April 9, 1957 C. C. BROWN 2,788,073

WELL HEAD APPARATUS

Filed Sept. 12, 1952 4 Sheets-Sheet 1

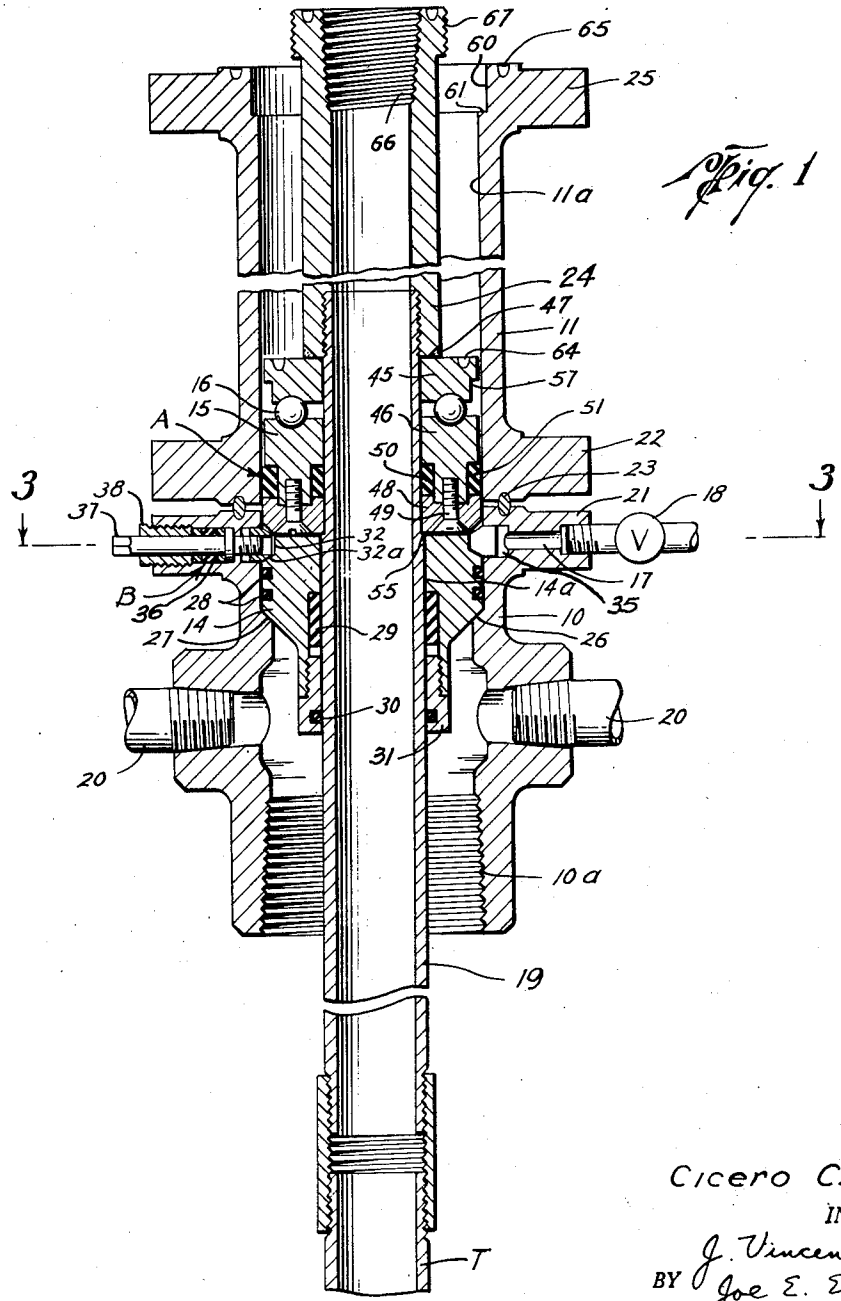

Fig. 1

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WELL HEAD APPARATUS

Filed Sept. 12, 1952 4 Sheets-Sheet 2

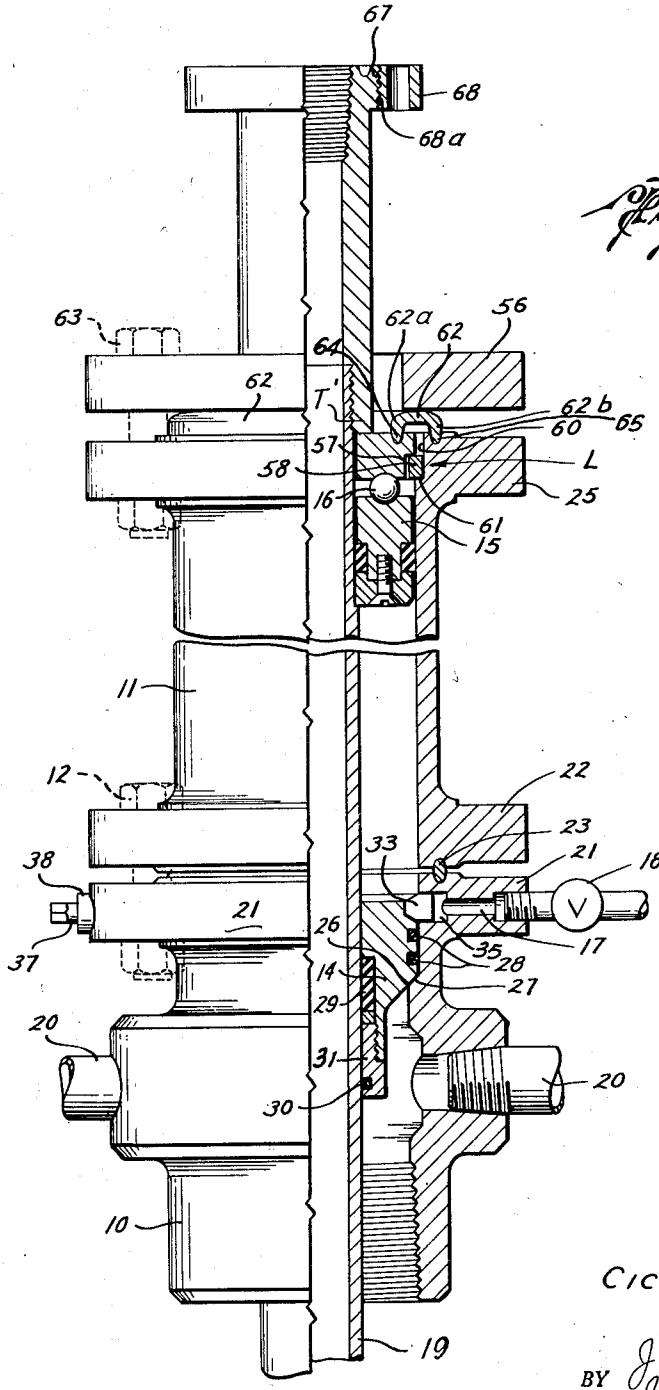

Fig. 2

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WELL HEAD APPARATUS

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Fig. 3

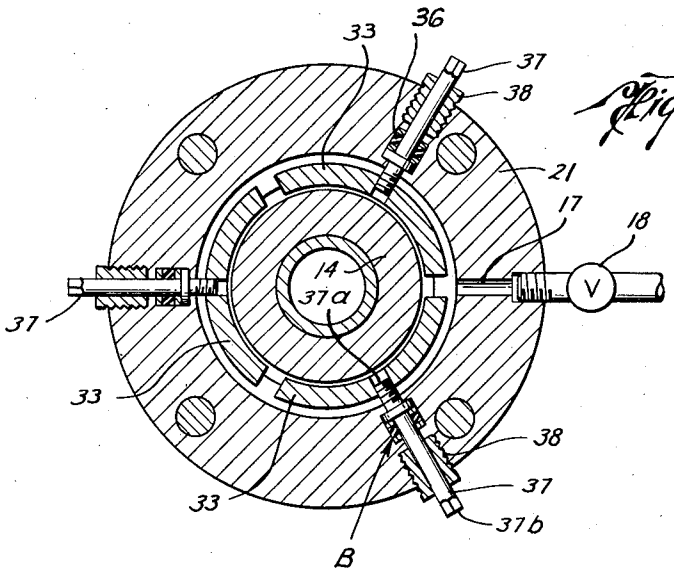


Fig. 4

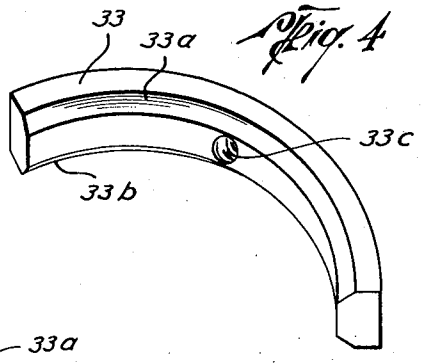
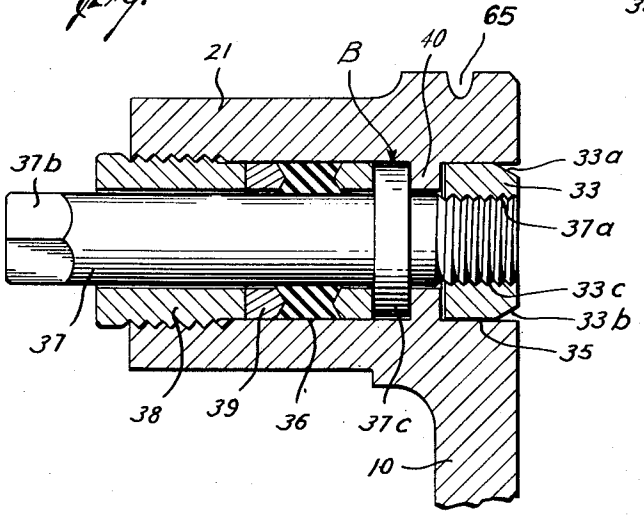


Fig. 5



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WELL HEAD APPARATUS

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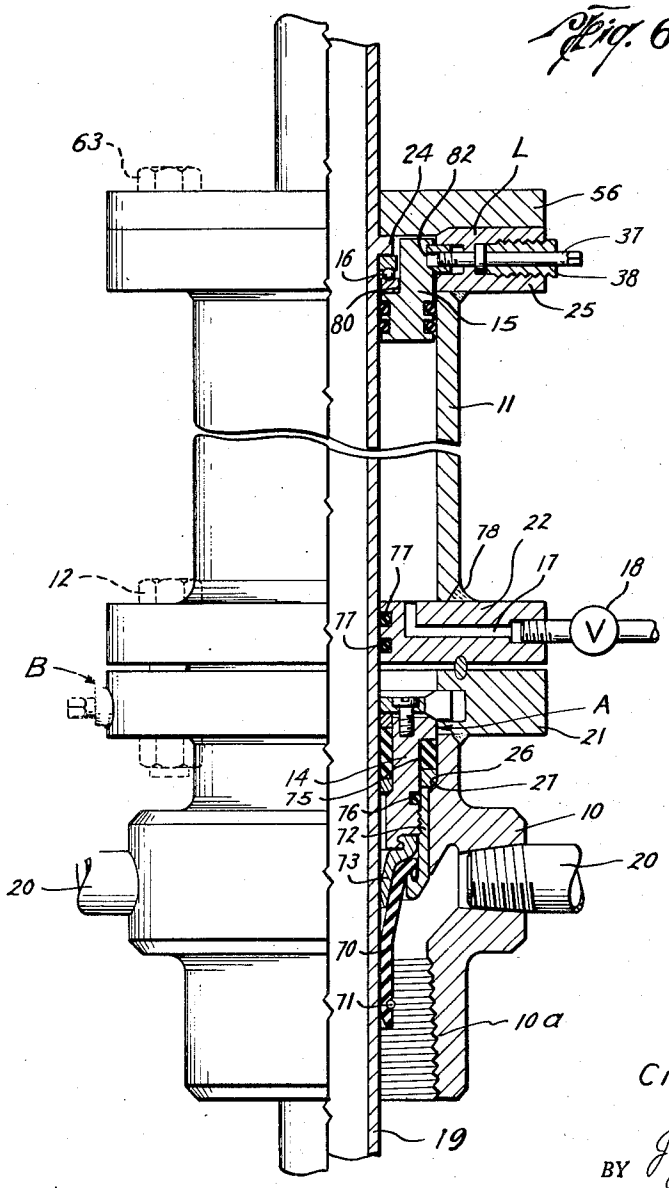
Fig. 6



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United States Patent Office

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WELL HEAD APPARATUS

Cicero C. Brown, Houston, Tex.

Application September 12, 1952, Serial No. 309,334

7 Claims. (Cl. 166—78)

This invention relates to new and useful improvements in well head apparatus.

This application is an improvement on my copending U. S. patent application, Serial Number 262,014, filed December 17, 1951, for Well Head Apparatus, now Patent No. 2,660,248, issued November 24, 1953.

An object of this invention is to provide a well head apparatus which is so constructed that the well tubing which is suspended from the apparatus may be either rotated or moved longitudinally, as conditions require, whereby various well operations and the setting of the well tools may be accomplished after the tubing has been landed, such apparatus constituting an improvement over the above-identified application in that the longitudinal movement of the tubing is effected by fluid pressure.

An important object of this invention is to provide an improved well head apparatus including a tubing hanger assembly which has a piston member which co-acts with the tubing whereby a fluid pressure may be utilized for causing longitudinal movement of said piston member and said tubing to set a well packer or the like, or to place the tubing under tension after setting of the well packer or the like.

Another object of this invention is to provide in a well head apparatus a hold-down means for the tubing hanger body which is adapted to be slidably engaged with said body, thereby eliminating the damaging effects due to the usual rotatable hold-down means.

Still another object of this invention is to provide a hold-down means for a tubing hanger body which engages substantially the entire annular upper edge or groove in said body, thereby distributing the load on said hold-down means and assuring uniform seating of the hanger body in the tubing head.

The construction designed to carry out the invention will be hereinafter described together with the other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

Figure 1 is a vertical sectional view of the well head apparatus of this invention.

Figure 2 is a view, partly in section and partly in elevation, and illustrating particularly the locking arrangement for locking the piston member in the raised position.

Figure 3 is a horizontal sectional view taken on line 3—3 of Figure 1, and illustrates particularly the the hold-down means or device for holding the tubing hanger body in its seated position.

Figure 4 is a view illustrating one of the arcuate shoe members of the hold-down means or device.

Figure 5 is a sectional view, illustrating details of the hold-down means or device of this invention for use with the well head apparatus.

Figure 6 is a view, partly in elevation and partly in section, illustrating a modified form of the apparatus shown in Figure 1.

In the drawings, the numeral 10 designates the tubing head, which is adapted to be mounted on and supported by a conventional casing head (not shown). Above the tubing head 10 there is mounted a tubular adapter or extension 11 which is suitably secured to the tubing head 10 by bolts 12 (Fig. 2) or any similar securing means. The tubing head 10 and the adapter 11 have substantially the same inside diameter and are adapted to receive the tubing hanger assembly designated by the letter A. The tubing hanger assembly A includes a tubing hanger body 14 which seats in the tubing head 10 and is held in the seated position by a hold-down means or device designated by the letter B, which will be described in detail hereinafter. The tubing hanger assembly A also includes a piston member 15 disposed above the tubing hanger body 14 and such piston member 15 includes an anti-friction means such as the ball bearings 16. The tubing hanger assembly A has a tubular stem 19 extending therethrough, which has an upper portion 24 of enlarged outside diameter as compared to the diameter of the tubular stem 19. The lower end of the tubular stem 19 is coupled to the upper end of the tubing string T so that the tubing T moves longitudinally and rotatably with the stem 19. The enlarged diameter portion or projection 24 of the stem 19 contacts and is preferably secured to the upper portion of the piston member 15, whereby the stem 19 and the tubing T may be rotated on the anti-friction means 16 while the tubing hanger body 14 remains fixed relative thereto. Longitudinal movement of stem 19 and tubing T can also be effected by admitting fluid under pressure to a point below the piston member 15 through an inlet 17, which inlet communicates with a pump or other source of fluid pressure (not shown), the inlet of such fluid pressure being controlled by a valve 18. The fluid pressure moves the piston member 15, and consequently the tubing T, longitudinally from the position shown in Figure 1, wherein the piston member is resting upon the upper end of the tubing hanger body 14, to a position as shown in Figure 2 where it is locked by a suitable locking means L. The particular construction of the well head apparatus of this invention therefore permits rotation of the tubing, where necessary to set a rotatable type packer, or longitudinal movement by hydraulic or fluid pressure to set a packer or similar tool which is adapted to be set by longitudinal movement. Also the longitudinal movement of the stem 19 and tubing T can be utilized to place the tubing under tension after the packer or similar device within the well casing has been set or otherwise actuated.

Referring now to Figures 1 and 2 particularly, therein it can be seen that the tubing head 10 has threads internally disposed at 10*a*, which threads provide a connection through an adapter or directly to the conventional casing head (not shown). The tubing head 10 also has the usual side outlets 20 for the passage of well fluids. The upper end of the tubing head has a radial flange 21 which has longitudinal openings therethrough for the reception of the bolts 12 (Figure 2). These bolts 12 connect the tubing head 10 to the adapter or extension 11 which has a similar flange 22 with aligned openings therethrough wherein the bolts 12 are mounted. A suitable seal ring 23 is disposed between the flanges 21 and 22 in the usual manner. The adapter 11 is preferably of substantially the same internal diameter as the internal diameter of the tubing head 10 and in effect forms an extension of the tubing head 10. This adapter 11 may be of any desired length, the length to be determined by the particular use to which the apparatus is subjected. For example, if the apparatus is to be used in conjunc-

tion with a well packer on the lower end of the tubing which is set by a longitudinal movement, rather than a rotational movement, the length of the adapter **11** will be determined by the amount of longitudinal movement necessary to set the packer, as well as any additional longitudinal movement desired to place the tubing T under tension. The upper end of the adapter **11** has a flange **25** with suitable longitudinal bolt openings therethrough, whereby the usual blowout preventer and control equipment may be mounted thereon. Also this flange **25** permits the connection of the particular locking device L of this invention, as will be described in detail hereinafter.

As was previously pointed out, the tubing hanger assembly A includes a tubing hanger body **14**. In the form of the invention shown in Figures 1 and 2, this tubing hanger body **14** has a downwardly and inwardly inclined conical or taper metal seating surface **26** which seats upon a similarly inclined annular shoulder or seat **27** on the inside of the tubing head **10**. This engagement of the seating surface **26** with the inclined seat **27** provides a metal-to-metal contact and seal. Additionally, there is disposed about the periphery of the hanger body **14** seal rings **28** which enhance the seal between the tubing head **10** and the hanger body **14**. The bore **14***a* of the hanger body is of a smooth highly-polished metallic surface which provides a metal-to-metal seal with the outer surface of the tubing tubular stem **19**. Further sealing action is provided with the annular resilient band **29** and the seal ring **30** which are disposed between the outer surface of the tubular stem **19** and the bore **14***a*. The band **29** is disposed above a packing nut **31** and the ring **30** is positioned in a recess in the inner surface of the nut **31**. It will be appreciated that these seal rings and the seal band can be made of any suitable resilient material such as rubber or synthetic material which will serve to prevent the passage of fluids.

About the upper peripheral surface of the hanger body **14**, there is formed an annular groove **32** which has the lateral surface thereof **32***a* inclined inwardly and upwardly. This groove **32** is adapted to receive a hold-down means or device generally indicated by the letter B, as particularly shown in Figures 3–5, which device B serves to hold the hanger body **14** in its seated position with the inclined conical surface **26** in engagement with the inclined shoulder **27** of the tubing head **10**. The hold-down means or device B includes a segmental, arcuate shoe member **33** which is of a length equal to substantially one-third of the circumference of the annular groove **32** in the tubing hanger **14**. With the shoe member **33** being of substantially one-third the circumference of the annular groove **32**, there is employed three of such shoe members so that substantially uniform engagement throughout the entire periphery or circumference of the groove **32** is effected. It will be appreciated, of course, that if the length of the shoe member **33** is shortened or lengthened, that more or less of the shoe members **33** may be utilized as desired, so long as substantially the entire periphery or circumference of the annular groove **32** is contacted by the shoe members **33**.

Each shoe member **33** has an upper inclined surface **33***a* and a lower inclined surface **33***b* to facilitate the seating of the shoe member within the groove **32**. The lower inclined surface **33***b* in its seated position will contact the inclined surface **32***a* of the groove **32**, while the upper inclined surface **33***a* permits the piston member **15** to seat upon the top of the tubing hanger **14**, as will be hereinafter described. Each shoe member **33** fits within an annular inner recess **35** in the tubing head **10**, and such recess **35** is of sufficient lateral depth to permit the entire shoe member to be withdrawn so that the full bore of the tubing head **10** is available without obstruction. This recess **35** communicates with a lateral passage **36** in the flange **21** of the tubing head **10**. As many of such passages **36** may be formed as desired for corresponding with the number of shoe members **33** which are utilized. Within each passage **36** there is disposed a shaft **37** having threads **37***a* (Fig. 5) on one end thereof which engage with threads **33***c* in an opening substantially centrally disposed in the shoe member **33**, while the other end of the shaft **37** preferably has flat surfaces **37***b* which are adapted to receive a wrench or handle to turn the shaft **37**. Intermediate of the two ends of the shaft **37** there is formed a radial flange **37***c* which is of substantially the same diameter as the passage **36**, while the rest of the shaft **37** is of a reduced diameter, leaving an annular space between the shaft **37** and the walls of the passage **36**. A locking nut **38** holds the shaft **37** in position with a packing means **39** of the usual type inserted between the nut **38** and the radial flange **37***c*. The radial flange **37***c* is prevented from movement toward the shoe member **33** by reason of an inwardly extending radial shoulder **40**, so that the radial flange **37***c* is confined in its axial movement, and thereby confines the axial movement of the shaft **37**. Since the shaft **37** is confined against axial movement in the passage **36**, upon rotation of such shaft **37** the threads **37***a* engage with the threads **33***c* to effect a lateral movement of the shoe member **33**. As will be appreciated, this movement of the shoe member **33** will be from its retracted position shown in Figure 5 to its locking position shown in Figure 1. Of course when it is desired to remove the tubing hanger body **14**, it is simply necessary to reverse the rotation of the shaft **37** to retract the shoe member **33** to the position shown in Figure 5. By reason of the particular construction of the hold-down means B the engagement of the shoe member **33** in the annular groove **32** of the hanger body **14** is effected through a sliding action of the shoe member **33** with respect to the groove **32**. There would actually be little contact between the shoe member **33** and the inclined surface **32***a* of the groove **32** until the shoe member **33** and reached its final and fully seated position, so that there is very little wear with this construction. Additionally, the contact of the shoe members **33** throughout substantially the entire periphery or circumference of the annular groove **32** results in a uniform distribution of the load on the hold-down means B and thereby assures a proper seating of the tubing hanger body **14** in the position shown in Figure 1.

When the tubing hanger body **14** of the tubing hanger assembly A is in the seated position shown in Figure 1 with the hold-down means B holding the hanger body **14** in position, the piston member **15** of the tubing hanger assembly A is disposed above such body **14**. As was previously pointed out, the piston member **15** includes an anti-friction means such as the ball bearings **16** which are disposed between an upper race plate or ring **45** and a lower race plate or ring **46** which have suitable grooves therein for the rolling action of the ball bearings **16**. The upper race plate **45** is in contact with and is preferably welded as at **47** to the enlarged diameter portion **24** of the tubular stem **19**. The lower race plate **46** has attached therebelow an annular plate or ring **48** which is connected by means of screws **49** or any similar securing means. Suitable recesses are also provided in the lower portion of the race plate **46** to receive the sealing rings **50** and **51** of rubber or a similar resilient material. The seal ring **50** provides a seal between the piston member **15** and the exterior of the tubing T while the seal ring **51** provides a seal between the bore **11***a* of the tubing head extension **11** and the piston member **15**.

It will be observed in Figure 1 particularly that the tubing T is of a reduced cross-section or thickness in the area adjacent the piston member **15** whereby a shoulder **55** is provided on the tubing exterior surface to engage with the lower edge of the lower ring **48**. This confines the piston **15** between the enlarged tubing section T' and the shoulder **55** and thereby connects the piston member **15** to the tubing T so that movement of the piston member **15** effects a similar movement of the tubing T. As

can be seen in Figs. 1 and 2, the inlet for the fluid under pressure through line 17 permits the pressure fluid to act below the piston member 15 to urge such member 15 longitudinally upwardly within the tubing head extension 11.

Thus, by means of the fluid pressure entering through the inlet line 17, the piston member 15 may be moved from its initial or lower position wherein it is resting upon the top of the tubing hanger 14, as shown in Figure 1, to its raised or upper position shown in Figure 2. The movement of the piston member 15 from its lower to its raised positon also moves the tubing T a corresponding amount, depending upon the length of the tubing head extension 11. When the piston member 15 reaches its raised position as shown in Figure 2, the flange ring 56 has not yet been put into position so that the piston member 15 can be moved up a sufficient distance to expose the groove 57 in the periphery of the upper race member 45. In other words, the groove 57 is moved up above the top of the flange 25 so that a flexible metallic spring-like ring 58 can be placed in position within the groove 57. This ring 58 is preferably of the split-ring type which tends to expand radially outwardly. When the ring 58 has been placed below the groove 57, the piston member 15 is then moved downwardly by a release of some of the fluid pressure 17 to place the ring 58 within the recess 60 of the flange 25.

This recess 60 forms a shoulder 61 upon which the ring 58 rests. Thus the ring 58 prevents the further downward movement of the piston member 15 once the ring 58 has been placed in the position shown in Figure 2. This ring 58 therefore comprises one of the elements of the locking means L which holds the piston member 15 in the raised position. Additionally to prevent the further upward movement of the piston member 15 once it has reached the raised position shown in Figure 2, the flange 56 and the U-shaped ring 62 can be placed in position and locked to the flange 25 by means of bolts 63 which pass through aligned openings in the flanges 56 and 25. The legs 62*a* and 62*b* fit into annular notches 64 and 65 respectively, thereby preventing displacement of the U-shaped ring 62. Although this particular form of locking means L has been shown in Figure 2 for securing the piston member 15 in the raised position, it will be appreciated that other types of known locking structures could be utilized for such purpose. Additionally, it will be appreciated that the ring 58 may be of suitable thickness so that it can be initially disposed in the groove 57 when the well head apparatus is lowered into the position shown in Figure 1 so that upon the raising of the piston member 15 the ring 58 will automatically snap into position in contact with the walls of the recess 60.

In the operation of the well head apparatus shown in Figures 1 and 2, the tubing T with the tubing hanger assembly A are forced or moved downwardly through the blowout preventer equipment or other similar control equipment which would be disposed on the flange 25, which equipment is conventional and is therefore not shown in the drawings. In this connection, it will be observed that the upper end of the enlarged diameter portion 24 may have a plug threaded into the threads 66 to prevent the release of pressure during the lowering of the tubing into the casing and while the blowout preventers are in use. Also, the upper end of the portion 24 may have threads around the periphery thereof, such as those designated by the numeral 67 whereby the exterior diameter of the assembly is reduced but permitting the addition thereto of a flange 68 having matching threads 68*a* for threading to the threads 67. This flange 68 is preferably added so that the usual Christmas tree equipment can be attached thereto.

Until the tubing hanger body has reached its seated position as shown in Figure 1, the shoe members 33 on the hold-down means B are retracted, but as soon as the tubing hanger body 14 is seated, the hold-down means B is actuated to move the shoe members 33 into the position shown in Figure 1 thereby securing the tubing hanger body 14 in its seated position. Due to the presence of the plug or backcheck valve (not shown), which is threaded into the threads 66 in the tubing, and since the tubing hanger body 14 is sealing off the annular space between the tubing head 10 and the tubing T, the blowout preventer equipment may be removed from the flange 25 and then the usual Christmas tree equipment may be added to the tubing at its upper end.

With the Christmas tree equipment in position, the usual washing operations can be effected through the tubing to displace the mud within the casing, as well as the other well operations such as acidizing. Thereafter, the packer or other well device which may be connected to the tubing T may be actuated by a rotation of the tubular stem 19 on the anti-friction means or ball bearings 16 to effect a rotation of the tubing T, if such rotation is desired or necessary to set a rotatable type of packer or other type of equipment.

If the packer is set by rotation, then it is usually desirable, particularly in older tubing, to take a tension in the tubing, and this is effected by the admission of a fluid under pressure through the inlet 17 by the opening of the valve 18, whereby the piston 15 and the connected tubing T is moved longitudinally the distance of the tubing head extension 11 and is then secured in its locked position as shown in Figure 2.

In some instances it may not be necessary or desirable to rotate the tubing T and the longitudinal movement can then be utilized to set the packer or other tool by simply moving the piston member 15 upwardly. Thus it can be seen that the longitudinal movement of the tubing T by the use of the fluid pressure can serve to actuate a reciprocating type packer or can be used to take a tension in the tubing when setting a rotatable type packer. It should also be pointed out that the tubing head extension 11 may be of suitable length so that a tension may also be obtained in the tubing even though the packer or other device is set simply by a longitudinal movement. This length of the tubing head extension 11 can easily be calculated by knowing the particular tool that is being used and therefore the desired length or height of the tubing head extension 11 can be determined and such size can be used.

In Figure 6, a modification of the structure shown in Figures 1 and 2, is illustrated. This modification is based upon the same principle of operation, but utilizes a somewhat different construction for the tubing hanger body 14 and the piston member 15. Thus in Figure 6, the tubing hanger body 14 has an annular resilient lip or sleeve 70 which is held in firm engagement with the tubular stem 19 by means of a circular spring 71 engaging within a groove in the lower end of the resilient sleeve 70. This resilient sleeve 70 is held on the tubing hanger body by a hook-shaped member 72 and is retained against inward collapse by metallic hook-shaped segments 73. The tubing hanger body 14 of Figure 6 has a similar inclined seating surface 26 which engages with the inclined shoulder 27 on tubing head 10. Also, a packing means 75 and an O-ring 76 are utilized in the form shown in Figure 6.

Also, in Figure 6, the tubing hanger body 14 is first placed in the seated position shown therein and thereafter the flange 22 is placed in position with the seal rings 77 in annular recesses of the flange 22 being in sealing contact with the exterior of the tubular stem 19. Preferably this flange or ring 22 is secured to the tubing head extension 11 by a weld 78 so that the ring 22 and the tubing head extension 11 as well as the ring 25 will be assembled as a unit after the tubing hanger body 14 has been seated in position.

When the tubing hanger body 14 has been seated and is held down by the hold-down means B and the tubing extension 11 and the related structure thereto have been placed in position and held there by the bolts 12, then the tubular stem 19 with the piston member 15 are lowered

into position with the stem 19 extending through the tubing hanger body 14 and having the tubing string T therebelow (Fig. 1). It will be observed that in the modification of Figure 6 the piston member 15 cannot pass below the upper surface of the ring 22. Also, the piston member 15 differs from that shown in Figures 1 and 2 in that the ball bearing structure 16 is formed within an inner annular recess 80 and the enlargement 24 takes the form of a radial flange on the tubular stem 19.

The locking means L used in the form of the invention shown in Figure 6 is similar to the hold-down means B utilized and described in detail in connection with Figures 3–5. A suitable groove or recess 82 is provided in the annular periphery of the piston member 15 to receive the shoe member of this locking means L. It is not considered necessary to describe the details of this construction since in all respects it is identical with the hold-down means B as particularly described above. Although the tubular stem 19 in Figure 6 has not been shown with an annular flange 68, it will be appreciated that such annular flange can be utilized or a similar construction can be used in order to receive the Christmas tree equipment.

The operation of the device in the modification shown in Figure 6 is substantially identical with that shown in Figures 1 and 2, with the exception that the tubing hanger body 14 would first be placed in position separately and thereafter the tubing head extension 11 with the rings 22 and 25 would be placed in position and thereafter the tubing T, tubular stem 19 and the piston member 15 would be lowered into the casing through the well head assembly.

It will be appreciated that the locking means L shown in Figures 1 and 2 could be utilized in Figure 6 if desired, and vice versa. Likewise, the particular tubing hanger body 14 shown in Figures 1 and 2 could be utilized in Figure 6, and vice versa.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed is:

1. A well head apparatus for supporting tubing in a well pipe, comprising a tubing hanger assembly adapted to be supported in a tubing head, said assembly including a hanger body in which the tubing may move longitudinally, said assembly also having a piston member engageable with said tubing so that longitudinal movement of said piston member effects longitudinal movement of said tubing, means to supply fluid under pressure to said piston member to move same and said tubing longitudinally, and bearing means connected to said tubing and resting upon said piston member for permitting a rotation of the tubing relative to the hanger body.

2. The apparatus as set forth in claim 1, including a hold-down means adapted to slidably engage said hanger body and to hold said body in seated position in the tubing head.

3. A well head apparatus including, a tubing head, a hanger assembly supported in said tubing head and including a hanger body seated in said tubing head, tubular means forming part of said hanger assembly depending from said hanger body and connected with a well tubing for suspending said tubing, mounting means for mounting said tubular means for rotation and longitudinal movement of said well tubing with respect to the hanger body, said mounting means including an annular piston mounted on said tubular means and adapted to be moved longitudinally by fluid pressure for moving said tubular means and said tubing longitudinally therewith relative to said hanger body, and means mounting said tubular means with said piston for rotating said tubular means relative to said piston and said hanger body whereby rotation of said tubing relative to said hanger body is effected.

4. A well head apparatus including, a tubing head having a supporting seat, a hanger engageable with and supported upon said seat, a tubular stem mounted within the hanger and having its lower end depending therefrom and connected with a well tubing, mounting means for mounting the tubular element for rotation and longitudinal movement of said well tubing with respect to the hanger, said mounting means including an annular piston mounted on and surrounding said tubular stem and adapted to be moved longitudinally by fluid pressure for moving said tubular stem longitudinally therewith relative to said hanger body, and means for mounting said tubular stem with said piston for rotating said tubular stem relative to said piston and said hanger body whereby rotation of said tubing relative to said hanger body is effected.

5. In a well head apparatus for supporting a tubing in a well casing, a tubing hanger assembly, comprising a tubing hanger body, a tubular stem extending through said hanger body and connected to a well tubing disposed below the hanger body, a fluid-pressure actuated annular piston member surrounding said stem and disposed above said hanger body, an anti-friction bearing associated with said piston member, and an annular enlargement on said stem engageable with the upper race of said bearing whereby said stem is rotatable on said bearing with respect to said piston member and whereby longitudinal movement of said piston member relative to said hanger body is transmitted to said stem and said tubing.

6. The structure set forth in claim 5, wherein said anti-friction bearing comprises a lower race formed in an annular lateral surface of the piston member, bearing elements disposed on said lower race, and wherein said upper race is disposed on said bearing elements.

7. The structure set forth in claim 5, wherein said piston member has an internal annular recess in which said anti-friction bearing is seated, and wherein said enlargement is disposed above said bearing.

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