

[54] **HEAD TO HANGER HYDRAULIC CONNECTION**

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

[58] Field of Search ..... 166/88, 89;  
285/137 A, 137 R

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[57]

**ABSTRACT**

Well completion apparatus comprises a tubing head and a tubing hanger, tubing suspended from the hanger, a valve in the tubing biased to closed position and adapted to be opened by the pressure from a control line, a control line extending from the valve to the tubing hanger and connected to passage means in the tubing hanger, passage means in the tubing head adapted for connection to a source of control pressure fluid, and means for connecting the passage means in the head with the passage means in the hanger. In one embodiment a retractable screw type tubular stinger in the tubing head makes the connection with the tubing hanger passage means by sealingly entering a socket in the tubing hanger. Means is provided to align the tubing hanger azimuthally relative to the tubing head to allow the stinger to enter such socket. In another embodiment the tubing hanger is provided with annular isolation seals above and below an annular groove in the tubing hanger at the outer end of the passage means therein, the seals engaging the tubing head above and below the passage means therein. In this embodiment no azimuthal alignment means is required.

**14 Claims, 4 Drawing Figures**

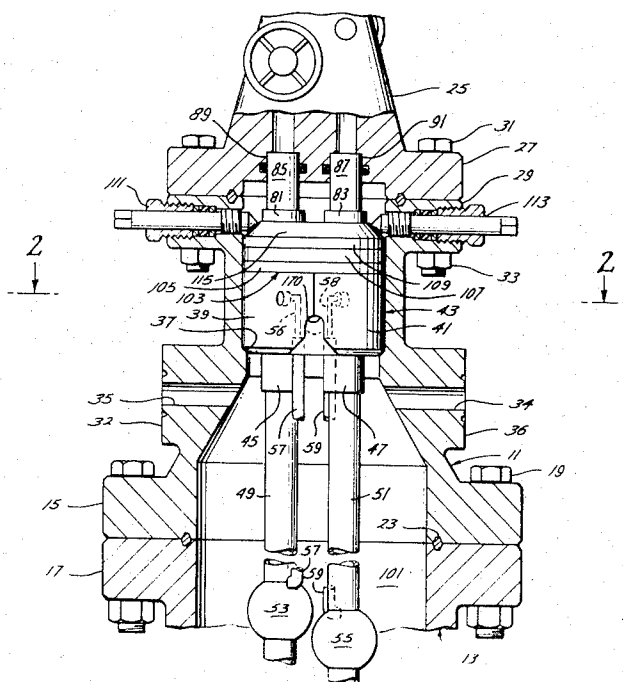


*Fig. 1*

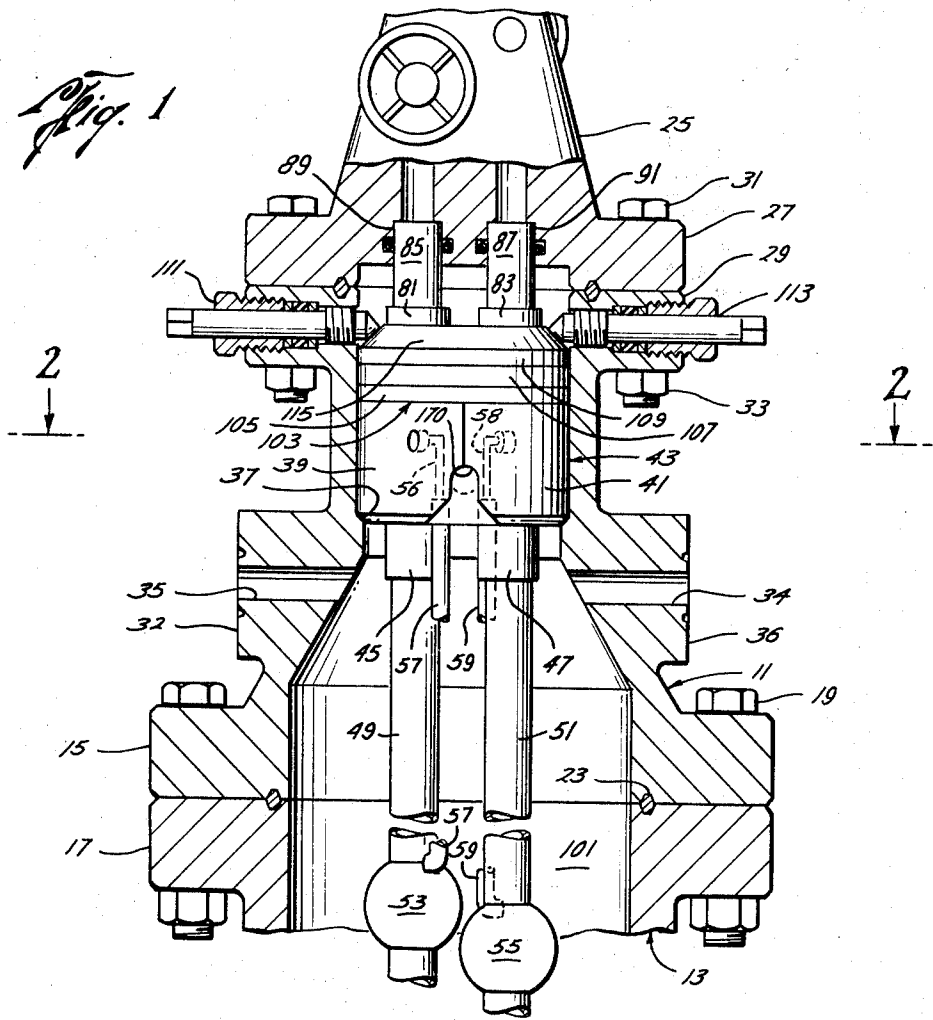


*Fig. 2*

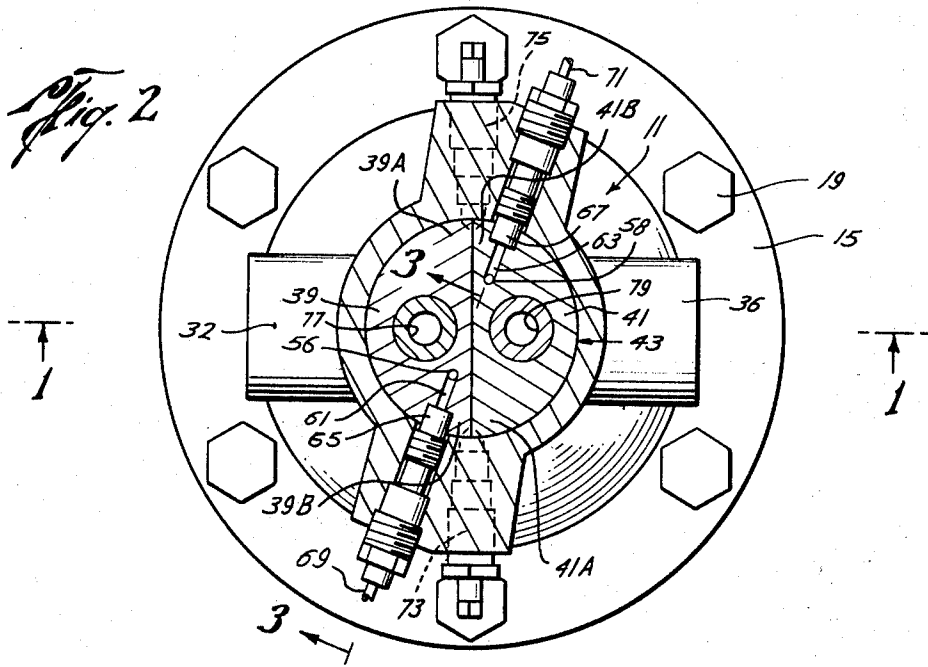


*Fig. 3*

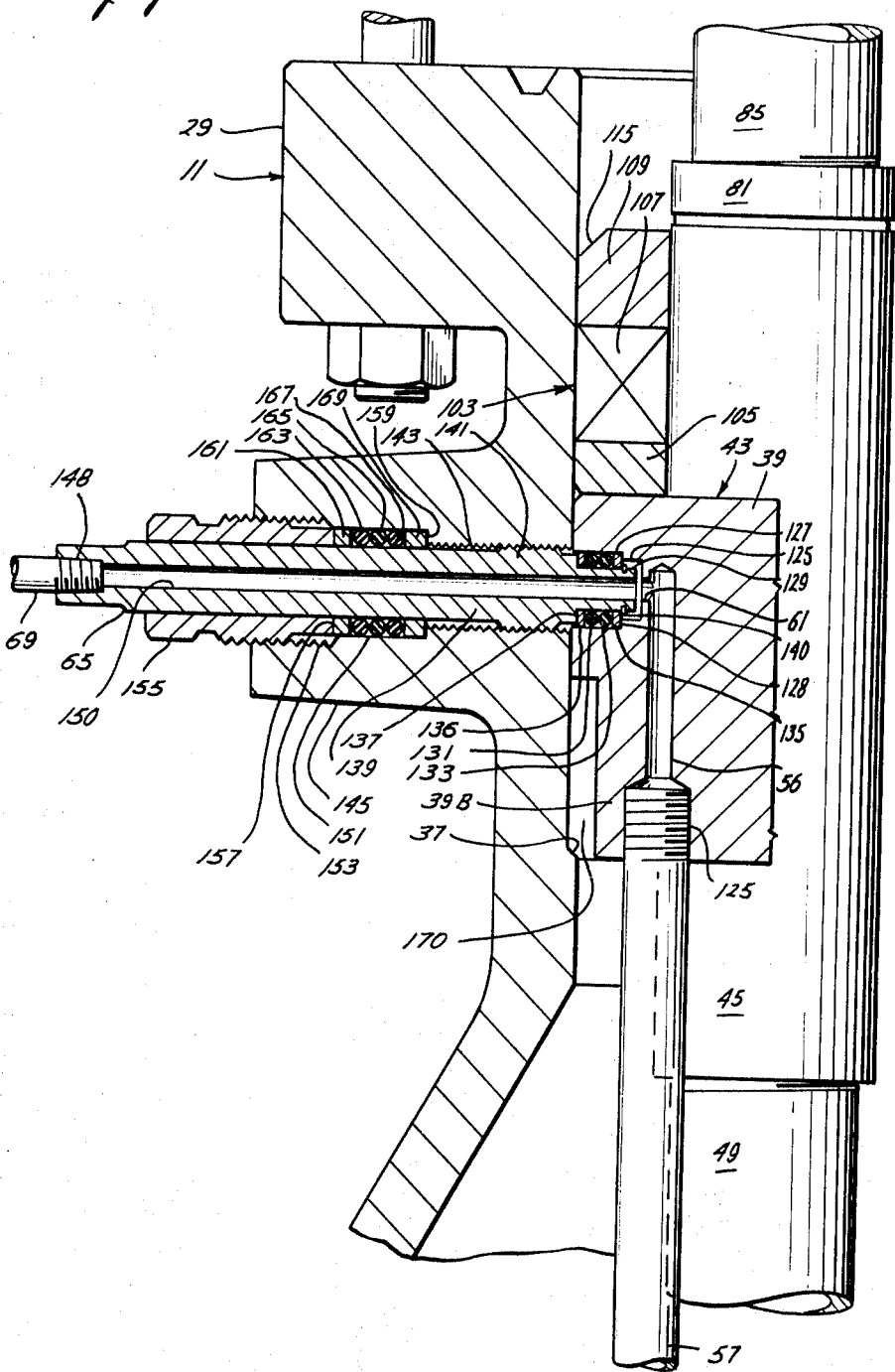
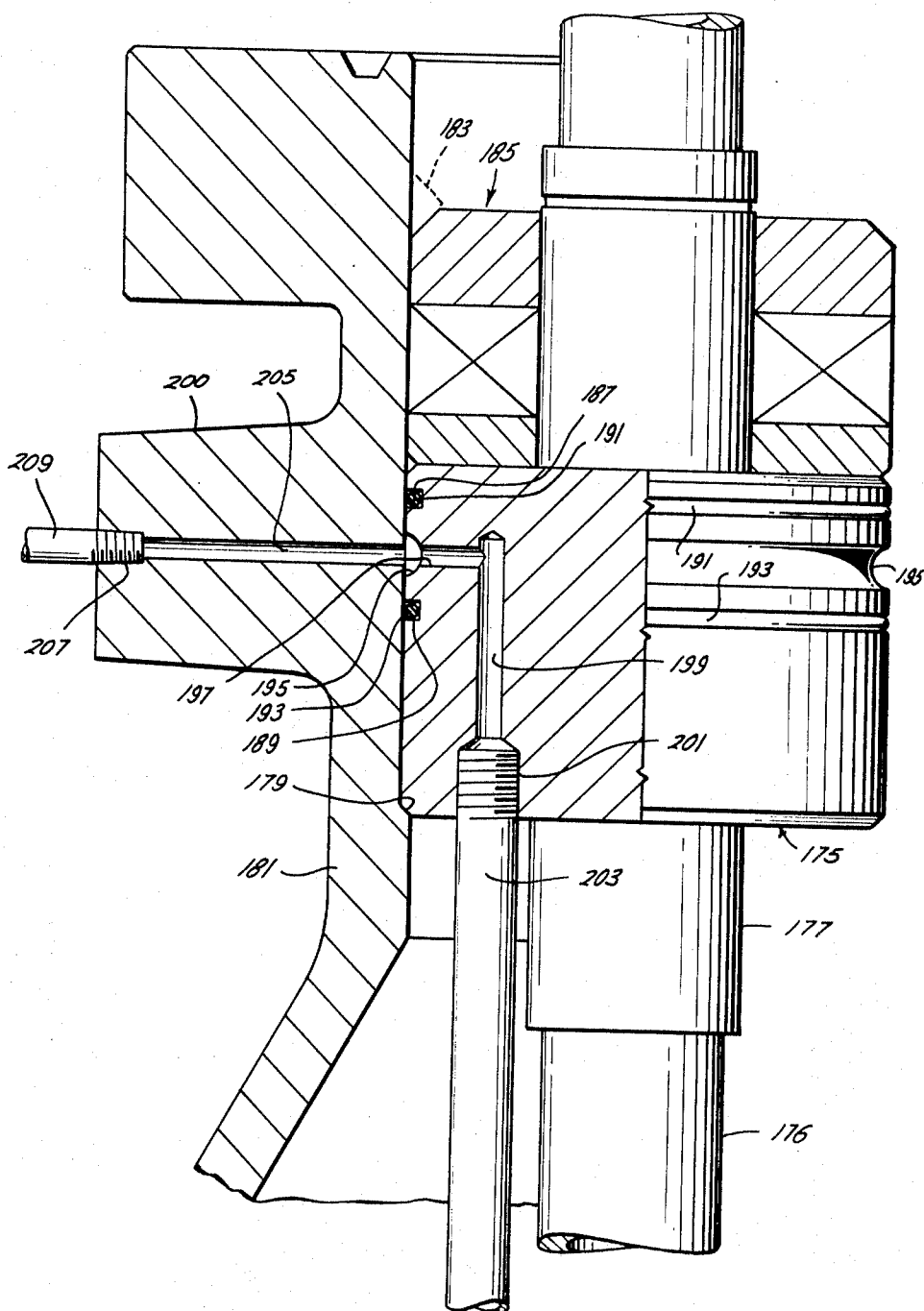


*Fig. 4*



## HEAD TO HANGER HYDRAULIC CONNECTION

## BACKGROUND OF THE INVENTION

## 1. Field of The Invention

This invention relates to well completion equipment and more particularly to means for connecting a hydraulic line to a tubing valve for operating the valve.

## 2. Description of the Prior Art

It is known to provide a valve in a well tubing string to close the flow passage through the tubing, e.g., in case of accident necessitating shutting off the flow from the well through the tubing. Such a valve may be spring biased or pressure differential biased toward the closed position. The valve may be moved to open position by actuating means powered by hydraulic fluid in a pipe line or conduit extending down to the valve from the top of the well, e.g., from a source of pressurized hydraulic fluid on an above water platform in the case of a subsea well. If the hydraulic fluid pressure fails for any reason, e.g. if the platform is blown away in a hurricane, the tubing valve moves to closed position, shutting in the well.

The hydraulic fluid conduit that extends from the tubing valve to the top of the well is usually a small diameter pipe, e.g., 1/2 inch to 1 inch in outer diameter, disposed outside of the tubing and parallel thereto. Heretofore, such hydraulic conduit or pipe has been screwed into a socket in the lower end of a longitudinal passage extending up through the body of the tubing hanger. By suitable means such passage is continued upwardly to a level above the tubing head top flange into the master valve or valve adapter spool. At that level the hydraulic fluid passage has been connected to a port extending transversely, e.g., radially, out through the lower flange of the tree element (valve or spool). A hydraulic fluid line coming from a source of fluid under pressure is screwed into a threaded socket at the outer end of such transverse port.

In the case of a multiple parallel tubing string completion the aforementioned means for making connection between the hydraulic fluid passage extending up through the tubing hanger and the transverse port in the tree element flange includes for each tubing string a short pipe nipple intergral with or screwed into the tubing hanger at the upper end of the hydraulic fluid passage through the tubing hanger. This hydraulic fluid nipple extends up through the sandwich seal that packs off, between the flow nipple and tubing hanger, The hydraulic fluid nipple extends upwardly into and seals with a vertical socket in the lower face of the tree element, which socket connects with the transverse port in the valve element flange. Alignment means is provided between the tubing head and hanger such that when the tree element is positioned on the tubing head with the bolt holes of the respective tree and head flanges in register, the hydraulic fluid nipple can be in alignment with the vertical socket in the tree element that is to telescope thereover.

The above described connection between the hydraulic fluid transverse passage in the tree element flange and the hydraulic fluid passage extending longitudinally up through the tubing hanger has been modified to omit the need for alignment means in the case of a single tubing well completion. The wall of the flow nipple in a single tubing completion is made thick enough so that the hydraulic fluid passage in the tubing hanger body can be continued up into the flow nipple

to the level of the tree element. At that level, the hydraulic fluid passage in the flow nipple is extended transversely, e.g., radially, horizontally, outwardly to an annular groove around the flow nipple. Such groove is located so as to be at the level of the transverse passage in the tree element flange. Annular seal rings around the tubing nipple above and below the annular groove provide means to seal the connection between the radial passage and the annular groove.

In all of the above described constructions there exists the objection that if the tree is not in position, there is no way to connect the hydraulic fluid conduit in the well with the source of pressurized hydraulic fluid whereby the tubing valve can be opened. Thus, when tubing is run in through blowout preventers mounted on top of the tubing head, it is necessary to omit the tubing valve if any operations are to be conducted through the tubing requiring an open passage through the tubing. The tubing valve must be installed later, e.g. run in on a wire line, and can be opened only when the blowout preventers have been removed and the tree has been installed.

## SUMMARY OF THE INVENTION

According to the invention the aforementioned objections to the prior art constructions are overcome by providing a transverse, e.g., radial, passage for hydraulic fluid in the side of the tubing head at the level of the tubing hanger body below the flow nipples and sandwich pack off that surmount the hanger body, and providing means to connect such transverse passage in the tubing head with the longitudinal, e.g., vertical hydraulic fluid passage in the tubing hanger body.

The latter means preferably is in the form of a retractable stinger in the transverse passage and engageable in fluid tight relationship with a transverse, e.g., radial, port in the side of the tubing hanger body. The transverse port in the hanger body connects with the longitudinal vertical passage extending downwardly to the lower face of the hanger body.

As in the prior art constructions, the lower end of the vertical passage in the tubing hanger terminates in a socket to receive the hydraulic fluid conduit that extends down to the safety ball valve in the tubing.

The just described form of connection means requires that the tubing hanger be aligned with the tubing head so as to place the transverse passage in the tubing head in register with the transverse port in tubing hanger. However in the case of multiple parallel string completions such alignment means is required in any event in order to place in registry the bolt holes on the tubing head flange and the tree (e.g., multiple valve) flange when the sockets in the latter are placed over the tubing flow nipples. Also, such alignment means is present even in the case of single completion hangers if the latter are of the currently popular type employing retractable lock screws to support all or part of the load on the tubing hanger.

In the case of parallel string multiple completion hangers, wherein the hanger is split, each of the transverse ports in the tubing hanger is located at a part of the hanger body where there is adequate material to provide for a sealing connection with the stinger, in other words, in the part of the body of the hanger to one side of the main flow passages therethrough.

In an alternative embodiment of the invention, an annular groove is provided around the body of the tubing

hanger, and the groove connected by a transverse port with a longitudinal hydraulic fluid passage in the tubing hanger extending down to a threaded socket in the lower face of the hanger body. The socket connects to the hydraulic fluid conduit that extends down alongside of and parallel to the tubing to the tubing valve. The annular groove in the tubing hanger is at the same level as a transverse port in the tubing head and communicates therewith regardless of the azimuthal position of the hanger relative to the head. Annular seals are provided extending around the hanger above and below the annular groove that carries the hydraulic fluid. The annular seals isolate the annular groove and prevent the hydraulic fluid from leaking out between the head and hanger. This construction is especially suited for single completions where no alignment means is provided. It can also be adapted to multiple completions by providing a plurality of annular grooves and annular isolation seals. This can be done easily in the case of multiple completion tubing hangers having integral bodies if there is enough wall thickness to accommodate the grooves and seals, but is more difficult in the case of split hangers, e.g., if the isolation seals extend between the hanger body sectors.

Other objects and advantages of the invention will appear from the following description of preferred embodiments thereof, reference being made for illustration to the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical section through a tubing head and tubing hanger embodying the invention, adjacent parts also being shown;

FIG. 2 is a horizontal section taken at plane 2—2 of FIG. 1;

FIG. 3 is a vertical section to a larger scale, taken at plane 3—3 of FIG. 2; and

FIG. 4 is a vertical section, partly in elevation, similar to FIG. 3 showing a modification.

#### DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to FIG. 1 there is shown a wellhead structure including a tubing head 11 surmounting a casing head 13 (shown only fragmentarily). The lower flange 15 of the tubing head is secured to the upper flange 17 of the casing head by bolts 19 and sealed thereto by ring gasket 23. The casing head 13 may surmount further casing heads (not shown), the stack of casing heads being flanged or in other manner connected together in any known manner as desired.

Surmounting the wellhead structure is a tree including, for example, as the lower element thereof, a plural (e.g., dual) bore valve 25. The lower flange 27 of the valve 25 is secured to the upper flange 29 by bolts 31 and nuts 33.

Between the flanges 15 and 29 of the tubing head its generally tubular body is provided with ports 34, 35 through which fluids can be introduced into and withdrawn from the tubing head. Around the ports 34, 35, there are bosses 36, 32 to receive cap screws by which connections can be made to the ports 34, 35, or by which cover plates can be secured thereover.

In the upper part of the tubing head there is an annular shoulder 37 on which are supported the sectors 39, 41 of the split body of multiple (e.g., dual) bore tubing hanger 43. Integral with the sectors 39, 41, respectively and extending downwardly therefrom are tubular cou-

plings 45, 47. Tubing strings 49, 51 are supported from the hanger 43 by virtue of the upper ends of the strings being screwed into the couplings 45, 47.

In the tubing strings are connected ball valves 53, 55 biased to closed position by springs or pressure differential and moved to open position by hydraulic pressure. Such valves are well known, being shown for example, at page 3,883 of the Composite Catalogue of Oil Field Equipment and Services, 1970-71 Edition. Extending upwardly from the valves 53, 55, are pipes 57, 59 for hydraulic fluid under pressure, the pipes constituting hydraulic control lines for the valves 53, 55. These lines extend upwardly alongside the tubing strings 49, 51 and are screwed into sockets in the lower ends of the sectors 39, 41 of the tubing hanger body. The sockets are at the lower ends of vertical fluid passages 56, 58 (described in more detail hereinafter) which extend upwardly in the hanger sectors and connect to transverse fluid passages 61, 63 extending out to the sides of the hanger sectors.

Referring now to FIG. 2, the passages 61, 63, receive therein retractable tubular stingers 65, 67, (described in more detail hereinafter), which connect to hydraulic fluid lines 69, 71. The lines 69, 71 lead to a suitable source of pressurized hydraulic fluid (not shown) and to valve means for admitting such fluid to the lines and exhausting it therefrom as is required to open and close tubing valves 53, 55.

The sectors 39, 41 are held in predetermined azimuthal position in the tubing head 11 by alignment means comprising retractable lock screws 73, 75. These lock screws also retain the hanger sectors on the seats provided by annular shoulder 37 and may support some of the weight and pressure on the hanger body. The sectors 39, 41 respectively have flow passages 77, 79 therethrough which connect with the couplings 45, 47 at the lower ends of the sectors.

As best shown in FIG. 2, the hanger sectors 39, 41 are provided with wings 39A, 39B, 41A, 41B at the sides of the flow passages 77, 79. The control fluid passages 56, 58, 61, 63 are located in these wings.

Referring once again to FIG. 1, there are tubular seal couplings 81, 83 integral with and extending upwardly from the hanger sectors 39, 41 in fluid flow relationship with the flow passages 77, 79 through the hanger sectors. Flow nipples 85, 87 are screwed into the couplings 81, 83 in fluid tight relationship and extend upwardly into sockets 89, 91 in the bottom of the dual bore valve 25 to which they are sealed, e.g., by O rings or by a suitable dual bore packing gland.

When the well is flowing, oil or gas flows upwardly through tubing strings 49 and 51 and the valves 53, 55 into hanger couplings 45, 47, and thence through flow passages 77, 79 in the hanger sectors 39, 41 and seal couplings 81, 83 into flow nipples 85, 87 and into the dual bore valve, the fluid flow being sealed off from the annulus 101.

Fluid flow in the annulus past the tubing hanger is blocked off by hanger seal 103 comprising metal base plate 105, rubber seal disc 107, and compression plate 109, all of which have two holes therein through which extend seal couplings 81, 83. Retractable lock screws 111, 113, (and others not appearing in the drawing) extend radially through flange 29 and engage the bevel 115 at the outer upper edge of compression plate 109 to wedge it down and compress seal disc 107 into seal-

ing engagement with the seal couplings 81, 83 and the inner periphery of the tubing head 11.

The hanger couplings 45, 47 are adapted to receive retrievable back pressure valves. (check valves closing to prevent upward flow) not shown.

Except for the hydraulic control fluid passage means the tubing head and hanger just described are the same as the tupe R equipment described on page 4,196 of the 1971 edition of the Composite Catalogue of Oilfield Equipment and Service and more fully on page 20 of the Rockwell Manufacturing Company catalogue V-404.

Referring now to FIG. 3 there is shown in more detail the hydraulic control fluid passage means of the present invention. In the tubing head 11 is suspended sector 39 of the tubing hanger, same being hung on support shoulder 37. Tubing 49 is connected to hanger coupling 45. Control line 57 is screwed into threaded socket 125 in the lower face of the hanger sector, whereby it is placed in communication with vertical passage 56 extending upwardly therefrom. Vertical passage 56 connects to radial passage 61 near the upper part of the hanger sector, within the wing 39B below seal coupling 81.

The radial passage 61 is enlarged by counterbores 125, 127. A shoulder 128 is formed between the counterbores. Counterbore 125 received the reduced diameter end 129 of stinger 65. Counterbore 127 receives packing material rings 131, 133, junk ring 135 and compression ring 136 which provide means to seal between the stinger and hanger sector wing. Junk ring 135 bears against shoulder 128. Compression ring 136 receives thrust from shoulder 137 at the juncture of the reduced diameter end 129 of the stinger and the main body 139 of the stinger. Prior to assembly with the tubing hanger the rings 131-136 are held on the end of the stinger between shoulder 137 and split ring 140 snapped into a groove in the end of the stinger.

The main body of the stinger is provided with an enlargement 141 which is exteriorly threaded. The threaded portion 141 is screwed into threaded passage 143 in the tubing head 11. Passage 143 is formed in boss 145 on the side of the tubing head.

From the foregoing it is apparent that stinger 65 is a tubular screw, threaded through the tubing head into the tubing hanger and compressing the packing 131, 133 to seal between the end of the stinger and the tubing hanger passage 61. The flow passage 150 through the stinger is thus sealed in fluid flow relationship with passage 61 in the tubing hanger.

Instead of compressible packing material rings the seal could be effected by means of O rings, in which case the junk and compression rings could be omitted.

The stinger is held in place in the tubing head by means of the threads on portion 141 and passage 143. The outer end of the stinger is interiorly threaded at 148 for connection to a hydraulic line 69.

To seal between the stinger and the tubing head, passage 143 is provided with counterbore 151, 153. Counter bore 153 is threaded and receives a gland nut 155 which is screwed therein. Between the inner end 157 of the gland nut and shoulder 159 at the inner end of counterbore 151 is received packing means including compression ring 161, packing material rings 163, 165, 167 and junk ring 169. By screwing in the gland nut the packing material rings are compressed to seal between the stinger and tubing head.

In the use of the above described apparatus, the stingers will be retracted until the tubing hanger sectors have been landed in the tubing head. The tubing hanger will be azimuthally aligned by lock screws 73, 75 serving as alignment means cooperating with the bevel groove 170 formed in the hanger sectors. With the hanger sectors in place and held down by lock screws 111, 113 etc. acting through sandwich seal 105, 107, 109, the stingers are extended into the tubing hanger sectors in fluid flow relationship with the hydraulic control fluid passages 61, 63. The valves 53, 55 can then be opened hydraulically so that whatever operations desired can be performed therethrough. At this time the blowout preventer may be removed prior to attachment of the master valve 25, the tubing hanger having been lowered through the preventer. With the master valve and tree in place, the well may be produced. Should the above described completion apparatus be broken off of the tubing strings, the hydraulic control lines 57, 59 will be broken off too and valves 53, 55 will automatically shut in the well.

Referring now to FIG. 4 there is shown another embodiment of the invention which eliminates the need for azimuthal alignment of the tubing hanger with the tubing head and especially useful for single completions. The FIG. 3 construction is the same as that of FIG. 2 except that a single bore tubing hanger is used, alignment groove and lock screws are omitted, and the hydraulic control fluid passage means is modified. The single bore tubing hanger 175 is provided with an integral hanger coupling 177 into which tubing 176 is screwed. The hanger is supported on shoulder 179 of tubing head 181 and is held down by lock screws 183 through sandwich packoff 185.

Around the body of the hanger there are upper and lower isolation seal annular grooves 187, 189 in which are received O rings 191, 193. The latter seal between the body of hanger 175 and the interior of tubing head 181.

Between isolation seal grooves 187, 189 the tubing hanger is provided with annular flow passage groove 195. Groove 195 communicates through radial passage 197 and vertical passage 199 with socket 201 in the lower face of the body of hanger 175. Hydraulic control line 203 is screwed into socket 201.

Regardless of the azimuthal position of hanger 175, annular passage 195 will be in communication with port 205 in the tubing head. Port 205 extends through boss 200 at the side of the tubing head. The outer end of port 205 is interiorly threaded at 207 for connection to a hydraulic control fluid line 209.

It will be apparent that in the FIG. 4 embodiment of the invention, the same as in the FIG. 1-3 embodiment, the hydraulic fluid passage means is connected without reference to the presence or absence of the blowout preventer or the master valve of the tree. It is therefore possible, as with the FIG. 1-3 embodiment, to install the tubing shut off valve when the tubing is run in through the preventer and to move the shut off valve to open position as may be required for other operations prior to removing the preventer and installing the valve and tree.

The construction of FIG. 4 could be adapted to split hangers for multiple completions by carrying the isolation seals completely around each hanger sector and joining the upper and lower seals on each sector over

the area where the sectors abut. Compare the packoff seals shown in U.S. Pat. No. 2,794,505 to H. Allen.

Instead of joining the upper and lower seals, additional sets of upper and lower seals could be provided at different levels, each set with a tubing hanger control fluid passage arcuate groove there-between, for connection to tubing head passages at different levels.

Tubing hanger constructions employing integral bowls receiving a plurality of hanger nipples could conceivably be adapted to the present invention, e.g., by employing FIG. 3 type stingers in the tubing head entering radial passages in the bowl, the bowl passages being connected to the hanger nipples by isolation seals similar to the FIG. 4 construction, but the construction must be adapted to pass the shut off valves and control tubing, e.g. as in U.S. Pat. No. 2,830,665, with appropriate modification and relocation of the isolation seals.

All embodiments of the invention are adapted for use not only with single and dual, but triple, quadruple and other higher multiple parallel string completions.

While preferred embodiments of the invention have been shown and described, modifications thereof can be made by one skilled in the art without departing from the spirit of the invention.

I claim:

1. Well completion apparatus comprising a tubing head, a tubing hanger supported within the tubing head, connection means on an underside of the tubing hanger for making connection to a pressure fluid control line, passage means in said tubing hanger extending upwardly from said connection means and thence outwardly to the side of the tubing hanger adjacent the inner periphery of the tubing head, and passage means extending through the side of the tubing head in fluid flow communication with said passage means in the tubing hanger and adapted for connection with a pressure fluid line outside the tubing head.
2. Apparatus according to claim 1 including seal means at the juncture of said passage means to prevent escape of pressure fluid from said passage means into the tubing head.
3. Apparatus according to claim 2 wherein the passage means in the tubing head is formed by a tubular stinger which is disposed in the side of the tubing head and is movable between an extended position in which the inner end of the stinger is received in the passage means in the tubing hanger, and a retracted position in which said end is withdrawn from the passage means in the tubing hanger.
4. Apparatus according to claim 3 in which the passage means in the tubing head includes means for holding the stinger in the desired one of said positions against forces acting axially thereon.
5. Apparatus according to claim 4 wherein said seal means comprises a packing means in the annulus between the end of the stinger and the passage means in the tubing hanger.

6. Apparatus according to claim 4 wherein said means for holding the stinger in the desired position comprises threads on the stinger and tubing head, and said seal means includes means whereby said packing means is compressed when said stinger is moved to said extended position.

7. Apparatus according to claim 6 wherein said passage means in said tubing head includes packing gland means to seal between said stinger and said tubing head, said packing gland means being provided in a boss on the side of said tubing head.

8. Apparatus according to claim 7 in which said tubing head includes an upper flange above said boss and a lower flange below said boss, said flanges providing means for making connection respectively to an upper tree element and a casing head respectively.

9. Apparatus according to claim 8 wherein said tubing hanger includes sandwich packoff means for sealing between the tubing hanger and tubing head above the level of said seal means between said passage means.

10. Apparatus according to claim 9 including tubing suspended from said tubing hanger, valve means in said tubing biased to closed position and adapted to be opened by the pressure of a control fluid, conduit means connecting said valve to said connection means in the tubing hanger for conducting said control fluid to the valve to hold the valve open, and means for supplying said control fluid to said passage means in the tubing head.

11. Apparatus according to claim 2 wherein said seal means comprises upper and lower annular seals disposed around said tubing hanger between said hanger and head respectively above and below the terminus at the exterior of said hanger of said passage means in said hanger, said seals being respectively above and below the terminus at the interior of said head of said passage means in said head, and said passage means in said hanger including an annular groove around the outside of said hanger at a level between said annular seals which are respectively above and below said annular groove.

12. Apparatus according to claim 2, said tubing hanger including a plurality of sectors for suspending a plurality of tubing strings, each sector including a vertical flow passage and wings at each side of said flow passage,

said passage means in said tubing hanger being disposed in one of said wings.

13. Apparatus according to claim 12, said tubing hanger and tubing head being provided with means for azimuthally aligning said hanger in said head for registry of said passage means in said head and hanger.

14. Apparatus according to claim 13, said passage means in said head and hanger being duplicated in each sector, each passage means in each sector including a vertical portion extending upwardly from a lower face of the hanger and a radial portion extending inwardly from the outer periphery of the hanger to said vertical portion.

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