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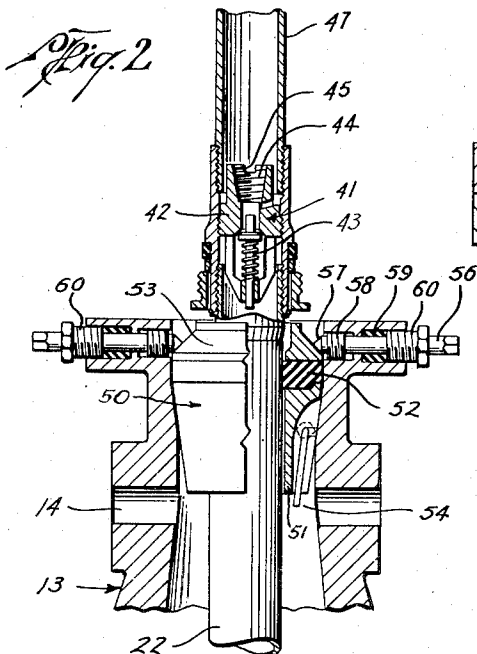
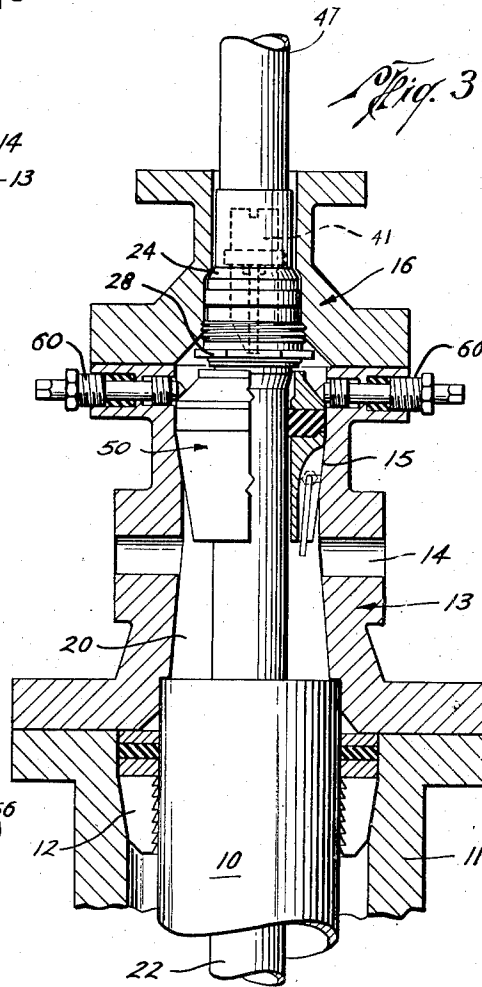
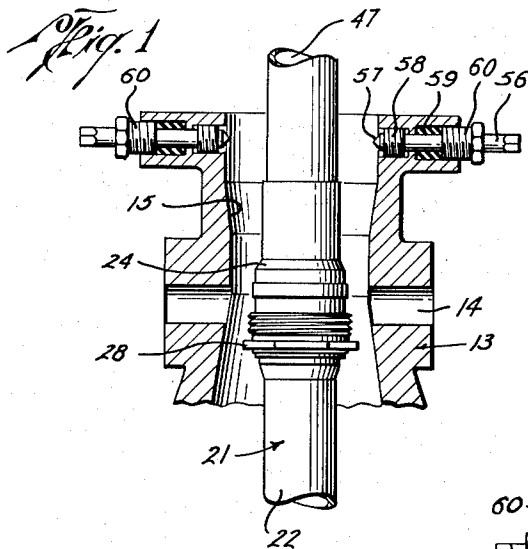
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PIPE HANGER AND SEAL ASSEMBLY

Filed May 2, 1952

2 Sheets-Sheet 1



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ATTORNEYS

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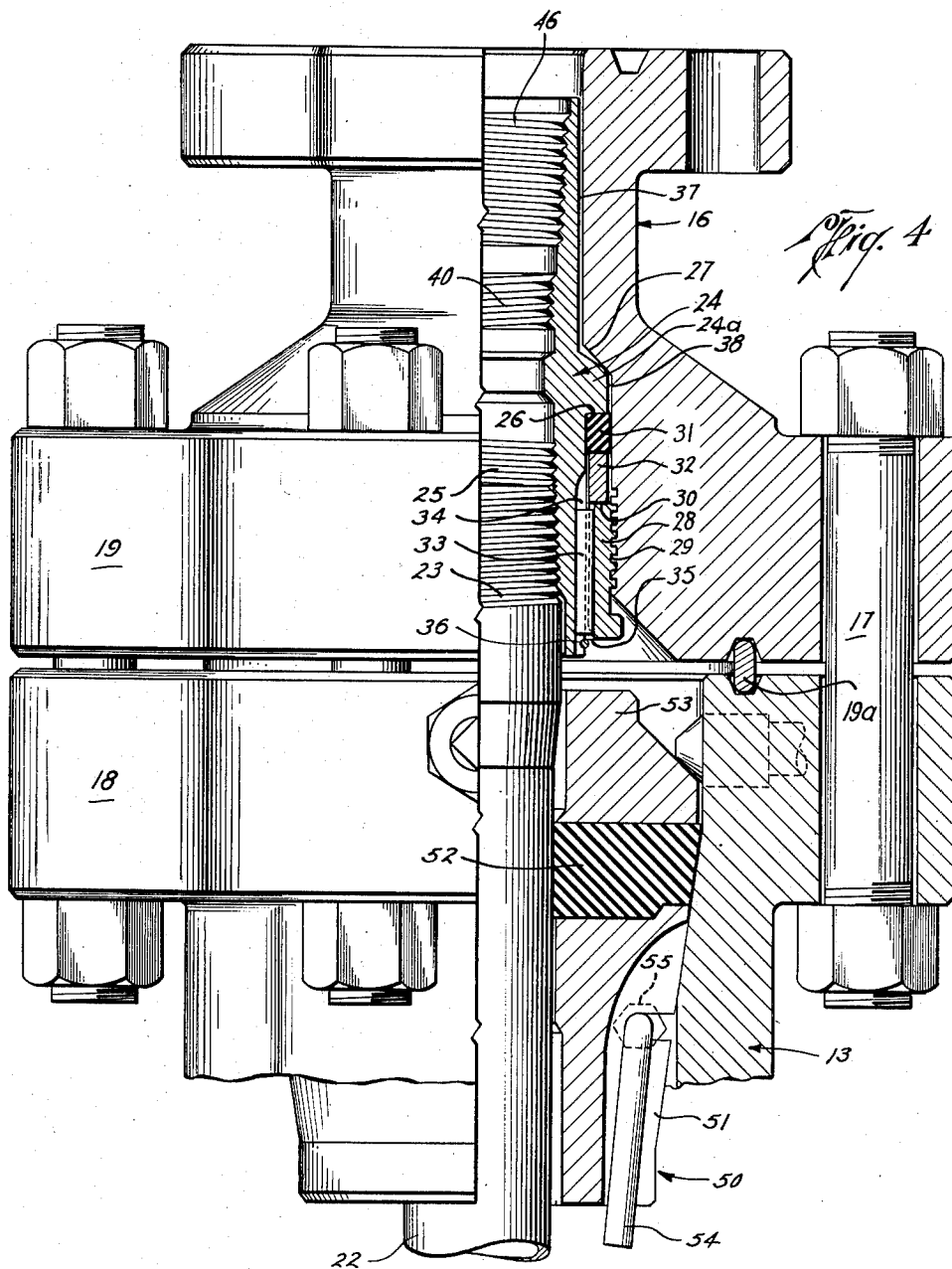
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PIPE HANGER AND SEAL ASSEMBLY

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2 Sheets-Sheet 2



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PIPE HANGER AND SEAL ASSEMBLY

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10 Claims. (Cl. 285—23)

This invention relates to an improved apparatus for hanging a pipe in a well. In one of its aspects, it relates to an improved pipe hanger and seal assembly adapted to be used in completing a well.

In completing and producing oil wells, it is often desired to suspend the tubing from the Christmas tree and this has heretofore been accomplished by providing a rigid screwed connection between the tubing and Christmas tree. Such a rigid connection often results in excessive stress concentrations in the well head apparatus and particularly at the threaded connection due to the difficulty of securing accurate axial alignment between the tubing and Christmas tree. Thus, when the axis of the tubing is not coaxial with that of the Christmas tree from which it is hung, any rigid screwed connection therebetween must force these two elements toward coaxial alignment with the result that there occurs eccentric loading with resultant excessive stresses at the screwed joint. Not only does this weaken the joint but it also greatly increases its likelihood of leaking.

It is therefore an object of this invention to provide a pipe hanger assembly functioning to suspend a tubing or the like from a bonnet, the latter being adapted to form a part of the well head equipment, in such a manner that the connection between the bonnet and tubing will permit limited movement of the tubing with respect to the bonnet and limited axial misalignment therebetween and yet avoid excessive stresses and non-uniform loading at the connection.

Another object is to provide a pipe hanger assembly which can be easily assembled into a well head apparatus, which permits a wide variety of tubing manipulations and which is adapted to be used though a well be completed in any one of several manners.

Another object of this invention is to provide a pipe hanger and seal assembly wherein a pipe or tubing can be connected to a bonnet in such a manner as to suspend the tubing from the same, the weight of the tubing effecting the expansion of a resilient seal between the tubing and the bonnet despite axial misalignment therebetween.

Another object of this invention is to provide a well head assembly wherein the tubing is flexibly suspended from a Christmas tree or other well head control apparatus surmounting a tubing head, the arrangement being such that the tubing can be freely manipulated, if desired, prior to mounting of the Christmas tree on the tubing head.

Another object of this invention is to provide a pipe suspending and sealing apparatus adapted to flexibly suspend a pipe from a Christmas tree or other apparatus, there being provided a resilient seal effectively expanded by the weight of the tubing and permitting limited misalignment of the tubing with respect to the Christmas tree.

Another object of this invention is to provide a pipe suspending and sealing assembly including the lower portion of a Christmas tree or equivalent wherein the weight of the pipe effects a seal between the pipe and the Christmas tree and wherein means are provided for limiting movement of the pipe out of the well.

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Other objects, advantages and features of this invention will be apparent to one skilled in the art upon a consideration of the written specification, the appended claims and the attached drawings wherein:

Fig. 1 illustrates a possible operational step wherein a tubing having a portion of the apparatus of this invention assembled as a part thereof is lowered through a tubing head past the point of suspension of the tubing; Fig. 2 illustrates another operational step wherein the apparatus of Fig. 1 has had a tubing-to-tubing head seal installed therein;

Fig. 3 illustrates the apparatus of this invention in an assembled state for well production except that the tubing back pressure valve has not been removed; and

Fig. 4 is a detailed view, partially in cross-section, of the pipe assembly and sealing apparatus of this invention.

Like characters of reference are used throughout the several views to designate like parts.

Referring to the drawings, there is shown a well head assembly including a casing 10 suspended in a casing head 11 by casing hanger 12 in a manner familiar to those skilled in the art and surmounted by a tubing head 13 having lateral fluid passages 14 and a bowl 15. Bonnet or adapter spool 16, which can be a lower portion of a conventional Christmas tree, is adapted to be mounted on the tubing head by means of studs 17 passing through registering holes in flanges 18 and 19 of the tubing head and bonnet, respectively. A flange seal ring 19a is provided to effect a seal between the flanges.

Tubing head 13 is provided with a longitudinal interior passage 20 of sufficient size to permit tubing assembly 21, comprising tubing 22 and the suspending connection described more fully below, to be passed therethrough as illustrated in Fig. 1. Referring to Fig. 4, the tubing assembly is shown to include a conventional well tubing 22 having a threaded end 23. Connected to the threaded end is a hanger nipple 24 having internal threads as at 25 for connection with the threaded end of tubing 22. Hanger nipple 24 is provided with an annular outturned flange 24a thereby defining an outturned shoulder 26 which, when the assembly is in its Fig. 4 position, is facing towards tubing head 13. The passage through bonnet 16 is preferably formed of different diameters to thereby provide an inwardly extending shoulder 27 which is adapted to engage flange 24a and limit movement of hanger nipple 24 out of the bonnet in a direction away from tubing head 13.

Received around hanger nipple 24 and slidable longitudinally with respect thereto is an annular nut 28 having a releasable connection, as by threads 29, with bonnet 16. The threads on nut 28 are preferably coarse, loose-fitting external threads and are adapted to be meshed quickly and easily with internal threads formed at the end of the passage in bonnet 16 closest to tubing head 13. In this manner, there is provided a member which is removably connected to the bonnet and carried by the latter to provide an inturned shoulder 30 oppositely disposed from and facing shoulder 26 of hanger nipple 24.

Disposed between shoulders 26 and 30 is a sealing means which can comprise an annular resilient sealing element 31 and an annular gland ring 32. It will be noted that nut 28 and the sealing means can be said to comprise an anchoring and sealing means between the nipple and bonnet because they anchor or suspend the tubing from the bonnet and, at the same time, effect a seal therebetween. It will further be noted that resilient sealing element 31, which can be an oil resistant rubber, such as neoprene, is provided with extended sealing surfaces along its sides so that upon movement of shoulder 26 of hanger nipple 24 toward gland ring 32 and shoulder 30, sealing element 31 will be compressed longitudinally and expanded laterally to form an effective seal not only with

shoulder 26 but also with the bonnet and the oppositely disposed portion of the hanger nipple. If desired, element 31 may be suitably reinforced with fabric, fiber, or the like. With the apparatus assembled as in Fig. 4, it will be evident that the effective weight of tubing 22 which must be suspended in the well is borne across sealing element 31 so that such weight effectively expands the sealing element despite limited lateral or angular misalignment between the nipple and bonnet or limited relative movement therebetween. As used in the specification and claims, the terms "misalignment" and "axial misalignment" mean that the axes of the parts referred to are not coaxial with respect to each other; for example: the axes are parallel but not common; or the axes are inclined relative to each other but not intersecting; or the axes are inclined relative to and intersect each other.

Means are provided for limiting relative rotation between nut 28 and hanger nipple 24. Such means can comprise a key 33 received in keyway 34 of the hanger nipple and the registering keyway 35 in the nut. Such an assembly permits nut 28 to move longitudinally with respect to the hanger nipple but substantially prevents rotation therebetween. A snap ring 36 carried in a groove in the hanger nipple below the nut and key can be provided to prevent nut 28 and key 33 from dropping off the hanger nipple when manipulations, such as in Fig. 1, are being carried out. With this type of assembly, it will be apparent that hanger nipple 24 can be resiliently connected to bonnet 16 by merely stabbing the latter over the tubing assembly and then rotating either the tubing while the bonnet is held steady or rotating the bonnet while the tubing is held steady. It will not be necessary to apply a wrench to nut 28 inasmuch as key 33 will prevent rotation with respect to the tubing. With such an apparatus, the seal between the hanger nipple and the bonnet does not depend upon the effectiveness of a threaded connection but rather upon a resilient packing. The torque required to effect a reliable mechanical and pressure tight joint is relatively small, being in the order of 25 ft. lb. to hold 10,000 p. s. i. of fluid pressure.

In accordance with one important feature of this invention, hanger nipple 24 has a loose fit with the bonnet and nut 28 to permit limited lateral movement and axial misalignment therebetween without encountering harmful eccentric loading of the hanger nipple, the bonnet, or the connection therebetween and the resultant stress concentrations and failure of the connection between the tubing assembly and the bonnet. Thus there is a clearance as indicated at 37 between the upper portion of the hanger nipple and the upper portion of the bonnet as well as at 38 between the intermediate portions of these two structures. Also it will be noted that nut 28 has an internal diameter larger than the external diameter of hanger nipple 24 at the region where the nut surrounds the hanger nipple. Also key 33 is of less width than the combined depth of keyways 34 and 35 so that there likewise can be limited relative movement between the hanger nipple and the nut at this point, the key being of sufficient width nevertheless to engage both keyways and prevent relative rotation between the nut and the hanger nipple. It will thus be apparent that hanger nipple 24 and tubing 22 are free to shift laterally and angularly a limited amount with respect to bonnet 16 and thereby adjust for axial misalignment so as to more uniformly dispose the hanging stress on the bonnet without imposing excessive bending loads on the connection between the tubing assembly and the bonnet. In this connection, resilient element 31 will continue to effect a seal between the hanger nipple and bonnet even though the latter two are not exactly coaxial as compressive forces exerted on one side of the resilient element will cause the material to flow around the nipple and the weight supported by the resilient element will be substantially uniformly distributed around the element.

The upper end of hanger nipple 24 is threaded as at 40 to receive a back flow valve 41 adapted to prevent flow

from the well out of the tubing but permitting flow into the well. Such type of valve is well known to those skilled in the art and comprises essentially a valve body 42 having external threads engageable with threads 40 and a spring loaded valve element 43 adapted to seat on body 42. It is provided with a threaded portion 44 and a notch 45 adapted to receive a suitable tool for removal of the valve from the hanger nipple through the Christmas tree.

The upper end of nipple 24 is threaded as at 46 for connection with a handling or tubing joint 47 to permit suspending of well tubing 22 and manipulation thereof prior to the time the tubing is suspended by the bonnet as shown in Fig. 4.

Means can be provided for sealing between the tubing and the casing for purposes more fully explained below. As illustrated in the drawings, there is provided a tubing-to-tubing head seal assembly designated generally by the numeral 50 which is of the split, wrap-around type so that it can be positioned around tubing 22 without having to pass it downwardly from the upper end of the tubing. Briefly, this seal assembly comprises a radially split bowl seating element 51 adapted to seat in bowl 15 of the tubing head. Packing means 52, as of rubber, and a radially split upper backup ring 53 are mounted above the seating element as shown. The elements 51 and 53 are thus divided longitudinally into halves and are hinged by packing 52 and split at a diametrically opposing point so that the halves of the assembly can be spread apart to permit them to be passed around tubing 22. Then, after the assembly has been thus positioned around tubing 22, latch 54, which is secured to one half of the assembly by nut 55, extends through the slotted portion of the other half of the assembly and is turned to clamp the two halves of the assembly together. The above-described assembly is commercially available and well known to those skilled in the art. It is to be understood that any other known means can be substituted for the described tubing-to-casing sealing assembly.

The tubing head is equipped with lock screws 56 extending through the upper flange thereof and having inner ends 57 adapted to engage backup ring 53 to hold the sealing assembly within the bowl of the tubing head and to expand packing 52. The lock screws have a threaded engagement as at 58 with the tubing head and are equipped with packing 59 expanded by packing nut 60 to provide a seal around the lock screws.

In operation, resilient element 31, gland ring 32 and nut 28 are placed over the hanger nipple in the manner shown and key 33 inserted after which snap ring 36 is positioned to maintain the assembly in proper position. Back flow valve 41 is screwed into threads 40 of the hanger nipple to assume the position indicated in the drawings. Then, hanger nipple 24 is made up in the well tubing at the desired point of suspension thereof by screwing the upper end of the tubing joint 22 into the threaded end 25 of the hanger nipple.

As illustrated in Fig. 1, the tubing string can be picked up by handling joint or tubing section 47 in a manner well known to those skilled in the art and manipulated without the tubing assembly including nut 28 interfering with such manipulations. Thus, should it be desired to lower the tubing past its point of suspension into the well, such can be done because nut 28 and the sealing means thereabove are sufficiently small in diameter to pass through the tubing head and casing head. During such preliminary manipulation, the blowout preventers are ordinarily in place and nut 28 can also be passed through them.

When it is desired to seal in the well, the tubing can be picked up by handling joint 47 and raised until hanger nipple 28 clears the blowout preventers and then the tubing-to-casing sealing apparatus 50 positioned around the tubing joint 22 by hinging the halves apart, passing the assembly around the joint, and then latching the halves together by means of latch 54. The seal assembly can then

be passed downwardly through the blowout preventers to position it in bowl 15 of the tubing head and hold down screws 56 tightened to give the desired degree of seal between the tubing and tubing head. At this point, the well is completely sealed in, the sealing apparatus 50 sealing between the tubing head and tubing and back flow valve 41 preventing flow out of the tubing.

The well can be washed in with the assembly as in the Fig. 2 position, the conventional blowout preventers being in place on tubing head 13. Alternatively, the well can be washed in with the blowout preventers in place and before seal assembly 50 is positioned as in Fig. 2, the seal assembly being added through the preventers after the well is washed. As still another alternative, the assembly of Fig. 2 can be made up and the tubing lowered until hanger nipple 24 rests on backup ring 53. Then handling joint 47 can be unscrewed from hanger nipple 24, withdrawn from the preventers and the latter removed. Handling joint 47 can then be re-screwed into the hanger nipple and the well washed in although this procedure should be employed when well head pressures are relatively low.

After the preventers have been removed and the handling joint again connected to the hanger nipple, the tubing can be lifted to elevate nut 28 while assembly 50 maintains a sliding seal with the tubing. The tubing is then supported on a suitable spider and slips resting on the top flange of the tubing head while the handling joint is removed. Then bonnet 16 is screwed to nut 28 by revolving the bonnet while holding the tubing steady or by revolving the tubing while holding the bonnet steady. The handling joint can then be reconnected and the bonnet and tubing manipulated to set packers or the like, if desired. Then after the bonnet has been lowered and connected to the tubing head, the handling joint is removed and the upper portion of the Christmas tree lowered until the latter is seated on the top flange of bonnet 16. If desired, the well can be washed in through the Christmas tree with fluids being introduced through tubing 22 and valve 41 and removed through casing 10 and passages 14 in the tubing head. After the washing in operations are completed, the well can be put in production by merely unscrewing back flow valve 41 with a suitable tool insertable through the Christmas tree.

If at any time it is desired to further manipulate tubing 21, it will merely be necessary to unbolt the bonnet from the tubing head. The Christmas tree can then be picked up with the tubing suspended therefrom and the manipulations accomplished while still retaining the well sealed in by means of assembly 50.

From the above, it will be apparent that the arrangement of the apparatus of this invention permits many different methods of completing a well. The well can be washed in through blowout preventers or a Christmas tree without having to be shut in at any time.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the structure.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. An apparatus which comprises, in combination, a well head assembly including a tubing head, a bonnet on said tubing head, said well head assembly and bonnet having a passage therethrough, a tubing within said passage, a nipple connected as a part of the tubing to be

manipulatable therewith and having an outturned shoulder facing downwardly toward said tubing head, an annular nut around and slidable longitudinally of the nipple with external threads thereon engaging corresponding internal threads on said bonnet and providing an upwardly facing shoulder opposing said outturned shoulder, packing means between said shoulders and expansible to provide a seal between said bonnet and nipple and to transmit the weight of the tubing and nipple to the bonnet through the nut, said nipple having a loose fit with said bonnet and nut to permit limited lateral and angular movement of the nipple with respect to the nut and a force transmitting connection supporting said nut on said nipple and preventing relative rotation but permitting limited longitudinal movement therebetween whereby the nipple packing means and nut are carried with the tubing during manipulation thereof and so that relative rotation of the nipple and the bonnet secures said nut to the bonnet.

2. The apparatus of claim 1 in combination with opposing shoulders carried by said nipple and bonnet positively preventing more than a predetermined amount of longitudinal movement of said nipple away from said head when the bonnet is fixedly mounted on said head.

3. An apparatus which comprises, in combination, a bonnet having a passage therethrough and having an internally threaded portion, a hanger nipple having an outturned shoulder adapted to be received in the passage-way and connectable with a tubing to be hung from said bonnet, said nipple being sufficiently smaller than the passage to permit lateral and angular movement of the nipple with respect to the bonnet within predetermined limits, an externally threaded nut loosely received about the nipple and screwed to said threaded portion of the bonnet and providing a shoulder facing the outturned shoulder on the nipple, stop means carried by the nipple and engageable with the nut to limit movement of the nut along the nipple in a direction away from the nipple shoulder so as to retain the nut on the nipple when disconnected from the bonnet, means connecting between the nut and nipple and limiting relative rotation therebetween, and packing means between said shoulders expandable to seal between the bonnet and nipple upon relative longitudinal movement of the nipple and nut in a direction to move the shoulders toward each other.

4. A tubing hanger and seal assembly adapted to suspend a tubing from and form a seal with a bonnet or the like in a well head which comprises, in combination, a hanger nipple including means for connecting the nipple as a part of the tubing string so that movement of the tubing string causes corresponding movement of the nipple, a connector loosely and slidably carried by the nipple for longitudinal movement relative thereto and including means for releasably connecting the connector with the bonnet responsive to rotation of the connector relative to the bonnet, said nipple having an annular shoulder opposing an annular shoulder on said connector, packing means carried by the nipple and connector between said shoulders and expandable to form a seal between the assembly and the bonnet responsive to movement of the connector shoulder toward the nipple shoulder, said packing transmitting the weight of the nipple to the bonnet through the connector to suspend the nipple from the bonnet, and force transmitting means between the connector and nipple limiting relative rotation therebetween so that relative rotation of said nipple and bonnet will connect the connector with the bonnet, said force transmitting means limiting relative longitudinal movement between the connector and nipple so that the connector as well as the packing means is carried by the nipple and yet providing a sufficiently loose connection between the connector and nipple to permit misalignment of the nipple relative to the connector while the latter is connected to the bonnet.

5. A tubing hanger and seal assembly for suspending a tubing from and forming a seal with the bonnet or the

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like on a well head structure comprising, in combination, a hanger nipple including means for connecting the same as a part of the tubing so that the tubing and nipple move together as a unit, an annular nut slidably mounted on and for longitudinal movement with respect to said nipple and having means for releasably connecting the nut to the bonnet responsive to relative rotary movement of the nut and bonnet, and annular packing also carried by the nipple between opposing shoulders on the nut and nipple expansible outwardly of the nipple upon relative movement of said shoulders toward each other to compress the packing, said packing transmitting the weight of the nipple to the bonnet through the nut to suspend the nipple from the bonnet, and means between the nipple and nut limiting longitudinal movement of the nut relative to the nipple in a direction such as to move said shoulders apart so that said nut when disconnected from said bonnet is supported on and carried by said nipple along with said packing; the last mentioned means also substantially preventing relative rotation between the nipple and nut whereby relative rotation of the nipple and the bonnet can connect the nut and bonnet, said nipple having a loose fit with the nut to permit limited axial misalignment between the nipple and nut.

6. A well head assembly for suspending a tubing in a well which comprises, in combination, a tubing head having a bowl, a bonnet on said tubing head, said tubing head and bonnet having a passageway therethrough, a tubing within said passageway, a nipple connected as a part of said tubing to be manipulatable therewith and having an outturned shoulder facing downwardly toward the tubing head, an annular nut around and slidable longitudinally of the nipple with external threads thereon engaging corresponding internal threads on said bonnet and providing an upwardly facing shoulder opposing said outturned shoulder, packing means between said shoulders expansible outwardly to provide a seal between said bonnet and nipple and transmitting the weight of the tubing string to the bonnet through the nut, said nipple having a loose fit with said bonnet and nut to permit limited lateral and angular movement of the nipple with respect to the nut, a force transmitting connection supporting said nut on said nipple and preventing relative rotation but permitting limited longitudinal movement therebetween whereby the nipple packing means and nut are carried with the tubing during manipulation thereof and so that relative rotation of the nipple and the bonnet secures said nut to the bonnet, said tubing head passageway being of sufficient size to permit free passage of said nipple, nut and packing means and seal means in the bowl of said tubing head providing a seal between the tubing and said tubing head and yet permitting the tubing to rotate and move longitudinally with respect to the tubing head, said seal means being separate from said nipple, nut and packing means.

7. A tubing hanger assembly which comprises in combination a bonnet adapted to rest on a tubing head which has a passageway therethrough adapted to receive a tubing string suspended from the bonnet, said bonnet having a passageway therethrough, a nipple in the bonnet passageway adapted to suspend a string of tubing from the bonnet and having an outturned downwardly facing shoulder in the bonnet passageway, a connector loosely and slidably carried by the nipple below the shoulder for longitudinal movement relative to the nipple, said bonnet and connector including means for releasably connecting the connector with the bonnet responsive to relative rotation of the connector and bonnet, said connector providing a shoulder opposing said nipple shoulder, packing means carried by the nipple between said shoulders and transmitting the weight on the nipple to the bonnet through the connector and expandable by the weight supported on the packing means to provide a seal between the bonnet and nipple, said nipple having a loose fit with the bonnet and connector to permit limited misalignment

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between the bonnet and nipple, a loose spline connection between the nipple and connector preventing relative rotation therebetween while permitting longitudinal movement and limited misalignment therebetween so that relative rotation of the nipple and bonnet secures the connector to the bonnet, and stop means carried by the nipple whereby the packing means and connector are carried with the nipple during manipulation thereof, said nipple, packing and connector dimensioned to permit free movement of the nipple, packing and connector through the tubing head passageway.

8. The assembly of claim 7 wherein said nipple is provided with internal threads to receive a handling joint to support and manipulate the nipple prior to it being connected to the bonnet.

9. A tubing hanger and seal assembly comprising a tubing head having a passageway therethrough, a bonnet adapted to rest on a tubing head and be secured thereto, the bore through said bonnet being threaded at its lower end, a hanger nipple including means for connecting the nipple to a string of tubing to suspend the string from the nipple, a downwardly facing annular shoulder on the nipple adapted to be supported from the bonnet and to suspend a string of tubing in a well, an annular packing carried by the nipple and in abutment with the shoulder, a nut carried by the nipple and engageable with the threaded section of the bonnet, said nut providing a shoulder facing said nipple shoulder and supporting said nipple shoulder through the packing to suspend the nipple from the bonnet, force transmitting means between the nut and nipple limiting relative rotation therebetween so that the nut may be secured to the bonnet by relative rotation of the nipple and bonnet, said bonnet bore and nut being dimensioned relative to the nipple to permit limited misalignment of the nipple and bonnet to prevent unequal stress on the hanger assembly, means limiting movement of the nut away from the nipple shoulder to hold it in position to be engaged by the bonnet, and split packing means in the tubing head passageway adapted to seal between the tubing head and a string of tubing suspended from the bonnet, said packing removable from the passageway to permit the nipple to be moved in the portion of the tubing head passageway occupied by the packing means.

10. An apparatus which comprises in combination, a tubing head, a bonnet on said tubing head, said tubing head and bonnet having a passageway therethrough, a nipple in the passageway adapted to suspend a string of tubing from the bonnet and having an outturned shoulder in the bonnet passageway and facing toward the tubing head, a connector loosely and slidably carried by the nipple for longitudinal movement relative thereto, said bonnet and connector including means for releasably connecting the connector with the bonnet responsive to relative rotation of the connector and bonnet, said connector providing a shoulder opposing said nipple shoulder, packing means carried by the nipple between said shoulders and expandable to provide a seal between the bonnet and nipple and a flexible support for the nipple, said nipple having a loose fit with the bonnet and connector to permit limited misalignment between the bonnet and nipple, a force transmitting connection supporting the connector on the nipple and preventing relative rotation but permitting limited longitudinal movement therebetween whereby the packing means and connector are carried with the nipple during manipulation thereof so that relative rotation of the nipple and bonnet secures said connector to the bonnet, said tubing head passageway diameter dimensioned relative to the nipple, packing and connector to permit free movement of the nipple, packing and connector through the tubing head passageway and split packing means in the tubing head passageway adapted to seal between the tubing head and a string of tubing suspended from the bonnet, said packing being

removable from the passageway to permit the nipple to be moved in the portion of the tubing head passageway occupied by the packing means.

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