

April 6, 1965

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3,177,013

DUAL STRING SUSPENSION ASSEMBLY

Filed Sept. 30, 1957

2 Sheets-Sheet 1

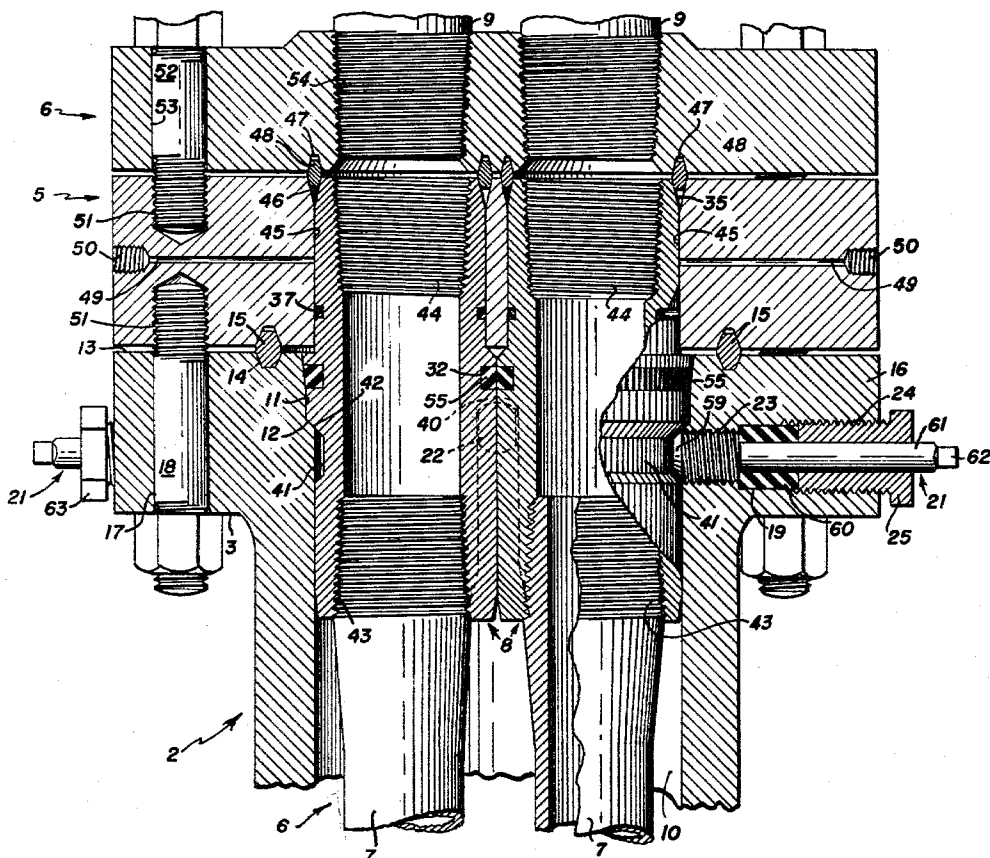


FIG. 1.

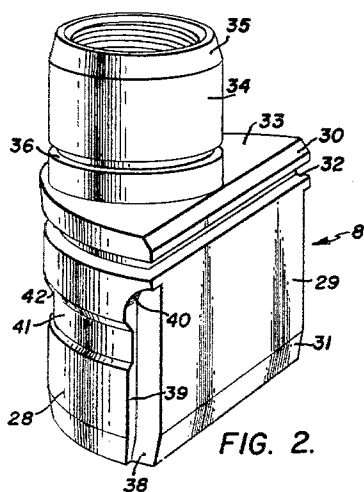


FIG. 2.

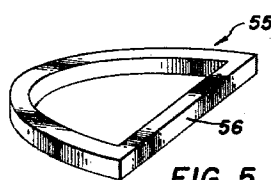


FIG. 5.

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2 Sheets-Sheet 2

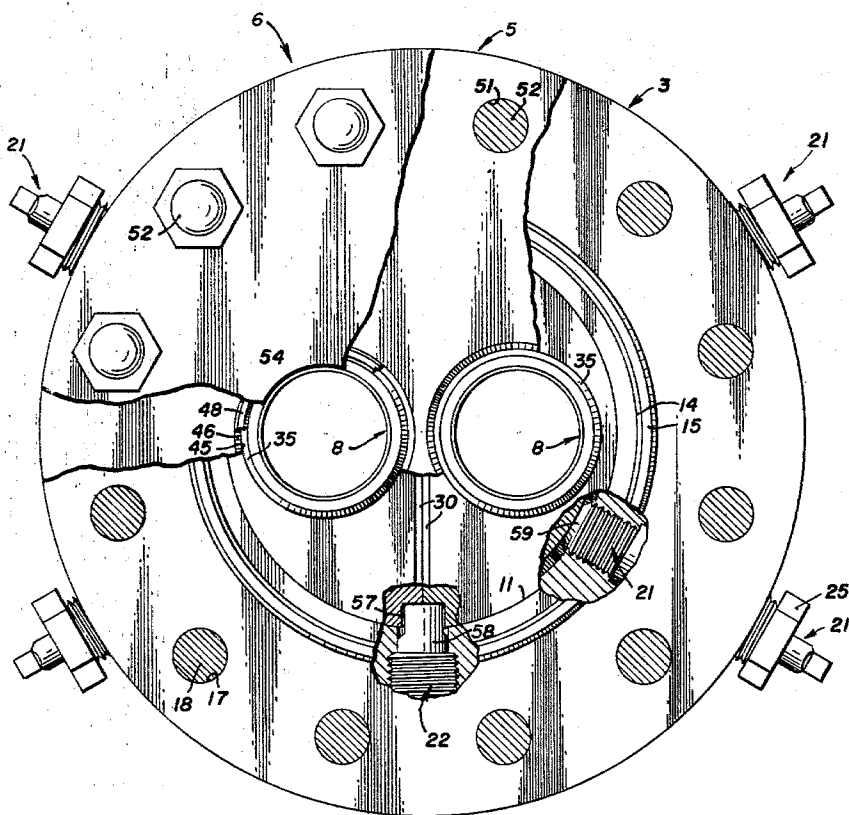


FIG. 3.

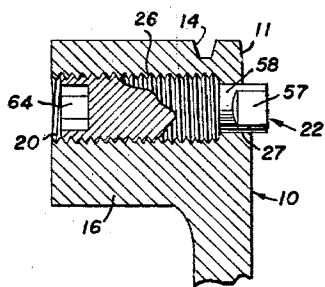


FIG. 4.

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DUAL STRING SUSPENSION ASSEMBLY

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8 Claims. (Cl. 285-137)

This invention relates generally to oil well tubing hanger assemblies and more specifically to an improved dual-string hanger which permits two strings of tubing having independent oil and/or gas flow to be suspended from the same well head and to extend simultaneously down through the same casing to communicate with separate producing formations in the same well.

An object of this invention is to provide a multiple tubing hanger assembly in which each tubing is sealed from the other and all tubing strings are sealed from the atmosphere by a metal ring seal.

Another object is to provide a multiple tubing hanger assembly which will permit the installation and servicing of production and control equipment and the running and landing of the first string of tubing with a full open bore in the tubing head, and will permit the second string of tubing to be inserted thereafter without interference with the control equipment even where either or both tubing string includes gas lift valves or other exterior protuberances installed thereon.

Another object is to provide a dual tubing hanger assembly wherein each tubing is threaded into a semi-circular mandrel having an external semi-circular packing ring which temporarily seals the assembly during completion and also permits testing of the permanent metal seal ring after installation.

A further object is to provide a hanger assembly of this type wherein each tubing string and its attached mandrel is guided into place by a stationary guide pin which holds the first mandrel in place against lateral or rotational movement while the second is being installed but without actually supporting any weight after installation.

A further object is to provide a stationary guide pin for the purposes of the preceding object which is also retractable to provide a full unobstructed open inner bore in the hanger assembly to permit swabbing the well casing and to permit installation of casing packers without interference from any inward projections in the tubing head.

A still further object is to provide a guide pin which is threaded at its outer end to permit rotation and retraction but which includes a generally circular guiding inner end with vertical flat sides thereon to prevent rotation of the pin once the guide end has engaged its slot in the mandrel, and to prevent indentations in the guide slot as would occur if a round end were employed on the guide end.

Another object is to provide a semi-circular mandrel for a tubing hanger assembly which includes a continuous V-groove at the circumference of the mandrel to receive a bevelled end locking screw so that the engagement of the screw in the V-groove is self-aligning to a position where it will positively lock the tubing string against a blowout when the sealing flange is removed.

Yet another object is to provide a tubing hanger assembly comprising a stationary tubing head flange capable of receiving separately installed mandrels with attached tubing strings and capable of being capped from above in a manner to permit the separate individual production to be taken from each tubing string and where the mandrels and capping means employ self contained sealing means located entirely within the assembled tubing head with no external access thereto except through a testing port for each tubing string.

A further object is to provide a sealing arrangement as in the preceding object wherein a metal sealing ring also acts in a manner to guide an adapter flange in place over

the mandrel and to hold down the tubing mandrel to prevent any upward vertical movement and to prevent leakage around the top of the mandrel even though there is no smooth precision fit required between the flat surface of the sealing flange, the adapted flange, and the mandrel.

An additional object is to provide a tubing hanger assembly of the type described wherein a pair of semi-circular tubing string supporting mandrels are adapted to be inserted into the opening of a tubing head and be entirely supported therein by a continuous tapered surface which is located in horizontal alignment with the guide pin holes for the retractable guide pins so that there is no tendency during installation for the mandrel to tilt on its support.

These and other objects and advantages will be apparent from an examination of the following specification and drawings in which:

FIGURE 1 is a cross sectional, elevational view of the tubing hanger assembly of this invention;

FIGURE 2 is a detail perspective view of one of the mandrels of FIGURE 1;

FIGURE 3 is a top plan view in fragmentary cross section of the tubing hanger assembly of FIGURE 1, but with the tubing removed;

FIGURE 4 is a fragmentary detail view of the installation of one retractable guide pin of this invention;

FIGURE 5 is a detail perspective view of one of the semicircular resilient material sealing elements shown in FIGURE 1.

Referring now more particularly to the numeral references in the drawings it will be observed that the complete tubing hanger assembly, indicated generally at 2, consists basically of a tubing head body 3 in which is sealingly seated a pair of tubing hanger mandrels 8. To the body 3 there is attached a sealing flange 5, which flange is in turn attached to an adapter flange 6 to thus complete separately sealed fluid courses from the well tubing strings 7 through the individual mandrels 8 and out through the surface pipes 9.

The tubing head body 3 has a central passage therethrough which includes a relatively large vertically extending main bore 10 and a larger counter-bore 11 to form an unbroken annular upward facing tapered surface 12. The top face 13 of the flange 16 on body 3 is grooved at 14 to receive a hexagonal oval shaped metal seal ring 15. The flange 16, on the body 3 has a series of annularly spaced holes 17 extending therethrough to receive studs 18 at assembly. The flange 16 also has a plurality of radially extending bores 19 and 20 therein to threadedly receive the adjustable locking screws 21 and the retractable guide pins 22. Bores 19 include two graduated diameter threads 23 and 24 to receive respectively the corresponding threads of locking screw 21 and locking screw packing gland 25, whereas bores 20 include threads 26 which terminate just short of central bore 10 to permit a smaller diameter short length bore 27 to connect the threaded bore 26 with bore 10.

The separately mountable and removable mandrel assembly is comprised of a pair of complementary shaped hollow mandrels 8 each of which have a generally semi-circular shaped body 28 having a substantially flat face 29 thereon which terminates at its top and bottom ends in tapered surfaces 30 and 31. The body 28 has a sealing ring groove 32 therein which completely encircles the upper end thereof. Tapered surface 30 joins a flat horizontal land 33 from which a circular neck 34 extends. Neck 34 includes a top taper 35 and a sealing groove 36 extends thereabout, which is adapted to receive an O ring seal 37 at assembly.

At each edge the flat face 29 terminates in a vertical slot 38 which in turn terminates at a vertical side 39 and a curved top edge 40.

The circular portion of body 28 includes a circumfer-

ential groove 41, the upper edge of which terminates in an enlarged downwardly facing tapered surface 42 which is arranged to come into mating contact with upwardly facing shoulder 12 to limit downward movement of mandrels 8 in body 2. The lower open end of each mandrel 8 is interiorly threaded at 43 to engage production tubings 7 and the upper ends of each mandrel is interiorly threaded at 44 to receive a threaded lifting tool (not shown) of some type suited to lift and position the mandrels and their attached tubing 7 into the hanger assembly 2.

The sealing flange 5 has two (or more) vertical bores 45 therethrough to fit over the upper ends 34 of mandrels 8 at assembly. Each bore 45 is countersunk at 46 to provide a tapered surface to cooperate with the tapered surface 35 of mandrel 8 and the tapered grooves 47 in adapter flange 6 to receive metal seal rings 48 of the same type as ring 15 to form a pressure seal around each mandrel. The combination of the metal sealing rings 15 and 48 and the O ring 37 would provide an effective safeguard against leakage about mandrels 8; however, to test the effectiveness of the seal there are provided radially extending channels 49 which extend between sealing flange bore 45 and a threaded test port 50 for each mandrel 8 present. The sealing flange 5 also includes an upper and lower series of annularly spaced threaded holes 51 on the upper and lower faces thereof to receive respectively the upper and lower studs 52 and 18 to secure the sealing flange between the tubing head 3 and the adapter flange 6.

The adapter flange 6 includes a series of annularly spaced mounting holes 53 for reception of studs and has a pair of threaded passages 54 therethrough to threadedly engage surface pipe 9 to complete the tubing hanger assembly as above described.

The previously mentioned sealing groove 32 is adapted to receive a substantially D-shaped resilient seal ring 55 which preferably has a high tensile strength before the first mandrel 8 is lowered into place in the tubing head 3. When the second mandrel 8 is then lowered into place beside the first, its lower taper 31 engages and slightly compresses the straight section 56 of the ring 55 and permits the entire flat face 29 to slide by and engage the corresponding face of the first mandrel. During the lowering into place of either mandrel 8, there vertical slots 38 must be in alignment with guide pins 22 and the vertical sides 39 of these slots must slidably engage the flats 57 on the end 58 of pins 22. The flats 57 will obviously prevent pins 22 from being accidentally rotated and backed out of their bores 20 after installation which would be undesirable as that might then permit rotation of the mandrel assembly, or lateral and rotational movement of the tubing string 7 if only one mandrel 8 were in bore 10. The engagement of flats 57 will also prevent indentation in slot edges 39 during repeated use as would occur with the use of a hardened round pin.

When the downwardly facing tapers 42 of mandrels 8 have fully engaged the upward facing surface 12 in tubing head 3, the end 58 of guide pin 22 will still be a short distance below the curved top edge 40 of slot 38 to insure that the entire load of the tubing string 7 will be supported at surface 12, although the end 58 prevents lateral or rotational movement of mandrels 8 with reference to the bore 10. Since the axis of pin 22 at this engagement is substantially horizontally aligned with the midpoint of surface 12 there is no tendency for the tubing string to tilt in the well bore and interfere with the installation of production or other equipment which is also lowered into the well bore.

The function of locking screws 21 which have a bevelled end 59 are to engage in the groove 41 and prevent mandrels 8 and tubings 7 from being displaced upwardly by pressure when flanges 5 and 6 are removed from the assembly for work-over operations.

The top land 33 may, if the mandrel 8 moves upwardly,

engage the under side of sealing flange 5 to prevent the mandrel 8 from being displaced upwardly through bore 45 when flange 5 is in place and the flange 6 is not in place, and the rings 48 will prevent any lateral movement of mandrels 8 when flange 6 is in place.

A packing ring 60 is compressed about the stem 61 of locking screw 21 by the action of threaded packing gland 25 to provide a fluid seal about pin 61. Wrench flats 62 and 63 on stem 61 and packing gland 25 permit installation and adjustment of the locking screws 21 and also permit retraction of the locking screws 21 to allow removal of the mandrels 8 and provide a full opening in central bore 10.

The wrench engaging socket head 64 in guide pin 22 permits its retraction so that central bore 10 has its full diameter completely through tubing head body 3. The bore 10 is preferably as large, or larger, in diameter as the well casing (not shown) to which the tubing head 3 is attached to thereby permit the running and setting of packers, flow valves, acidizing tools, and other production or workover tools normally used in wells.

In the installation of the tubing supporting assembly described above, the tubing head 3 is sealingly secured to the casing head (not shown) in the usual manner known in the art. As one of the tubing strings 7 is made up it is lowered into the well through the bore 10, which is at this time full open because the locking screws 21 and positioning pins 22 are retracted out of the bore. After the first tubing string is made up and lowered to desired depth, one of the mandrels 8 is attached to the upper end thereof. The positioning pins 22 are screwed inwardly so that the inner ends will engage the slots 38, and the mandrel is lowered into the bore 10 until the shoulder 42 comes to rest on shoulder 12, thereby suspending the tubing string to the head 3. The pins 22 prevent lateral and rotational movement of mandrel 8 when so positioned, but such pins do not actually contact the upper end of slots 38 so that no weight is supported by such pins.

The second tubing string 7 and mandrel 8 are then assembled and lowered into the well as described above until the mandrels 8 are in coinciding relationship as shown in FIG. 1. The locking screws 21 are screwed inwardly to engage in channels 41 after the mandrels are in place in the head 3. The sealing flange 5 is then placed over the upper ends of the mandrels 8 and drawn down tightly against head flange 16 by studs 18 as seal ring 15 is compressed. The adapter flange 6 is then placed over the sealing flange 5 and drawn tightly thereto by studs 52 as seal rings 48 are compressed. Surface pipes 9 are then attached in passages 54 and to surface control equipment and storage facilities.

One of the mandrels 8 and tubing string 7 attached thereto may be removed from the well without removing the other for the purpose of work-over or treating. This may be done by simply removing the equipment above the head 3 and withdrawing the screws 21 and raising the mandrel out of the head. Of course, suitable blow out control equipment would be installed prior to pulling the tubing.

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

I claim:

1. A multiple tubing hanger assembly for installation at a well boring comprising, a tubing head having a central bore and a counterbore opening to the top thereof and an annular upwardly facing tapered surface formed at the intersection of said bore and counterbore, a substantially circular mandrel assembly having an annular exterior downwardly facing tapered surface about its circumference inserted into said bore until said tapered surfaces engage and prevent further downward movement of said mandrel assembly and a pair of vertical slots at diametrical locations on the surface of said mandrel as-

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sembly and extending vertically above said engaged tapered surfaces, a removable pin inserted through the wall of said head and into sliding engagement with each said slot to thus guide and center said mandrel assembly when the latter is lowered into said bore until said surfaces engage, the upper ends of said slots being above said guide pins when said tapered surfaces are engaged; said mandrel assembly being comprised of separable complementary mandrels, each mandrel being attached to a tubing spring, and capping means to seal about the upper end of each mandrel and to prevent any upward movement of said mandrel assembly.

2. A tubing hanger assembly as in claim 1 characterized by the fact that the axis of said guide pin and the midpoint of said upwardly facing tapered surface substantially coincide to prevent tilting of one of said mandrels when a second mandrel is removed from the assembly.

3. A mandrel for a tubing hanger assembly comprising a semi-cylindrical body having a threaded bore at the lower end of said body to receive a string of tubing, a vertical flat face on said body, a continuous uninterrupted semi-circular circumferential groove in said body to receive a like shaped packing ring, an external tapered surface on the curved circumference of said mandrel below the packing ring groove, a vertical guide slot opening to the bottom and to the face of said mandrel, the top of said slot terminating below said packing ring groove and above said tapered surface, a second circumferential groove in the curved circumference of said mandrel and located below said tapered surface, said packing ring groove and below the top of said slot, the lower end of said mandrel being tapered at its flat face side, and the lower end of said mandrel being tapered at its semi-circular circumference.

4. A multiple tubing hanger assembly for installation at a well bore, comprising: a tubing head having a central bore and a counterbore opening to the top of said head, an annular upwardly facing tapered surface formed at the intersection of said bore and counterbore, a substantially circular tubing supporting mandrel assembly made of separable complementary halves and having a substantially continuous downwardly facing tapered surface about its circumference inserted into said bore until said tapered surface engages said upwardly facing surface to thereby prevent any further downward movement of said mandrel assembly as long as said surfaces are engaged, a vertical slot at diametrically opposed locations on said mandrel assembly, and a guide pin anchored in the wall of said tubing head and projecting into each slot to prevent any lateral movement of said mandrel assembly once said surfaces are engaged, the axis of said

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guide pins being in substantial horizontal alignment with the midpoint of said tapered surfaces when the tapered surfaces are engaged.

5. A tubing hanger assembly as in claim 4 wherein said guide pin threadedly engages said tubing head to permit complete retraction from the bore to provide a full opening therethrough.

6. A tubing hanger assembly as in claim 5 wherein said guide pins include a flat surface on their innermost end in close sliding engagement with said mandrel slots to prevent unintended rotation of said guide pins after said mandrel slot is engaged therewith.

7. In a tubing supporting device; a tubing head having a central bore through said head and an annular upwardly facing shoulder about said bore; a pair of complementary and separable mandrels having coinciding exterior surfaces suspended on said shoulder, each mandrel having a tubing string attached therebelow and coinciding vertical slots in opposite edges of said mandrels; and retractable pins extending through the wall of said head into said slots to prevent lateral or rotational movement of the mandrels.

8. In a tubing supporting device, a tubing head having a central bore through said head and an annular upwardly facing shoulder in said bore; a pair of complementary and separable mandrels removably inserted in said head having an annular channel about said mandrels, an enlarged downwardly facing shoulder at the upper edge of said channel arranged to contact the upwardly facing shoulder to suspend the mandrels in the head and coinciding vertical slots in opposite edges of said mandrels, said slots extending above said downwardly facing shoulder; retractable pins extending through the wall of the head into each slot; and a plurality of retractable screws extending through the wall of the head and into the said channel to retain the mandrels in the head against pressure therebelow.

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