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LANDING NIPPLE FOR WELL TUBING

Filed April 23, 1956

2 Sheets-Sheet 1

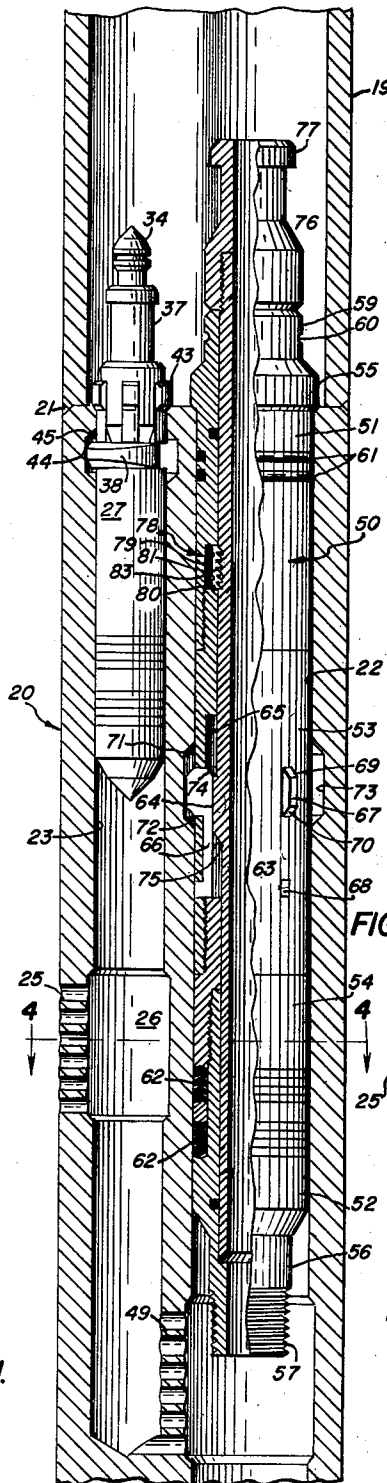
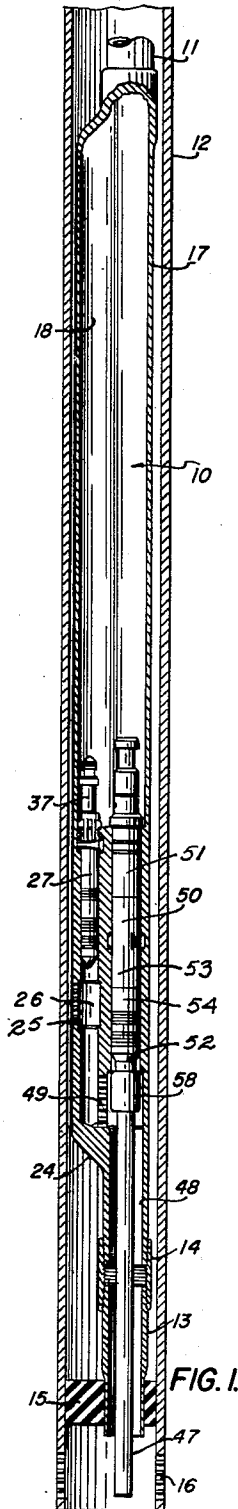


FIG. 3.

FIG. 2

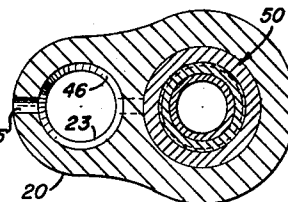


FIG. 4.

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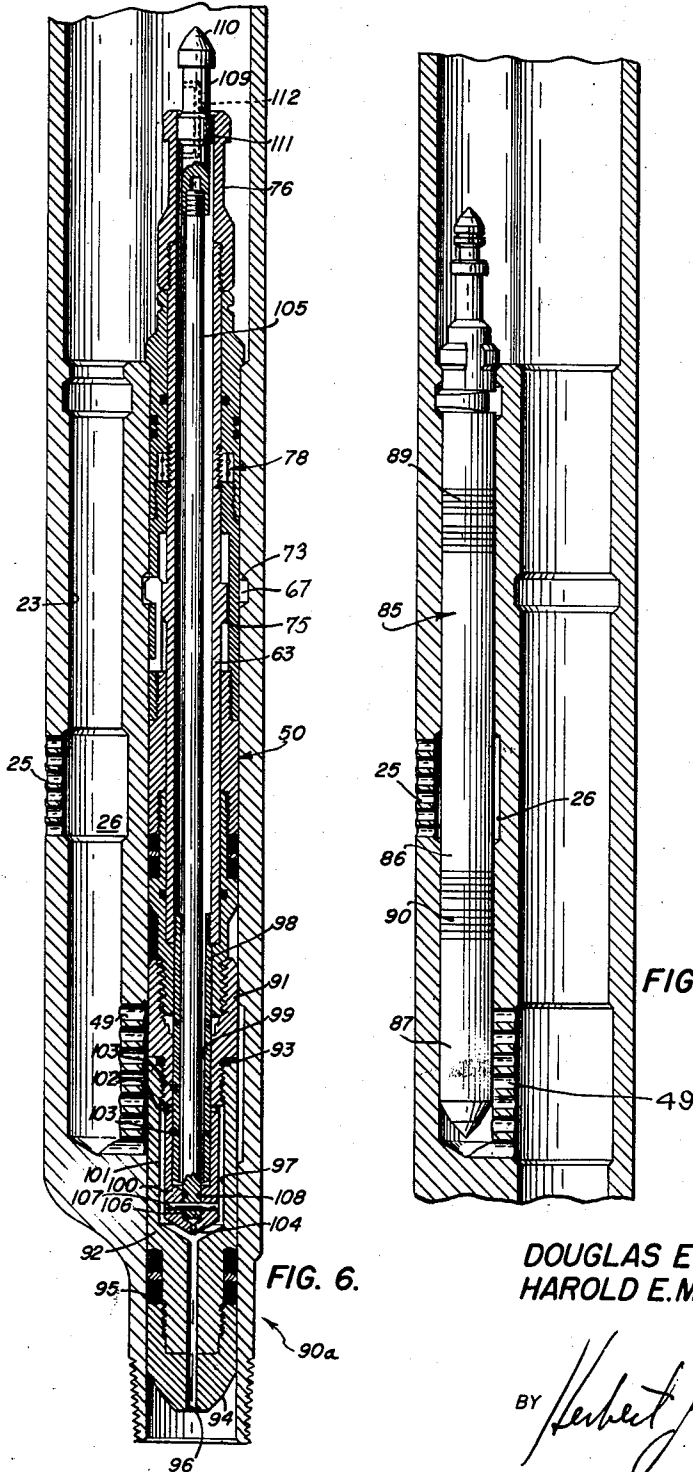


FIG. 5.

FIG. 6.

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LANDING NIPPLE FOR WELL TUBING

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Application April 23, 1956, Serial No. 579,931

12 Claims. (Cl. 166—102)

This invention relates to landing nipples for use in oil and gas wells.

While the invention may be advantageously used in place of conventional landing nipples, it is particularly useful in permanent type well completions where various operations below the earth's surface are carried out by means of a wire line without removing the well tubing from the well. In permanent type completions it is sometimes necessary or desirable to locate a blanking plug or similar device below a circulating port between the casing annulus and the tubing and above the packer on the lower end of the tubing so as to circulate above the producing formation, as for example, when treating the casing and string of tubing with a chemical solution to reduce corrosion. At other times it may be desirable to close the circulating port and provide full opening in the tubing, as for example, when lowering a gun perforator below the tubing end. When removing sand or when cementing the circulating port is open and a small diameter pipe or tubing extension is supported above the circulating port and extends downwardly into the production zone of the well. By this arrangement pressures may be applied simultaneously through the casing and the tubing for treating the earth formation, for example with cement for sealing off a zone, acidizing the formation for increasing permeability or for fracturing a production zone with a liquid.

Heretofore, several landing nipples, spaced one above the other in the tubing, were required to carry out these and other operations. The present invention is directed to, and has for its primary object, a single nipple for carrying out all of the foregoing operations as well as others, and consists primarily of an elongated hollow nipple for connection in the lower end of a well tubing and which nipple includes parallel bores and an arrangement of ports whereby various arrangements of blanking plugs, chokes, valves and other inserts may be employed for quickly and conveniently accomplishing the referred to operations.

These and other objects of the invention will become apparent from the following description and the accompanying drawings, wherein:

Figure 1 is a vertical sectional view of a landing nipple in accordance with the invention positioned in the lower end of a well casing, and showing a tubing extension attached to a tubular hanger mandrel for use in cementing a formation or for washing sand out of the bottom of the well.

Figure 2 is an enlarged vertical section of the lower end of the present landing nipple and showing the arrangement of inserts as illustrated in Figure 1.

Figure 3 is a vertical sectional view of a plug and locking arrangement therefor employed in certain operations, such as cementing a formation or cleaning sand from the well.

Figure 4 is a transverse sectional view taken on lines 4—4 of Figure 2.

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Figure 5 is a vertical sectional view of the lower end of the present landing nipple and showing an elongated blanking plug inserted therein for closing the circulating port in the side of the nipple.

Figure 6 is a vertical sectional view of the lower end of the present landing nipple and showing a pressure equalizing blanking plug and choke installed in the nipple bore in alignment with the well tubing, and

Figure 7 is a transverse sectional view taken on lines 7—7 of Figure 3.

A typical installation of the invention is shown in Figure 1 wherein an exemplary form of the present landing nipple 10 is shown connected in the lower end of a string of tubing 11 in a well casing 12. A short tubular member 13 is connected with the lower end of the nipple 10 by means of a collar 14, and which tubular member is provided with a packer 15 therearound for sealing off the casing 12 above the production zone. It is to be noted that the packer 15 is schematically illustrated and that the short tubular member 13 is eccentrically positioned through the packer for reasons hereinafter set forth. The casing 12 below the packer 15 is perforated, as at 16, to provide communication between the casing and the production formation.

The body 17 of the nipple 10 is elongated and hollow and is of greater internal cross sectional area than the internal cross sectional areas of the ends thereof and includes a laterally offset portion or pocket 18 for receiving and operating a suitable kick-over tool, such as now in use by the industry and illustrated and described in U. S. Patent No. 2,679,903, issued June 1, 1954, to Harold E. McGowen, Jr., one of the present joint inventors, and Howard H. Moore, Jr. The size, and particularly the length, of the pocket are such as to permit operation of the kick-over tool, as more fully described in the aforesaid patent. The transverse section of the body 17 is generally elliptical, as shown in Figure 4, and the upper hollow portion 19 is preferably made separate from the lower portion 20 and subsequently welded thereto, as shown at 21 in Figure 2. The lower portion 20 of the nipple is solid except that the same is provided with parallel bores 22 and 23, the axis of the first said bore being in axial alignment with the tubing 11. In contrast to the showing in the aforesaid patent the parallel bores formed in the otherwise solid lower nipple member 20 have substantially continuous walls except for the lateral apertures formed therein, as hereinafter described. For the purpose of the present description the first referred bore 22 will herein be referred to as the inline bore, which extends entirely through the solid lower portion 20 of the nipple, and the second referred to bore 23 will be referred to as the side pocket bore, the lower end of which terminates in a shoulder 24 at the lower end of the offset portion or pocket of the nipple 10. The diameter of the inline bore is slightly less than the inside diameter of the well tubing 11. One or more circulating ports 25 are provided in the lower portion 20 of the nipple intermediate the ends of the side pocket bore 23 to provide communication between said bore and the interior of the casing 12. A portion of the diameter of the side pocket bore 23 is enlarged, as at 26, adjacent the circulating ports 25 to provide communication with the inlet ports of certain equipment to be installed, as for example, a gas lift valve, not shown.

When removing sand from the lower portion of the casing 12, when cementing through the casing perforations 16 or when performing similar operations, an arrangement such as shown in Figure 1 is employed. The upper end of the side pocket bore 23 is closed by means of a removable plug 27, such as the one shown in detail

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in Figure 3. The plug 27 is comprised of a cylindrical body 28 having a pointed guide 29 threadedly secured in its lower end. The intermediate portion of the guide 29 is of reduced diameter for receiving packing rings 30 and a packing ring spacer 31 therearound. As shown 5 latching means similar in construction and operation to that disclosed in McGowen application Serial No. 543,679, filed October 31, 1955, is provided for selectively locking the plug 27 within a suitable recess in the side pocket bore 23 with the aid of coacting sliding sleeve and laterally movable locking ring members which will now be briefly described. The upper end of the body 28 is provided with a concentric threaded tubular neck 32 which receives a locking sleeve guide 33 therethrough. The guide 33 is in the form of a rod the lower end of which is threadedly engaged in an extension of the plug body 28. The upper end of the guide 33 extends above the neck 32 where it is provided with an enlarged integral head 34 for engaging a running tool, not shown. Preferably, the head 34 is a ring, and has a circular groove 35 therearound, and the ring is adapted to fit over the upper end of the guide 33 where it is welded in place. The apex of the head shown thereabove is weld material which has been machined to form a point as shown in the upper portion of Figure 3. Since running tools are well known in the art, the same is not herein described in detail, but it is to be understood that the tool is raised and lowered on a wire line and is usually provided with jars for driving a plug, valve, choke, or the like, in a bore in well tubing beneath the earth's surface. In operation, the running tool is connected to the lower end of the before mentioned shifting tool, which in turn, is connected with jars and the wire line. The circular groove 35 in the head 34 is for receiving, or partially receiving, transverse shear pins, not shown, in the running tool. Vertical flutes 36 are provided at the upper end of the body 23 and around the tubular neck 32 and are integral therewith. A locking sleeve 37 is slidably mounted on the guide 33. The upward movement of the sleeve 37 on the stem or guide 33 is limited by the head 34, and its downward movement is limited by the shoulder 39 on top of the plug 27, and which sleeve is downwardly and inwardly tapered at its lower end for coaction with the inner diameter of an eccentric locking ring 38 which is supported on the shoulder 39 formed by the upper end of the large diameter of the body 28. The sleeve 37 is also provided with a flange 40 around its upper end for engagement with a pulling tool, not shown, which is used for retrieving the plug 27. Like the running tool, the pulling tool is connected with the lower end of a shifting tool, jars and wire line. The lower end of the sleeve 37 is slotted, as at 41 (Fig. 7) whereby longitudinal sliding coaction is provided between the fingers 42 thus formed and the previously described flutes 36.

The upper ends of the flutes 36 are shouldered, as at 43, for supporting the plug 27 on the upper end of the lower landing nipple body 20 around the upper end of the side pocket bore 23. The bore 23 is provided, near its upper end, with an annular recess 44 having a downwardly facing beveled surface 45 around its upper portion for coaction with the upper outer periphery of the eccentric locking ring 38. Similarly, the upper end of the side pocket bore 23 is beveled, as at 46, for coaction with the locking ring 38, which beveled surface aligns the ring as the plug is being positioned in the bore. The outside diameter of the locking ring 38 is eccentric relatively to its inside diameter, and when the plug 27 is being lowered into place the sleeve 37 is in a raised position and thus the outside diameter of the locking ring 38 may assume a position concentric with the axis of the plug 27 when the ring contacts the beveled surface 46 at the upper end of the bore 23. As the plug 27 is jarred into place the sleeve 37 slips downwardly and the lower end thereof slides into position

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within the inside diameter of the ring 38 and causes the outside diameter to assume an eccentric or offset position, thus locking the plug in place. When removing the plug 27 a pulling tool is lowered into position and engages the flange 40 on the upper end of the sleeve 37. Upon raising the tool, the sleeve 37 is moved upwardly and engages the head 34 on the guide 33. As the plug 27 is raised the upper outer periphery of the ring 38 contacts the downwardly facing beveled surface 45 in the annular recess 44 and causes the ring to assume its concentric position and thereby unlocks the plug from its installed position.

In carrying out sand cleaning or cementing operations, a small diameter tubing extension 47 is supported by the nipple 10 and extends downwardly below the end of the short tubular member 13 and packing 15 into the lower portion of the well casing 12. The tubing extension 47 is preferably made of aluminum and the outside diameter thereof is smaller than the inside diameter of the inline bore 22 and short tubular member 13 so as to provide an annulus 48 therearound. A communicating port 49 is provided in the wall between the side pocket bore 23 and the adjacent inner diameter of the inline bore 22 providing communication between the interior of the casing 12 above the packer 15 and the interior of the casing therebeneath. The tubing extension 47 is suspended by means of a tubular hanger mandrel 50, shown in detail in Figure 2. The tubular hanger mandrel 50 includes upper, lower and two intermediate body portions 51, 52, 53, 54, all of the same outside diameter. The upper body portion 51 includes a shoulder 55 for engaging the upper periphery of the inline bore 22 in which the tubular hanger mandrel is slidably received. The lower end of the lower body portion 52 is above the communicating port 49 when the mandrel is installed, and is provided with an integral tubular extension 56 having threads 57 on the lower end thereof and whereby the tubing extension 47 may be connected therewith by means of a collar 58. The upper end of the upper body portion 51 is of reduced diameter, as at 59 and is provided with recesses 60 on opposite sides thereof for engagement with shear pins in a running tool. Since the hanger mandrel 50 is installed in axial alignment with the tubing 11, a kick-over tool is not required for seating such mandrel. Ring seals 61 are provided around the upper body portion 51 for engagement with the diameter of the inline bore 22, and chevron type sealing rings 62 are provided between the lower body portion 52 and the lowermost intermediate body portion 54. The inside diameters of the upper body portion and the upper intermediate body portion 51 and 53 are equal and are slightly larger than the inside diameters of the lower body portions 52 and 54 for reasons which will become apparent. A tubular sleeve 63 is mounted for limited longitudinal sliding action within the tubular hanger mandrel 50 and includes a circular shoulder 64 around its outer surface intermediate its ends. The circular shoulder 64 is positioned within an annular recess 65 in the lower end of the upper intermediate body portion 53, which recess extends to the upper end of the lower intermediate body portion 54. Radially spaced dogs 66 are positioned within the annular recess 65, which dogs have outwardly directed projections 67 and 68 at their upper and lower ends, respectively. The projections 67 and 68 are received in openings, not numbered, in the intermediate body portion 53, and the upper projections 67 are adapted to extend outwardly thereof. The upper and lower outer edges of the upper dog projection 67 are beveled as at 69 and 70 for coaction with upper and lower beveled surfaces 71 and 72 in an annular recess 73 in the inline bore 22. The dogs 66 are also beveled at their upper inner corners 74 for coaction with a downwardly facing beveled surface 75 at the lower end of the circular shoulder 64 on the sleeve 63. Ring seals are provided in the inner diameters of the upper and lower body portions 51 and

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52 for coaction with the upper and lower diameters 63. The upper extending end of the sleeve 63 is threaded for engaging an extension 76, and which extension is provided with a flange 77 around its upper end for engagement with the pulling tool. When installing the tubular hanger mandrel 50, the tubing extension 47 is connected with the lowermost body portion 52 by means of the collar 58 while the assembly is at the earth's surface. However, it is to be understood that some operations may not require the tubing extension 47. When installing the hanger mandrel 50 in the inline bore 22 the tubular sleeve 63 is initially in its raised position and the dogs 66 are retracted. After the shoulder 55 on the upper body portion 51 seats on the upper periphery of the inline bore 22, continued downward movement of the sleeve 63 extends the dogs 66 radially and the projections 67 on the upper ends thereof are received within the annular recess 73 locking the mandrel in place. The last referred to action of the dogs takes place by reason of the sliding contact of the sleeve shoulder 64 against the inner surfaces of the dogs. The sleeve 63 is held in its lower position by means of a holding device 78 in a recess 79 in the lower end of the upper body portion 51. The holding device 78 is conventional and is not, therefore, described in detail and consists primarily of a segment 80 of frangible material having downwardly inclined frangible teeth 81 which engage corresponding teeth 82 in the surface of the sleeve 63. The segment 80 is normally urged toward the mandrel teeth 81 by means of springs 83 in the recess 79.

When removing the hanger mandrel 50, a pulling tool is lowered and engages the flange 77 on the sleeve extension 76. As the sleeve 63 is moved upwardly, the teeth 81 on the segment 80 break, and continued upward movement of the sleeve 63 causes the shoulder 64 therearound to engage the upper end of the recess 73. The beveled corners 69 on the dog projections 67 contact the beveled ends 71 in the recess 73, thus causing the dogs to move inwardly and permit the hanger mandrel to move upwardly out of the inline bore 22 and to the earth's surface through the tubing 11.

The installation shown in Figure 5 is for closing the circulating port 25 when performing operations requiring substantially full tubing opening, such as swabbing. The blanking plug 85 is identical with the plug 27 shown in Figures 1, 2 and 3, except the body 86 and lower guide 87 are long enough to extend the plug below the circulating ports 25. Ring seals 89 are provided around the upper portion of the body 86 above the circulating ports 25, and additional ring seals 90 are provided around the body below said ports and above ports 49. The locking mechanism is identical with that described in connection with the previously referred to plug 27 and, therefore, carry the same reference numerals.

Some operations, as for example the use of a gas lift valve (not shown) in the side pocket bore 23, require closing the communicating port 49 between the side pocket bore and the inline bore 22. The operation is carried out by adding a blanking plug extension 90^a to the lower end of the hanger mandrel 50 (Fig. 6). The plug extension 90^a includes upper and lower cylindrical bodies 91 and 92 of the same outside diameter as the hanger mandrel 50 and is provided with a ring seal 93 where the two bodies are connected with each other. A lower guide 94 is threadedly engaged on the lower cylindrical body 92 and chevron type seals 95 are provided therebetween. Since the landing nipple 10 in a well is usually filled with liquid, the installation of the mandrel 50 with blanking plug extension 90^a thereon in the inline bore 22 below the communicating port 49 has a piston action and it is desirable to equalize pressures above and below the mandrel during the installing operation. Accordingly, an axial port 96 is provided through the lower cylindrical body lower guide 94 and which port communicates with a cylindrical chamber 97 in the upper portion of the

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lower cylindrical body 92. A tubular sleeve extension 98 is secured to the lower end of the previously described sleeve 63 and extends downwardly through the lowermost body portion of the mandrel 50. The upper body 91 of the plug extension has an axial bore 99 slidably receiving the sleeve extension 98, but the lower end of the upper plug body 91 is closed at its lower end to form a thimble shaped integral housing 100. The outside diameter of the housing 100 is less than the diameter of the chamber 97, thus providing an annular passage 101 therearound. The upper end of the housing 100, but below the connection of the upper plug body 91 and lower plug body 92, is provided with lateral ports 102 for communication with the plug bore 99. Ring seals 103 are provided in the bore 99 above and below the lateral ports 102. When installing the mandrel 50 and plug extension 90^a, the sleeve 63 is initially in a raised position and the lower end of the sleeve extension 98 is above the port 102 and whereby communication is provided upwardly through the lower vertical port 96, through the passage 101 and to the inner area of said sleeve extension, thereby equalizing pressures above and below the plug extension seals 95 between the plug bodies 91 and 92. After the mandrel 50 is locked in place the sleeve is moved downwardly by suitable means, such as jarring operation, and the lower end of the sleeve extension 98 moves downwardly below the lateral port 102 and thereby seals off communication between the upper and lower lengths of well tubing 11.

When removing the mandrel 50 and plug extension 90^a considerable pressure differential may exist above and below the same. If the pressure below the installed mandrel and plug assembly is great, there is danger of blowing the assembly from the tubing 11; if the pressure above the assembly is great there may be difficulty in removing the assembly. To overcome pressure differentials, a vertical port 104 is provided in the lower end of the thimble shaped housing 100 and is normally closed by means of the end of a rod or prong 105 received in a bore 106 in the upper end of the port. The prong 105 is held in place by means of a shear pin 107 positioned therethrough and through the sides of the housing 100. A ring seal 108 is provided around the lower end of the prong 105 for preventing flow of fluids or pressure around the prong until the prong is removed. The upper end of the prong 105 is provided with a pulling neck or extension 109 having a pulling tool head 110 on the upper end thereof. A guide shoulder 111 extends around the extension 109 and is in sliding contact with the inner diameter of the mandrel sleeve extension 76. A bypass port 112 is provided in the extension 109 above and below the shoulder 111. It is to be noted that the diameter of the prong 105 is less than the inside diameter of the sleeve extension 98 whereby communication is provided therearound when the sleeve extension is raised above the lateral port 102. In order to equalize pressures above and below the mandrel 50 and plug extension 90^a after the latter is installed and locked in place, a pulling tool is lowered and engages the head 110 of the prong 105. By pulling upwardly, the pin 107 is sheared and thereby allows liquid or gas to flow through the vertical port 96 in the plug extension 90^a. After the pressure differential has been relieved, the mandrel 50 and plug extension 90^a are removed as described in connection with the operation of the tubing mandrel hanger.

From the foregoing, it will be apparent that bottom hole operations, such as cementing the formation, acidizing and fracturing, may be carried out by means of the arrangements illustrated in Figures 1, 2, 5 and 6. The short blanking plug 27 is installed in the side pocket bore 23 (Figures 1 and 2) and the tubing hanger mandrel 50 and tubing extension 47 are installed in the inline bore. Thus, liquids may be circulated either downwardly through the tubing 11 and upwardly through the casing

12, or vice versa. When fracturing, pressure may be applied through both the tubing 11 and the casing 12. It will be noted that the string of tubing 11 is positioned near one side of the casing 12 in all operations to accommodate the offset portion 18 of the landing nipple 10. When swabbing, the elongated blanking tube plug 85 (Figure 5) is inserted in the side pocket bore 23, and the inline bore 22 is open. By reason of the mandrel hanger construction 50 and plug extension 90^a (Figure 6), the lower tubing may be entirely sealed off by positioning the lower end of the sleeve extension 98 downwardly below the ports 102 in the plug housing 100. Thus, it will be apparent that a single landing nipple, as described in the foregoing, may be employed for carrying out various operations without removing the tubing from the well.

The invention is not limited to the exemplary construction illustrated and described in the foregoing, but may be made in various ways within the scope of the appended claims.

What is claimed is:

1. A landing nipple for use in connection with a string of tubing in a well, said nipple comprising an elongated body including an unobstructed hollow upper body portion and a lower portion having an insert receiving bore and a second insert receiving bore parallel with the first bore, said bores communicating at their upper ends with the interior of the hollow body, the upper hollow portion of said body being of sufficient size above said bores to accommodate the operation of a kick-over tool therein, means providing communication between said bores, and means providing communication between said second bore and the exterior of the landing nipple body, each of said insert receiving bores having locking portions adapted to coact with portions carried by their respective inserts for selectively locking the inserts in place within the receiving bores.

2. A landing nipple for use in connection with a string of tubing, said nipple comprising an elongated body including an unobstructed hollow upper body portion and a lower portion having an insert receiving bore in alignment with the axis of the well tubing, and a second insert receiving bore parallel with the first said bore, said bores communicating at their upper ends with the interior of the hollow body, the upper hollow portion of said body being of sufficient size to accommodate the operation of a kick-over tool therein, means providing communication between said bores, and means providing communication between the second said bore and the exterior of the landing nipple body, each of said insert receiving bores having locking portions adapted to coact with portions carried by their respective inserts for selectively locking the inserts in place within the receiving bores.

3. In combination with a landing nipple as defined in claim 1, a tubular wire line removable hanger mandrel insert having a tubular extension on the lower end thereof and adapted to extend downwardly below the nipple body, and a blanking plug insert adapted to be received in the second said insert receiving bore, the lower end of

said blanking plug being above the last said communicating means, and locking portions carried by each of said inserts coacting with the locking portions of said bores.

4. In combination with a landing nipple as defined in claim 3, the construction wherein said hanger mandrel is provided with a plug extension on the lower end thereof, said plug extension being adapted to extend below the means for communication between said bores.

5. In combination with a landing nipple as defined in claim 4, the construction wherein said plug extension is provided with passage means therethrough, and wherein said tubular hanger mandrel is provided with a slidable closure means therein arranged to close the passage means through said plug extension, and means selectively sliding said closure means.

6. A landing nipple as set forth in claim 1, wherein the lower body portion is solid except for the parallel bores.

7. A landing nipple for use in connection with a string of tubing in a well, said nipple comprising an elongated unobstructed hollow upper body member of sufficient size to accommodate the operation of a kick-over tool therein, and a solid lower body member having a pair of parallel insert receiving bores therein, one bore being in alignment with the axial bore of the well tubing and the other being laterally off-set therefrom, said bores communicating at their upper ends with the interior of the upper body member, port means in the lower portion of said solid body member connecting said bores, and other port means in the outer wall portion of the laterally off-set bore communicating with the exterior of the landing nipple body.

8. A landing nipple as set forth in claim 7, wherein the bore connecting port means is located below the port means communicating with the exterior.

9. The combination with a landing nipple as defined in claim 8, of a plug coacting with the laterally off-set bore and terminating short of the upper port means.

10. The combination with a landing nipple as defined in claim 8, of a blanking plug coacting with the laterally offset bore and extending beyond the upper port means but terminating short of the lower port means connecting the two bores.

11. In combination with a landing nipple as defined in claim 7, of a removable hanger mandrel insert within the inline bore.

12. In combination with a landing nipple as defined in claim 7, of well tubing connected with said nipple and including a portion extending below said nipple, well casing surrounding said tubing and nipple, a packer interposed between the casing and tubular extension, and removable inserts in said bores controlling the flow of fluid therethrough.

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