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PIPE HANGER AND SEAL ASSEMBLY WITH MEANS TO LIMIT PRESSURE APPLIED TO THE SLIPS

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Fig. 1

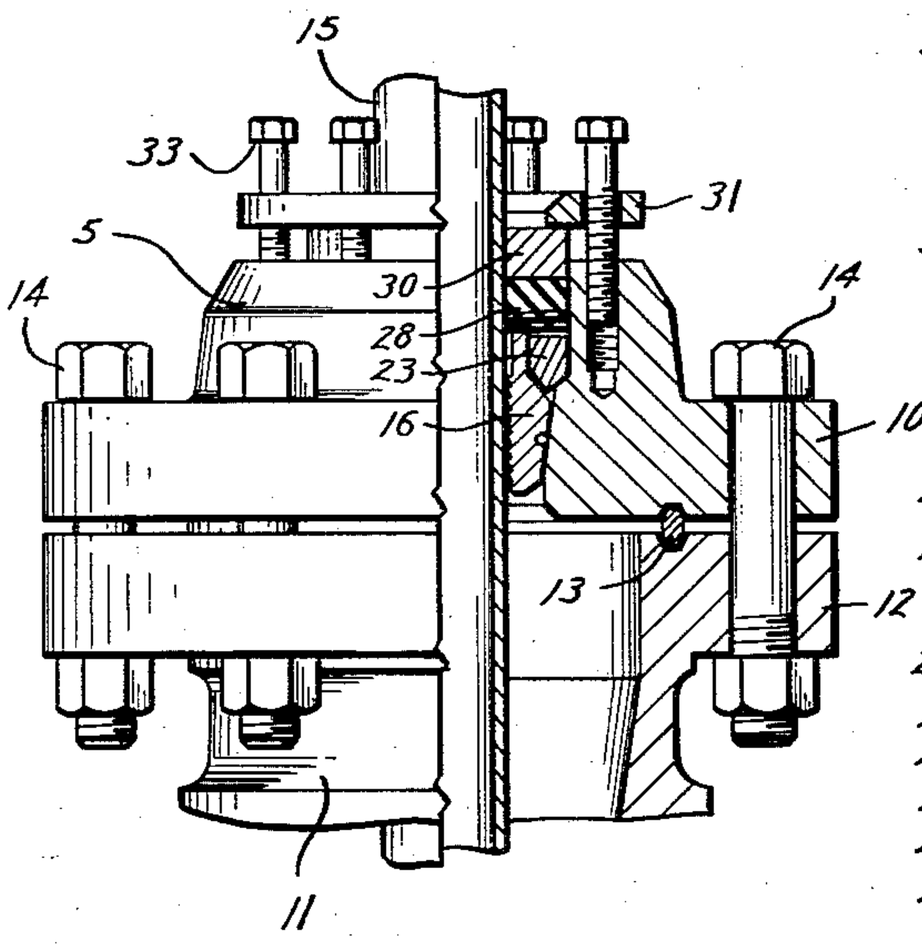
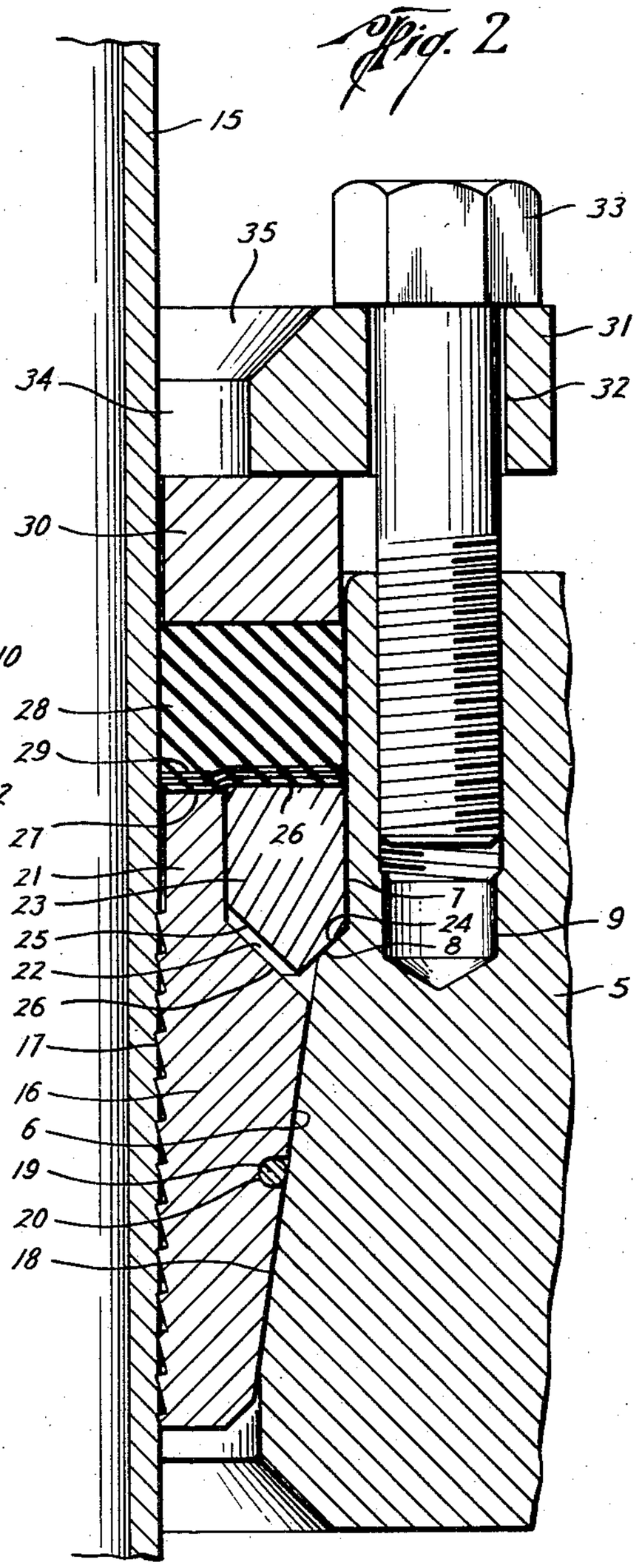


Fig. 2



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PIPE HANGER AND SEAL ASSEMBLY WITH MEANS TO LIMIT PRESSURE APPLIED TO THE SLIPS

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2 Claims. (Cl. 285—148)

This invention relates to well head apparatus for suspending a string of pipe in a well and, more particularly, to improvements in well head apparatus of the type in which the force utilized to expand the packer which seals between the well head and pipe is transmitted through the packer to the slips supporting the pipe to resist any tendency of the slips to rise in the tapered bowl due to well pressure or other forces.

Some trouble has been experienced in the field with well head hangers of the type described above due to the fact that when tightening down on the bolts used to expand the packer an excessive downward force is occasionally exerted on the slip assembly. This excessive force causes the slip assembly to be driven downwardly into the tapered bowl to such an extent that the tubing is sometimes severely stressed and caused to compress and reduce the inside diameter an undesirable amount. A relatively slight reduction in diameter may be sufficient to interfere with easy operation of tools which must be run inside the tubing.

It is an object of this invention to provide a pipe hanging and seal assembly of the type referred to above in which the slip assembly is protected against an excessive downward force.

Another object of this invention is to provide a pipe hanging and seal assembly of the type referred to in which only a portion of the downward force exerted by the compressed packing in the annulus between the pipe and hanger fitting from which the pipe is hung is transferred to the slip assembly.

Another object is to provide a pipe hanging and seal assembly of the type referred to in which a portion of the downward force usually exerted upon the slip assembly by the packing is transmitted directly to the hanger fitting from which the pipe is hung.

Another object is to provide a pipe hanging and seal assembly of the type referred to in which only a portion of the downward force exerted by the compressed packing in the annulus between the pipe and hanger fitting from which the pipe is hung is transmitted to the slip assembly with the remainder of such downward force being transmitted directly to the hanger fitting.

Another object is to provide a pipe hanging and seal assembly of the type referred to in which a portion of the downward force exerted by the packing in the annulus between the pipe and hanger fitting is borne by a gland member whose downward movement is limited by the hanger fitting from which the pipe is hung.

Other objects, features and advantages of this invention will be apparent to those skilled in the art from a consideration of the drawing, the written specification, and the claims.

In the drawing wherein there is shown by way of illustration one embodiment of this invention and wherein like reference numerals are used to indicate like parts:

Fig. 1 is a view partially in vertical elevation and partially in vertical cross section of a well head hanger and seal assembly constructed in accordance with this

invention with a string of tubing suspended therefrom; and

Fig. 2 is a view in cross section on an enlarged scale of a fragment of the hanger assembly of Fig. 1.

The hanger and seal assembly illustrated employs a lower gland which surrounds a reduced diameter portion at the upper extremity of the slip assembly to protect the slip assembly from excessive downward force. The lower gland overlies a portion of the slip assembly, thus reducing the area of the slip assembly exposed to contact with the packing and is shouldered in the hanger fitting to transmit force exerted upon the gland directly to the hanger fitting. The packing is of the flowable type and hence the slip assembly will be subject to only a portion of the downward force exerted by the packing.

Referring now more in detail to the drawing, the numeral 5 indicates a well head fitting, such as a tubing head, having a tapered zone 6 in the bore thereof, such taper converging in a downward direction and providing a slip bowl. The well head fitting 5 is also provided with a substantially cylindrical zone 7 above the tapered zone 6, such cylindrical zone 7 being formed on a slightly greater diameter than the uppermost portion of tapered zone 6. An upwardly diverging tapered zone 8 interconnects tapered zone 6 and cylindrical zone 7 and provides a shoulder therebetween. The upper end of fitting 5 is tapped as at 9 at circumferentially spaced points about the bore through the fitting 5. The fitting 5 is provided with a flange 10 extending outwardly from its lower end for the purpose of securing it to a suitable fitting indicated by the numeral 11. Fitting 11 may be a valve, or other suitable fitting and is provided with a flange 12 at its upper end matching the flange 10 on hanger fitting 5. Between well head fittings 5 and 11, there is interposed a customary type seal 13 so that when flanges 10 and 12 are drawn together by the ring of bolts 14 extending through flanges 10 and 12 a seal will be formed between the two fittings.

Located within the bore through well head fittings 5 and 11 is a pipe 15 which may be a string of well tubing to be hung in well head fitting 5 and sealed thereto in a manner to be explained below.

The pipe 15 is hung within fitting 5 by a segmented slip assembly 16 seated in bowl 6. Slip assembly 16 is provided with conventional teeth 17 on its interior face and a downwardly converging exterior face 18 which mates with bowl 6 in the conventional manner to cause the teeth 17 to bite into the exterior surface of pipe 15 upon downward movement of the slip assembly 16 within slip bowl 6. This downward movement is, of course, provided by the weight of pipe 15. The several segments which form the slip assembly are held in assembled relationship about the pipe by a snap ring 19 in an exterior groove 20 in slip assembly 16. This snap ring holds the several slip segments against axial movement along the pipe relative to each other in the conventional manner so that the slip segments will move downwardly into the bowl under the weight of the pipe as an integral unit.

To prevent all of the downward force employed in making up the seal between the tubing and hanger fitting from reaching the slip assembly, only a portion of the upwardly facing surface of the slip assembly is exposed to downward pressure. The remainder of the upwardly facing surface is protected by a member positioned between the slip assembly and packing, with the member shouldered on the fitting. For this purpose slip assembly 16 has a reduced diameter portion 21 at its upper end to provide an annular space 22 above a portion of the slip assembly. That is, the outer diameter of reduced diameter portion 21 is less than the outer diameter of

the slip assembly at its point of largest diameter, such point of largest diameter being the uppermost portion of slip assembly **16** which is in contact with slip bowl **6**.

An annular lower gland **23** is positioned within space **22** to overlie the portion of the slip assembly **16** to be protected. Lower gland ring **23** is formed with an internal diameter slightly greater than the external diameter of portion **21** of the slip assembly and with an external diameter slightly less than the diameter of cylindrical bore **7** in fitting **5**. The clearances between the portion **21** of the slip assembly and the gland, and between the fitting and gland should be no more than necessary to permit easy assembly of the parts so that large cracks into which packing might flow will be avoided. Gland **23** has a downwardly converging taper **24** on its lower end which mates with shoulder **8** to support the lower gland within the fitting **5**. Radially inward from surface **24** the lower gland **23** is provided with a downwardly diverging taper **25** which is substantially parallel to a confronting surface **26** on slip assembly **16**. As best shown in Fig. 2, parallel surfaces **25** and **26** are spaced from each other when the pipe has been hung in the fitting and the seal between the pipe and fitting completed so that downward force upon lower gland **23** will be transmitted through shoulder **8** to fitting **5** and none of this downward force will be transmitted to slip assembly **16**. The lower gland **23** will be centered within fitting **5** by the coaction of shoulder **8** and the converging taper **24** on lower gland **23**. This feature will insure that lower gland **23** is concentrically positioned within fitting **5** to thereby avoid large gaps between the lower gland and slip assembly on the one hand and the lower gland and fitting **5** on the other hand into which packing material might flow. Lower gland **23** may be an integral 360° member or it may be a segmented member. When an integral form is employed, the inner diameter of gland **23** should be large enough to pass over a conventional pipe collar to permit the gland to be received about a conventional length of pipe. This form of construction will require that the reduced diameter portion of slip assembly **16** be formed with an outer diameter approximating the diameter of conventional pipe couplings. On the other hand, if a segmented gland is employed, the outer diameter of the reduced diameter portion **21** of slip assembly **16** may be reduced to a lesser value if desired as lower gland **23** does not have to pass over a pipe collar.

The axial dimension of lower gland **23** is such that with the gland seated upon shoulder **8** and the slips supporting pipe **15** of the upper surface **26** of gland **23** will be slightly below the upper surface **27** of reduced diameter portion **21** with surfaces **26** and **27** providing a platform upon which a packing may be positioned. This relationship is best illustrated in Fig. 1. After the assembly has been completed and the packing compressed, the surface **27** will have moved downward slightly relative to gland **23** as best illustrated in Fig. 2, as the force exerted by the compressed packing will drive the slips downward in the bowl **6**.

From the explanation of the illustrated form of the invention as it has thus far progressed, it is believed apparent that lower gland **23** overlies a portion of the slip assembly and spaces such portion of the slip assembly from a packing to be supported in part by lower gland **23**. This results in a reduction in the upwardly exposed area of the slip assembly which will be in contact with the packing and, therefore, the force exerted by the packing upon the slips when the packing is compressed will be less than would be the case in a conventional hanger assembly of the type illustrated. In other words, in the prior art the entire top surface of the slip assembly normally provides a platform which supports a packing and which receives downward force exerted by such packing over the entire top surface of the assembly. The construction explained above transmits a large amount of this downward force directly to fitting **5** through shoulder **8** and permits only a portion of such downward force to be exerted upon the surface **27** provided by the reduced diameter portion **21** of the slip assembly.

An annular packing element **28** formed of resilient material such as rubber which is yieldable and flowable but substantially incompressible is positioned in the annular space defined by pipe **15** and cylindrical portion **7** of the bore through well head fitting **5**. This packing is preferably split to permit it to be distorted and positioned about the pipe as will be well understood by those skilled in the art. The radial dimension of the packing is such as to snugly embrace the pipe and in its incompressed form to substantially fill the annular space between pipe **15** and fitting **5**. Packing **28** rests upon the platform provided by the lower gland **23** and reduced diameter portion **21** of the slip assembly. Preferably, packing **28** has a reinforced area **29** adjacent its lower face. The area **29** may be provided by molding into packing **28** layers of duck or any other type of fabric or the like as will be understood by those skilled in the art. The purpose of the reinforced area **29** is to prevent packing **28** from flowing into any space between the components of the platform provided by surfaces **26** and **27**.

An upper gland **30** is received about the pipe and rests upon packing **28** and completes the confinement of packing **28** in the well head fitting. Upper gland **30** is preferably segmented so that it will substantially completely fill the annular space between the pipe **15** and the cylindrical portion **7** of well head fitting **5**. A gland plate **31** rests upon upper gland **30** and is provided with a ring of circumferentially spaced bolt holes **32** which are in register with tapped holes **9** in well head fitting **5**. A plurality of bolts **33** are received in holes **32** and made up in the tapped holes **9** in well head fitting **5** to compress packing **28** by downward movement of gland plate **31** and upper gland **30**. Gland plate **31** is preferably an integral 360° member and for this purpose is provided with an internal bore **34** of sufficient diameter to pass over a conventional pipe collar. The upper surface of gland plate **31** is beveled as at **35** to prevent a pipe collar from hanging up on the gland plate when it is desirable to move the pipe string downwardly after gland plate **31** has been placed in position.

It will now be assumed that pipe **15** is a string of production tubing which has been run into a well and has reached a position where it is desired that it be hung and sealed. While pipe **15** is suspended by the apparatus employed in running the pipe, the slip assembly **16** is dropped into bowl **6** and the weight of pipe **15** gradually transferred from the hoisting equipment to slips **16** until the pipe **15** is entirely supported by the slip assembly. The hoisting equipment may then be released from pipe **15** and lower gland **23** placed about the pipe and moved into the annular space **22** until it seats upon shoulder **8** in well fitting **5**. Packing **28** is then placed about the pipe and moved downwardly until it rests upon the platform provided by the slip assembly and lower gland. Upper gland **30** is then positioned about the pipe and gland ring **31** placed in position to rest upon upper gland **30**. Bolts **33** may then be made up in tapped holes **9** until the desired pressure is exerted upon packing **28**.

It will be appreciated that packing **28** is a flowable material and hence the downward force exerted by packing **28** upon lower gland **23** and slip assembly **16** will be substantially equal over the entire lower face of the packing. Bearing in mind that lower gland **23** is supported by well head fitting **5**, it will be appreciated that the downward force exerted through packing **28** will only be exerted upon the slip assembly through the upwardly facing surface **27** on the reduced diameter portion **21**. Due to the small area provided by surface **27**, the force exerted upon slip assembly **16** is but a portion of the force applied through gland plate **31** and in the illustrative embodiment is less than half of such applied force. Thus, when pack-

ing 28 is compressed, it will tend to hold the slip assembly seated against pressure within the well; but in the event of excessive compression of packing 28, the excess force will in part be transmitted directly from the packing to the well head fitting by lower gland 23 and the danger of severe stressing of the tubing by transmission of such force through the slip assembly will be eliminated.

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 apparatus.

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 drawing is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. A pipe hanger and seal assembly comprising, a well head hanger fitting having a tapered slip bowl in the bore thereof and an annular shoulder above the bowl, a slip assembly vertically movable in the bowl for suspending a pipe therefrom, said slip assembly having a reduced diameter portion at its upper end to provide an annular space between the slip assembly and the hanger fitting overlying a portion of the slip assembly, an annular lower gland removably positioned in said annular space and seated on said shoulder and having a top surface substantially flush with, and substantially closing said annular space at, the top of said reduced upper end, an annular packing supported by the lower gland and the reduced diameter portion of the slip assembly and adapted to seal between the hanger fitting and a pipe suspended therein, and means for exerting a downward force on the packing to compress the packing and urge the slip assembly toward seated position in the bowl.

2. The pipe hanger and seal assembly of claim 1 wherein the means for exerting a downward force on the packing includes an upper gland bearing upon the packing, a gland plate bearing upon the upper gland, and bolts extending through the gland plate and threadedly received in the hanger fitting.

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