of body 60 so that there is a lateral opening 86 between these counterbores. The upper counterbores are tangent to the sides of the body 60 so that there are lateral openings at the sides 87 and 88 of these counterbores. Thus, the hanger body 60 is of a minimum size, and there is no spare room either at the outer sides of the tubing strings or between the tubing strings. This arrangement, made possible by the form of the supports for hanging the tubings in the hanger body, distinguishes this apparatus from hanger apparatus wherein slip supports for the tubings are used. Where slip type supports are used, strong lateral support for the slips must be provided all around the tubing openings through the hanger, but in this invention, no such strong lateral support is provided along a diameter perpendicular to the axes of the counterbores, and perpendicular to the axes of the two tubing strings 54, 55 supported therein.

A "landing collar" or coupling means supports each of the tubing strings in the hanger body, the coupling 90 supporting string 54 at seat 69 around opening 65 and the coupling 91 supporting string 55 at seat 75 around opening 66. Each of the couplings 90, 91, which are identical, has a detachable support sleeve 92 which is threaded onto threads 93 around an intermediate part of the coupling, which threads are preferably of the "Acme" form shown, or of another suitable strong thread form. The crests of the threads 93 do not extend radially outward beyond the lower outer parts of the couplings.

The couplings 90, 91 each have a passage 94 vertically therethrough, being of a tubular form, and the passages may have recesses 95, 96 formed therearound to removably receive annular projecting flanges of a back pressure valve 97 which is thereby locked therein. The back pressure valves have upper handing means 98 and 99 by means of which they may be handled by tools (not shown) to be removed from or inserted into the seated couplings from above, and through surmounting equipment and/or blowout prevention means, not shown but customarily used in completing wells.

Couplings 90, 91 each has a lower threaded socket 100 into which is screwed a threaded upper end of one of the tubing strings, string 54 being shown screwed into socket 100 of coupling 90 and string 55 being shown screwed into socket 100 of coupling 91. Couplings 90, 91 each also has an upper threaded socket 101 whereby the nipples 104, 105 are connected to extend into and be sealed into the surmounting member 110 above tubing head 30.

Member 110 may be any dual bore device, but is usually a dual bore valve for controlling flow from the two tubing strings in the well. Member 110 has lower flange 111 which is bolted by bolts 112 and sealed by steel ring gasket 113 to upper flange 39 of tubing head 30. The nipples 104, 105 extend, respectively, into the lower ends of passages 115, 116 of member 110, which are provided with suitable packoff recesses, and are sealed therein by the elements 117—120 which are urged upwardly to form seals therearound by a disc-shaped plate 121 which is urged upwardly at bevel surface 122 thereof by the plurality of lock-screws radially through flange 111. Tubing string 54, coupling 90, nipple 104, and passage 115 form one continuous flow passage or path from the well, and tubing string 55, coupling 91, nipple 105 and passage 116 form another continuous passage from the well parallel with, but separate from, the other.

The procedure for tensioning tubing strings 54 and 55 is as follows: Referring again first to FIGURE 1, and also to FIGURES 2–6, the completion assembly is provided with suitable blowout prevention means (not shown) in place of member 110, which latter is not installed until after couplings 90, 91 and packoff means 145 are in place and the blowout prevention means has been removed. Tubing string 55 is first run into the well, the coupling 91 being screwed onto the top thereof, and a handling joint 130 being screwed into the socket 101 thereof and extending upwardly through the blowout preventor to furnish means for lowering the tubing so that the well pressure is kept under control throughout the operations. The sleeve 92 of coupling 91 is not at this time in place on threads 93 so that the coupling, including threads 93, the upper part of the coupling, and the lower end of the handling joint can be run to below the seat 51 of the tubing head. The lower end of string 55 is sealingly received through an aperture 131 of a suitable dual well packer means 132 which longitudinally divides the interior of casing 15. After passing through packer 132, the tubing string is run additionally to be received through an aperture 134 of a single-apertured well packer means 135 farther down in the well. The locations of the packer means in the well is dependent on the areas of the well from which it is hoped to obtain production of petroleum products on from which such production has already been ascertained, it being used to separate the areas of production by longitudinally dividing the casing by packers so that separate production may be derived from each of the tubing strings. The packer means 132 and 135 may be of the single and dual bore types shown at pages 538, 539, 542, 849, and 850 of the "Composite Catalog of Oil Field and Pipe Line Equipment," World Oil, Gulf Publishing Co., Houston, Texas, 21st edition, volume 1. The descriptions therein fully explain how the packers are set and held in place in casing 15. Other suitable packer means are known in the art and may be substituted for those indicated in the above page references. The latching means shown, and indicated schematically by reference numeral 136, is exemplary only, and many suitable latching means for the purpose are known in the art.

A suitable latch means 136 of packer 135 secures the tubing string 55 in the packer after the lower end of the tubing string has passed a suitable distance therebelow. The assembled length of tubing string 55 is made such that when the lower end thereof is a suitable distance below packer 135, and the string has been secured at its bottom by latching to the packer, the threads 93 of coupling 91 will be at a proper predetermined distance below seat 75 of the hanger body, which is next installed around tubing 55 and lowered into the hanger body so that when the tubing string is "stretched" or pulled upwardly and the sleeve 92 lowered around the handling joint and screwed onto threads 93 of the coupling, after which lower seat 140 of the sleeve is seated on seat 75, then the resulting longitudinal tension in the tubing string will be of the desired amount. The packer means 135, and also packer means 132, is of a type capable of being securely fixed at its position in casing 15 so that the tensioning may be achieved.

The assembly is now in the condition shown in FIG-

URE 3, the hanger **60**, its coupling **91** and sleeve **92** being in place, and the one tubing string **55** being properly tensioned in the well. The handling joint **130** is now removed so that socket **101** of coupling **91** is empty. Tubing string **55** is supported in tension at lower socket **100** of coupling **91** and at latch **136** of fixed packer **135**.

Referring particularly now to FIGURE 2, the second tubing string **54** is run, again making use of a suitable handling joint **130** which is now screwed into the upper socket **101** of coupling **90**, which in turn is screwed over the threaded upper end of tubing string **54**. Tubing string **54** is run in the usual manner and inserted at its lower end through the second aperture **140** of packer device **132**. The lower end of string **54** is positioned at a suitable, usually small, distance below packer **132** and there latched securely by latching device **141** at aperture **140**. Again the length of the string **54** is made such that coupling **90** is suitably positioned below seat **69** of hanger **60** so that when the string is stretched upwardly and the sleeve **92** of coupling **90** screwed thereon, the lower seat **140** of the sleeve being then seated on seat **69**, the tubing string **54** will be under the desired proper tension between its connection to coupling **90** at the socket **100** thereof and packer **132**. The handling joint **130** is now removed from socket **101** of coupling **90**.

The equipment is now in the condition shown in FIGURE 4, both tubing strings **54**, **55** having been run into the well and set in tension by the couplings **90**, **91** seated in and supported by hanger body **60**.

Next, the packoff means **145** shown above hanger body **60** in FIGURE 5 is set into place on the upper surface **146** of body **60**. Pack off assembly **145** comprises a lower support plate **148** which is circular and receivable in opening **50** of the tubing head. Plate **148** is counterbored at its underside at **149**, **150** and the plate fits over the two sleeves **92**, sleeve **92** of coupling **90** being received in counterbore **149** and sleeve **92** of coupling **91** being received in counterbore **150**. A thin web **151** is left between the counterbores, but at the sides of the plate above lateral openings **87**, **88** of body **60**, where the couplings **90**, **91** are nearest to the tubing head wall, the counterbores **149**, **150** intersect the sides of the plate so that there are no side walls for the counterbores at those areas. Above each of the counterbores **149**, **150** there is a circular opening **153**, **154**, respectively, through which the couplings **90**, **91** are respectively disposed.

A sealing element **155** of resilient elastomeric material is supported upon the flat upper surface of plate **148**. Element **155** has circular openings **156**, **157** which are received over the couplings **90**, **91**, respectively. A packing compression plate **159**, having circular openings **160**, **161** for the couplings, flushly covers sealing element **155** and is urged downwardly to compress the sealing element by a plurality of the lockscrews **163** radially through flange **39** of the tubing head, the lockscrews engaging the bevel surface **164** of plate **159**.

After the tubings **54**, **55**, couplings **90**, **91**, and packoff means **145** are in place, the blowout prevention means is removed from its connection with flange **39**, and nipples **104**, **105**, packoff elements **117—121**, and member **110** are assembled as shown in FIGURE 5.

Reviewing the method of operation described above, the first string **55** (could alternatively be string **54**) is run and correctly spaced out to provide the desired amount of tension when seated or "landed." The collar **91**, less the sleeve **92**, is threaded on the top end of tubing **55**. The tubing is lowered through both packers **132**, **135** and latched into the lower packer **135**, the collar **91** being below the point of final suspension in the tubing head. The hanger body **60** is next stripped over the handling joint and lowered into place by handling joints. The aligning slots **83**, **84** correctly azimuthly align

the hanger body on shoulder **51** of the tubing head bowl by engaging pins **63**, **64** so that the holes for bolts **112** will be aligned for ultimate assembly of the upper parts of the apparatus. Tubing string **55** is stretched upwardly until the "Acme" thread **93** of collar **91** is above the hanger body. Sleeve **92** is then stripped over the handling joint and lowered and threaded onto threads **93**. (This is done with a tube-type spanner wrench with or without a magnetized end, not shown.) Tubing **55** is then lowered to seat surface **140** of the sleeve on seat **75** of the hanger body. The handling joint is then removed.

The second string **54** (or alternatively, string **55**) is then run through the second opening **65** of the hanger body, spaced out and latched through the upper packer **132**, and landed in the same manner as the first string. With both strings landed in proper tension, the pack off assembly **145** is lowered into position by use of handling rods. Lockscrews **163** are then tightened down on the pack off assembly to effect a fluid-tight seal.

Obviously, the apparatus is adaptable to suspension in tension of single strings and multiple strings in any number.

Hanger body **60** has tapped openings **169** in its upper surface for engagement by the handling rods, not shown. The upper surface of plate **159** also has such openings (not shown) for engagement by the handling rods. The pack off assembly **145** is held together as a unit during its installation by a plurality of screws **170**, only one being indicated by dashed lines in FIGURE 5.

While preferred embodiments of the apparatus and method have been shown and described herein, many modifications thereof may be made by a person skilled in the art without departing from the spirit of the invention, and it is intended to protect by Letters Patent all forms of the invention falling within the scope of the following claims.

We claim:

1. Apparatus for setting a pipe in longitudinal tension in a well, comprising a tubing string disposed in a well, a sleeve means releasably coupled about an upper portion of the tubing string, tubing elevating means for drawing upwardly on the upper end of each said tubing string to longitudinally tension the tubing string prior to coupling said sleeve means to said tubing string, a support for said sleeve means at the top of the well, and packer means in the well engaging a lower portion of said tubing string with said tubing string in longitudinal tension between said sleeve means and said packer means.

2. Apparatus for setting plural parallel pipes in longitudinal tension in a well, comprising a plurality of parallel tubing strings disposed in a well, a sleeve means releasably coupled about the upper end of each said tubing string, a support for each said sleeve means at the top of the well, tubing elevating means for drawing upwardly on the upper end of each said tubing string to longitudinally tension the tubing string prior to coupling said sleeve means to said tubing string, and packer means in the well engaging a lower portion of each said tubing string with each said tubing string in longitudinal tension between said packer means and its said sleeve means.

3. Combination of claim 2, said packer means comprising a separate packer for each said tubing string.

4. Combination of claim 2, said sleeve means each being screwed onto a said tubing string, each said tubing string and sleeve means having registering threads therefor.

5. Apparatus for setting one or more tubing strings in longitudinal tension in a well in excess of the longitudinal tension caused in each tubing string by its weight, comprising well head means having a vertical opening therethrough and including seat means in said vertical opening for supporting hanger body means, hanger body means disposed in said vertical opening and seated upon said seat means to be supported thereby, said hanger

body means having a tubing opening therethrough for receiving each tubing string to be supported thereby, a tubing string disposed through each said tubing opening of said hanger body, upwardly facing seat means in said hanger body means at each said tubing opening thereof, each said tubing string having a threaded portion above the said upwardly facing seat of the tubing opening through which it is disposed, seating means removably threadedly engaged with said threaded portion of each said tubing string and seated upon the upwardly facing seat of the tubing opening through which the tubing string is disposed to support the tubing string, hold-down means in the well spaced below said hanger body for fixedly but releasably holding the lower end portion of each said tubing string against upward movement, and tubing elevating means for drawing upwardly on the upper end of each said tubing string to longitudinally tension the tubing string prior to threadedly engaging said seating means on said threaded portion of the tubing string.

6. Apparatus for setting one or more tubing strings in longitudinal tension in a well, comprising well head means having a vertical opening therethrough and including seat means in said vertical opening for supporting hanger body means, hanger body means disposed in said vertical opening and seated upon said seat means to be supported thereby, said hanger body means having a tubing opening therethrough for receiving each tubing string to be supported thereby, a tubing string longitudinally tensioned from its lower end disposed through each said tubing opening of said hanger body, each said tubing string including a coupling means connected thereto, upwardly facing seat means in said hanger body means around each said tubing opening, each said tubing string having a threaded portion immediately above the upwardly facing seat of the tubing opening through which the tubing string is disposed, a seating means screwed onto the threaded portion of each tubing string and seated upon the upwardly facing seat of the tubing opening through which the tubing is disposed, and means in the well engaging each tubing at a portion thereof spaced below said well head means for holding the tubing in longitudinal tension.

7. Apparatus for supporting well pipes in longitudinal tension in a well, comprising well head means at the top of the well having a plurality of tubing openings therethrough, engagement means in the well for holding the lower ends of well pipes fixed against upward movement, the same plurality of well pipes as said plurality of tubing openings disposed parallel in the well, the lower end of each said well pipe being held fixed in the well by said engagement means, each said well pipe extending through a said tubing opening to above the tubing opening at the top of the well from its fixed lower end, each said well pipe having connection means above the tubing opening through which it extends at its upper end for connection with means for drawing the upper end of the well pipe upwardly to longitudinally tension the well pipe, drawing means above the upper ends of the well pipes for connection thereto at said connection means thereof for drawing the upper end of each well pipe upwardly, thread means on each well pipe spaced below its connection with said drawing means and freely receivable through the tubing opening, said thread means of each said well pipe being below the tubing opening seat means through which the upper end of the well pipe extends when the well pipe is longitudinally tensioned less than a desired amount, said well head means including seat means around each said tubing opening thereof, said thread means of each said well pipe being above the tubing opening seat means through which the upper end of the well pipe extends when the well pipe is longitudinally tensioned by said drawing means at least to said desired amount, and seating means engageable with said thread means of each said well pipe above said tubing opening seat when the well pipe is longitudinally tensioned at least to said desired amount and seatable on the tubing opening seat when said drawing means is disconnected from the connection means of the well pipe, said drawing means being adapted to draw upwardly on the upper end of each said tubing string to longitudinally tension the tubing string prior to threadedly engaging said seating means on said threaded portion of the tubing string.

References Cited in the file of this patent

UNITED STATES PATENTS

1,822,444	MacClatchie	Sept. 8, 1931
2,134,311	Minor et al.	Oct. 25, 1938
2,390,393	Rubly	Dec. 4, 1945
2,690,344	Allen	Sept. 28, 1954
2,704,579	Brown	Mar. 22, 1955
2,830,665	Burns et al.	Apr. 15, 1958