

Dec. 21, 1943.

H. ALLEN

2,337,221

WELL HEAD

Filed Nov. 7, 1938

7 Sheets-Sheet 1

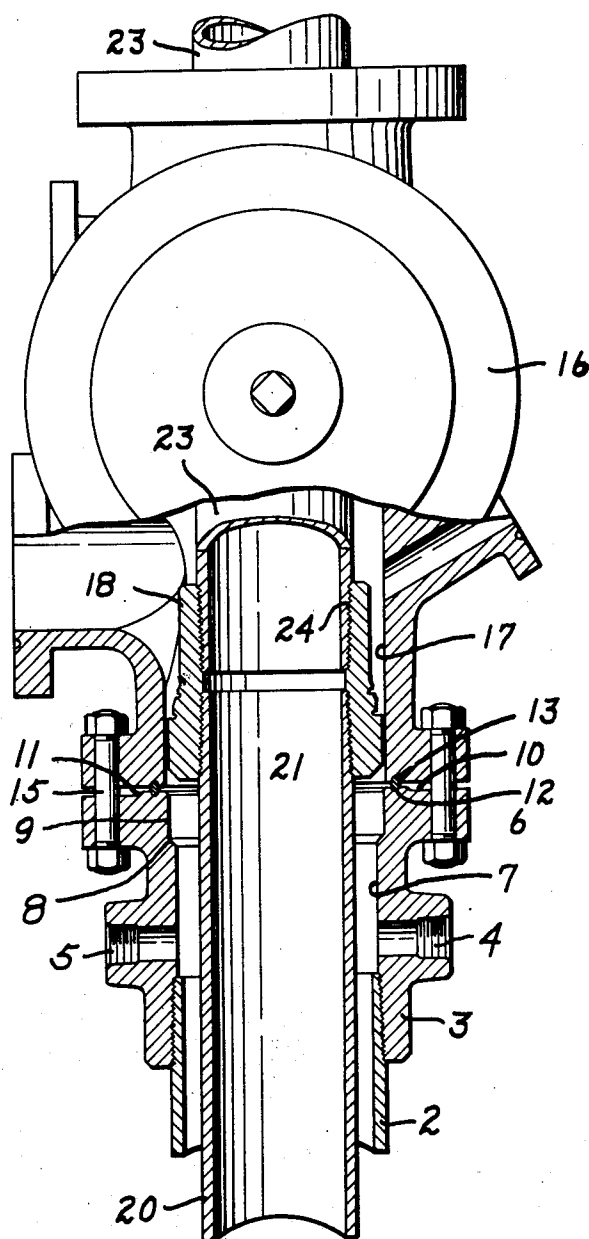


Fig. 1

BY

HERBERT ALLEN
INVENTOR.

Jesse R. Stone
&
Lester B. Clark
ATTORNEYS.

Dec. 21, 1943.

H. ALLEN

2,337,221

WELL HEAD

Filed Nov. 7, 1938

7 Sheets-Sheet 2

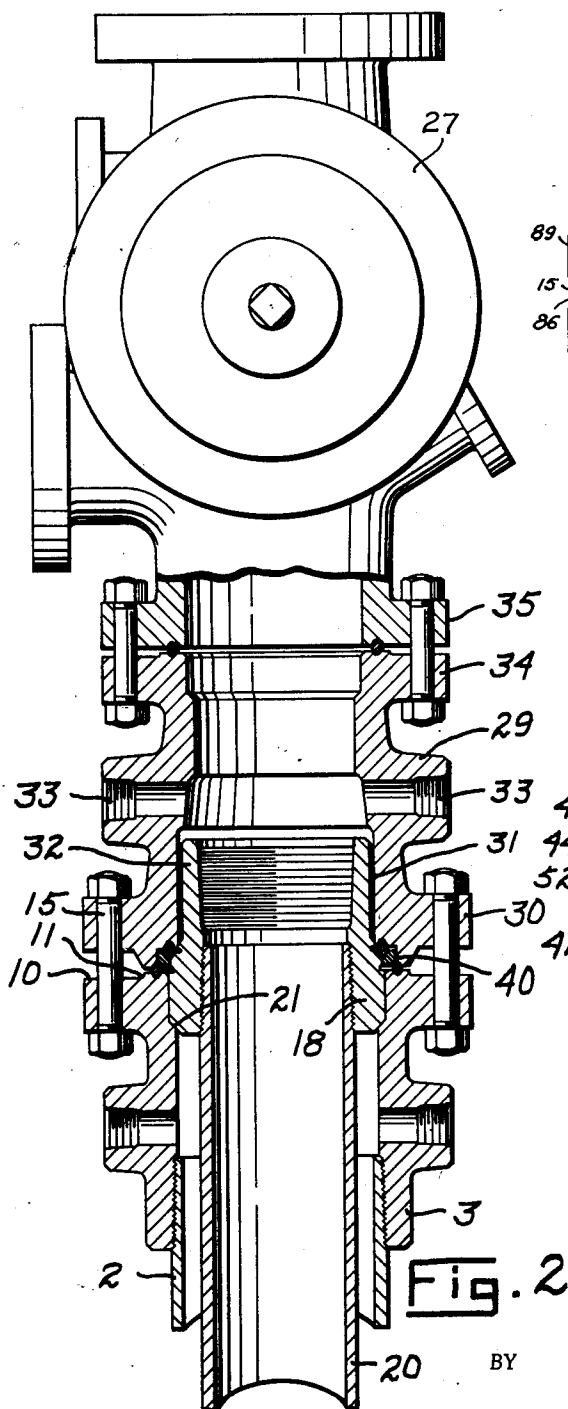


Fig. 2

BY

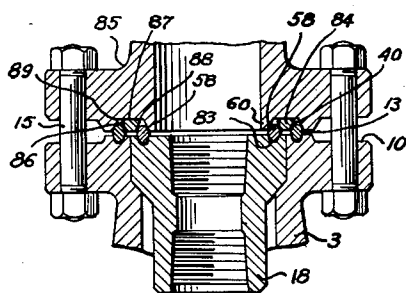


Fig. 6

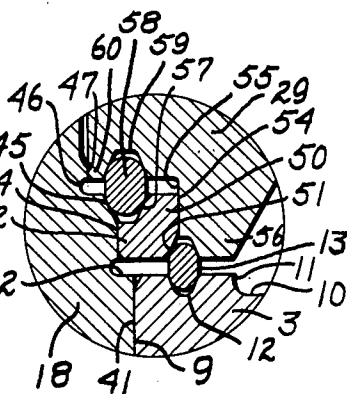


Fig. 3

HERBERT ALLEN
INVENTOR

Jesse R. Stone
Lester B. Clark
ATTORNEYS

Dec. 21, 1943.

H. ALLEN

2,337,221

WELL HEAD

Filed Nov. 7, 1938

7 Sheets-Sheet 3

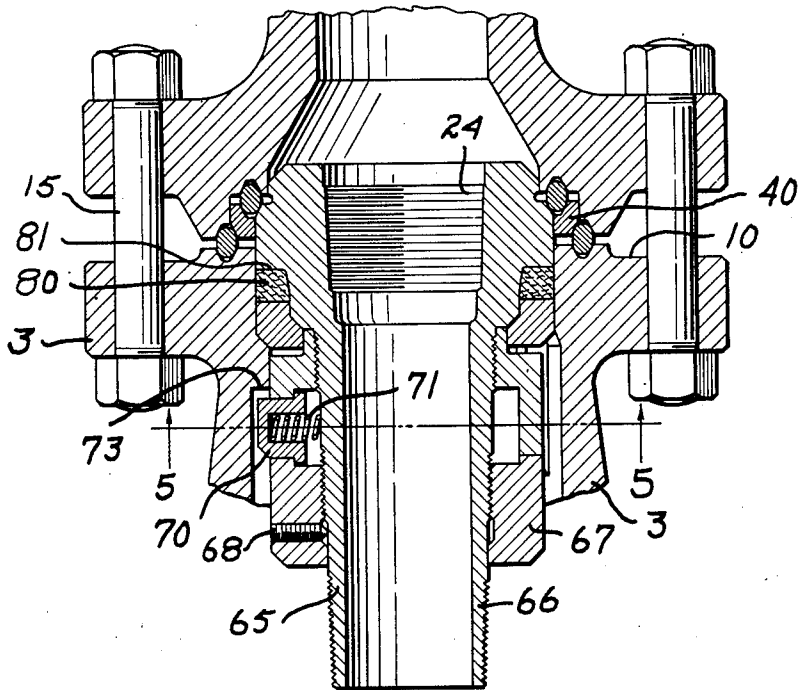


Fig.4

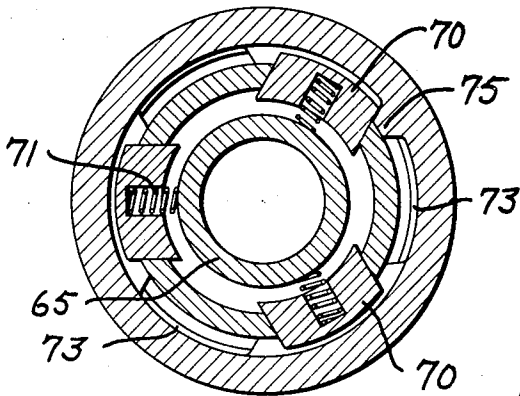


Fig. 5

BY

HERBERT ALLEN
INVENTOR.

INVENTOR.
Jesse P. Stone
Lester B. Clark
ATTORNEYS.

Dec. 21, 1943.

H. ALLEN

2,337,221

WELL HEAD

Filed Nov. 7, 1938

7 Sheets-Sheet 4

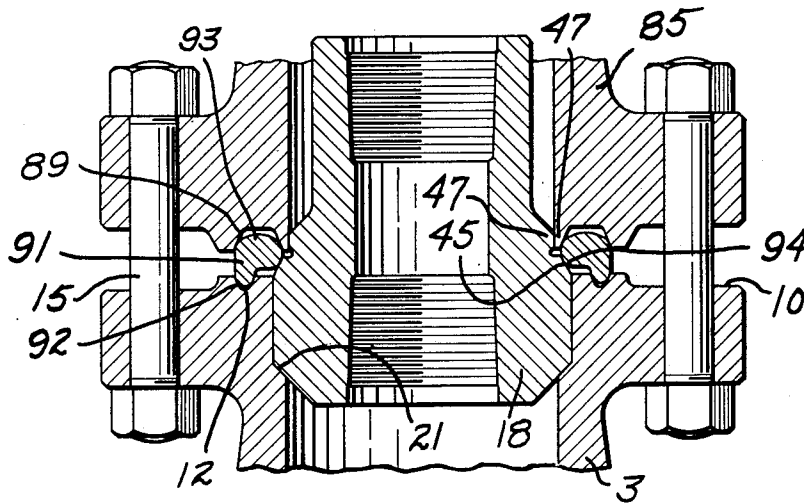


Fig. 7

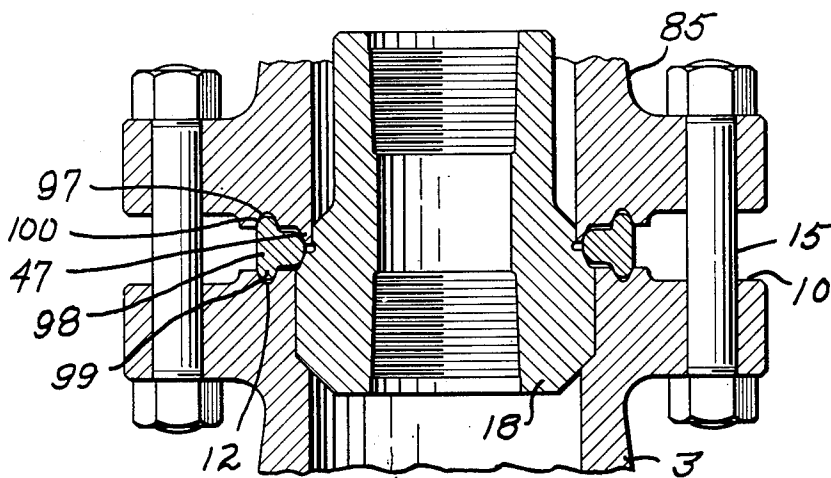


Fig. 8

HERBERT ALLEN
INVENTOR.

BY *Jersey H. Stone*
Arthur B. Clark
ATTORNEYS.

Dec. 21, 1943.

H. ALLEN

2,337,221

WELL HEAD

Filed Nov. 7, 1935

7 Sheets-Sheet 5

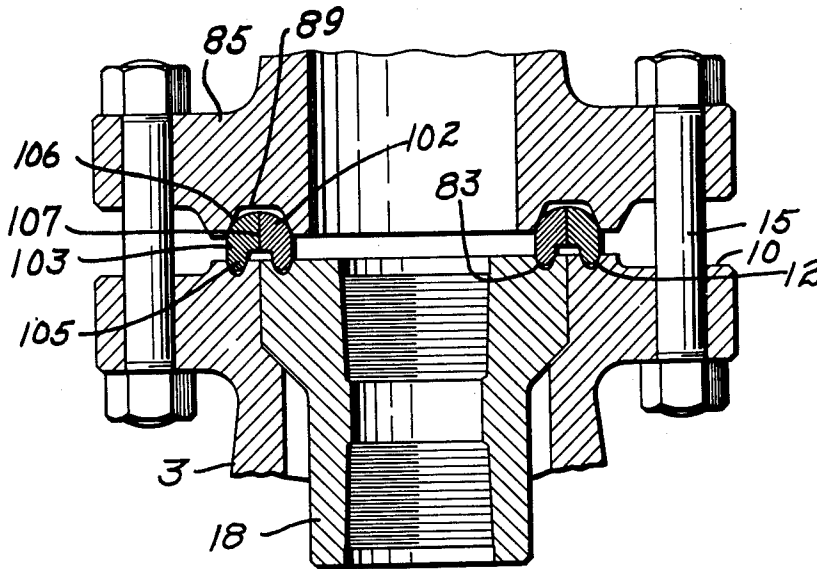


Fig. 9

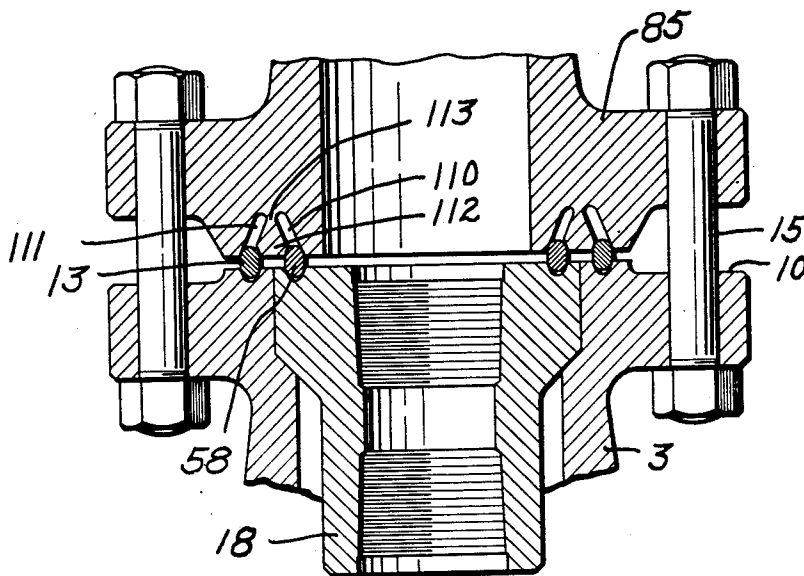


Fig. 10

BY

HERBERT ALLEN
INVENTOR.
Jesse R. Stone
Lester B. Clark
ATTORNEYS.

Dec. 21, 1943.

H. ALLEN

2,337,221

WELL HEAD

Filed Nov. 7, 1938

7 Sheets-Sheet 6

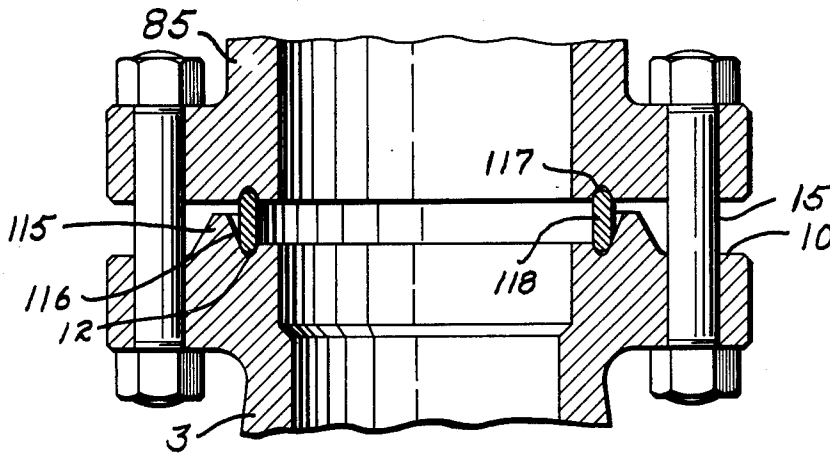


Fig. 11.

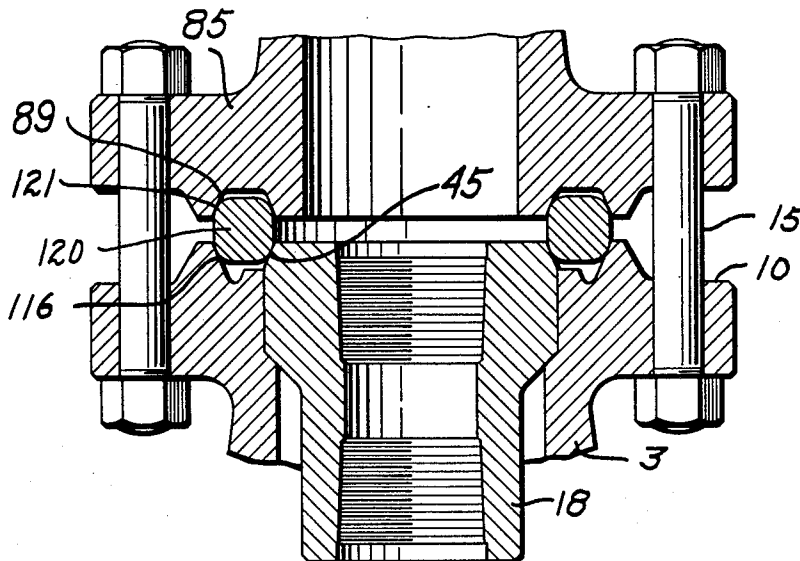


Fig. 12

HERBERT ALLEN
INVENTOR.

BY

Jesse P. Stone
Lester B. Clark
ATTORNEYS.

Dec. 21, 1943.

H. ALLEN

2,337,221

WELL HEAD

Filed Nov. 7, 1938

7 Sheets-Sheet 7

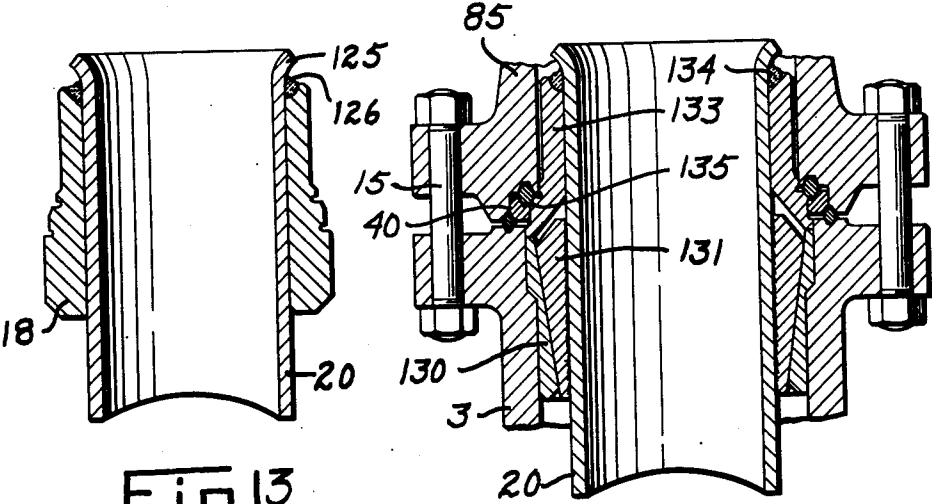


Fig. 13

Fig. 14

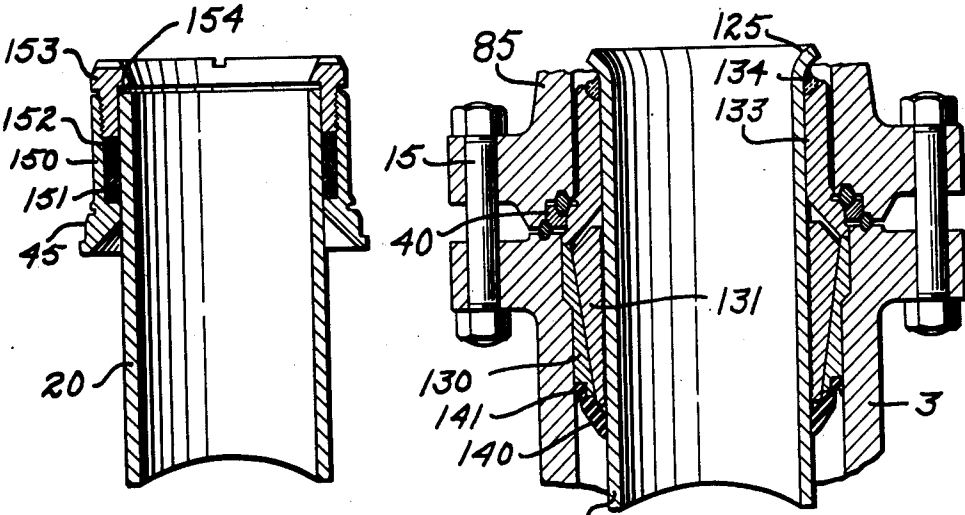


Fig. 16

Fig. 15

HERBERT ALLEN
INVENTOR.

Jesse R. Stone
&
Lester B. Clark
ATTORNEYS.

BY

UNITED STATES PATENT OFFICE

2,337,221

WELLHEAD

Herbert Allen, Houston, Tex., assignor to Cameron
Iron Works, Houston, Tex.

Application November 7, 1938, Serial No. 239,320

11 Claims. (Cl. 285—22)

The invention relates to a well head construction whereby a seal is maintained at the head to prevent leakage between the tubing and the casing and at the same time to hold the tubing firmly in position.

Various types of casing and tubing seals have been provided heretofore but in practically all of them there has been no provision for any tolerance in the manufacture of the parts and it is almost impossible to so construct the tubing hangers and the casing head so that they will fit precisely one with the other. It is therefore necessary that a seal be provided to close the area between the hanger and the casing-head, which seal will have some flexibility in its adaptation of the parts so that a positive seal will be maintained even though the parts are of slightly different size or fit.

It is one of the objects of the invention to provide a casing seal ring and a tubing seal ring in combination with an adapter ring against which the seal rings will abut to equalize the applied pressure and fit themselves into position.

Another object of the invention is to provide a combination seal and hold-down for tubing hangers wherein any inequality of the parts is compensated for by adjustment of the sealing assembly, so as to form a positive seal.

A still further object of the invention is to provide a latching assembly for tubing hangers which may be sealed in position.

Still another object of the invention is to provide various types of sealing and adapter rings for well heads.

Other and further objects of the invention will be readily apparent when the following description is considered in connection with the accompanying drawings, wherein:

Fig. 1 is a side elevation of a well head in which the tubing hanger is being inserted, illustrating the arrangement of the blowout preventer on the casing head through which the tubing hanger is lowered.

Fig. 2 is a view similar to Fig. 1 but showing the hanger landed in position, the larger blowout preventer removed and a spool and smaller valve applied to the top thereof with the tubing hanger sealed in position.

Fig. 3 is a magnified view of the seal and hold-down for the hanger.

Fig. 4 shows a form of the hold-down and seal wherein the hanger is latched against removal.

Fig. 5 is a section taken on the line 5—5 of Fig. 4.

Fig. 6 shows a modified form of the seal and

hold-down wherein an adapter ring is arranged to bear against two spaced sealing rings.

Fig. 7 shows a seal wherein the adapter and seal rings have been combined into one element which is of irregular cross section.

Fig. 8 shows another form of the single ring which is substantially T-shaped in cross section.

Fig. 9 shows a form of the hold-down and seal where a number of rings abut together in order to permit equalization of the parts.

Fig. 10 is another form of the seal wherein a tongue portion in the hold-down member compensates for inequalities of the parts.

Fig. 11 is a view of the casing and hold-down seal which may be used when no tubing hanger is present.

Fig. 12 illustrates a construction for the casing of Fig. 11 where a tubing hanger is to be sealed and held in position.

Fig. 13 shows a sectional view of a hanger which is welded to the pipe on location at the time the exact elevation of the top of the tubing has been ascertained.

Fig. 14 shows an assembly where the tubing is supported on slips in the casinghead and then a flange applied thereto by which a seal and hold-down is provided.

Fig. 15 is a view similar to Fig. 14 but illustrating a wiper at the bottom of the assembly so that a seal will be maintained with the tubing as it is landed into the hole and before it is landed in position.

Fig. 16 shows a form of hold-down flange which may be attached to the tubing when it has been cut off at the elevation where it is to be suspended and can be used with the construction of Figs. 14 and 15 where the tubing is supported on slips.

In Fig. 1 the well casing is indicated generally at 2 and is surmounted by a casinghead 3. This head has the usual flow openings 4 and 5 thereon and the flange 6 extends laterally at the top. The inside bore 7 is enlarged near the top to provide a seat 8 for the tubing hanger which is of a shape to be deposited into the enlarged area 9, directly above the seat.

The upper surface 10 of the head may be slightly raised at 11 and just outside of the cylindrical area 9 it is provided with an annular groove 12 which will be designated as the casinghead groove. A casing seal ring 13 is disposed in this groove and cooperates with any type of fitting which has a groove therein which may be deposited on the well head.

In the drilling operation, as illustrated in Fig.

1, a drilling valve, blowout preventer and gate valve, as circumstances may require, will be attached by the bolts 15 to the casinghead.

In Fig. 1 a blowout preventer 16 is so attached and is merely illustrative of any desired type of fitting. Attention is directed to the fact that the size of the bore 17 in this fitting 16 is such that it will permit the lowering of the tubing hanger 18 therethrough, so that the string of tubing 20 may be lowered into position and landed with the shoulder 21 of the tubing hanger on the seat 8 in the casinghead while the drilling equipment 16 is still in position. The lowering of this string of tubing is accomplished by means of a setting pipe or nipple 23 which is engaged in the threads 24 on the inside of the top of the tubing hanger 18.

Fig. 2 shows an assembly after the tubing hanger 18 has been landed in position in its seat. The drilling fitting 16 has been removed because it is of larger size and is an expensive piece of equipment. It is not desired that this expensive equipment remain on the well as a permanent fitting because it may be used on other wells and the assembly of Fig. 2 illustrates a construction by which the large fitting 16 may be replaced by a smaller fitting 27. In order to reduce the size of the parts so as to support the smaller fitting 27 an adapter spool 29 has been attached to the casinghead 3.

The spool 29 has a lower flange 30 and an inside bore 31 which is of a size to fit about the upper portion 32 of the hanger 18. Flow connections 33 may be provided on the spool 29 and the upper flange 34 is arranged to receive the flange 35 of the fitting 27. In this manner the size of the bore is reduced to substantially that of the tubing 20 and the fitting 27 is much less expensive and is not constructed to withstand as high pressures as is the fitting 16.

The tubing hanger 18 must be held down in position and must be sealed in this position.

It has been found in practice that rubber and composition packings deteriorate quickly, due to the presence of the oil and gas and that it is therefore desired to secure a metal hold-down and seal construction for well heads of this sort. Such an assembly is illustrated at 40 in Fig. 2 and a magnified view thereof is seen in Fig. 3. The edge of the tubing hanger 18 is shown at the left of Fig. 3 while the upper face 10 of the casinghead 3 is illustrated in the lower right hand corner of Fig. 3. The casing groove 12 carries the casing seal ring 13 which has been referred to previously.

The joint 41 between the hanger 18 and the bore 9 of the casinghead 3 must be sealed to prevent the escape of pressure upwardly outside of the tubing and inside of the casing.

It is expensive and difficult to measure the bore 9 and the seat 8 on the one hand and the periphery of the tubing hanger 18 and the shoulder 21 thereon on the other hand so that any two of them which may be assembled together in the field will be an exact fit. In other instances the seat 8 may be disfigured or damaged during the drilling operations by the drilling tools being lowered and raised in the well bore so that when the drilling has been completed and it is desired to seat the hanger 18 therein, it is impossible to obtain a seal at the seat 8.

Thus in the majority of instances when the tubing hanger is deposited on the seat 8 there will be inequalities in the parts so that it is impossible to insure that the shoulder 42 on the

hanger will be at the exact elevation of the top of the face 11 on the top of the hanger. Some prior practices provide for a seal ring at the junction of the hanger and the casing but due to inequalities it is practically impossible to seat a ring at this point and maintain a seal. There must be a certain amount of flexibility in the joint to allow for differences in size and positioning in the parts.

The present invention contemplates a series of sealing assemblies which will admit of such flexibility.

In Fig. 3 the hanger 18 has been provided with an outstanding enlargement 44 which has an outwardly and downwardly inclined shoulder or seat 45. In order to allow for adjustment of the parts a cutout section 46 is provided directly above the shoulder and a lip 47 projects above the shoulder 45.

An adapter ring 50 is shown as having been deposited on the casinghead 3. This adapter ring has a sealing shoulder 51 on the lower outside corner which is arranged to abut the upper edge of the casing seal ring 13. It has an inwardly projecting lower portion 52 which will abut against the periphery of the enlargement 44 and the outer periphery of the ring is arranged to abut the inside face 55 of a downwardly projecting flange 56 on the spool 29 or such other fittings as may be deposited on the casinghead 3.

The upper inside portion of the ring 50 is also formed with a shoulder or inclined face 57 which is arranged to abut the inside lower edge of the tubing seal ring 58 which seal ring is wedged against the seat 45 on the tubing hanger by being held downwardly in the groove 59 which is formed on the bottom of the spool 29 or other fitting which groove is inside of the flange 56. The inside of the groove 59 is defined by a lip 60 which may have some flexibility to allow a slight amount of movement of the ring 58 so that the lip 60 may be forced against the lip 47 on the hanger 18. The spool 29 or other fitting will be drawn firmly against this sealing assembly by the bolts 15.

It seems obvious from the foregoing construction that there is a great deal of flexibility in the parts of this sealing assembly because if the hanger 18 does not move to its exact position, as seen in Fig. 3, the cut away portion beneath the enlargement 44 will allow for such a position of the hanger and the adapter ring 50 will then fit against the enlargement in a slightly lower position. This will mean that the tubing seal ring 58 will merely seat in a position a little further down on the seat 45 and a little further up on the seat 57 and that the casing ring 13 will be wedged outwardly a little more.

On the other hand if the tubing hanger 18 moves downwardly further than the position shown in Fig. 3, just the opposite of the position of the parts just described will occur.

The fact remains that there are three elements, a casing seal ring 13, an adapter ring 50 and the tubing seal ring 58, all of which may yield to some extent and which will fit faces together to provide a seal. Thus, irrespective of any differences of size or construction of the parts, a positive seal is insured.

Fig. 4 shows an assembly which will be utilized upon a seal where enormous pressures are contemplated and where it is desired to insure that the tubing will not be blown from its seat when the drilling fittings 16 are removed and before

the production equipment such as the spool 29 and the permanent fittings 27 are attached. This construction embodies a tubing hanger 65 which has a downwardly projecting portion 66 thereon to which a latch assembly 67 is connected. This latching assembly 67 may be threaded or otherwise fixed to the portion 66 and in Fig. 4 a locking set screw 68 has been provided. The assembly 67 carries a plurality of dogs 70 which are radially moved and normally held outwardly by means of springs 71. These dogs are seen in section in Fig. 5.

A casinghead 3 has been provided with downwardly facing shoulders 73 which are disposed at intervals circumferentially around on the inside. Between these shoulders are open spaces so that the hanger 65 may be moved upwardly even though the dogs 70 are extended. When the hanger is inserted the dogs may or may not pass through these openings but if they pass over a shoulder 73, they will be forced inwardly and then snapped outwardly again against the shoulder. The hanger 65 will be set by means of a setting pipe or nipple 23 which will be engaged in the threads 24, preferably with a right hand thread.

In this manner the tubing hanger is lowered into position, the dogs 70 snapped under the shoulder 73 and then the setting pipe is rotated to the left to unscrew it. This rotation will turn the hanger 65 in a counter clockwise direction, as viewed in Fig. 5 until the dog 70 abuts against the stop rib 75. At this time the operator knows that the dogs 70 are underneath the shoulder 73 and continued rotation permits the unscrewing of the setting nipple to leave the hanger latched in the casinghead.

When the hanger is to be removed, the setting nipple 23 is reinserted and turned to the right until the threads 24 are made up. The hanger 65 then turns to the right in a clockwise direction until the dogs 70 engage the stop rib 75, as seen in Fig. 5. When the operator cannot turn his setting pipe any more, he knows that the dogs have been turned so that they have moved outwardly from beneath the shoulder 73 and the tubing hanger can now be removed.

Fig. 4 shows a packing 80 which is carried beneath a shoulder 81 on the hanger. This packing may be compressed by the weight of the tubing.

A sealing assembly 40 which has been previously described can be affixed over the tubing hanger 65 so as to hold it in position.

Fig. 6 shows another form of construction wherein the sealing assembly 40 has been modified somewhat in that the tubing seal ring 58 has been deposited in a groove 83 in the upper face of the hanger 18 but is confined by the lip 60 on the hold-down fitting 85 which is equivalent to the spool or other fitting 29, but which may be the permanent fitting 27 which is positioned on the well bore, because of the fact that this construction of Fig. 6 permits a reduction in size directly at the tubing hanger.

In order to allow for inequalities of the parts and to hold the sealing rings 13 and 58 in position, the adapter ring 84 is of a peculiar configuration and of substantially a keystone shape in cross section. This ring has a downwardly and inwardly inclined face 86 on each side thereof which will engage with the rings 13 and 58 and its upper surface is curved at 87 so that it will engage against the base 88 of a wide groove 89 which is formed in the body of the hold-down

member 85. It will be noted that this groove 89 is of such a width that it spans both of the rings 13 and 58. Any inequalities in the parts are compensated for by adjustment of the three rings 13, 58 and 84 so that they fit together and provide a seal because the rings may engage the inclined face 89 of the adapter ring at different points along the face, depending upon the position of the hanger and the hold-down member.

Fig. 7 shows another form of construction wherein the hold-down member 85 is the same as described in connection with Fig. 6. The hanger 18 is substantially the same as shown in Fig. 2, in that it is provided with the shoulder 45, the lip 47 and the bottom shoulder 21. In this form of the invention the casing ring 13, the adapter ring 50 and the tubing ring 58 have all been combined into a single seal ring 91. This ring has a downwardly directed portion 92 which engages in the casing groove 12 and has an enlarged irregular body portion 93 which will fit into the spanning groove 89 and will also have a curved portion 94 which will engage the seal shoulder 45 on the hanger 18 and will also engage the lip 47 on the hold-down member 85. This ring will have sufficient flexibility to accommodate adjustment of the parts.

Fig. 8 shows a form almost identical with that of Fig. 7 except that the spanning groove 89 has been made of an irregular configuration to provide an arcuate groove 97 which tapers off to the lip 47. The seal ring 98 is substantially T-shaped in cross section with the wider head facing outwardly and in a vertical position so that the lobe 99 on the lower side fits in the casing groove 12 and the upper lobe 100 fits in the groove 97. It seems obvious that this ring can tilt slightly to accommodate itself to the parts.

Fig. 9 shows another form wherein the tubing hanger 18 is the same as shown in Fig. 6 in that the casing groove 12 and the tubing groove 83 are at substantially the same elevation. The hold-down member 85 is the same as seen in Fig. 6. In Fig. 9, however, the sealing assembly 40 is made up of an inner seal ring 102 and an outer seal ring 103. These two rings each have a downwardly facing flange or lobe 105 which, on the inner ring is arranged to engage in the tubing groove and in the outer ring to engage in the casing groove. The upper curved face 106 on each ring is arranged to engage the edges of the spanning groove 89 which will tend to wedge the two rings together. Each ring is provided with a smooth contact face 107 and these two faces on the two rings abut together. In this manner any difference in elevation between the casing and the hanger will be compensated for by the positioning of these faces at slightly different elevations. The tighter the hold-down member 85 is drawn down, the tighter the parts will be wedged together.

Fig. 10 shows an arrangement similar to Fig. 9 except that the hold-down member 85 has been modified to provide an inner slot 110 and an outer slot 111. These slots are upwardly inclined toward each other and create a tongue or flange 112 which is supported by the narrow neck portion 113 so that it will have some flexibility when it is forced against the casing ring 13 and the tubing ring 58. In this manner any inequalities of the parts will be compensated for.

Fig. 11 shows a form wherein the casing head 3 has its upper face 10 modified somewhat in that it has an upstanding annular rib 115 which has a downwardly and inwardly inclined face 116.

The casing groove 12 is provided at the base of this face. The hold-down member 85 has a narrow groove 117 therein which is arranged to receive the seal ring 118. This form of construction may be used where no tubing hanger is to be held down or slid in place, and may be used during the drilling operation to provide a seal.

Fig. 12 shows the same type of casing head as illustrated in Fig. 11 where the tubing hanger 18 is to be slid in position and the hold-down member 85 has a wide spanning groove 89 which has been previously described. A seal ring 120 having a substantially square cross section is disposed between the parts and has four rounded shoulders 121 thereon which will engage with the edges of the spanning groove 89, with the face 116 and with the shoulder 45 on the hanger 18. This ring may fit itself in between these four contacts to provide a seal.

In many instances it is impossible to determine prior to the setting the exact elevation at which the tubing is to be suspended and in many instances after this elevation has been determined the tubing 20 must be cut off and then threaded to receive the hanger 18 so that it may be suspended at the desired elevation. This operation is often inconvenient and Fig. 13 shows an arrangement whereby the hanger 18 may be slipped over the tubing 20 after it has been cut off and the tubing flanged outwardly at 125 so that a bead of welding material 126 may be deposited around the top of the hanger to anchor it firmly on the pipe. The hanger has all of the parts described in Figs. 2 and 3 and may be sealed in position in the casinghead.

Fig. 14 shows an arrangement whereby the tubing will be suspended in the casing head 3 by means of a tapered bowl 130 which is arranged to receive a set of slips 131. These slips support the tubing 20.

In order to provide a hold-down for such an arrangement a hold-down flange 133 has been welded to the tubing by the bead 134 of welding material so that it is firmly fixed to the tubing. This hold-down 133 is formed on its lower outside face 135 with the shoulder and enlargements which have been previously described in connection with the tubing 18 in Fig. 3. In this manner the sealing assembly 40 can be applied and held in position by hold-down member 85.

Fig. 15 shows the same construction as illustrated in Fig. 14 except that a flexible wiper member 140 has been applied to the bottom of the adapter bowl 130 by being attached to the cut away shoulder 141. This wiper is of a flexible material such that it will yield sufficiently to permit the passing of the packings on the tubing 20 as they are lowered into the well bore but in event there is an upward pressure, it will tend to form a seal by clinging to the tubing and after the slips 131 have been placed it will tend to prevent any leakage until such time as the seal assembly 40 and the hold-down member 85 are positioned.

Fig. 16 shows another form of the hold-down flange 133 which may be applied to the tubing without either threading or welding and includes a body portion 150 which has a recess at 151 to receive the packing rings 152, which rings are held in position by a gland 153 which is threaded to the inside of the body 150. This flange 133 is provided externally with the shoulder 45 the same as the hanger 18. This construction can be applied to the tubing as soon as it is cut off and the overhanging lip 154 on the gland 153

will prevent the tubing 20 from moving upwardly when the flange is anchored by the sealing assembly and the packing 152 will prevent leakage along the periphery of the tubing.

Broadly the invention contemplates a sealing assembly for well heads and tubing hangers which will have a considerable amount of flexibility to accommodate inequality of the parts and to still maintain a seal.

What is claimed is:

1. A well head including a casing head, circumferentially spaced lugs therein having downwardly facing shoulders, a tubing hanger, spring loaded dogs thereon to snap under said shoulders to latch said hanger, a stop member adjacent one of said lugs to be engaged by a dog when the hanger is latched so that a setting pipe may be unscrewed from said hanger and to be engaged by another of said dogs when said hanger is rotated in the opposite direction to reconnect the setting pipe to the hanger to indicate that the dogs have moved to a position from beneath said hanger so as to be removed.

2. A well head, a slip adapter bowl therein, slips in said bowl, a pipe supported in said slips, a hold down flange welded to said pipe above said slips, a shoulder on said flange, a seal ring on said head, an adapter ring thereon having a shoulder, a tubing seal ring abutting said shoulders, and a hold down member to force said tubing ring to sealing position and to engage said first seal ring.

3. A well head, a slip adapter bowl therein, slips in said bowl, a pipe supported in said slips, a hold down flange welded to said pipe above said slips, a shoulder on said flange, a seal ring on said head, an adapter ring thereon having a shoulder, a tubing seal ring abutting said shoulders, a hold down member to force said tubing ring to sealing position and to engage said first seal ring, and a wiper member carried by said adapter bowl to seal about said pipe before said seal rings are positioned.

4. A packing connection to provide a seal between adjacent flanges including a groove in each flange, a metal seal ring in each groove, a filler member between said rings, sealing faces on said filler to force the upper metal seal ring inwardly and the lower metal seal ring outwardly.

5. A packing connection to provide a seal between adjacent flanges including a groove in each flange, a metal seal ring in each groove, and a filler member between said rings, said grooves being offset vertically so that said rings wedge against diagonal faces of said filler member.

6. A well head assembly including a casing head, a string of pipe therein, a slip adapter and set of slips in said casing head supporting the string of pipe, a holddown flange above said slips about said pipe and weld affixing the flange to the pipe above the slips, and means to clamp said flange to the casing head.

7. A well head assembly including a casing head, a string of pipe therein, a slip adapter and set of slips in said casing head supporting the string of pipe, a holddown flange above said slips about said pipe, a weld affixing the flange to the pipe above the slips, means to clamp said flange to the casing head, and means to seal between the pipe and casing head below the slips.

8. A well head assembly including a casing head, a set of slips supported therein to receive a string of pipe in the well, means to seal about the pipe and against the inside of the casing

head below the slips, a holddown flange welded to the pipe, and means to clamp the flange to the casing head.

9. A metal sealing assembly to provide a seal between two members and an adjacent third member including a seal ring to contact one of the members and the third member, metal gasket to contact the other member and the third member, and a filler ring to seal with the seal ring and the gasket.

10. A metal sealing assembly to provide a seal between two members and an adjacent third member including a seal ring to contact one of the members and the third member, metal

gasket to contact the other member and the third member, and a filler ring to seal with the seal ring and the gasket, and to also contact one of the members and the third member.

11. A sealing assembly for three adjacent members including offset grooves in two of the members, a beveled area on each of two of the members, a filler ring having two beveled faces to cooperate with the beveled areas in forming two composite grooves, and a metal seal ring disposed in each of said offset grooves and having the opposite side thereof in one of said composite grooves.

HERBERT ALLEN.