Jan. 9, 1940. F. W. HILD 2,186,139

SAFETY CASING HEAD

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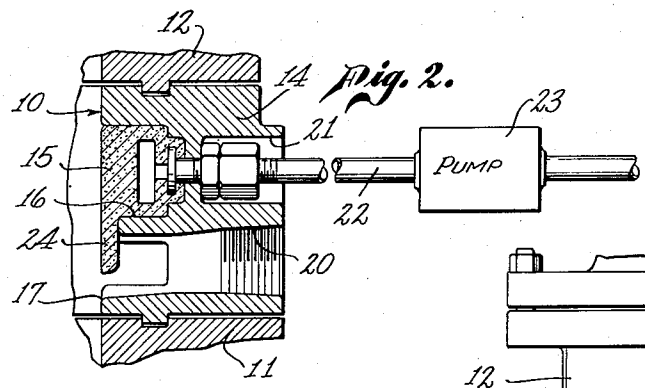


Fig. 2.

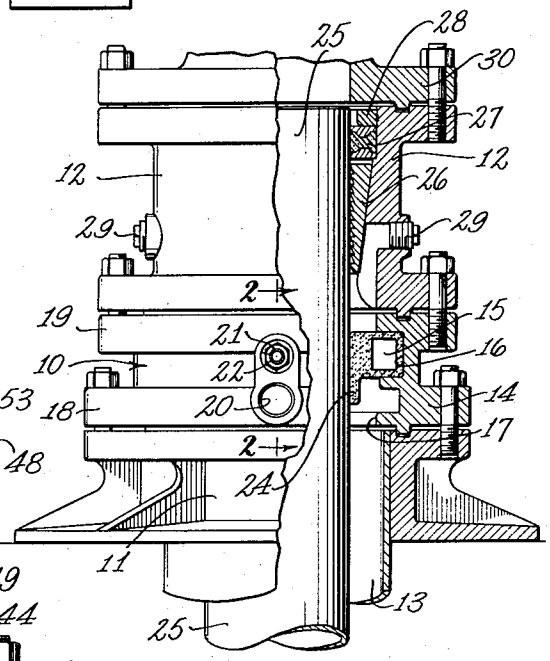


Fig. 1.

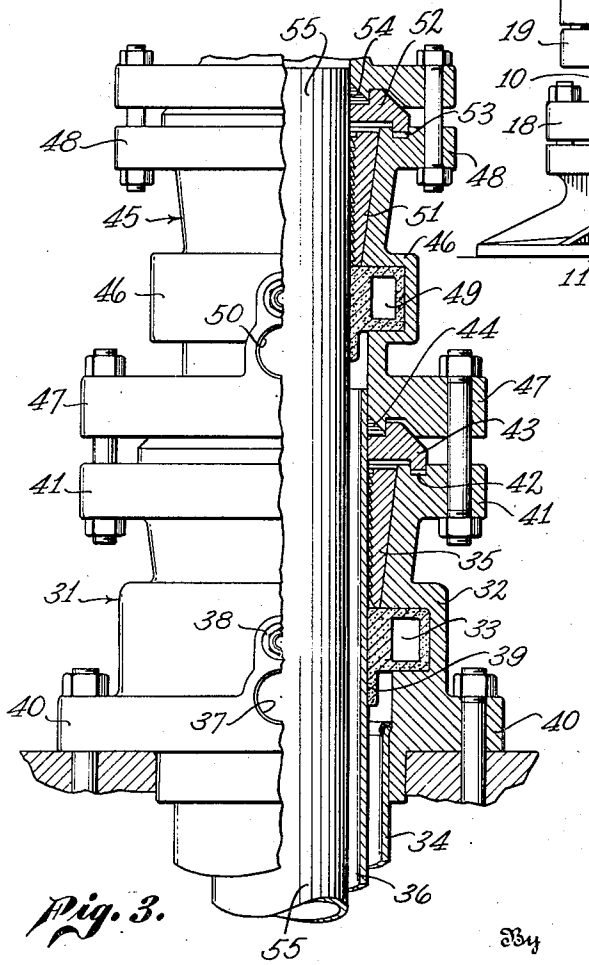


Fig. 3.

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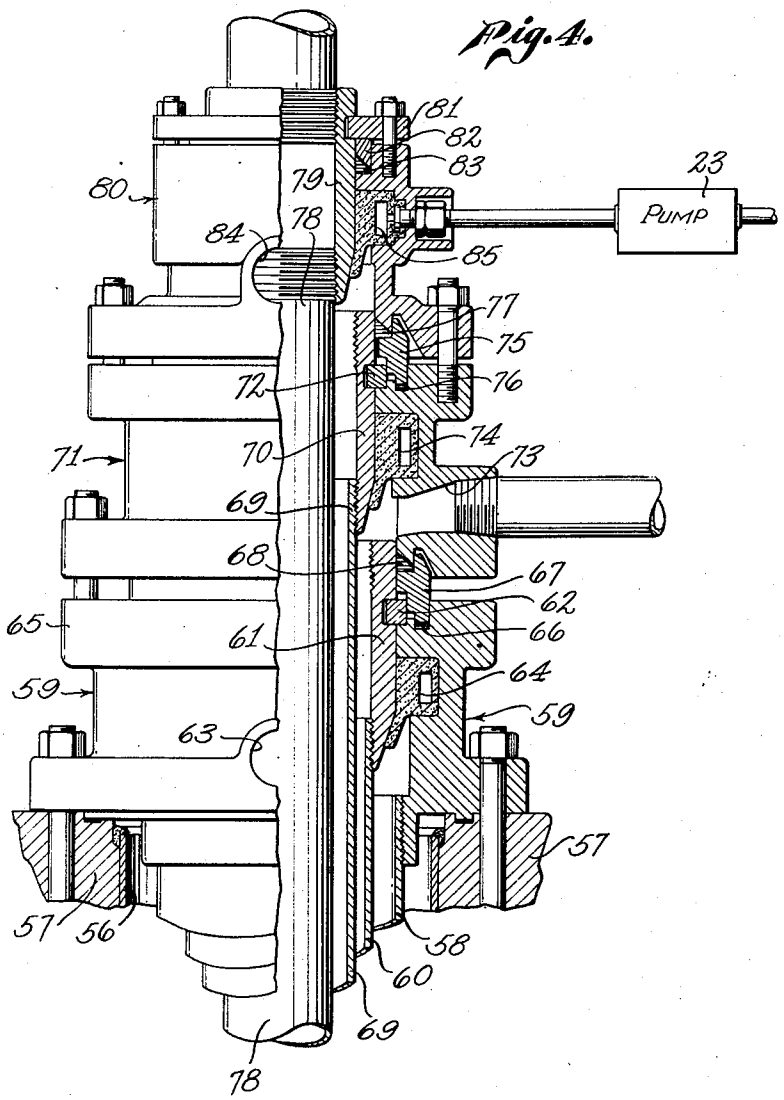
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Fig. 4.



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SAFETY CASING HEAD

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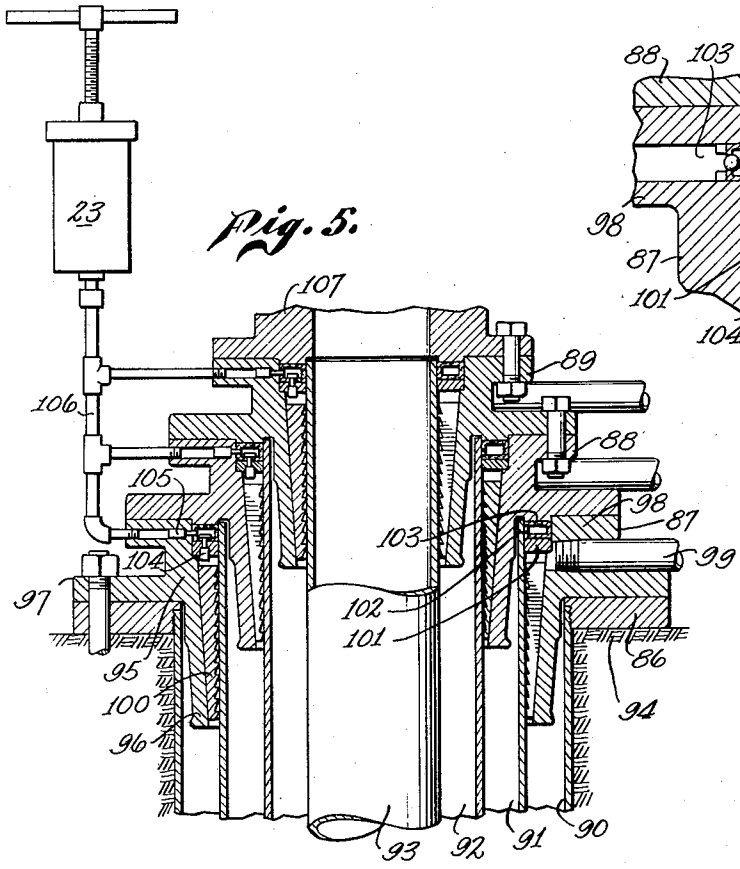


Fig. 5.

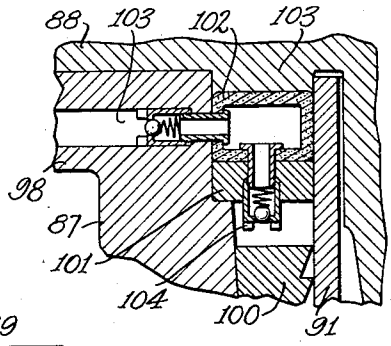


Fig. 6.

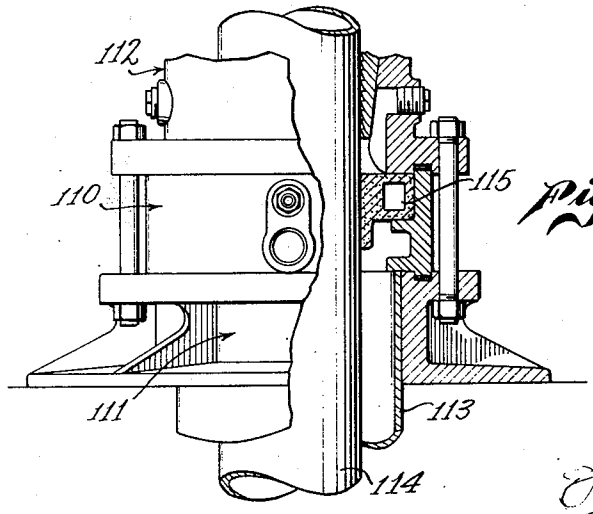


Fig. 7.

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UNITED STATES PATENT OFFICE

2,186,139

SAFETY CASING HEAD

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Application January 9, 1937, Serial No. 119,796

10 Claims. (Cl. 166—14)

My invention relates to casing heads for supporting casings in oil and gas wells, this application being a continuation-in-part of my copending applications Serial No. 733,854, filed July 5, 1934, for Expanding seal, and Serial No. 108,777, filed Nov. 2, 1936, for Casing heads for pressure drilling. It is an object of the present invention to provide safety casing heads for wells which may be drilled with or without mud fluid.

Disastrous, costly experiences of the past have demonstrated the serious risk and danger of relying solely upon weighted fluid to control well pressure, hence a control column comprising master valves and mechanical blowout preventers of various types for the axial outlet is practically universal equipment for well drilling. Indeed it is the practice in some fields of high pressure and expensive well jobs to install two and even three master valves and also two blowout preventers in the control column for each well.

But in all cases and in all fields the control column is above the casing heads. So in order to install any of the currently used casing heads, or to secure and seal the casing to the casing head, the control column with its master valves and blowout preventer must be removed; but before this may be done it is essential that there be no pressure at the casing head, and so the well is "killed" by mud fluid. But the mud may become "gas-cut", its specific gravity lessened and its capacity for holding the well pressure be correspondingly diminished.

Thus there is the inconsistency and serious hazard of the well being unprotected by any mechanical shut-off device, and reliance placed solely upon the mud fluid in the well to control the well pressure during the protracted, critical period of installing the casing heads and landing and securing the casing. The danger here involved is greater than during the drilling period because it is not possible to pump mud to the bottom of the hole where it should go to be effective.

Withdrawal of the drill pipe not only lowers the mud level, but the swab action draws in gas from the pressure formation. Mud or weight material pumped in during the withdrawal, usually does not go to bottom, but leaves the lower mud fluid in gassy condition and lighter in weight so that the counter pressure of the mud column diminishes. Moreover, when casing with its end closed in the customary manner, is being lowered, it displaces the heavier mud fluid at the top, which further reduces the counter pressure.

It is an object of my invention to provide a mechanical means for closing the intercasing space between the casing being landed and the next adjacent casing, prior to removal of the drilling control column.

When the natural clays fail to provide mud of sufficient weight, then weight materials such as barites and iron oxides are added. These weight materials in the quantities used per well are quite expensive. My invention has for one of its objects a simple low cost mechanical closure for the intercasing space, which supplements the ordinary mud fluid of natural clays so that the costly heavier weight materials will not be needed.

It is an object of the invention to provide a sub-casing head which may be interposed between two casing heads and which will provide a mechanical shut-off below and for the upper of the two.

It is well known that the heavy mud fluid frequently seals off the productive formation so as to lessen the production and even at times to kill it off permanently. Hence pressure drilling is coming into wide use. But here also, at present, the mud fluid still is relied upon down to the top of the productive horizon; the mud is then replaced by oil and/or gas for circulating during "drilling in". My invention makes reliance upon the mud quite unnecessary.

Another object is to provide a sub-head adapted to be secured to a casing head and having means for effecting seal against the casing prior to removal of the well control column, and prior to securing the casing to the casing head. A further object is to provide the sub-head with suitable openings for conducting fluid from the well.

Still another object of the present invention is to provide in a casing head a packing means which may be urged against a casing by fluid pressure from an external source and which will effect seal by both said pressure and by the well pressure so that in the event of failure or lessening of either pressure, the seal will be maintained.

Still another object is to provide a casing head employing a hollow packer which seals three elements, namely, the casing and two adjoining casing heads.

Other objects and advantages will be apparent from the following description and the accompanying drawings;

Figure 1 is an elevational view in part section of the sub-casing head and shows a packer effecting seal against a casing.

Figure 2 is a sectional view on the line 2—2 of

Figure 1, and shows the packer relaxed and in retracted position.

Figure 3 is an elevational view in part section of an assembly of casing heads employing tapered slips for securing the upper end of the casing.

Figure 4 is an elevational view in part section of an assembly of my improved casing heads each employing a collar as the terminal end of the casing.

Figures 5 and 6 are reproduced from my aforesaid co-pending application Serial No. 733,854, Figure 5 being a sectional elevation of casing heads employing slips and hollow packers for securing and sealing casings and Figure 6 is a detail of a portion of Figure 5.

Figure 7 is an elevational view in part section of another form of sub-casing head.

Referring to the drawings and particularly to Figures 1 and 2, the sub-casing head 10 is interposed between and secured fluid tight to a lower casing head or landing base 11 and an upper casing head 12. The outer casing 13 is secured to the lower casing head 11.

The sub-head 10 comprises the body 14 and the hollow expanding packer 15 which is contained in an annular recess 16 of the body. A circular opening 17 extends vertically through the body having minimum diameter about the same as the inner diameter of the casing 13, so that any object such as a bit which can pass through the casing may be passed through the sub-head. The body 14 has lower and upper flanges 18 and 19 respectively which are provided with suitable means such as bolts, tongue, groove and gaskets for fluid tight connections to the casing heads 11 and 12 respectively. The body 14 has lateral openings 20 and 21 of which the lower one 20 is threaded to receive a pipe for conducting fluid from the casing head.

Secured into the upper opening 21 is a hollow stem 22 which leads to the interior of the hollow packer 15. A pump 23 may be connected to the stem 22 for inflating the packer. Extending downward from the inner face of the packer 15 is the dependent annular lip 24. When the packer is not inflated and is therefore retracted into recess 16, the well pressure tends to urge the lip 24 against the wall of opening 17 and the remainder of the packer further into the recess 16. When fluid pressure as by the pump 23 is admitted into the hollow interior of the packer 15, the packer is urged radially inward so that the inner face of the packer and its lip effect closure and seal against the casing 25 which extends through the sub-head 10. The well pressure acting now on the outer surface of the lip 24 forces the lip against the casing. Should the pump pressure fail, the well pressure will hold the lip against the casing. Should the well pressure lessen or stop, the upper portion of the packer will be held against the casing by the pump pressure. Thus the packer effects seal either by external pressure or by well pressure. Manifestly when both pressures are exerted the shut-off and seal are doubly assured.

Figure 1 shows the casing 25 held in the casing head 12 by the tapered slips 26 and sealed therein by the packer 27 and the retaining nut 28. Plugs 29 close the lateral outlets in the body of the casing head 12. The numeral 30 may indicate the sub-head for the next casing head for supporting the next inner casing.

But prior to the insertion of the slips 26 and the packer 27, the numeral 30 may represent the bottom of a well control column comprising the usual master valve and blowout preventer. The casing 25 may then be considered as being lowered through the control column and through the sub-head 10, where the packer 15 may have been expanded against the casing, the lower end of which is closed by a valved float shoe. Shut-off and seal below the control column would then be in effect, and if the hole were also then filled with mud, there would be triple insurance against the well blowing out, namely the mud, the sub-head 10 and the well control column.

Casing 25 may now be anchored and cemented after which the control column may be disconnected from casing head 12 and lifted upward. The sub-head 10 and the mud then provide double protective insurance. The casing may then be stretched to desired tension and the slips 26 inserted into the casing head 12 for permanently securing the casing thereto. The portion of the casing above the casing head is then cut off and the packer 27 for sealing between the casing and casing head is inserted. Then to the casing head 12 may be secured the next sub-head (numeral 30) together with its casing head. The well control column may then be added ready for the next drilling and casing cycle.

Figures 3 and 4 show the equivalent of sub-head 10 incorporated in each casing head body. Thus in Figure 3 the casing head 31 has the body 32 which contains in a suitable recess the hollow packer 33. The outermost casing 34 is secured as by welding to the lower portion of the body 32. Above the packer recess the body is taper bored to receive the slip 35 permanently securing the upper end of the next casing 36 to the casing head. Below the packer recess the body 32 has the lateral openings 37 and 38 of which the lower one 37 is threaded to receive the usual vent pipe, and the upper opening 38 contains the stem for the hollow packer 33. The packer and its dependent annular lip 39 are in sealing contact with the casing 36 which is the intermediate casing of this assembly.

The body 32 has lower and upper flanges 40 and 41 respectively. The lower flange rests upon a suitable foundation. The upper flange 41 is grooved to receive a metallic gasket 42, which prior to the insertion of the slips 35, may have served to render fluid tight connection with the well control column. But as here illustrated, there is seated on the gasket 42, a gland or sealing cap 43 which fits around the intermediate casing 36 and receives a second metallic gasket 44 which seals against the casing.

Seated on the gasket 44 is the casing head 45, the body 46 of which has lower and upper flanges 47 and 48 respectively. The lower flange 47 is firmly bolted to the upper flange 41 of casing head 31 and this bolt pressure together with the weight borne by casing head 45 forces the gasket 44 securely into seal against the casing 36 and the sealing cap 43, and also increases the sealing effect of gasket 42. Similarly the casing head 45 has the hollow packer 49, the vent opening 50, the slips 51, the seal cap 52 and the metallic gaskets 53 and 54. Seated on the upper gasket 54 and bolted to the casing head at the upper flange 48 may be the well control column or another casing head. The slips 51 permanently secure the inner casing 55 to the casing head 45.

Referring to Figure 4, the outermost casing 56 is welded to the landing base 57. The second casing 58 is threaded into the lower end of casing head 59 which is secured fluid tight to the landing base by suitable bolts. The third casing

60 is threaded into a terminal collar 61 which is secured to casing head 59 by the locking ring 62. A lateral threaded opening 63 in the lower part of the casing head is adapted to receive a pipe for conducting fluid from the casing head. A hollow packer 64 is contained by the casing head in a suitable recess above the opening 63 and below the locking ring 62. The hollow packer has a dependent annular lip and is in sealing contact with the terminal collar. The casing head has an upper flange 65 with a groove containing a metallic packing 66. Seated on this packer is the gland or seal cap 67 which surrounds terminal collar 61 and contains the metallic packing 68 for sealing against the collar.

The fourth casing 69 is threaded into terminal collar 70 which is secured to the next casing head 71 by the locking ring 72. The casing head 71 is seated on the packing 68 and bolted to upper flange 65 of casing head 59. The casing head 71 has lateral threaded opening 73, hollow packer 74, seal cap 75 and metallic packings 76 and 77.

The fifth and innermost casing 78 with its terminal collar 79 is secured to the topmost casing head 80 by locking ring 81. The topmost casing head is seated on packing 77 of casing head 71 and bolted thereto. Under the locking ring 81 is the gland or seal cap 82 bearing on the metallic packing 83 which is in the upper part of the casing head. The locking ring is bolted to the casing head, the weight of the casing 78 acting through the locking ring and the gland 83 to force the packing 83 into seal against the terminal collar. The casing head 80 has lateral vent opening 84 and hollow packer 85.

Figures 5 and 6 show the casing heads 86, 87, 88 and 89 nesting one into the other for supporting the casings 90, 91, 92 and 93 respectively on foundation 94. In lieu of threaded joints, tapered slips in the collars grip the casings and expanding seals provide the fluid tight packing at the joints.

The outermost or surface string of casing 90 is threaded into base plate 86 which rests directly on foundation 94. Seated on base plate 86 is casing head 87 which has the double flanged body 95 from which projects downwardly the pendent tapered slip ring 96. The body has lower flange 97 and an upper flange 98, the space between the flanges permitting bolt heads or nuts for securing to the next casing head 88. The interflange space is bridged at one or more places to form blocks with radial threaded vent holes for receiving vent pipes 99.

When lowering the casing 91 into final position in casing head 87, the slips 100 are inserted between the slip ring 96 and the casing, and then the portion of casing projecting above the body 95 is cut off. The slips are sufficiently below the top of the flange 98 to permit inserting the packing ring 101 and the expanding seal or packer 102. The packing ring rests on a shoulder in the body 95 into which it is tightly seated. The seal 102 is also well below the top of flange 98 so as to provide a groove for the tongue 103 of casing head 88 which rests upon and nests into casing head 87.

A hole in the packing ring 101 receives a check valve 104 which provides controlled passage into hollow packer 102 for fluid under pressure from casing 91. Also a hole bored radially through upper flange 98 of casing head 87 receives a check valve 105 which connects the interior of hollow packer 102 with a tube 106. This tube leads to pump 23 which contains suitable fluid for filling and expanding the seal 102. The pump 23 operates to open check valve 105 and to close check valve 104. But when the fluid pressure in casing 91 exceeds the pressure in the packer 102 caused by the pump, then the check valve 104 is forced open by the casing pressure and the check valve 105 is forced to closure.

In like manner, the casing heads 88 and 89 contain slips for gripping and supporting the casings 92 and 93 respectively. Each casing head has a hollow packer with two check valves similarly disposed as described for casing head 87, the radial check valves being connected to the tube 106.

The flange 107 of a control column which may include the usual master valve, blowout preventer and mud cross rests upon the top casing head 89 and is seated on the hollow packer of that casing head.

It will be seen that the pressure in each hollow packer of Figure 5, due to the pump may be the same, but that each packer may receive higher pressure from its casing without altering the pressure in the other seals.

In Figure 7 the sub-head is interposed between and secured by suitable bolts to the landing base 111 and the casing head 12. The outer casing 113 is secured to the landing base 111, and the next casing 114 is permanently secured by suitable taper slips to the casing head 112. The sub-head 110 contains the hollow packer 115 which has a dependent annular lip and likewise the sub-head has lateral openings for vent pipe and for packer stem as described for Figure 1. The hollow packer 115 at its upper side bears against the bottom face of casing head 112, the packer effecting seal against the casing 113, the sub-head 110 and the casing head 112. Metallic packings for additional seal may be inserted between the contacting faces of the sub-head 110 and casing head 112 and also the sub-head and the landing base.

In the foregoing description, the term "casing head" is intended to apply to the elements permanently secured to the casing and utilized as permanent equipment for the well. In this respect, the casing head is distinct from the drilling control column, which is a removable tool and capable of being used with a succession of wells, and moreover is distinct from the tubing head which also is removable. An important differentiating feature is that the casing head is always below the master valve, the latter being always the bottom member of the control column and the tubing head.

I claim:

1. In a casing head assembly for permanently holding an outer casing and an inner casing in suspension and adapted to receive a temporarily superimposed drilling control column, through which the inner casing is adapted to be passed, a casing head for the inner casing, a hollow inflatable packer in the casing head, the inner face of the packer having a normal relaxed diameter substantially that of the outer casing and adapted to be moved into seal with the inner casing for closing the intercasing space prior to the securing of said inner casing to the upper casing head, said packer being adapted to maintain said seal during the lowering and cementing of the inner casing, means for inflating said packer, supporting means for the inner casing above said packer and a second packer above said supporting means sealing between the casing head and the inner casing.

2. In a casing head assembly for permanently holding an outer casing and inner casing in a well, and adapted to be secured to a temporarily superimposed drilling control column, a casing head for one of the casings, a hollow packer in the casing head for sealing to the last mentioned casing, supporting means for the inner casing above said packer and a second packer above said supporting means sealing between the casing head and the inner casing, said hollow packer being normally relaxed to an inner diameter substantially equal to the inner diameter of the casing head and adapted to be moved into packing seal with said casing prior to the placing of said supporting means in said casing head.

3. In a casing head assembly as defined by claim 2, the combination therewith of means for passing fluid under pressure into said hollow packer for effecting said movement of the packer.

4. In a casing head assembly for permanently holding an outer casing and an inner casing in suspension and adapted to receive a temporarily superimposed drilling control column, through which the inner casing is adapted to be passed, a casing head for the inner casing, a movable packer in the casing head, the inner face of the packer having a normal diameter substantially that of the outer casing and adapted to be moved into seal with the inner casing for closing the intercasing space prior to the securing of said inner casing to the upper casing head, said packer being adapted to maintain said seal during the lowering and cementing of the inner casing, means for moving said packer, supporting means for the inner casing above said packer and a second packer above said supporting means sealing between the casing head and the inner casing.

5. A casing head for a well casing, comprising toothed gripping means for engaging said casing to hold the same in suspension, packing means above said last named means for sealing the casing head to the casing, the casing head having appropriate surfaces for receiving and engaging both said means, a movable packer below said surfaces adapted to be moved into prior seal on the casing for closing the well external to the casing prior to placing the aforesaid gripping and packing means on their respective surfaces in the casing head, the movable packer being retractable to an inner diameter substantially equal to the inner diameter of the casing head.

6. In a casing head assembly as defined in claim 4 the combination therewith of means for effecting said movement of said packer.

7. A casing head for a well casing, comprising toothed gripping means for engaging said casing to hold the same in suspension, packing means above said last named means for sealing the casing head to the casing, the casing head having appropriate surfaces for receiving and engaging both said means, an inflatable packer below said surfaces adapted to be moved into prior seal on the casing for closing the well external to the casing prior to placing the aforesaid gripping and packing means on their respective surfaces in the casing head, the inflatable packer being retractable to an inner diameter substantially equal to the inner diameter of the casing head.

8. In a casing head assembly as defined in claim 7 the combination therewith of means for inflating said packer.

9. In well equipment subject to well pressure and through which a pipe is adapted to extend; an annular hollow inflatable packing having a supplementary annular sealing member depending from the inflatable packing and extending below the inner face thereof, the inflatable packing being adapted to receive fluid under pressure for moving the packing and the supplementary member to the pipe, the said fluid pressure forcing the packing to seal on the pipe and the well pressure forcing the supplementary member to seal on said pipe.

10. In well equipment subject to well pressure and through which a pipe is adapted to extend; an annular hollow, inflatable sealing member adapted to be forced by internal fluid pressure within the member, to seal on the pipe, and a supplementary annular flexible sealing lip depending from said member and extending below the inner face thereof, said lip being adapted to be forced by the well pressure to seal on the pipe and to maintain said seal in the event of failure or absence of fluid pressure in said member.

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