Oct. 14, 1969 J. H. FOWLER 3,472,530

PIPE APPARATUS

Filed Sept. 20, 1966 2 Sheets-Sheet 1

Fig. 1

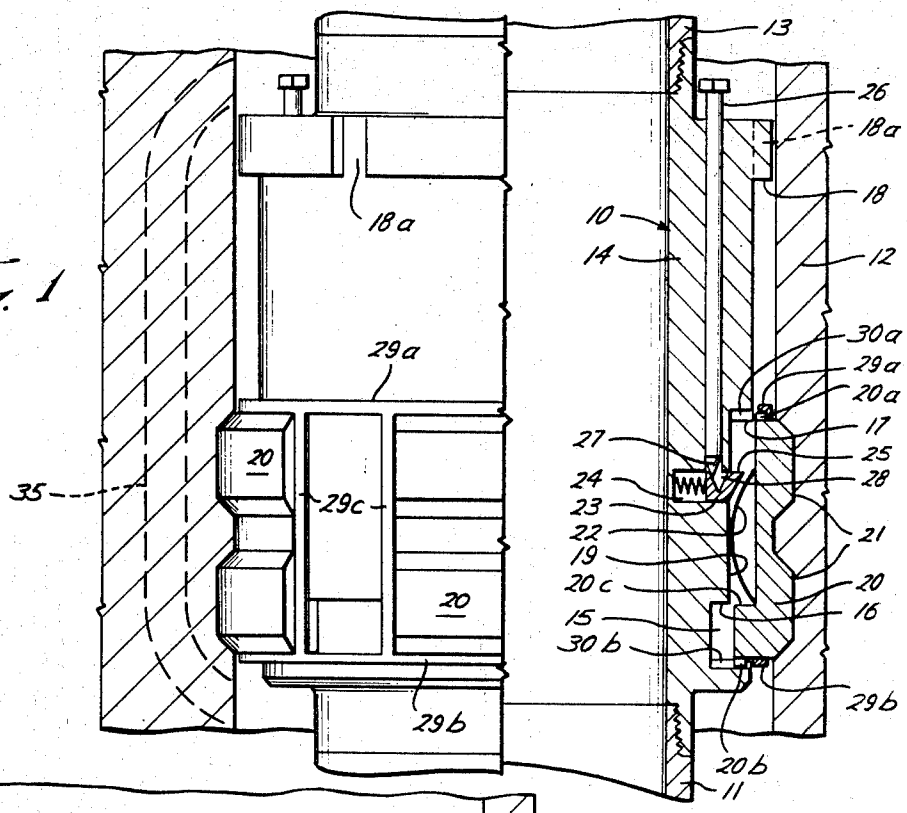
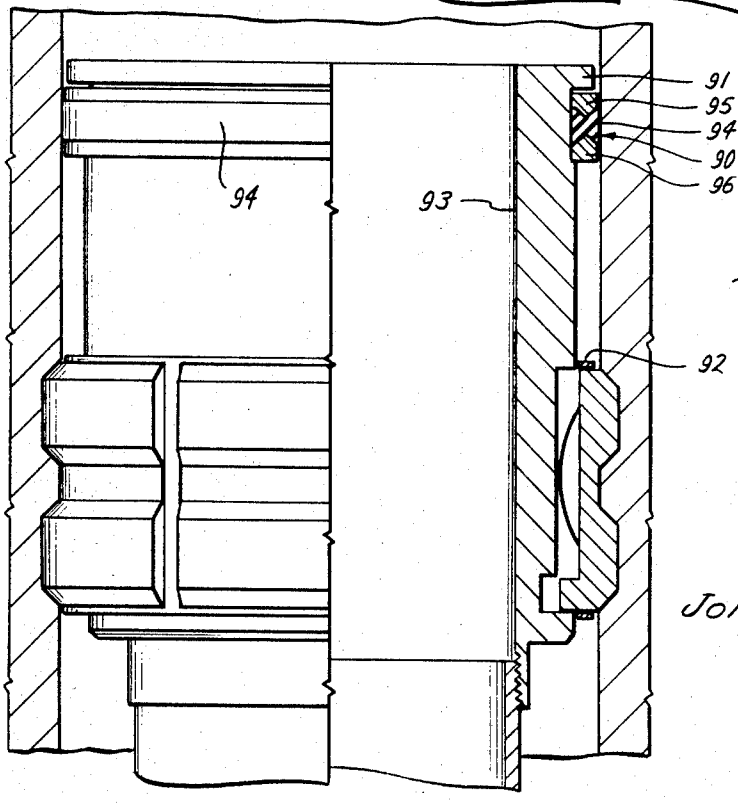


Fig. 3



John H. Fowler
INVENTOR.

Oct. 14, 1969 J. H. FOWLER 3,472,530

PIPE APPARATUS

Filed Sept. 20, 1966 2 Sheets-Sheet 2

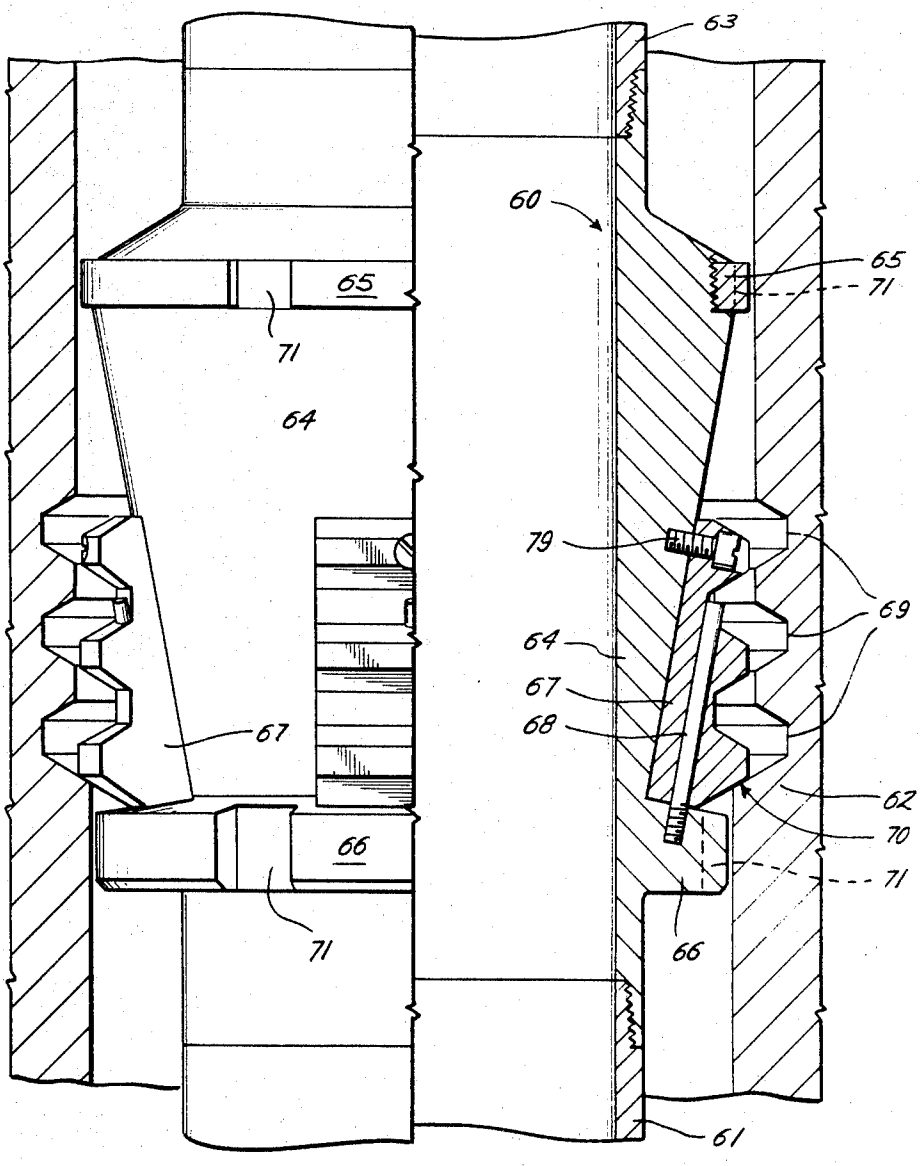


Fig. 2

John H. Fowler
INVENTOR.

United States Patent Office

3,472,530
Patented Oct. 14, 1969

3,472,530

PIPE APPARATUS

John H. Fowler, Houston, Tex., assignor to Rockwell Manufacturing Company, Houston, Tex., a corporation of Pennsylvania

Filed Sept. 20, 1966, Ser. No. 580,628
Int. Cl. F16l 3/02
U.S. Cl. 285—3 10 Claims

ABSTRACT OF THE DISCLOSURE

Pipe suspension apparatus for supporting casing or the like in a well comprising a wellhead, a tubular mandrel concentrically disposed in the wellhead and suspension means mounted on the mandrel. The wellhead is provided with internal annular grooves, the upper and lower limits of which are frusto-conical surfaces. The suspension means comprises a plurality of segments whose outer faces conform to the shape of the wellhead grooves. In one embodiment the tubular mandrel has several downwardly facing shoulders formed by uniformly reduced cylindrical exterior portions. The segments are resiliently mounted on the mandrel and held near its lower portions by the wellhead sidewall and at least one of the downwardly facing shoulders. As the mandrel is lowered into the wellhead these segments move radially outward to engage the wellhead grooves freeing them to move upwardly relative to the mandrel until a larger diameter portion moves between the segments locking them in the extended position supporting the mandrel within the wellhead. A hold down latch is mounted on the mandrel to laterally engage the lower edge of the segments to also prevent upward movement of the mandrel. In another embodiment the mandrel is tapered and the segments have corresponding tapered inner faces. The lowermost wellhead groove projects slightly into the wellhead bore providing a stop for the segments on downward movement of the mandrel and suspension means. On further downward movement of the mandrel the tapered surfaces of the mandrel and segments and frusto-conical surfaces of the wellhead groove cooperate to force the segments radially outward and upwardly with respect to both mandrel and wellhead, into the grooves locking the mandrel against downward movement in the wellhead.

This invention pertains to oil and gas well apparatus and more particularly to apparatus used to hang casing or tubing within the well.

Normally in well pipe suspension apparatus, a pipe hanger, to which casing or tubing is attached for suspension, is supported by support means within a wellhead or casing. The support means usually is in the form of an internal shoulder or tapered portion of the well head. This results in reduced access to the well bore. Thus, the passage of well quipment during drilling and completion of the well is limited to diameters somewhat less than the wellhead bore. This may be overcome on surface wells by use of retractable support means. But, in relatively inaccessible wellheads, such as those in underwater wells, this may be very costly and difficult.

To provide for a full internal diameter relatively free from obstructions, it is, therefore, necessary to provide a support means which does not substantially violate the internal diameter of the wellhead bore. In an underwater

well it is also necessary that the hanger device be capable of engaging the support means while being lowered from a remote location.

A principal object of the present invention is to provide a means of hanging casing or tubing so that very little or no shoulder is required on the supporting element, providing substantially full opening access to the well.

Another object of the invention is to provide a pipe-hanging support which allows relatively complete access to the well bore and pipe hangers which may easily be installed in remotely located wellheads such as those underwater.

Other objects will become apparent on further description of the invention.

Briefly stated, the invention utilizes hanger equipment comprising a mandrel, to which pipe is attached for suspension, and suspension means mounted thereon. The suspension means is held in a neutral position until automatically released by engagement with preformed grooves on the internal wall of a wellhead or support element. On being released, the suspension means anchors the suspended pipe to the support element, without the necessity of substantial internal shoulders.

In the present invention annular internal grooves are provided in a wellhead leaving a substantially open bore therethrough. In one embodiment the lower limit surface of one groove projects slightly into the bore. A tubular mandrel is provided on which a suspension means is mounted comprising segments whose outer faces conform to the shape of the wellhead grooves. In one embodiment these segments are resiliently mounted on a lower reduced diameter of the mandrel so that when the mandrel is lowered into the wellhead these segments move radially outward engaging the wellhead grooves and freeing the mandrel for further downward movement to a position between the segments whereby they are locked outwardly by a larger diameter portion of the mandrel. The mandrel and attached casing are then supported in the wellhead by the segments. A hold down means is also provided to then prevent the mandrel from moving upwardly in the wellhead. In another embodiment for use with the slightly projecting lower groove surface the mandrel is tapered and the inner faces of the segments are tapered to cooperate therewith. The segments are initially mounted on the lower part of the mandrel within a diameter slightly less than the well bore. As the mandrel is lowered into the wellhead the lower edge of the segments contact the projecting lower groove and are forced outwardly into the grooves by the cooperating tapered mandrel and segment faces to support the mandrel and attached apparatus.

Several embodiments of the invention are described herein. For a better understanding of the invention and its embodiments reference is now made to the following description and the accompanying drawings, wherein:

FIGURE 1 is an elevation in partial section of one embodiment of the invention shown in a partially engaged position;

FIGURE 2 is an elevation in partial section of another embodiment of the invention showing initial engagement of the suspension means with the wellhead;

FIGURE 3 is an elevation in partial section of the embodiment of FIGURE 1 adapted for surface installation.

Referring first to FIGURE 1, the first embodiment of the invention will be described. A pipe hanger **10** is shown supporting casing **11** within wellhead **12**. Attached to the

upper end of hanger 10 is riser 13, which in underwater casing operations may constitute a casing extension reaching to the surface of the water.

Hanger 10 includes a tubular mandrel 14 which has connection means at each end thereof to receive casing 11 and riser 13. Near the base of mandrel 14 a groove 15 is machined to form a lower reaining shoulder 16 for cooperation with a portion of segments 20 to be explained later. Moving upwardly from groove 15, mandrel 14 has stepped up diameters so that upper retaining shoulder 17 and support shoulder 18 are provided, the function of which will be explained later. The vertical distances between lower retaining shoulder 16 and upper retaining shoulder 17 and between upper retaining shoulder 17 and support shoulder 18 are substantially the same.

Suspension means is provided including segments 20 conveniently formed by machining an annular ring and cutting it into four segments 20. The outer faces of segments 20 are formed to cooperate with preformed grooves 21 on the interior circumference of wellhead 12. The inner faces of segments 20 are correlatively conformed to the shape of groove 15 and the lower diameter of mandrel 14 so that on compression of a spring 22 segment 20 will be prevented from upward movement by lower retaining shoulder 16 and upper retaining shoulder 17. On outward movement of segments 20, retaining shoulders 16 and 17 are cleared allowing segments 20 to move upwardly on mandrel 14 until stopped by support shoulder 18 and upper retaining shoulder 17.

A light metal cage holds and guides segments 20 so all segments are assured of moving up or down in unison. The cage is formed by joining upper ring 29*a* and lower ring 29*b* with vertical strips 29*c* between segments 20. Small lugs 20*a* and 20*b* are provided on the upper and lower portion of segments 20 which ride in slots 30*a* and 30*b*. Thus, segments 20 are prevented from being forced free from hanger 10.

Each of the four segments 20 may occupy an arc substantially less than 90 degrees, for example, 45 degrees, so that space is maintained between segments 20 to allow annular fluid flow past hanger 10. Shoulder 18 may also be provided with passages 18*a* to aid in fluid flow. However, ducts 35 (shown by hidden lines) may be provided in wellhead 12, making this unnecessary.

Hold down latch 23 mounted in a groove 24 on lower diameter 19 is spring biased to extend out of groove 24. The latch has an upwardly and outwardly beveled face so that a flat shoulder 25 is provided. Latch retractor 26 is inserted through a vertical hole in mandrel 14 communicating with groove 24. It has a conical tip 27 to cooperate with a conical depression 28 in hold down latch 23. In its spring biased position (as shown), latch 23 is extended so that the point of conical tip 27 rests on the inner edge of depression 28. If latch retractor 26 is forced downwardly by a tool adapted for such purpose, latch 23 will be completely retracted in groove 24 due to the cooperation of conical tip 27 and depression 28.

In operation hanger 10 would be lowered into wellhead 12 with casing 11 and riser 13 attached thereto. Segments 20 would be depressed against mandrel 14 and held in a neutral position by upper and lower retaining shoulders 16 and 17 and the interior wall of wellhead 12. As hanger 10 moves downwardly, segments 20 become juxtapoisitioned to grooves 21. Spring 22 causes segments 20 to be forced into cooperative grooves 21 on wellhead 12. This frees mandrel 14 for further movement downward relative to segments 20 and grooves 21. As mandrel 14 continues downward, it comes to a stop; support shoulder 18 and upper retaining shoulder 17 resting on ring 29*a* and segment shoulder 20*c* respectively. Hold down latch 23, due to its beveled face, has been retracted allowing segments 20 to pass upwardly. With segments 20 in their uppermost position, hold down latch 23 is free to spring outwardly. Thus, segments 20 are locked outwardly by mandrel 14; hanger 10 and casing 11 are held down by hold down latch 23.

To remove hanger 10 and casing 11, latch retractor 26 is forced down, as by dropping an annular ring onto it, so that conical tip 27 cooperating with depression 28 causes hold down latch 23 to be retracted. Mandrel 14 and casing 11 are then pulled upward. Segments 20 are forced against mandrel 14 due to the cooperating beveled surfaces of grooves 21 and segments 20. Hanger 10 is thereby freed, allowing its removal along with attached casing 11.

Another embodiment of the invention is described with reference to FIGURE 2. Hanger 60 is shown supporting casing 61 within wellhead 62. Attached to the upper end of hanger 60 is riser 63.

Hanger 60 includes a tubular mandrel 64 with connection means, such as threads, at each end thereof to receive casing 61 and riser 63. The exterior of mandrel 64 is tapered in a downwardly converging surface. Shoulders 65 and 66 are provided at the upper and lower ends of the tapered surface. Passageways 71 in shoulders 65 and 66 allow passage of fluid by hanger 60.

Suspension means are attached to mandrel 64 including segments 67. Segments 67 are formed by machining grooves on the exterior of a cylinder, tapering the interior of the cylinder to cooperate with the tapered surface of mandrel 64, and cutting into vertical segments. As in another embodiment described herein, space may be left between segments 67 to allow fluid passage, but if desired ducts may be provided through the sidewall of wellhead 62. Segments 67 rest on shoulder 66 and are held against the tapered portion of mandrel 64 by guide rods 68 which pass through holes in segments 67 parallel to cooperating tapered surfaces of mandrel 64 and segments 67. Guide rods 68 are attached to shoulder 66 by screw threads. Shear screw 79 passes through segments 67 into mandrel 64 holding segments 67 at their lowermost position on mandrel 64. Shoulder 65 may be in the form of a ring threadingly connected to mandrel 64. This will allow segments 67 to be easily mounted on guide rods 68 by removing the ring and sliding segments 67 over rod 68.

The interior of wellhead 62 has grooves 69 machined on it to cooperate with the outer face of segments 67 to form a key lock. The bottom surface of the last groove in wellhead 62 extends slightly into the bore of wellhead 62 forming a very small shoulder at 70. Shoulder 70 is only wide enough to cause shearing of screw 79 by interference with the lower edge of segment 67, and is not wide enough to provide enough support to support the hanger and the casing.

In operation, hanger 60 and casing 61 would be lowered into wellhead 62. The lower edge of segments 67 would contact shoulder 70 causing screw 79 to be sheared on further downward movement. This would free segments 67 to move upward and radially outward relative to mandrel 64. On further downward movement of mandrel 64, segments 67 would be forced into grooves 69 by the cooperating tapered surfaces on mandrel 64 and segments 67, finally coming to a stop on contacting shoulder 65. Thus, an effective key lock suspension is obtained, anchoring hanger 60 and casing 61 to wellhead 62.

To remove hanger 60 and attached casing 61, an upward force is applied to them. Segments 67 are forced inwardly due to the cooperating beveled surfaces of grooves 69 and segments 67 and guide rod 68. Thus, hanger 60 and casing 61 are free to be removed from the well.

Although, the embodiments described heretofore are for underwater extended casing operation, the invention may be readily adapted for surface installation. In such use, an annular seal could be provided. For example, seal 90 as shown in FIGURE 3 could be used at the upper end of either of hangers 10 or 60 (FIGURES 1 and 2). A shoulder 91 is provided on mandrel 93. An annular seal 90 is mounted between shoulder 91 and the upper end of 92 suspension means. Resilient ring 94, mounted between

holding rings **95** and **96**, would be compressed as mandrel **93** moves downwardly forcing seal **90** against edge of suspension means **92**, effectively sealing on both sides thereof.

As can be seen in the embodiments of the invention described herein, effective pipe suspension is obtained without substantial internal shoulders on the supporting wellhead. Installation and removal are both easily and remotely obtained.

I claim:

1. Pipe suspension apparatus comprising:

wellhead means having annular grooves therein, said grooves each being defined by a bottom wall and two side walls;

tubular mandrel means concentrically disposed in said wellhead means, said mandrel means having a plurality of downwardly facing shoulders formed by correspondingly reduced outside diameters of said mandrel means;

suspension means releasably attached to said mandrel means comprising segments resiliently mounted and longitudinally held to said mandrel means by the side wall of said wellhead means and at least one of said downwardly facing shoulders on said mandrel means, said suspension means, wellhead means and mandrel means all being so constructed and arranged so that said segments will engage said side walls of said grooves on said wellhead means as said mandrel is lowered into said wellhead means and allow said mandrel means to move axially downward relative to said segments, said mandrel means stopped only by contact of said segments with another of said downwardly facing shoulders on said mandrel means thereby suspending said tubular mandrel means within said wellhead means.

2. The combination of claim **1**; and hold down means resiliently mounted on said mandrel means engageable with at least one of said segments in said stopped position to hold said suspension means in locked position with said wellhead means, said hold down means being retractable to release said suspension means for disengagement.

3. Pipe suspension apparatus comprising:

wellhead means having preformed annular grooves therein; the lower limits of said grooves being defined by downwardly and inwardly converging frusto-conical surfaces, the lower limit surface of the lowermost of said annular grooves extending slightly into the bore of said wellhead means;

tubular mandrel means concentrically disposed in said wellhead means, the exterior of which is provided with a downwardly converging tapered surface;

suspension means mounted on said mandrel means, said suspension means including segment means having outer faces correlatively formed to engage said preformed grooves and inner faces tapered to cooperate with said mandrel means tapered surface, said suspension means, wellhead means and mandrel means being so constructed and arranged so that as said tubular mandrel means is lowered into said wellhead the lower edge of said segment means first contacts said extending lowermost groove surface causing said segment means to be forced upwardly and outwardly relative to both said mandrel means and said wellhead means into said preformed grooves thereby supporting said mandrel means within said wellhead.

4. The combination of claim **3** wherein the upper limits of each of said grooves is defined by upwardly and inwardly converging frusto-conical surfaces substantially in contact with said segment means in said supporting position so that on upward movement of said mandrel means said segment means are forced radially inward along said upper limit surfaces freeing said mandrel means and said suspension means for removal from said wellhead.

5. Pipe suspension apparatus comprising:

wellhead means having preformed annular grooves therein;

tubular mandrel means concentrically disposed in said wellhead means, said mandrel means provided with a reduced diameter cylindrical portion and a cylindrical portion of larger diameter than said reduced portion;

suspension means releasably held around said reduced diameter cylindrical portion of said mandrel means by the side walls of said wellhead means, said suspension means including segment means whose outer face conforms to the shape of said preformed grooves within said wellhead, said segment means resiliently biased away from said mandrel means, to engage said preformed grooves to free said suspension means for limited longitudinal movement relative to said mandrel means to a position wherein said suspension means surrounds said larger diameter cylindrical portion of said mandrel means which prevents disengagement of said segment means from said preformed grooves, and means adjacent said larger diameter portion abutting said segment means thereby suspending said tubular mandrel means within said wellhead means.

6. The combination of claim **5** and hold down means comprising a latch resiliently mounted on said mandrel means to laterally engage a portion of said suspension means in said position surrounding a larger diameter portion of said mandrel means preventing longitudinal movement of said mandrel means in either direction relative to said suspension means.

7. The combination of claim **6** wherein said hold down means comprises a latch retractor mounted for longitudinal movement on said mandrel means to laterally retract said latch freeing said mandrel means for longitudinal movement in at least one direction.

8. Pipe suspension apparatus comprising:

wellhead means having preformed annular grooves therein, said grooves each being defined by a bottom wall and two side walls;

tubular mandrel means concentrically disposed in said wellhead means, said mandrel means having a plurality of downwardly facing shoulders thereon formed by uniformly reduced diameters thereon;

suspension means including segment means having outer faces correlatively shaped to the form of said preformed grooves in said wellhead, said segment means being releasably held to said mandrel means by the sidewall of said wellhead means and at least one of said downwardly facing shoulders on said mandrel means, said suspension means, wellhead means and mandrel means all being so constructed and arranged so that said segment means is resiliently biased to engage said side walls of said preformed grooves on said wellhead as said tubular mandrel means is lowered into said wellhead to release said segment means from said mandrel means allowing said mandrel means to move downwardly relative to said segment means to be stopped by at least another of said downwardly facing shoulders to lock said suspension means to said wellhead.

9. The combination of claim **8**; and hold down means resiliently mounted on said mandrel means and engageable with said suspension means in said locked position to hold said suspension means in said locked position with said wellhead means, said hold down means being retractable to release said suspension means for relative motion on said tubular mandrel means.

10. Pipe suspension apparatus comprising:

wellhead means having preformed grooves therein, said grooves each being defined by a bottom wall and two side walls, the lowermost surface of the lowermost said groove extending slightly into the bore diameter of said wellhead means;

tubular mandrel means concentrically disposed in said

wellhead means, said mandrel means being conically tapered on the exterior thereof;

suspension means mounted on said mandrel means including segment means, the outer face of said segment means conforming to the shape of said preformed grooves on said wellhead, the inner face of said segment means being a tapered surface conforming to the shape of said tapered mandrel means, said segment means having a diameter larger than the diameter of the said lowermost surface of said groove, said segment means having guide rods passing therethrough parallel to said tapered surface, said guide rods having means thereon attaching said rods to said mandrel, said segment means being releasably attached to said mandrel means by shear means whereby on downward motion of said mandrel means said segment means engage said lowermost surface and said shear means are sheared thereby freeing said segment means to move radially outward to engage said walls defining said grooves in said wellhead means.

References Cited

UNITED STATES PATENTS

1,619,268	3/1927	Rasmussen	166—217
1,847,087	3/1932	Greve	24—263.5
1,902,075	3/1933	Howard	285—143
2,690,344	9/1954	Allen	166—217 X
3,273,915	9/1966	Bishop et al.	285—140 X
3,345,084	10/1967	Hanes et al.	205—321 X

CARL W. TOMLIN, Primary Examiner

D. W. AROLA, Assistant Examiner

U.S. Cl. X.R.

166—129, 136, 217; 285—82, 141, 317