This invention pertains to multiple completion equipment wherein provision is made for running gas lift apparatus down the well through the pipe hanger apparatus.

An object of the invention is to provide multiple completion equipment having hanger elements through which gas lift apparatus may be run into the well.

Another object of the invention is to provide such multiple completion equipment which is of the same size as standard completion equipment.

Another object of the invention is to provide such completion equipment which is safe and dependable.

A further object of the invention is to provide completion apparatus wherein air lift apparatus may be run through the pipe hanger means in connection with a string of pipe without the necessity of altering or removing the hanger means.

In the completion of wells for production of subterranean minerals, particularly petroleum minerals, it is frequently necessary to provide means for elevating the liquid well products to the surface of the ground. In the case of petroleum wells, it often happens that there is insufficient pressure in the well to cause the liquid petroleum to rise through the production tubing to above ground level, either originally or after the well has been produced for some time and the underground pressure has as a result thereof become depleted. A common expedient in obtaining production of liquid minerals including petroleum from wells having insufficient well pressure for spontaneous production is to lower product elevating means into the well to raise the liquids within the well to the surface. Common elevating means so used are pumps and lifts, such as gas lifts. Many of the gas lifts have protruding side portions which prevent their being run through standard tubing openings. The completion equipment of the present invention is novelty designed to permit the running of gas lift valves and apparatus through the same openings provided for running and suspending the well pipe strings, thereby eliminating the necessity of removing the hangers to run the gas lift valve and apparatus into the well.

Several embodiments of the invention are included for the purpose of indicating the diverse application of the invention. Regardless of the disposition of the pipe hanger apparatus in the well head, the invention may be applied. An essential characteristic of the invention in any application thereof is the provision of hanger openings adapted to pass gas lift apparatus. Included within the scope of the invention are modifications adapted by mechanical alteration to pass any other type or types of apparatus not passable through standard well pipe and tubing string openings of hanger equipment. In the embodiments shown, recess means are provided at the sides of the hanger openings to permit running of the oversize or offset or otherwise distorted equipment such as gas lifts and the like through the hangers. In each embodiment, the sealing means closes off the recess opening during normal operation of the hanger, that is, when multiple well pipes or tubing strings are supported in the well by the hanger. Needless to say, a great saving of time and expense results from the avoidance of the necessity of removing parts of the well head when apparatus larger in at least one radial dimension than a well pipe is to be run into a well. The invention is adaptable to all types of multiple completion well heads.

Other objects, uses, advantages, and improvements of the invention will appear from the following description of preferred embodiments thereof, reference being made to the accompanying drawings, of which:

Figure 1 is an elevation, partly in vertical section, of a well and dual completion equipment according to the invention disposed in the well, the representation being schematic;

Figure 2 is a vertical section taken through the axes of a preferred embodiment of the invention;

Figure 3 is a horizontal section taken at line 3—3 of Figure 2;

Figure 4 is a vertical section similar to Figure 2 of a second preferred embodiment of the invention;

Figure 5 is a horizontal section taken at line 5—5 of Figure 4;

Figure 6 is a plan view of a third preferred embodiment of the invention, the pack-off means and pipe coupling means being removed from the apparatus;

Figure 7 is a vertical section taken at line 7—7 of Figure 6; and,

Figure 8 is a vertical section taken at line 8—8 of Figure 6.

Referring now to the drawings in detail, preferred embodiments of the invention are shown in Figures 2—3, 4—5, and 6—8, and Figure 1 shows a manner of using the embodiment of Figures 2—3 which is applicable as well to the other embodiments.

Referring to Figure 1, there is shown a well hole 10 running down from ground level 11 and passing through an upper production stratum 12 and a lower production stratum 13, which are usually at considerable distances below ground lever 11 and which may be spaced apart by any distance along the well. There may be additional production strata through which the well passes besides the strata 12 and 13 shown. A well casing 22 is set in the well to support the walls of the well hole at the upper portions thereof. Two well pipes or tubings 14 and 15 are disposed through the well hole 16, pipe 14 extending to a greater depth therein and being sealed off with the wall of well hole 16 by a packer means 16 above stratum 13. Pipe 15 extends to a point in the well below stratum 12, and may terminate at any distance above packer means 16. Both of the pipes 14, 15, are suspended within a well head 17 surmounting the well, and including, for example, a dual bore valve means 18 for controlling flow through pipes 14 and 15 and the respective valve manifolds 19 and 20. Well head 17 also includes a lateral manifold 21 disposed through well casing 22.

The invention is not limited to wells of the type shown in Figure 1. In many wells, the casing will extend through the production strata so that perforation of the casing is made necessary. Many other arrangements are possible and the invention is adaptable to all.

Referring now to Figures 2 and 3 of the drawings, and still referring to Figure 1, well head 17 includes a tubing head 24 disposed between casing 22 and dual bore valve 18 at the top of the well. Tubing head 24 has a vertical opening 25 of circular horizontal section therethrough, the upper portion of opening 25 forming a bowl 26 wherein a hanger body may be supported. Bow 26 terminates at its lower end in a downwardly converging upwardly facing conical shoulder 27 around opening 25, shoulder 27 serving as means for supporting a hanger.
body disposed within bowl 26. A hanger body 28 having a non-concentric upper tubular neck 29 is seated at shoulder 30 thereof upon shoulder 27 at the lower end of the bowl. Below neck 29 body 28 is formed as a cylindrical disc which is closely fitted within the bowl 26. The neck 29 is non-concentrically disposed above the lower body portion, and a non-concentric circular bore 31 is provided through body 28 passing through the disc portion thereof and also upwardly through the neck. A second non-concentric coupling bore 33 is disposed through body 28 diametrically opposite bore 31. Bore 33 is of larger size than bore 31 and is of substantially elliptical horizontal cross-section as shown in Figure 3. Bore 31 has upper threaded socket 35 and lower threaded socket 34. Bore 32 has beveled shoulder 35 around the top thereof which is discontinuous adjacent bore 31, where the shoulder is merged into the wall of bore 31.

A coupling means 36 is disposed within bore 32 of the hanger body 28. Coupling 36 has a tubular portion which extends from the lower end of bore 32 to a point level with the top of neck 29 of the hanger body. A disc-shaped packoff collar 37 is made as an integral part of coupling means 36. Collar 37 is formed non-concentrically about the tubular portion at a point thereon below the upper end of the tubular coupling portion and at a location such that a plurality of lockscrws 38 disposed through upper tubular head flange 39 will engage an upper beveled surface 40 of collar 37. A packing element 41 of elastomeric material and packing support element 42, or junk ring, are disposed beneath collar 37, completely filling the opening 26 below collar 37 and over-lapping the outer portions of bore 32 around the tubular part of coupling means 36. Collar 37, packing element 41, and support element 42 fit closely within bowl 26 and have non-concentric openings 43, 44, and 45, respectively, which are aligned to fit closely around neck 29. Packing element 41 and support element 42 have an addition non-concentric opening 46 and 47, respectively, which fit closely around coupling 36 below collar 37. When packing element 41 is axially compressed between collar 37 and support element 42 a tight seal is formed around neck 29 and the tubular portion of coupling 36 within bowl opening 26. Axial compression of the packing is caused by the weight of pipe or tubing 15 suspended at a lower socket 48 of the coupling and/or by screwing in the lockscrws 38 against the surface 40.

Coupling 36 has an upper socket 49 into which is screwed a support collar 50. Collar 50 is attached to body 28. Collar 50 is screwed into socket 53 of the neck 29. These nipples provide concentric flow paths means from the flow paths within the hanger body and the coupling and are sealed into the upper element 18. A compression plate 53 having lower beveled surface 54 is urged upward by a plurality of lockscrs 55 disposed through lower flange 56 of element 18. Two non-concentric vertical circular openings 57, 58, receive nipples 50, 51, and identical packing collars 59 are seated respectively in recesses 60, 61 around the upper ends of openings 57, 58. Lower steel rings 62 surround collars 59 to act against collar rings 63 of elastomeric material and above each packing ring there is an upper steel ring 64 to support each packing ring from above. The compression plate 53 is disposed within lower opening 65 of element 18 above which are two non-concentric bores 66, 67 having around their lower ends lower recesses 68, 69 and thereabove shallower recesses 70, 71, respectively. Packing elements 62, 63, 64, are disposed within the lower recesses while the upper ends of nipples 50, 51, extend part way into the upper recesses. Portions of a valve chamber 72 and a valve seat 73 are shown above recess 70 of bore 66. Each of the bores 66, 67 is provided with a valve closure means above recesses 70, 71, respectively.

The tubing head 24 also has a lower flange 75 provided with a plurality of bolt holes 76 which serve as connection means for securing the tubing head above the well, usually above a casing head. The lower flange 56 of well head element 18 has a test port 77 which is used in testing the apparatus under pressure and which is closed by a means not shown when not in use for pressure testing purposes. The pressure testing means are likewise not shown.

Referring now to the modified embodiment shown in Figures 4 and 5 of the drawings, a tubing head 80 having therein a hanger body is conned by means of its upper flange 81 to a well head element 82 which surmounts the hanger head, element 82 having a lower flange 83 which is bolted to flange 81. The hanger body is formed within a vertical opening 84 axially through the tubing head, there being an upwardly facing annular conical shoulder 85 which forms the hanger-supporting portion of the bow. A hanger body 86 having a downwardly facing conical shoulder portion 87 therearound is disposed within the bowl, shoulder 87 being of the same taper as the shoulder 85 upon which it is supported. The upper edge 88 around the top of the hanger body is beveled to provide a contact or engagement surface for the inner ends of a plurality of lockscrs 89 which are disposed radially through flange 81 of the tubing head.

The hanger body 86 has two non-concentric bores 91 and 92 vertically through its lower portion which merge into a single larger upper circular opening 94 thereabove. The bores 91 and 92 are disposed to center on a diameter through the center of body 86. Bore 91 is circular, as shown in Figure 5. Bore 92 has an irregular horizontal cross section resembling a circle having a semicircular recess of smaller radius to one side thereof. The circle portion of bore 92 is of the same diameter as bore 91 and the semi-circular recess is disposed adjacent bore 91 as shown in Figure 5. When gas lift means is run into the well in combination with a pipe string, the pipe string extends axially through the circular portion of bore 92 and the offset gas lift means passes through the semi-circular recess. A conical shoulder 95 is provided around the upper edge of the circular portion of bore 92 for sealing of a coupling means for supporting a pipe in the well. Bore 91 also has a conical shoulder 96 around its upper edge.

A pair of identical coupling means 98 each having therearound a downwardly facing conical seat 99 are supported within lower bores 91, 92 and the upper opening 94 of the hanger body 86. Each coupling means has an upper socket 100, an upper idented socket 101 and an upper idented pin 102. The tubing strings 14, 15 in the well are screwed at their upper ends into these lower sockets 102 to be supported in the well. The upper sockets 101 receive the pipe nipples 50, 51, as in the embodiment shown in Figures 2-3. The upper ends of nipples 50, 51, are sealed into upper element 82 identically as they are sealed into element 18, Figure 2, the bores, openings, and recesses of element 82 being identical with those of element 18, already described.

The hanger body 86 has O-ring sealing means around shoulder 87 thereof to prevent leakage past the body at its seat in the hanger body, there being two such O-rings, 104 and 105, shown in Figure 4.

The couplings 98 each have a packing recess 106 around the upper portion thereof above the annular shoulders 95. Shoulders 95 protrude outwardly and have the conical portions at their lower surfaces, there being cylindrically formed portions above the conical portions and flat upper surfaces which form the lower ends of the packing recesses 106. A packing recess 107 is provided around the hanger body opening 94, the lower end of which is conical and coincides with the lower ends of the recesses 106. Since the couplings 98 are substantially cylindrical, the semicircular portion of bore 92 is not used when a coupling 98 is installed in bore 92. The semicircular portion is provided in order that gas lift
equipment may be run through the hanger body when there is no coupling 98 in place in bore 92. A lower packing support element 105, or junk ring, a packing element 109 of elastomeric material, and an upper compression element 110 are disposed around both of the couplings 98 and completely fill the space of openings 94 around the upper ends of couplings 98. Elements 108-110 are formed as circular disks each having nonconcentric alignable bore openings to receive the couplings 98 at the recess portions 100 thereof. Thus, the packing elements extend over the semicircular portion of bore 92, element 108 providing a gas barrier upon which element 109 is supported and compressed.

A third embodiment is shown in Figures 6-8. Referring to these figures, the pipe suspension means in this embodiment is disposed in a tubing head adapter means 112 surrounding a tubing head 113. The upper end of adapter 112 is threaded at its exterior 114 to receive a flange (not shown), the flange serving as means for connecting an upper well head element (not shown) such as the elements 18 and 82 shown in connection with the other embodiments. The two pipe nipples 50 and 51 are sealingly connected to the upper well head element as before. Bolts 115 are provided as means for compressing the flanges, respectively, of adapter 112 and tubing head 113 to connect these elements in a conventional manner, a standard metal joint gasket 116 being received in grooves at the flange faces to seal around the joint.

Adapter 112 has two noncircular vertical openings 118 and 119 through its central portion, which openings merge at their upper ends into a single larger opening 120, and at their lower ends into a single larger opening 121. Both of the openings 120 and 121 are of circular horizontal section, and the upper opening 126 serves as pack-off recess means. The upper openings 118 and 119 are of irregular shape to pass gas lift apparatus. Each of the openings has a portion of circular horizontal section and a portion of semicircular section to the side of the circular portion, so that each of the openings has a form similar to that of bore 93 of the embodiment of Figures 4-5. The semicircular portions are disposed adjacent the circular portion of the opposite opening so that they can be contained within the circular horizontal section of the tubing head adapter as shown in Figure 6. Figure 6 is a plan of the adapter 112 with the pack-off and tubing couplings removed. The circular portions of openings 118 and 119 are respectively provided with upper shoulders 122 and 123 which recess conically from the openings to provide support means for pipe or tubing strings, the shoulders also continuing around the semicircular portion of each opening as shown. The upper larger opening 120 has thereabout an upwardly facing shoulder 124 upon which packing means disposed in the upper part of the opening is supported, the part of opening 120 above shoulder 124 serving as a pack-off space.

Within each of the openings 118 and 119 there is supported a coupling, coupling 125 being disposed in opening 118 and coupling 126 being disposed in opening 119. These couplings each serve as means for supporting one of the tubing strings in the well and as path means for fluid flow past the hanger means from the well. The two couplings are identical and each has an upper tubular portion 128 through the pack-off zone, an outwardsly forming shoulder 129 having a semicircular upper surface and a downwardly converging lower surface, and a short tubular portion 130 below the shoulder. An upper threaded socket 131 and a lower threaded socket 132 are provided at the respective ends of each coupling. The couplings seat at the conical parts of shoulders 129 thereof upon the shoulders 122 and 123 respectively around the circular portions of openings 118 and 119. The tubular portion 130 of each coupling is received within one of the circular portions of openings 118 and 119 of the adapter. The tubular portion 132 of each coupling extends through opening 120 to the top of the adapter. The pipe nipples 50 and 51, as before, are screwed into the upper sockets 131 and have their upper ends sealingly connected into the upper well head equipment, mentioned before.

Pack-off means, including lower element 133, packing element 134 of elastomeric material, and upper element 135, are disposed within the pack off zone formed within openings 120 above shoulder 124 thereof. All of the packing elements have a circular outer shape and have alignable vertical circular openings which fit around the couplings 128 and 126, in particular the tubular portion 128 of each of the couplings. Lower element 133 also abuts the flat upper surfaces of the shoulders 129 of each of the two couplings which are level with shoulder 124 to form a solid support surface for compression of the packing. In Figures 6 and 8 there are shown a plurality of bolt holes 137 which pass vertically through the packing elements and are tapped into shoulder 124. The heads of each of a plurality of bolts 138 are received within a suitable recess around the bolt hole so that the bolt heads are recessed flush with the upper surface of element 135 as shown in Figure 8. The bolts 138 provide for adjusting the elastomeric element 134 between the two elements 133 and 135 to form a seal around the two couplings within the tubing head adapter.

The well pipes 14 and 15 are threadingly connected to the sockets 132 of couplings 125 and 126, and are supported in the well from the couplings which are supported upon the shoulders 122 and 123 of the adapter.

Similarly to the other embodiments, the lower packing element 133 covers the semicircular portions of bores 118 and 119 when the couplings 125 and 126 and the pack-off means are in place.

It will be noted that in the third embodiment, Figures 6-8, there is no separate hanger body as in the other embodiments. The tubing head adapter has a portion thereof adapted to serve as a hanger, and in case it is desired to remove the hanger, the adapter must be removed.

Referring now again to Figure 1, a plurality of gas lift devices 140 are shown spaced apart along tubing string 15. The devices 140 may take other shapes beside the representative shape shown. The devices 140 may be run into the well 10 through a side-recessed bore of any of the embodiments herein described. In the embodiment of Figures 2-3, devices 140 may be run with tubing string 15 through bore 32, it being only necessary to remove coupling 36 and pack off elements 41, 42, to enable this to be done. In the embodiment of Figures 4-5, devices 140 may be run through bore 92 when the coupling 98 is removed from the bore and the packing elements 108-110 are removed. In the embodiment of Figures 6-8, devices 140 may be included with both tubing strings 14 and 15 and run through bores 118, 119, with similar removal of the coupling and packing means. Of course, any surrounding elements such as 18, 82, and 112 would be removed prior to running the gas lift apparatus into the well. But the tubing strings need not be removed and a tubing string on which gas lift equipment is not to be run may remain in place supported by the hanger.

Obviously, multiple completion equipment other than dual can be adapted to embody the invention.

While preferred embodiments of the invention have been shown and described, 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. Well head apparatus for multiple completion wells comprising a body means above the well having a cylindrical opening therethrough from the well, hanger means
disposed in said opening having therethrough a plurality of passages each of circular cross section each for receiving and annularly supporting a pipe coupling means for supporting a pipe in the well whereby a plurality of well pipes may be supported in the well by said hanger means, at least one of said passages through said hanger means having a recessed side whereby means larger than said well pipe in at least one radial direction may be run into the well through said hanger means.

2. Well head apparatus for multiple completion wells comprising said above a well having a vertically disposed substantially cylindrical flow path therethrough from said well, hanger means annularly supportable in said flow path having therethrough a plurality of openings each of circular cross section to receive a well pipe therethrough, a means supportable in each of said openings for supporting a pipe in said well whereby a plurality of said pipes are supported in the well by said hanger means, at least one of said openings having side recess means whereby means larger than one of said well pipes in at least one radial direction may be run into said well through said hanger means.

3. Pipe hanger means comprising a supportable body having a plurality of vertically disposed well pipe-receiving passages therethrough each of circular cross section, means annularly supportable around the side of each of said passages for supporting a pipe beneath said body whereby a plurality of pipes in the well be supported by said body, at least one of said passages having side recess means from top to bottom whereby a means larger than one of said pipe supporting means in at least one radial direction may pass through the said passage around the side of which said pipe supporting means is supportable.

4. Well head apparatus for multiple completion wells comprising a lower well head element having a flow passage therethrough from a well, an upper well head element comprising said lower element having an extension of said flow passage therethrough, hanger means disposed in said flow passage through said lower element having a plurality of openings of cylindrical shape each to receive a well pipe vertically disposed therethrough, a means for annularly supporting a well pipe extending below said hanger means disposed through each of said openings and each supported around the side of the opening in which it is disposed whereby a plurality of said pipes are supported in the well by said hanger means, at least one of said plurality of openings having vertically extending side recess means whereby a means larger in at least one radial direction than one of said well pipes may be run through said opening and recess past said hanger means into the well.

5. The combination of claim 4 wherein said upper well head element has a separate flow passage therethrough for each of said well pipes supported by said hanger means, means being provided for directing fluid flow between each said supported well pipe and said respective separate flow passage through said upper well head element.

6. The combination of claim 5 including flow control means in each said separate flow passage, there also being provided means for sealing off between said flow directing means and the walls of said flow passage within said lower well head element.

7. The combination of claim 5 wherein said upper well head element is a multiple bore valve and said lower well head element is a tubing head.

8. Well head apparatus for multiple completion wells comprising a lower well head element having a flow passage therethrough from a well, a second well head element surmounting said lower element having an extension of said flow passage therethrough, a third well head element surmounting said second element having an extension of said flow passage therewith, integral hanger means formed within said flow passage extension through said second element having a plurality of openings of circular cross section vertically disposed therethrough through each of which a well pipe may be run into the well, a means for supporting a pipe below said hanger means disposed in each of said openings and each supported around the side of the opening in which it is disposed whereby a plurality of said pipes are supported in the well by said hanger means, at least one of said plurality of openings having side recess means extending its full length whereby a means larger in at least one radial direction than one of said well pipes may be run through said side-recessed openings of said hanger means into the well.

9. The combination of claim 8 wherein said third well head element has a separate flow passage therethrough for each of said well pipes supported by said hanger means, means being provided for directing fluid flow between each said supported well pipe and said respective separate flow passage through said third well head element.

10. The combination of claim 9 including flow control means in each said separate flow passage, there also being provided means for sealing off between said flow directing means and the walls of said flow passage extension within said second well head element.

11. The combination of claim 9 wherein said third well head element is a multiple bore valve, said second well head element is a tubing head adaptor, and said lower well head element is a tubing head.

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