

Nov. 28, 1967

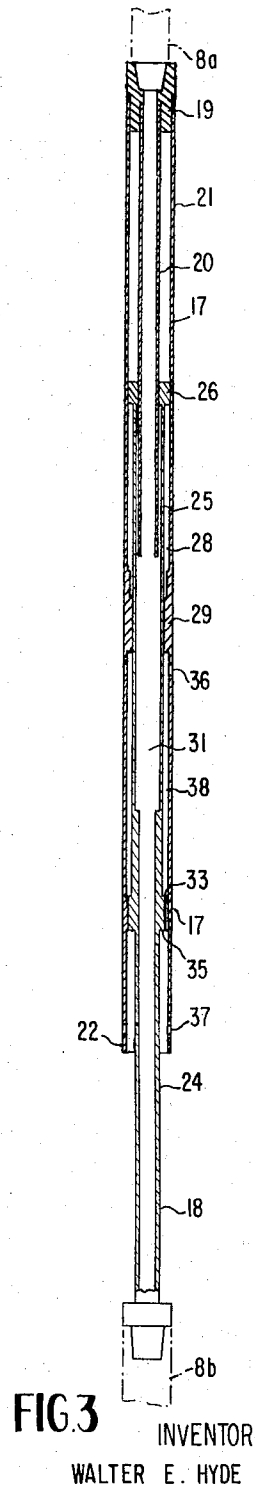
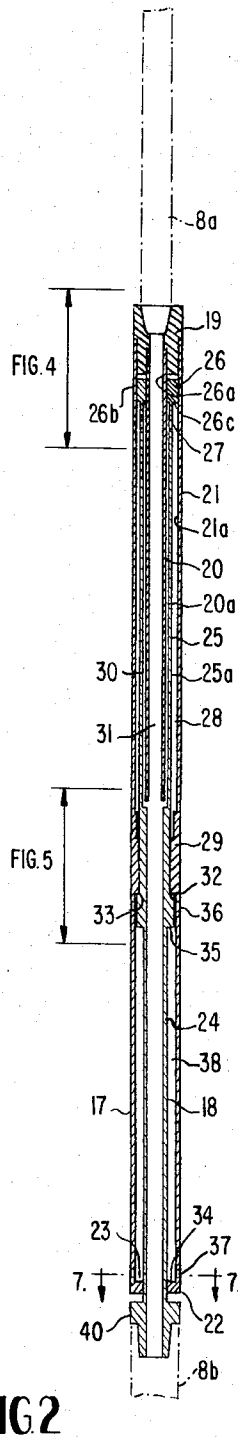
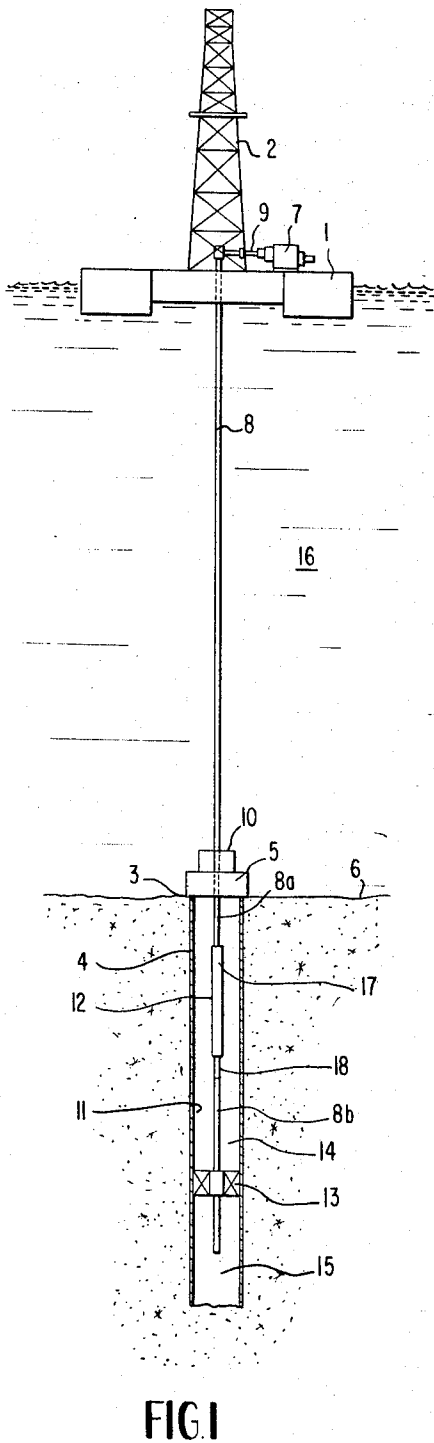
W. E. HYDE

3,354,950

METHOD AND APPARATUS FOR ACCOMMODATING TELESCOPING ACTION

Filed Feb. 25, 1965

2 Sheets-Sheet 1



INVENTOR
E. HYDE

BY *Burns, Doane, Benedict,*
Swecker & Mathis
ATTORNEYS

Nov. 28, 1967

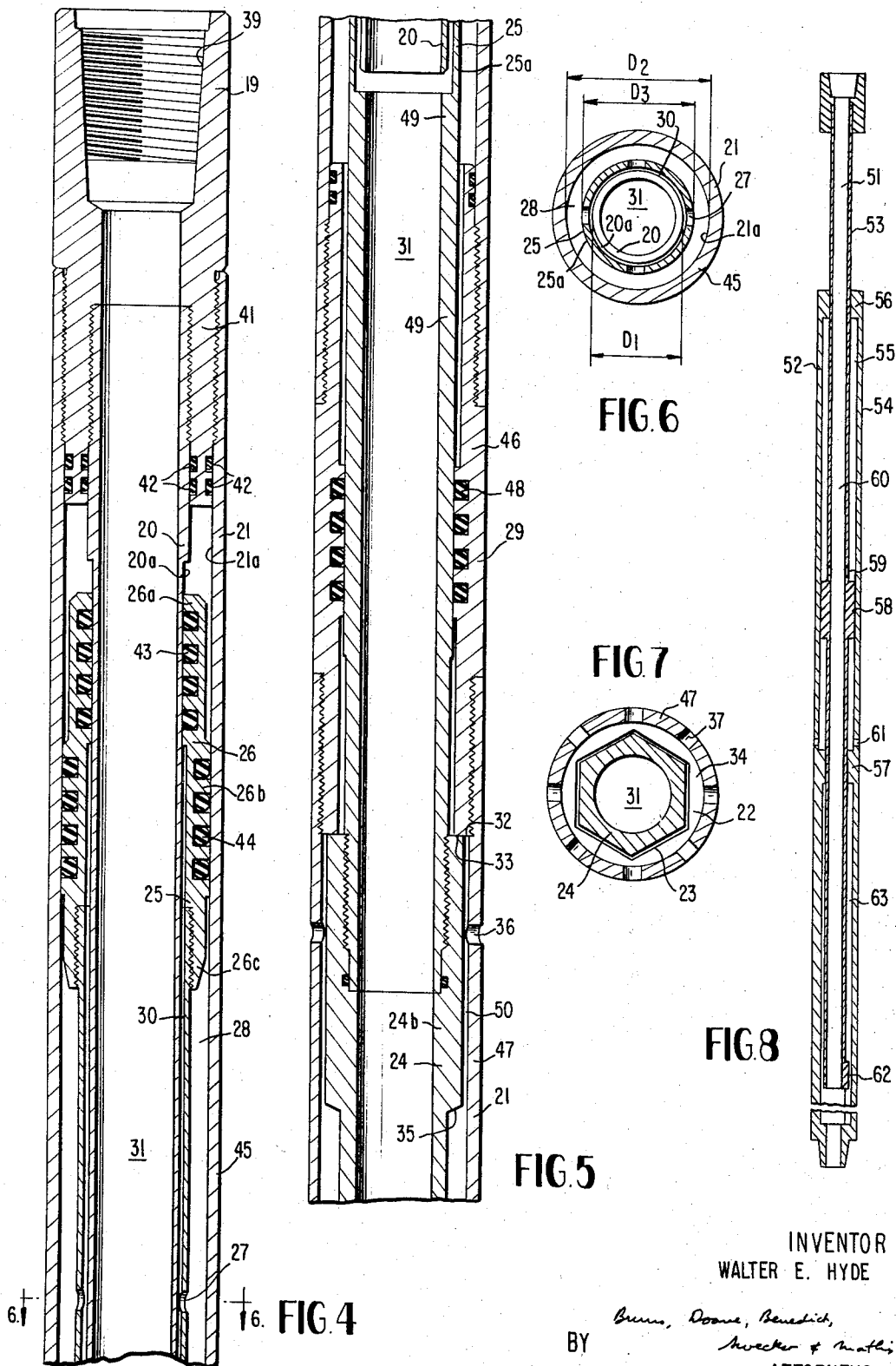
W. E. HYDE

3,354,950

METHOD AND APPARATUS FOR ACCOMMODATING TELESCOPING ACTION

Filed Feb. 25, 1965

2 Sheets-Sheet 2



INVENTOR
WALTER E. HYDE
BY *Burns, Doane, Benedict,
Swecker & Mathis*
ATTORNEYS

1

3,354,950

METHOD AND APPARATUS FOR ACCOMMODATING TELESCOPING ACTION

Walter E. Hyde, Duncan, Okla., assignor to Halliburton Company, Duncan, Okla., a corporation of Delaware
Filed Feb. 25, 1965, Ser. No. 435,152
10 Claims. (Cl. 166—5)

ABSTRACT OF THE DISCLOSURE

Apparatus for use in offshore wells including telescoping conduit portions associated with a well tool assembly. The apparatus including packer means and a mechanism for transferring fluid between the interior of the telescoping conduit and a reservoir carried by the conduits so as to maintain substantially the same pressure within the interior of the conduits as they undergo telescoping movement.

A method of accommodating the telescoping movement of conduits associated with a packer anchored within a well. In response to volume changes within the telescoped conduits resulting from their telescoping movement, fluid is transferred between the conduit interior and the reservoir carried by the telescoped conduits while one conduit remains anchored by a packer.

General background of invention

This invention relates to method and apparatus for accommodating telescoping action of relatively movable, fluid filled components. In particular, it relates to such method and apparatus which find particular utility in accommodating the telescoping movement of components of a slip joint incorporated in a conduit string extending from a floating platform to a submerged well.

The drilling and completion of submerged wells in offshore locations engenders unique and particularly vexatious problems. Many such problems are attributable to the rise and fall of floating platforms which are often used to support conduit strings which extend downwardly to submerged well locations. Such rising and falling action tends to impart undesirable axial movement to a conduit string.

It has heretofore been recognized that telescoping or slip joints may be incorporated in conduit strings so as to accommodate the rise and fall of buoyant platforms from which conduit strings extend. Such slip joints prevent the transmission of axial conduit string movement to well tools supported on the lower end of the strings within well bores.

Telescoping or slip joints previously utilized have, in and of themselves, created certain operational problems. In general these problems have involved changes in the interior volume of conduit strings, which changes of necessity affect the pressure of fluid contained within the strings. In many instances such pressure changes tend to adversely affect the use of well tools carried by the conduit strings or otherwise impede operations being conducted in submerged wells.

Other problems have been presented where slip joints have been incorporated in wells beneath a submerged well head. Movement of the components of a slip joint thus disposed may tend to produce changes in the pressure of fluid contained within the well annulus, i.e. fluid external to the slip joint. These changes may tend to produce deleterious results with respect to well apparatus exposed to the pressure of annulus fluid.

General summary of invention

Recognizing the need for improved telescoping or slip joint structure, it is an object of the present invention to

2

provide improved telescoping connections for incorporation in a conduit string, and methods of utilization thereof, which substantially obviate or minimize problems of the type heretofore noted.

It is a particular object of the invention to provide such methods and apparatus which enable relative telescoping movement of fluid filled conduit portions without substantially affecting the pressure of fluid contained therewithin.

It is a further object of the invention to provide such improved methods and apparatus by means of which the volume of fluid contained within a conduit string having telescoping portions remains substantially constant while telescoping action of these portions occurs.

It is yet another object of the invention to provide such improved methods and apparatus by means of which changes in the pressure of fluid contained within a conduit system does not substantially change the axial force imposed upon well tools supported at the lower end of the conduit string.

A still further and related object of the invention is to provide such improved methods and apparatus by means of which telescoping movement of components within a confined fluid body will not tend to produce substantial changes in the pressure of fluid within this body.

In accomplishing the foregoing objectives there is presented through this invention methods and apparatus for accommodating the telescoping action of relatively movable portions of conduit means.

One aspect of the invention relates to apparatus comprising first and second conduit means which are telescopically assembled. The interior of the conduit means is adapted to be filled with a substantially non-compressible fluid. A reservoir or cavity means carried by the telescopically assembled conduit means is adapted to contain non-compressible fluid in fluid communication with the interior of the assembled conduit means. Means are carried by the telescopically assembled conduit means for transferring volume of fluid between the reservoir and the interior of the conduit means, with the volume of fluid transferred being equal to the change in the volume of the interior of the assembled conduit means resulting from their telescoping movement.

Another independently significant aspect of the invention relates to the mode of operation of the components of the apparatus above described.

A particularly significant aspect of the invention involves structure by means of which the aforesaid volume of fluid is transferred between the conduit means carried reservoir and the interior of the conduit means. This structure comprises piston means carried by one of the conduit means and adapted to move through the reservoir, i.e. cavity means in response to telescoping movement of the first and second conduit means. This movement of the piston means is such as to cause the volume of a portion of the reservoir to change by an amount equal to the change in volume of the interior of the conduit means resulting from their telescoping movement. The volume change of this portion of the reservoir is such that a particular volume increase within the interior of the conduit means is accompanied by a decrease in volume of the same magnitude in the reservoir portion. Conversely, a decrease in the interior volume of the conduit means is accompanied by a corresponding increase in the volume of the aforesaid portion of the reservoir.

Other independently significant aspects of the invention pertain to arrangements whereby pressure changes in fluid contained within a conduit string do not substantially affect the axial loading on the lower end of the string.

The apparatus involved in this aspect of the invention includes telescopically assembled first and second conduit means. Annular seal means sealingly and slidably inter-

connect the first and second conduit means. Cavity means are carried by the first and second conduit means. Fluid reactive surface means carried by one of the conduit means faces the portion of the one conduit means extending away from the telescopically assembled portions of the first and second conduit means. In the normal well installation, this surface means will face downwardly. This surface means has a fluid reactive area extending transversely of the axis of telescoping movement of the conduit means, which area is generally equal to the cross sectional area of the interior of the annular seal means extending transversely of the axis of telescoping movement.

The significant method facet of the invention related to the operation of this apparatus involves the automatic exertion of a hydraulic force on the one conduit means which is substantially equal to a fluid pressure induced change in axial force imposed upon the first conduit means, but directed oppositely thereto.

In describing the invention reference will be made to preferred embodiments illustrated in the application drawings.

In these drawings:

FIGURE 1 is a schematic, fragmentary, partially sectioned, and elevational view of an offshore installation including floating work platform and a conduit string provided with telescoping portions extending downwardly into a submerged well;

FIGURE 2 is a schematic, partially sectioned, and enlarged elevational view of one embodiment of a telescoping or slip joint which may be advantageously incorporated in a conduit string as generally shown in FIGURE 1, with the components of the joint being illustrated in a relatively converged condition;

FIGURE 3 is a schematic and partially sectioned elevational view of the telescoping joint components shown in FIGURE 2, with these components being disposed in a partially extended condition;

FIGURE 4 is a fragmentary, sectioned and still further enlarged elevational view of a portion of the FIGURE 2 assembly as indicated in FIGURE 2;

FIGURE 5 is an enlarged, fragmentary, and sectioned view of another portion of the FIGURE 2 assembly as indicated in FIGURE 2;

FIGURE 6 is a transverse, sectional view of a portion of the FIGURE 2 assembly as viewed along the section line 6—6 of FIGURE 4;

FIGURE 7 is an enlarged, transverse, sectional view of a rotary force transmitting portion of the FIGURE 2 assembly as viewed along the section line 7—7 of FIGURE 2; and

FIGURE 8 is a schematic, partially sectioned, elevational view of another embodiment of a telescoping joint incorporating advantageous aspects of the invention.

Representative context of invention

FIGURE 1 schematically represents a typical offshore installation comprising a floating platform 1 supporting a derrick 2 and associated equipment hoisting and lowering apparatus.

Floating support 1 is positioned over a submerged well 3 which may be at least partially lined with casing 4 as generally shown. Submerged well head means 5 caps the well 4 at the submerged surface level 6.

The apparatus shown in FIGURE 1 is arranged for the conducting of pressure testing in connection with apparatus which may be used for operations such as well cementing.

The apparatus includes pump means 7, a conduit string 8 which extends generally downwardly from the floating platform 1 into the well 4, and connecting conduit and coupling means 9 which place the string 8 in fluid communication with the pump means 7.

Conventional well head seal means 10, incorporated in well head means 5, includes conventional annular seal

means which slidably and sealingly receives the conduit string 8 so as to allow the slidable passage of the string 8 into the well interior 11 and permit rotation of this string.

String 8 carries a telescoping joint 12 disposed within the well interior 11. A conventional, selectively expandable and retractable packer 13 is carried by the string 8 below the telescoping joint 12. As shown in FIGURE 1, packer 13 has been expanded radially outwardly into gripping and sealing engagement with the well periphery so as to isolate the annular space 14 (the space encircling a portion of the string 8 including the telescoping joint 12 between the annular seal 10 and the packer 13) from the portion 15 of the well interior beneath the packer 13.

As will be appreciated, the annular space 14 when filled with fluid, is, in effect, a fluid body isolated from the body of water 16 above the well head 5 and the well interior space 15 below the packer 13.

Packer 13 may comprise any of several conventional, commercially available packer structures including a central passage communicating with the interior of the conduit string 8 and provided with selectably operable valve means to control flow through this passage. In any of several well-known fashions, such packer carried valve means may be operated through appropriate manipulations of the conduit string 8 so as to cause either closing or opening of the packer valve and thus isolate the interior portion of the conduit string 8 above the packer valve from the portion of the conduit string below this valve.

Prior to the conducting of well cementing, i.e. the transmission of cement under high pressure into the well interior space 15 below the packer 13, it is desirable to pressure test the components of the string to insure that they will be able to perform properly during the cementing operation. In conducting such pressure testing, the interior of the string 8 will ordinarily be filled with a substantially non-compressible fluid such as drilling mud, the packer valve closed, and high pressure imparted to the fluid filling the string 8 and connecting conduit means 9 by the pump means 7.

The telescoping joint 12 includes two conduit-like, principal components, i.e. upper conduit means component 17 and a lower conduit means component 18 telescopically received in the lower end of the component 18.

The normal rise and fall of the floating platform 1 causes axial reciprocation of the upper portion 8a of the conduit string which extends upwardly from and is connected with the upper component 17 of the telescoping joint 12. This movement of the conduit string portion 8a causes reciprocating movement of the component 17 of the telescoping joint 12. The telescopic nature of the components 17 and 18 allows the lower component 18 of the telescoping joint 12 to remain stationary. Thus, the axial movement of the upper portion 8a of the conduit string is not transmitted to the stationary lower portion 8b of the conduit string, which lower portion is connected with and extends downwardly from the telescoping joint component 18 and is anchored in the well 3 by the packer 13.

Principal aspects of telescoping joint

The aspects of the FIGURE 1 installation with which this invention is concerned involve the slip joint 12. These aspects relate to the telescoping action of the components 17 and 18 which occurs without substantially affecting the pressure of fluid contained within the interior of the conduit string 8 and which may occur without affecting the pressure of fluid within the annular space 14. Related facets of this invention involve an arrangement whereby pressure changes may be produced in fluid contained within the conduit string 8 while the packer valve is closed without changing the axial loading on the packer 13 or the lower string portion 8b.

Other aspects of the invention relate to the manner in which the components 17 and 18 of the telescoping joint may be manipulated so as to provide the advantages previously noted.

With a representative context of the invention having been delineated, and with it having been established that the invention resides in the structure and mode of operation of the telescoping joint 12, structural and operational details of a representative and preferred slip joint will now be considered with reference to FIGURES 2 through 8.

FIGURES 2 and 3 illustrate one preferred embodiment of the telescoping joint 12. FIGURE 2 shows the principal components 17 and 18 in their relatively converged position while FIGURE 3 shows these components in a partially extended or separated position.

The principal elements of the upper component 17 comprise an uppermost and generally annular head 19, radially spaced and generally concentric inner and outer sleeve portions 20 and 21 respectively, and a collar-like, rotary force transmitting portion 22 having a polygonally configured central aperture 23. As schematically shown, sleeve portions are carried by and extend downwardly from the head 19. Sleeve portion 21 projects below the lower end of sleeve portion 20 and carries the collar portion 22.

Lower component 18 of telescoping joint 12 includes, as a major element, a rotary force transmitting, conduit-like portion 24. Conduit portion 24 has a polygonally configured outer periphery. The polygonal exterior of the portion 24 conforms in general shape to the polygonal configuration of the aperture 23. However, the size of the cross section of the force transmitting portion 24 is somewhat less than the size of the aperture 23 so as to allow the portion 24 to slide axially through the aperture 23 to accommodate the telescoping movement of the components 17 and 18.

The generally mating polygonal configuration of the exterior of the force transmitting portion 24 and the aperture 23 of the collar portion 22 provides the mechanism by means of which rotary force transmitted from the upper string portion 8a is transmitted to the lower string portion 8b through the telescoping joint 12.

An upper, sleeve-like, or tubular, portion 25 of lower component 18 supports, at its upper end, generally annular, piston-like, seal means 26. An inner edge 26a of this seal means is sealingly and slidably engaged with the outer periphery 20a of the inner sleeve portion 20. An outer edge portion 26b of the seal means 26, is sealingly and slidably engaged with the inner periphery 21a of the outer sleeve portion 21. The length of the sleeve portion 20 is such that piston edge portion 26a remains engaged with the periphery 20a through the travel path of the component 17.

As shown in FIGURE 2, inner sleeve portion 20 is spaced radially inwardly from the sleeve portion 25. These sleeve portions 21, 25 and 20 may be considered as first, second, and third sleeve means of consecutively smaller size.

Beneath, and in relatively close proximity to, the seal means 26 are first passage means comprising one or more radial ports 27 formed in the sleeve portion 25. The intermediate sleeve portion 25 is spaced radially inwardly from the inner periphery of the outer sleeve portion 21 so as to provide an annular cavity or fluid reservoir 28. An annular piston 29 projects radially inwardly from the sleeve portion 21 into slidably and sealing engagement with the outer periphery 25a of the tubular portion 25.

With this arrangement, the cavity 28 is varied in size depending upon the positioning of the piston 29. As upward movement of the piston 29 through the cavity 28 is caused by upward movement of the component 17, fluid contained within the cavity 28 is

displaced through the port means 27 so as to flow through a relatively restricted annular space 30 between the inner sleeve 20 and the tubular portion 25 into the interior 31 of the slip joint 12. Conversely, fluid displaced from the interior 31 of the slip joint 12, resulting from shortening of the conduit string 8 when the joint components 17 and 18 are converged, is transferred through the restricted annular passage 30 and the port means 27 and into the cavity 28.

Downward axial movement of the upper joint component 17 relative to the lower component 18 is limited by engagement of an annular shoulder 32 with a relatively lower annular shoulder 33. As shown in FIGURES 2 and 3, annular shoulder 32 projects radially inwardly from and is carried by the outer sleeve portion 21 while the annular shoulder 33 is carried by and projects radially outwardly from the sleeve portion 25, of the lower component 18.

Upward axial movement of the component 17 relative to the lowermost component 18 is limited by engagement of an annular shoulder 34 with a superposed annular shoulder 35.

As illustrated, shoulder 34 is carried by and projects radially inwardly from the outer sleeve portion 21 while annular shoulder 35 is carried by and projects radially outwardly from the force transmitting portion 24.

As illustrated, movement limiting shoulders 32 and 34 carried by the sleeve portion 21 are disposed on opposite sides of the intermediate portion of the force transmitting section 24 which supports the shoulders 33 and 35.

Shoulder 32, as shown, comprises a lowered end portion of piston 29. Fluid communication between the exterior of the telescoping joint 12 and the lower end of the piston 29 including the shoulder 33 may be provided by second passage means such as the radial ports 36 and 37 which intersect the outer sleeve portion 21 and communicate with an annular cavity portion 38 disposed beneath the shoulder 32 and between the outer periphery of the force transmitting section 24 and the inner periphery of the outer sleeve portion 21.

Structural details of telescoping joint

FIGURES 4 through 7 illustrate structural details of the telescoping joint assembly schematically shown in FIGURES 2 and 3.

As shown in FIGURE 4, for example, head 19 of the telescoping joint may be provided with a conventional, threaded female coupling 39 by means of which the component 17 is threadably secured to the lower end of the upper string portion 8a. A similar and schematically shown threaded portion 40 may be provided on the lower end of the component 18 for threaded engagement with the upper end of the lower string portion 8b.

As further shown in FIGURE 4, inner and outer sleeve portions 20 and 21 respectively of upper component 17 may be threadably connected with a downwardly depending, and inner and outer threaded, annular coupling portion 41. Conventional O-rings 42 may be carried by the coupling portion 41 to insure sealing engagement between the sleeve portions 20 and 21 and the head 19.

Annular seal means 26 may be provided with a plurality of conventional O-rings 43 carried on the inner annular face 26a so as to provide slidably and sealing engagement between the seal means 26 and the sleeve portion 20. Similarly, a plurality of conventional O-rings 44 may be carried by the outer face 26b of the seal means 26 so as to provide slidably and sealing engagement between the seal means 26 and the outer sleeve portion 21.

As will be apparent by reference to FIGURES 2, 3, 4 and 5, sleeve periphery 20a and sleeve periphery 21a are circular and uniform in cross section throughout the portions where they are contacted by the seal means 26.

as it undergoes relative movement with respect to the cavity 28. However, outer sleeve portion 21, for example, may be composite in character and include an upper tubular member 45, a threaded coupling 46 and a lower, generally tubular member 47 which terminates in and supports the force transmitting collar 22.

Coupling 46 defines annular piston 29 and carries a plurality of conventional O-rings 48 which provide slidable and sealing engagement with the outer surface 25a of the sleeve portion 25.

Somewhat similarly, component 18 may be fabricated from a plurality of threadably interconnected components. Thus, sleeve portion 25 may be threadably connected to annular seal means 26 at the upper end of this portion. A relatively thicker and integral continuation 49 of the tubular portion 25 extends downwardly below the lower end of the sleeve 20 and is threadably engaged with the upper end of the force transmitting portion 24 of the lower telescoping joint component 18. The upper end of the force transmitting component 24 is enlarged radially so as to provide the annular shoulders 33 and 35 as generally shown in FIGURE 5.

As shown in FIGURES 4 and 5, the periphery of the sleeve portion 25 above the continuation 49 which engages the piston 29 throughout its travel is circular and uniform in cross section.

As is further shown in FIGURE 5, the outer sleeve portion 21 is spaced radially outwardly from the enlarged portion 24b so as to provide a generally annular cavity 50 communicating with the lower end of the piston 26 (including the annular shoulder 32), the port means 36 and the cavity 38. In this fashion, continuous fluid communication between the piston 26 and fluid disposed externally of the telescoping joint 12 is assured.

As will be further noted by reference to FIGURES 4 and 5, the inner cross section of the inner sleeve portion 20 and the inner cross section of the portions 49 and 24 of the lower component 18 are circular and of the same size so as to define a substantially continuous and uniform flow passage extending axially through the telescoping joint, when the telescoping joint is converged as shown in FIGURES 2 and 5. Obviously, when the telescoping joint components are separated, an intermediate portion of the passage between the lower end of the inner sleeve portion 20 and the upper end of the intermediate portion 49 will be slightly widened to the diameter of the exposed inner periphery of the tubular portion 25.

As a matter of passing interest, it might be noted that the elements of the joint 12 should be assembled so as to provide a vacuum condition between the seal means 26 and the coupling portion 41 in the collapsed joint position shown in FIGURE 4. This will prevent the creation of high air pressure between the seal means 26 and this coupling portion when the component 17 moves downwardly from a raised position.

Significant relationships of piston and telescoping joint interior and other elements

In the assembled apparatus shown in FIGURES 2 through 7, the cross sectional area of the central aperture of the annular seal means 26, measured perpendicular to the axis of reciprocation of the components 17 and 18, and having a diameter D_1 is equal to the annular cross sectional area of the annular cavity or reservoir 28 also measured perpendicular to this axis of telescoping movement and disposed between the diameter D_2 and D_3 as shown in FIGURE 6.

Obviously, the cross sectional area of the central opening of the annular seal means 26 is substantially equal to the cross sectional area of the space bounded by the outer periphery 20a of the inner sleeve portion 20.

The cross sectional area of the central opening of the annular seal means 29 is also preferably equal to the

cross sectional area of the space bounded by the outer periphery of the string portion 8a which passes slidably and sealingly through the annular well head seal means 10. As will thus be appreciated, the cross sectional area of the central opening of the annular well head seal means 10 is substantially equal to the cross sectional area of the central opening of the annular seal means 29 when viewed in the context of the assembled system of FIGURE 1.

Mode of operation of telescoping joint and advantages

With the relationship in cross sectional areas noted, upward movement of the component 17 will in effect enlarge the capacity of the interior space 31 by an amount equal to the reduction in the space 28 caused by the upward movement of the piston 29 through the cavity 28. With the cavity 28 and the interior space 31 filled with fluid, this extension of the telescoping joint will cause the piston 29 to displace a particular volume of fluid from the cavity 28, through the port means 27 and the annular space 30, into the interior space 31. This particular volume will substantially equal the volume enlargement of the space 31. In this manner the space within the string 8 will remain fully filled with fluid.

Conversely, downward movement of the component 17 will cause a volume of fluid to be transferred from the interior space 31 to the cavity 28 so as to maintain the interior of the string 8 filled with fluid without producing any change in pressure in this fluid.

In the manner thus described, telescoping action of the components of the joint 12 caused, for example, by wave action in the vicinity of the floating platform 1, will not affect the extent to which the interior of the string 8 is filled with fluid or the pressure of this fluid except, of course, for changes resulting from differences in hydrostatic pressure attributable to the height of the fluid column above the joint 12.

This phenomena is particularly advantageous in that it prevents converging movement of the elements 17 and 18 of the joint 12 from creating excessive fluid pressure in the space 31 which could tend to damage portions of the string 8, including the joint 12 or well tools carried by the string such as the packer 13. Such pressure changes would be of considerable magnitude in a system where the packer valve was closed, the conduit string was filled with fluid, the connecting conduit 9 was filled with fluid, and the joint component moved through a distance of about several feet. In this connection it should be noted that one form of the joint 12 will accommodate about five feet of movement of the component 17.

With the cross sectional area of the annular space 28 being equal to the cross sectional area of the interior of the seal 26, it will be apparent that any change in pressure in the fluid contained within the space 31 which would change the axial loading on the lower end 8b of the string when this end is closed would be accompanied by an equal and oppositely directed force imposed upon the lower side 26c of the annular seal means 26. In this manner, changes in pressure of fluid contained within the closed string 8 are prevented from changing or adversely affecting the net axial load imposed upon the lower string portion 8b.

With the installation shown in FIGURE 1, where the component 17 may move axially within the confined space 14, the character of the telescoping joint 12 above noted prevents changes in the pressure of the fluid within this body from resulting as a consequence of movement of the joint component 17. With the central opening of the annular seal means 10 and the annular seal means 29 being of the same cross sectional area, the component 17 may undergo telescoping movement relative to the component 18 without producing pressure changes in fluid confined within a fully filled space 14. This, of course, advantageously prevents fluctuations in pressure imposed upon

the packer 13 while telescoping action of the joint 12 occurs. As will also be apparent, this insures that the net area of the component 17 exposed to downwardly directed fluid pressure is equal to the net area of this component exposed to upwardly directed fluid pressure so as to provide an essentially pressure balanced condition for this component, excepting, of course, for the minor differences in applied pressure resulting from the difference in elevation of the upper and lower ends of this component.

The restricted annular passage 30 may be advantageous in tending to prevent sediment from entering the cavity 28 and blocking the transfer port means 27.

The rotary force transmitting coupling, comprising the collar 22 and the force transmitting, polygonal portion 24, provide a structurally simple, yet rugged and effective, mechanism for transmitting high torque loads through the conduit string.

The interior components of the telescoping joint are advantageously arranged so as to maximize the continuity and uniformity of the axially extending interior passage of the telescoping joint 12.

Alternative embodiments and scope of invention

FIGURE 8 schematically illustrates an alternative embodiment of the slip joint 12.

In this embodiment an upper component 51 is carried by the lower end of the upper portion 8a of the conduit string 8, while a lower component 52 carries and is connected with the upper end of the lower portion 8b of the conduit string.

As illustrated, upper component 51 is telescopically assembled within the outer component 52.

Component 51 includes a generally tubular portion 53 which is spaced radially inwardly from a tubular portion 54 of the component 52 so as to provide an annular cavity or reservoir 55 between these components. The upper and lower ends of this cavity are sealed by annular seal means 56 and 57 which project radially inwardly from the tubular portion 54 into slidable and sealing engagement with the outer periphery of the uniform diametered portion 53 of the component 51.

An annular piston 58 is carried by and projects radially outwardly from the tubular portion 53 into slidable and sealing engagement with the inner periphery of the tubular portion 54. Port means comprising one or more radial ports 59 intersect the tubular portion 53 to provide fluid communication between the cavity 55 and the interior space 60 of the joint shown in FIGURE 8. Vent ports 61 intersect the tubular portion 54 immediately above the annular seal means 58.

As in the case of the earlier described embodiment, the transverse cross sectional area of the interior of the seal means 57 is equal to the transverse cross sectional area of the annular space 55. With this arrangement, of course, changes in volume in the interior of the space 59 caused by telescoping movement of the components 51 and 52 will be accompanied by equivalent but opposite changes in volume in the cavity 55. Thus, converging movement of the components 51 and 52 will cause fluid to be transferred from the space 59 to the annular cavity or reservoir 55 without changing the extent of filling or pressure of fluid within the string 8. Conversely, extension of the components 51 and 52 will cause a transfer of fluid from the cavity 55 into the interior space 59 through the communicating ports 59.

Rotary force is transmitted through the joint shown in FIGURE 8 by a lug and slot arrangement including one or more lugs 62 carried by and projecting radially outwardly from the component 51. These lugs 62 project into longitudinal slots 63 in the inner periphery of the lower end of the component 52 as schematically shown in FIGURE 8. In this fashion, the components 51 and

52 will transmit rotary force, although they are capable of undergoing relative axial movement.

While the invention has been described with reference to preferred embodiments, those skilled in the well art and familiar with the disclosure of this invention may well recognize other modifications, or additions, deletions, or substitutions which would fall within the purview of the invention as defined in the appended claims.

I claim:

1. An apparatus to allow relative movement between portions of offshore well conduit means, said apparatus comprising:

first conduit means;

second conduit means telescopically assembled with said first conduit means and defining a hollow interior;

annular seal means sealingly and slidably interconnecting said first and second conduit means and having an interior slidably engaging one of said conduit means;

means carried by said assembled first and second conduit means and defining radially spaced wall portions of cavity means, said cavity means having a cross sectional area generally perpendicular to the direction of telescoping movement of said first and second conduit means generally equal to the cross sectional area of the interior of said annular seal means extending perpendicular to said direction of telescoping movement;

piston means carried by one of said conduit means and adapted to move through said cavity means in response to said telescoping movement so as to cause the diminishing of the volume of a portion of said cavity means in response to the enlargement of the interior volume of said assembled first and second conduit means when said first and second conduit means are relatively separated and so as to cause enlargement of the volume of said portion of said cavity means in response to the diminishing of the interior volume of said assembled first and second conduit means when said first and second conduit means are relatively converged;

passage means providing fluid communication between the interior of said assembled first and second conduit means and said cavity means;

a conduit string portion connected to and extending upwardly from said first conduit means; and
a well tool assembly including packer means connected with and disposed beneath said second conduit means; said conduit string portion being axially movable; said packer means and said well tool assembly being adapted to engage internal portions of a well so as to secure said second conduit means against axial movement.

2. An apparatus as described in claim 1;

wherein said means carried by said assembled first and second conduit means and defining spaced wall portions of cavity means includes

first sleeve means carried by said first conduit means,

second sleeve means carried by said second conduit means and spaced radially inwardly of said first sleeve means, and

third sleeve means carried by said first conduit means and spaced radially inwardly of said second sleeve means;

wherein said annular seal means is carried by said second sleeve means and projects radially outwardly therefrom into slidable and sealing engagement with said first sleeve means and radially inwardly into slidable and sealing engagement with said third sleeve means;

wherein said piston means comprises

an annular piston carried by said first sleeve means

and projecting radially inwardly into slidable and sealing engagement with said second sleeve means;

said annular piston means being axially spaced from said annular seal means; and

wherein said passage means comprises

port means extending radially through said second sleeve means between said annular seal means and said annular piston;

said third sleeve means being adapted to remain in slidable and sealing engagement with said annular seal means throughout said telescoping movement of said first and second conduit means.

3. An apparatus as described in claim 1 including: means connecting said first and second conduit means to prevent relative rotation but permit relative axial movement of said conduit portions.

4. An apparatus as described in claim 3 wherein said means connecting said first and second conduit means comprises:

collar means carried by said first conduit means and including a central aperture having a polygonal cross section; and

a generally tubular portion of said second conduit means having a polygonal exterior configuration generally corresponding in cross section to the polygonal configuration of said aperture of said collar means, with said tubular portion of said second conduit means being slidably disposed within said aperture of said collar means.

5. An apparatus as described in claim 1:

wherein said first and second conduit means, a lower end of said portion of said conduit string, and said well tool assembly are disposed within a submerged well; and

wherein said apparatus further includes well head means at the top of said submerged well sealingly and slidably engaged with said conduit string portion so as to define a sealed annular space within said well beneath said well head means, above said packer means, and surrounding said first and second conduit means;

said conduit string portion extending upwardly to floating support means.

6. An apparatus as described in claim 5:

wherein said conduit string portion has a portion slidably and sealingly engaged with said well head means and has a circular cross section;

wherein said second conduit means has a circular cross section with an outer diameter substantially equal to the outer diameter of said conduit string portion in slidable and sealing engagement with said well head means; and

wherein said piston means is annular, carried by said first conduit means, and slidably engages an outer portion of said second conduit means having said circular cross section.

7. An apparatus for accommodating telescoping action of relatively movable portions of conduit means, said apparatus comprising:

first conduit means;

second conduit means telescopically assembled with said first conduit means;

annular seal means sealingly and slidably interconnecting said first and second conduit means;

cavity means carried by said first and second conduit means;

fluid reactive surface means carried by one of said conduit means, facing the portion of said one conduit means extending away from the telescopically assembled portions of said first and second conduit means, and having a fluid reactive area extending transversely of the axis of telescoping movement of said first and second conduit means generally equal to the cross sectional area of the interior of said an-

nular seal means extending transversely of said axis;

a conduit string portion connected to and extending upwardly from said first conduit means; and

a well tool assembly including packer means connected with and disposed beneath said second conduit means;

said conduit string portion being axially movable;

said packer means of said well tool assembly being adapted to engage internal portions of a well so as to secure said second conduit means against axial movement.

8. An apparatus for accommodating telescoping action of relatively movable portions of conduit means, said apparatus comprising:

first conduit means;

second conduit means telescopically assembled with said first conduit means;

reservoir means carried by said assembled first and second conduit means;

means for transferring a volume of fluid between said reservoir means and the interior of said conduit means, with said volume of fluid being equal to the change in volume of the interior of said conduit means resulting from telescoping movement of said first and second conduit means;

a conduit string portion connected to and extending upwardly from said first conduit means; and

a well tool assembly including packer means connected with and disposed beneath said second conduit means;

said conduit string portion being axially movable;

said packer means of said well tool assembly being adapted to engage internal portions of a well so as to secure said second conduit means against axial movement.

9. A method of enabling fluid pressure within conduit means to be changed without substantially affecting axial force transmitted through said conduit means, said method comprising:

disposing a conduit string having telescoping first and second portions within a well, with the lowermost of said portions having a closed interior beneath said first and second portions;

filling the interior of said conduit string with pressurized fluid;

changing the pressure of said fluid contained with said conduit string; and

exerting an hydraulic lifting force on said lowermost conduit string portion substantially equal to the change in downwardly directed axial force imposed upon said lowermost conduit string portion in response to said pressure change.

10. A method of accommodating telescoping action of relatively movable portions of conduit means at least partially disposed within a well, said method comprising:

disposing a conduit string having telescoping first and second portions within a well, with the lowermost end of said portions having a closed interior beneath said first and second portions;

maintaining one of said portions releasably anchored with packer means to an internal portion of said well;

filling the interior of said conduit string with substantially incompressible fluid communicating with a source of pressurized fluid;

allowing said first and second portions of said conduit string to undergo mutually telescoping movement so as to change the interior volume of said conduit means, while maintaining said interior volume filled with said fluid; and

transferring a volume of said fluid between a reservoir carried by said conduit means and the interior of said conduit means, with said volume of fluid being equal to the change in volume of the interior of said

13

conduit means resulting from said telescoping movement of said first and second portions of said conduit string.

References Cited

UNITED STATES PATENTS

2,373,280	4/1956	Weber	285—302
2,402,157	6/1946	Griswold	285—302 X

5

14

2,417,249	3/1947	Griswold	285—302 X
2,606,003	8/1952	McNeill	175—7
2,838,283	6/1958	Simmonds et al.	175—321 X
3,179,179	4/1965	Kofahl	166—.5
3,195,638	7/1965	Le Rouax	166—.5
3,211,224	10/1965	Lacy	166—.5

CHARLES E. O'CONNELL, *Primary Examiner*.
R. E. FAVREAU, *Assistant Examiner*.