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CASING SUSPENSION SYSTEM

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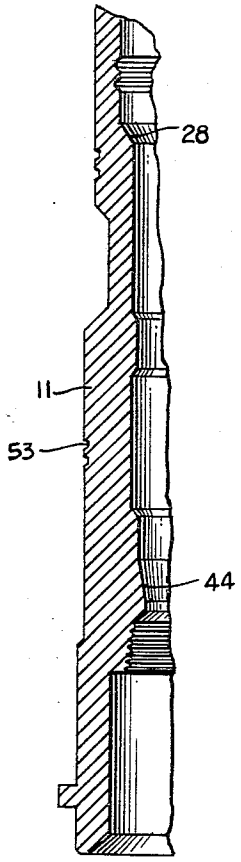

Fig. 2

Fig. 1

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CASING SUSPENSION SYSTEM

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This invention relates to apparatus for use on oil and gas well installations and pertains more particularly to apparatus for suspending multiple strings of well casing and/or tubing within a well from a well casinghead and/or a casing and tubing suspension body. The present invention is especially concerned with a casing suspension system for use in underwater wellhead installations.

In an attempt to locate new oil fields an increasing amount of well drilling has been conducted at offshore locations, such for example, as off the coast of Louisiana, Texas and California. As a general rule, the strings of casing in a well, together with the tubing string or strings, extend to a point well above the surface of the water where they are closed in the conventional manner that is used on land wells, with a conventional wellhead assembly being attached to the top of the casing. Attempts have been made recently to provide methods and apparatus for drilling and completing a well wherein both the well casinghead and subsequently the wellhead assembly and casinghead closure device are located underwater at a depth sufficient to allow ships to pass over them. Preferably, the casinghead and wellhead closure assemblies are located close to the ocean floor. In order to install equipment of this type underwater in depths greater than the shallow depths at which the diver can easily operate, it has been necessary to design entirely new equipment for this purpose. Thus, after drilling and completing an oil or gas well at an offshore location in a manner described in copending patent application, Serial No. 830,538, filed July 30, 1959, and entitled "Underwater Well Completion Method," of which this application is a continuation-in-part, the casing in the well may be suspended from the well casinghead by the equipment of the present invention.

It is an object of the present invention to provide a casing suspension system whereby multiple strings of casing may be nested within each other and securely anchored within the casinghead in the manner whereby well pressures or thermal expansion of the casing strings cannot cause the casing strings to move upwardly within the well.

Another object of the present invention is to provide apparatus for hanging one string of casing or tubing within another string of casing with the top of each string of casing and/or tubing being independently anchored to the inner wall of a well casinghead.

A further object of the present invention is to provide a casing suspension system wherein a casing hanger having a string of casing suspended therefrom is seated in a fluidtight manner within a well casing head, and a casing and/or tubing hanger having a string of casing or tubing suspended therefrom is seated in a fluidtight manner within the first casing hanger, with both casing hangers being independently anchored to the inner wall of the casinghead in a manner such that any well pressures or thermal expansion of the casing strings does not cause either casing hanger to move off its seat.

Still another object of the present invention is to provide a casing suspension system incorporating at least a pair of casing and/or tubing hanger which may be run into the well one at a time with the same running tool.

Another object of the present invention is to provide a casing suspension system employing at least two concentric strings of casing with the innermost casing string being provided with a casing hanger adapted to receive therethrough and seat therein one or more tubing strings.

These and other objects of this invention will be understood from the following description taken with reference to the drawing wherein FIGURE 1 is a diagrammatic view, taken in longitudinal cross-section of a casing suspension system mounted within a well casinghead of the present invention, and FIGURE 2 is a fragmental view taken in longitudinal cross section of another form of a well casinghead.

Referring to the drawing, a typical underwater well installation incorporating the apparatus of the present invention comprises an underwater casinghead **11** having a casing and tubing suspension body **12** positioned therein on a seat **13**. A series of strings of casing **14** and **15** are suspended within the casing and tubing suspension body **12** from suitable hangers **17** and **18**. If desired, the outermost casing **16** may be threaded or welded, as at **19**, to the lower end of the casing and tubing suspension body **12**. While the casinghead **11** is illustrated with a casing and tubing suspension body **12** suspended therein, in some installations the casing and tubing suspension body may form an integral part of the casinghead **11** as shown in FIGURE 2. The casinghead **11** extends upwardly from a suitable support member, such as a horizontal plate **21** which preferably rests or is cemented to the ocean floor in an underwater well installation. A string of conductor pipe or surface casing **22** is generally secured to the bottom of the casinghead **11**, as by welding, and extends into and is preferably cemented in the well drilled in the ocean floor.

The upper end of the casing and tubing suspension body **12** may be closed in any suitable manner, as by a casinghead closure body **20** having one or more vertical bores **23** and **24** therein. A wellhead closure assembly of this type is shown and described in copending patent application, Serial No. 834,096, filed August 17, 1959, and entitled "Wellhead Assembly Lockdown Apparatus." The casinghead closure **20** is provided with a circumferential expansible seal **25** and a series of radially-expanding locking dogs **26** adapted to engage one or more locking grooves **27** formed in the inner wall of the casing and tubing suspension body **12**. Due to the weight of flow control equipment generally installed above the casinghead closure **20**, a seating shoulder **28** is formed within the casing and tubing suspension body **12** for seating the casinghead closure rather than seating the entire weight of the assembly within the uppermost casing hanger **16**, which would be an alternative arrangement. In one arrangement of the present invention the casinghead closure **20** has a downwardly extending adaptor **31** from which a pair of tubing strings (not shown) may be suspended, as by threaded connections at **32** and **33**. O-ring seals **34** or any other suitable means are provided on the outer surface of the adaptor **31** near the lower end thereof, or on the inner surface of the hanger **17**, for forming a fluidtight seal between the lower end of the adaptor and the uppermost casing hanger **17**.

The uppermost casing hanger **17** may be provided with a seating shoulder or surface **37** on the inner surface thereof for seating the lower end of the adaptor **31**, if desired, or for seating any other suitable type of tubing hanger. A shoulder **40** is formed on the outer wall of the casing hanger **17** and is adapted to seat on a cooperating shoulder or seating surface **41** formed on the inner wall of the lower casing hanger **18**, with seals **42** being preferably provided for forming a fluidtight seal. Seals **42**, **45**, **47** and **48** are compression type packings, but could be O-rings or quad rings.

The outer surface of the casing hanger **18** is in turn provided with a seating shoulder **43** adapted to seat on a

cooperating seating surface or shoulder 44 formed on the inner surface of the casing and tubing suspension body 12. Seals 45 are provided for forming a fluidtight seal between seating surfaces 43 and 44. A large O-ring seal or other type packing member 46 is preferably provided between the casing and tubing suspension body 12 and the casinghead 11 with auxiliary seals 47 and 48 being provided in the seating surface or shoulder 51 on the lower end of the casing and tubing suspension body 12 which engages the seating shoulder 13 on the inner wall of the casinghead 11. As mentioned hereinabove in many well installations, especially those used on land, the casing and tubing suspension body 12 may be welded to or form an integral part of the casinghead 11. However, for ease in drilling and completing a well at an offshore location with the wellhead located underwater on the ocean floor, it is preferred, in such an installation, to have the casing and tubing suspension body 12 releasably secured to the casinghead 11. The casing and tubing suspension body 12 is preferably provided with a series of spring-loaded hold-down slips 52 which are adapted to engage the inner wall of the casinghead 11 and hold the tubing and casing suspension body therein against any pressures tending to force it upwardly therefrom. The casinghead 11 may also be provided with one or more grooves 53 on the outer surface or on the inner surface thereof for latching a running tool thereto when the casinghead is originally installed. Although the casinghead 11 is shown as being provided with a port 54 in the wall thereof, this fluid port 54 is normally closed by a suitable valve (not shown) during drilling operations and after the completion of the well.

The casing hangers 17 and 18 are provided with hold-down slips 57 and 58 which are mounted on the outer surface of the hangers 17 and 18 in a manner so as to engage the inner wall of the casing and tubing suspension body 12 at vertically spaced points. Thus, the casing strings 14 and 15 are independently anchored, through their casing hangers 17 and 18, to the casing and tubing suspension body 12 against forces, such as well pressure or thermal expansion of the casing strings, tending to raise the casing strings 14 and 15 within the well. It may be seen that the hold-down slips 58 are only subject to pressures within the annulus 59 between casing strings 15 and 16 which tend to move the lower casing hanger 18 off its seat 44. On the other hand, if the upper casing hanger 17 was anchored to the lower casing 18 as well as being seated therein, the lower hold-down slips 58 would be subjected to pressures within the annuli 59 and 60 between casing strings 14, 15 and 16.

The casing hangers 17 and 18 are provided on their inner surfaces near the top thereof with one or more grooves 61 and 62, respectively, to which a latching tool can be secured for lowering the casing hangers 17 and 18, and the casing strings 14 and 15, secured thereto, down into a well. It is preferred that both the casing hangers 17 and 18 have the same internal diameter near the top of the bore therethrough, that is, opposite the latching grooves 61 and 62, so that the same running tool (not shown) may be employed to run both casing hangers 17 and 18 into the casing and tubing suspension body 12. Additionally, it will be seen that by designing the upper casing hanger 17 so that the hold-down slips 57 thereof contact the inner surface of the casing and tubing suspension body 12, a substantial portion of the bore through the casing hanger 17 may be enlarged, as at 63 so as to accommodate an adapter 31 from which one or more tubing strings (not shown) may be suspended. Alternatively, since additional room is provided in the casing hanger 17 by the enlarged bore 63, another casing or tubing suspension head or hanger could be seated therein to suspend a string of tubing of fairly large diameter.

We claim as our invention:

1. A wellhead apparatus adapted to be positioned at the top of a well for suspending a combination of tubing and casing strings in the well, said apparatus comprising a casinghead fixedly positioned coaxially over said well, said casinghead having at least one seating shoulder formed therein, a first casing hanger having seating shoulders formed on the inside and outside thereof, said outside shoulder being formed to seat on a shoulder within the casinghead, a first string of casing secured to and suspending from the first casing hanger, a second casing hanger having seating shoulders formed on at least the outside thereof, said outer shoulder being formed to seat on the shoulder within said first casing hanger, a second string of casing secured to and suspending from the second casing hanger, and hold-down slip means carried outwardly by each of said casing hangers and positioned to engage the inner surface of said casinghead.

2. A wellhead apparatus to be positioned at the top of a well for suspending a combination of tubing and casing strings in the well, said apparatus comprising a casinghead fixedly positioned coaxially over said well, said casinghead having at least one seating shoulder formed therein, a first string of casing suspended in said well with the top of said casing secured to the lower end of said casinghead, a first casing hanger having seating shoulders formed on the inside and outside thereof, said outside shoulder being formed to seat on a shoulder within the casinghead, a second string of casing secured to and suspending from the first casing hanger, a second casing hanger having seating shoulders formed on the inside and outside thereof, said outer shoulder being formed to seat on the shoulder within said first casing hanger, a third string of casing secured to and suspending from the second casing hanger, hold-down slip means carried outwardly by each of said casing hangers and positioned to engage the inner surface of said casinghead, and closure means removably secured to the upper end of said casinghead.

3. A wellhead apparatus adapted to be positioned at the top of a well for suspending a combination of tubing and casing strings in the well, said apparatus comprising a casinghead fixedly positioned coaxially over said well, said casinghead including a casing and tubing suspension body secured in a fluidtight manner to said casinghead and having at least one seating shoulder formed therein, a first string of casing suspended in said well with the top of said casing secured to the lower end of said casing and tubing suspension body, seal means closing the space between said casinghead and said casing and tubing suspension body, a first casing hanger having seating shoulders formed on the inside and outside thereof, said outside shoulder being formed to seat on a shoulder within the casing and tubing suspension body, a second string of casing secured to and suspending from the first casing hanger, a second casing hanger having seating shoulders formed on thei inside and outside thereof, said outer shoulder being formed to seat on the shoulder within said first casing hanger, a third string of casing secured to and suspending from the second casing hanger, hold-down slip means carried outwardly by each of said casing hangers and positioned to engage the inner surface of said casing and tubing suspension body, and closure means removably secured to the upper end of said casing and tubing suspension body.

4. A wellhead apparatus adapted to be positioned at the top of a well for suspending a combination of tubing and casing strings in the well, said apparatus comprising a casinghead fixedly positioned coaxially over said well, said casinghead including a casing and tubing suspension body secured in a fluidtight manner to said casinghead and having at least one seating shoulder formed therein, a first string of casing suspended in said well with the top of said casing secured to the lower end of said casing and tubing suspension body, seal means closing the space between said casinghead and said casing and tubing suspension body, a first casing hanger having seating shoulders formed on the inside and outside thereof, said out-

side shoulder being formed to seat on shoulder within the casing and tubing suspension body, a second string of casing secured to and suspending from the first casing hanger, a second casing hanger having seating shoulders formed on the inside and outside thereof, said outer shoulder being formed to seat on the shoulder within said first casing hanger, a third string of casing secured to and suspending from the second casing hanger, hold-down slip means carried outwardly by each of said casing hangers and positioned to engage the inner surface of said casing and tubing suspension body, each of said casing hangers having a bore therethrough the upper ends of which are of the same diameter, groove latch means formed on the inner wall of said bore near the upper end thereof for securing a tool thereto, connector means carried by each casing hanger for securing at least one casing string thereto, the inner bore of said second casing hanger being adapted to receive and seal therein in a fluidtight manner the upper end of at least one tubing string, and closure means removably secured to the upper end of said casing and tubing suspension body.

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