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SEALING DEVICE FOR WELL HEADS

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FIG. 1

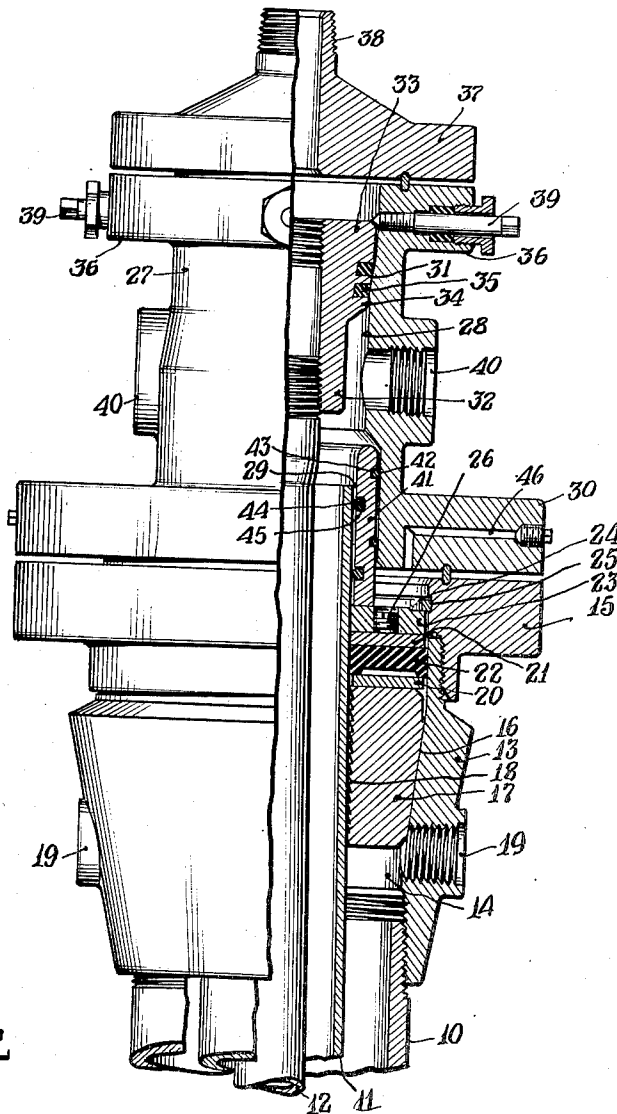
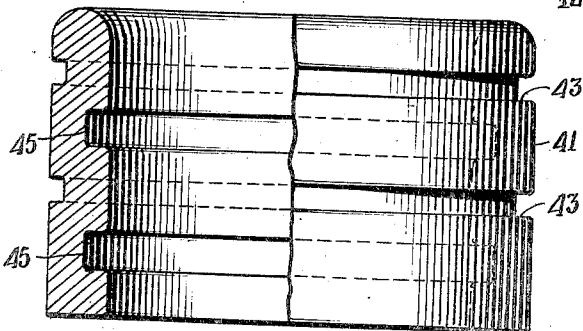


FIG. 2



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SEALING DEVICE FOR WELL HEADS

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4 Claims. (Cl. 166—14)

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This invention relates to improvements in well heads and particularly to an improved sealing structure to seal the annular space between a well pipe and a well head mounted thereon.

In deep wells drilled for the production of oil and gas, the well equipment conventionally includes a relatively large diameter string of pipe, commonly called the surface or conductor casing, which extends from the surface to a comparatively shallow depth, which is put in at the beginning of drilling operations, and has mounted on its upper end a relatively large diameter generally tubular fitting, known as a casinghead, through which subsequent drilling and completion operations are conducted, and which forms the base or foundation for additional surface equipment by means of which the well is produced and controlled. When the well has been drilled to producing depth a second, somewhat smaller diameter string of pipe, known as the casing or oil string, is then run through the surface pipe and its lower end is ordinarily cemented in the producing formation and perforated or otherwise opened to the producing formation. Finally, a third still smaller diameter string of pipe, commonly called the tubing, is run inside the oil string and is employed to conduct the formation fluids to surface.

In order to suitably support each of the pipe strings inside the others and to seal the annular spaces between the pipe strings various support and sealing devices are employed in conventional practice. Ordinarily, the oil string is supported in the casinghead by inserting conventional wedge-shaped toothed slips in the bore of the casinghead adapted to grip the oil string by wedging action between a suitably tapered surface in the casinghead and the exterior of the oil string and an annular packing assembly is then installed in the casinghead on top of the slips to provide a fluid-tight seal for the annular space between the oil string and the inner wall of the casinghead. The upper end of the oil string is then cut off somewhat above the top of the casinghead and a second tubular fitting, known as a tubinghead, is telescopically inserted over the projecting end of the oil string and suitably fastened to the casinghead. The tubing string is connected at its upper end to a fitting, known as a tubing hanger which is inserted in the bore of the tubing head and suitably landed on an appropriately shaped shoulder or inwardly tapered seat in the tubinghead to support the tubing string in this fitting. Suitable sealing elements are provided between the tubing hanger

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and the tubinghead to effectively seal the annular space between the tubing string and the tubing head. Appropriate and conventional flow connections are then made to the upper end of the tubinghead for conducting therefrom well fluids brought to the surface through the tubing string. Other flow connections are generally also provided which communicate with the bore of the tubinghead between the seals formed in the tubinghead and casinghead to provide communication with the bore of the oil string.

Such wellhead fittings, by the very nature of their form and assembly arrangement, will ordinarily provide an annular space between the bore of the tubinghead and the upper end of the oil string over which it is mounted. As a result, open communication is thus provided between the bore of the oil string and the interior of the casinghead above the sealing assembly installed on top of the slips which will be subjected to whatever pressures may exist in the oil string. This pressure will, of course, be exerted on the upper end of the packing assembly and the slips in the casinghead, and by virtue of the relatively large surface area of the packing assembly which will ordinarily be thus exposed to such pressure, very large total pressures will often be thus applied to the packing assembly tending to urge the latter and slips beneath in the downward direction with such force as to often result either in rupture of the casinghead or collapse of the upper end of the oil string.

In order to reduce or eliminate this serious hazard various types of sealing arrangements have heretofore been designed and employed to close the annular space between the upper end of the oil string and the bore of the tubinghead. The tubingheads are generally constructed to standardized dimensions, and while the pipe comprising the oil string is also of standardized dimensions, many variations may and do exist in the pipe due to conventionally allowable tolerances, varying weights and wall thicknesses, etc. As a result, the more conventional sealing arrangements are generally complicated, difficult to install and remove, relatively expensive to construct, and are often inefficient and are not universally adaptable to different installations of varying dimensions.

Accordingly, a principal object of the present invention is to provide an improved wellhead which will obviate or eliminate the several disadvantages of the kind noted inherent in more conventional designs.

A primary object is to provide an improved

form of sealing structure to seal the annular space between the oil string and the tubinghead.

An important object is the provision of an annular sealing element which is insertable in the annular space between the upper end of an oil string and the wall of a concentric tubing head to form a fluid-tight seal between these members of a well head structure.

In accordance with one embodiment of this invention the sealing element may comprise a tubular body constructed of metal dimensioned to be slidably insertable between the concentric surfaces to be sealed thereby and having compressible seals of the conventional O-ring type mounted in both the inner and outer peripheries of the body engageable with the adjacent surfaces to be sealed.

Other and more specific objects and advantages of this invention will become apparent from the following detailed description when read in conjunction with the accompanying drawing which illustrates one illustrative embodiment in accordance with this invention.

In the drawings:

Fig. 1 is a quarter-sectional longitudinal view of a well head constructed in accordance with this invention and shown mounted on the upper ends of the several strings of pipe constituting the upper end of a conventional well; and

Fig. 2 is an enlarged view in quarter-sectional elevation of a detail of the sealing sleeve in accordance with this invention.

Referring to Fig. 1, there is shown the upper end of the usual completed well, comprising a relatively large diameter surface pipe 10 having concentrically inserted therein an oil string 11 and a tubing string 12 of successively smaller diameters. A generally conventional casinghead is mounted on the upper end of surface pipe 10 and comprises a generally tubular body 13, having a bore 14 of approximately the same diameter as that of the surface pipe and equipped at its upper end with the usual bolt flange 15, which may be threadedly connected to the upper end of body 13, as illustrated, for ready removal, or may be made integral therewith in accordance with more conventional practice. The inner wall of body 13 is tapered inwardly and downwardly at 16 to form a wedging surface for seating a plurality of segmental slips 17 (only one shown) of generally wedge-shaped conventional construction having teeth or wickers 18 on their inner faces for tightly gripping the exterior of oil string 11 by wedging action of the slips between the oil string and tapered surface 16 of the casinghead. Body 13 is provided with the usual flow connections 19 providing communication between the exterior of the casinghead and the bore thereof.

A more or less conventional packing assembly is installed in the bore 14 of body 13 on top of slips 17 to seal the annular space between the exterior of the oil string and the inner wall of body 13. The packing assembly comprises upper and lower metal spacer rings 20 and 21, respectively, between which is inserted a sealing ring 22, constructed of natural or synthetic rubber or the like which when axially compressed will tightly seal the annular space. A compression ring 23 is mounted on top of the upper spacer ring 20 and is locked in position by means of a snap ring 24 which seats in an appropriate annular seating groove 25 provided in the inner wall of body 13 above the upper end of compression ring 23. A plurality of set screws 26

(one shown) extend through the compression ring into engagement with upper spacer ring 20, and are adapted, when screwed down to apply the required compression to sealing ring 22. It will be understood that the details of the casinghead, slips and sealing assembly do not in and of themselves form a part of this invention, but are merely illustrative, as these elements are of generally conventional form and may vary in considerable detail without altering the principal features of this invention.

In accordance with conventional practice, oil string 11 projects somewhat above the upper end of flange 15, substantially as shown, and is adapted to be enclosed by means of a more or less conventional tubinghead which comprises a generally tubular body 27 having a bore 28, the lower end of which is somewhat enlarged to permit body 27 to be easily installed over the projecting end of oil string 11, thereby defining an annular space 29 between the upper end of oil string 11 and the inner wall of body 27. The lower end of body 27 is provided with an external annular flange 30 mating with flange 15 and adapted to be connected thereto in any conventional manner, as by means of the usual bolts or studs (not shown) which ordinarily extend between such flanges. The inner wall of body 27 adjacent its upper end is provided with an inwardly and downwardly extending seating surface 31 and the upper end of tubing string 12 which projects above the upper end of oil string 11 is threadedly connected to a tubular sleeve member 32, commonly designated a tubing hanger, having an external enlargement 33, the periphery of which is tapered at 34 to complement the taper of seating surface 31 and has inserted therein one or more compressible packing rings 35 adapted to form a fluid-tight seal with seating surface 31 when the tubing hanger is lodged thereon and supports the weight of tubing string 12. The upper end of body 27 is provided with a flange 36 for the attachment of a flanged cover 37 provided with the usual flow connection 38 through which well fluid flowing through tubing 12 may be conducted from the well. Flange 36 may be provided with a plurality of angularly spaced locking pins 39 which extend radially through the flange and are adapted to engage tubing hanger 32 to lock the hanger and its attached tubing in place of the tubinghead. Outlet ports 40 are provided in the wall of body 27 below the seal formed by the tubing hanger to provide flow connections between the exterior of the tubinghead and the bore thereof which is in communication with the bore of oil string 11. It will be understood that the detailed construction of the tubinghead is merely exemplary of conventional tubingheads, which of itself does not form a part of this invention.

With respect to the general construction and assembly arrangement of casingheads and tubingheads of the more or less conventional design described above, it will be evident that annular space 29, if not otherwise controlled, will provide open communication between the interior of oil string 11 and the area above the packing assembly forming the annular seal between the oil string and the casinghead, and will therefore subject the packing assembly to whatever pressure exists in the oil string. In a typical well head assembly of conventional standardized dimensions the area thus subjected to pressure may be of the order of 55 square inches and may be greater or less depending upon the specific di-

mensions of the various parts of the assembly. The pressure in the oil string even in wells of moderate depth are frequently of the order of 3000 pounds per square inch or more. Thus, with a pressure of 3000 pounds in the oil string and an area of 55 square inches of packing assembly exposed to that pressure, it will be evident that in such a relatively common case, total pressures of the order of 165,000 pounds may be exerted on the packing assembly and through the packing assembly to the slips, which frequently produce destructive stresses on the casinghead and the oil string.

In order to obviate this undesirable condition the present invention contemplates the provision of an exceptionally simple form of sealing structure for annular space 29. This sealing structure comprises a metallic sleeve 41 having a length such as to extend entirely through annular space 29 and rest on the upper end of compression ring 23 which acts as a support or stop therefor, the upper end of sleeve 41 preferably, though not necessarily, extending somewhat above the upper end of oil string 11. The thickness dimension of sleeve 41 is preferably made such as to allow the sleeve to slide freely between the exterior of the oil string and the inner wall of body 27. One or more compressible resilient sealing rings 42 of the conventional O-ring type are circumferentially disposed in the exterior surface of sleeve 11, being seated in suitable grooves 43 dimensioned so that O-rings 42 normally protrude slightly therefrom into engagement with the adjacent wall of body 27. In the illustrative embodiment two O-rings 42 are shown, but as noted, one or more such rings may be used depending upon conditions encountered and the detailed design of the well head structure. One or more compressible, resilient sealing rings 44, also of the conventional O-ring type, are circumferentially disposed in the inner periphery of sleeve 41, being seated in suitable grooves 45 dimensioned so that O-rings 44 will normally protrude slightly therefrom into engagement with the adjacent surface of oil string 11. The cross-sectional diameter of the body of O-rings 44 may be made larger than that of outer rings 42 to take care of variations in the external dimensions of oil string 11 which may vary from installation to installation while the bore dimensions of body 27 of the tubing head will usually be standardized for use with various pipes of a given nominal diameter. It will be understood, of course, that the outer rings may be larger than the inner rings, or that both sets of the rings may be of the same size. However, in order to make the sealing structure of generally universal application, one set of the rings will ordinarily be made larger than the other. As illustrated the sealing rings may be positionally interspersed with the outer rings along sleeve 41, although this is not essential.

In installing the sealing structure in the well head, it is only necessary to slide the sleeve having the sealing rings in place, over the outer end of oil string 11 just before the tubinghead is put in position on top of the casinghead and surrounding the projecting end of the oil string. With this extremely simple sealing structure, it will be seen that a highly efficient seal will be provided for annular space 29 which will serve to completely segregate the packing assembly in the casinghead from pressure existing in the oil string and thus provide a simple and inexpensive means for protecting the casinghead seal from

the effect of pressure in the oil string. Flange 30 may be provided with test passageways 46 communicating with the annular space above the casinghead packing assembly, through which pressure fluid may be introduced from the exterior of the well head in order to test the efficiency of the seals both in the casinghead and between the tubinghead and the oil string.

It will be evident that the sealing structure hereinabove described will have wider application than in the specific arrangement described and that it may be used generally for sealing an annular space between two concentric cylindrical surfaces.

It will be understood that various alterations and changes may be made in the details of the illustrative embodiment without departing from the scope of the appended claims but within the spirit of this invention.

What I claim and desire to secure by Letters Patent is:

1. In combination with a well head structure which includes a tubular well head fitting having a pipe extending into the bore thereof defining an annular space therebetween, the upper end of said pipe being open to communication with said annular space, said structure having an annular compressible primary sealing element sealing said annular space at a point below the open end of the pipe, a pressure-excluding seal means for the portion of said annular space which extends between the open end of the pipe and said primary sealing element, comprising, a tubular metallic sleeve member slidable over the open end of the pipe into said portion of said annular space and positioned therein with its lower end seated on said primary sealing element, and compressible resilient sealing rings of the O-ring type circumferentially seated in the inner and outer surfaces of said sleeve member and projecting radially therefrom into sealing engagement respectively with the adjacent concentric surfaces of said pipe and said fitting.

2. In a structure according to claim 1, wherein the cross-sectional body diameter of said sealing rings on one side of said sleeve member is larger than that of the rings on the opposite side thereof.

3. In combination with a well head structure which includes a tubular well head fitting having a pipe extending into the bore thereof defining an annular space therebetween, the upper end of said pipe being open to communication with said annular space, said structure having an annular compressible primary sealing element sealing said annular space at a point below the open end of the pipe, a pressure-excluding seal means for the portion of said annular space which extends between the open end of the pipe and said primary sealing element, comprising, a tubular metallic sleeve member slidable over the open end of the pipe into said portion of said annular space and positioned therein with its lower end seated on said primary sealing element, pairs of longitudinally spaced circumferential grooves in both the inner and outer surfaces of said sleeve member, the depth of said grooves being less than the thickness of said sleeve member, and a compressible resilient sealing ring of the O-ring type seated in each of said grooves and projecting radially therefrom into sealing engagement respectively with the adjacent concentric surfaces of said pipe and said fitting.

4. In a structure according to claim 3 wherein the cross-sectional body diameter of said sealing

rings on one side of said sleeve member is larger than that of the rings on the opposite sides thereof.

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