Dec. 29, 1964 R. J. BAUER ETAL 3,163,223

WELLHEAD CONNECTOR

Filed July 26, 1961 3 Sheets-Sheet 1

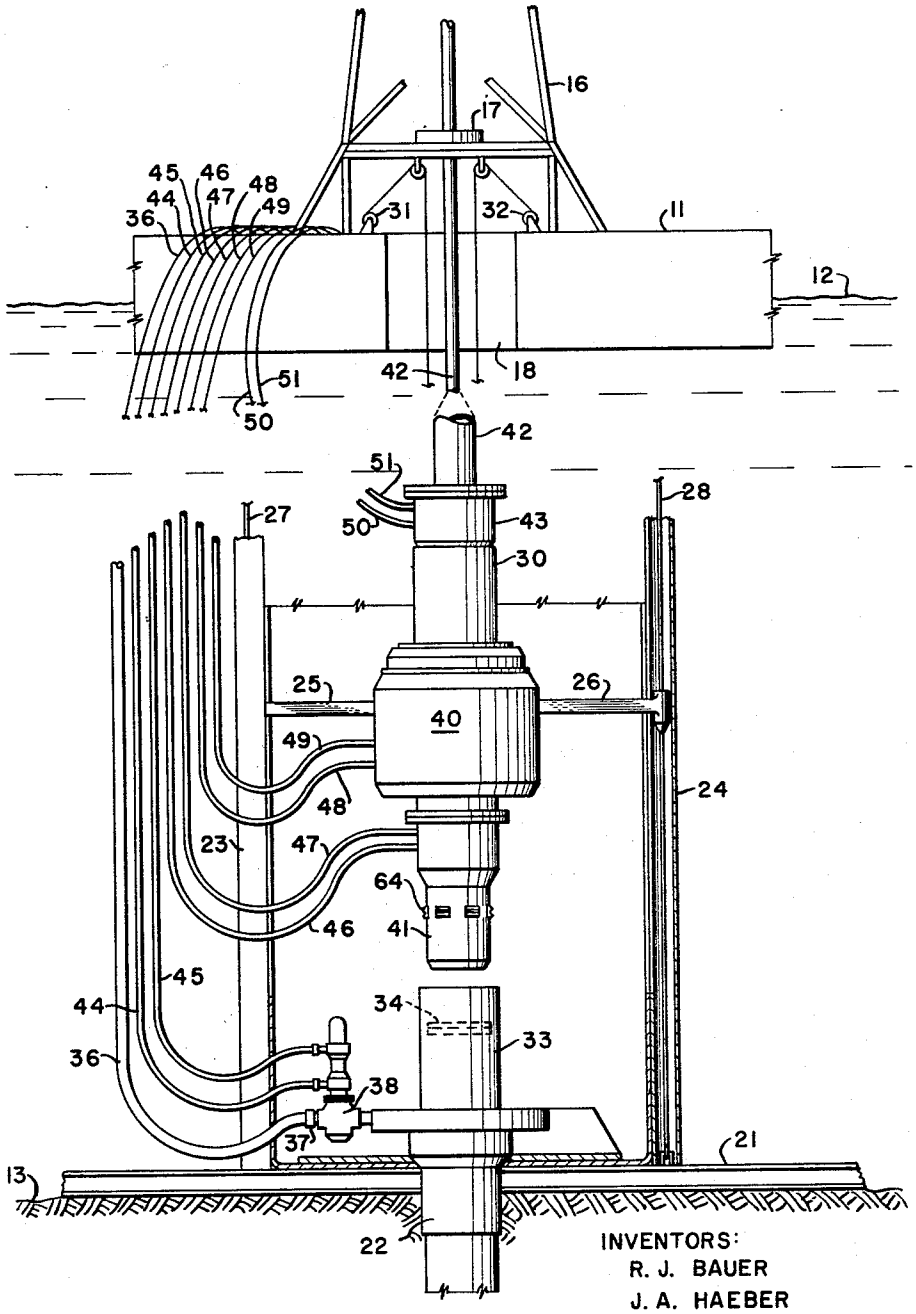

FIG. 1

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WELLHEAD CONNECTOR

Filed July 26, 1961 3 Sheets-Sheet 2

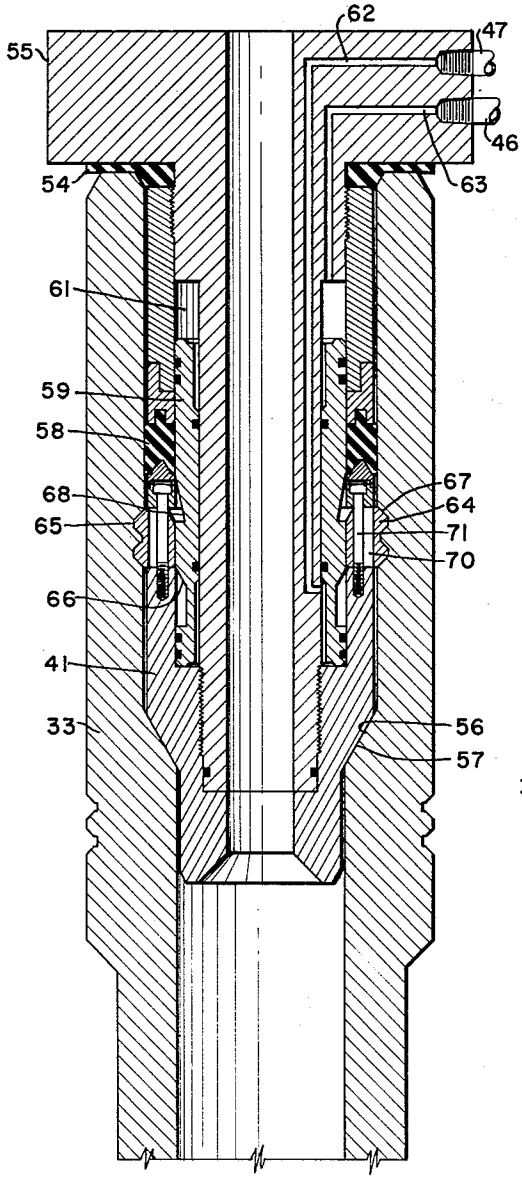

FIG. 2

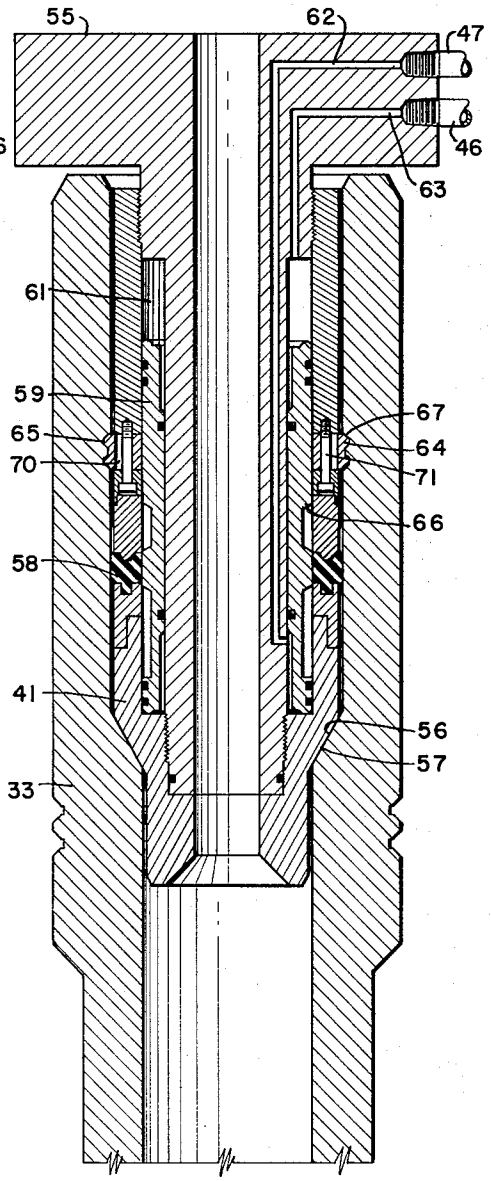

FIG. 3

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Filed July 26, 1961 3 Sheets-Sheet 3

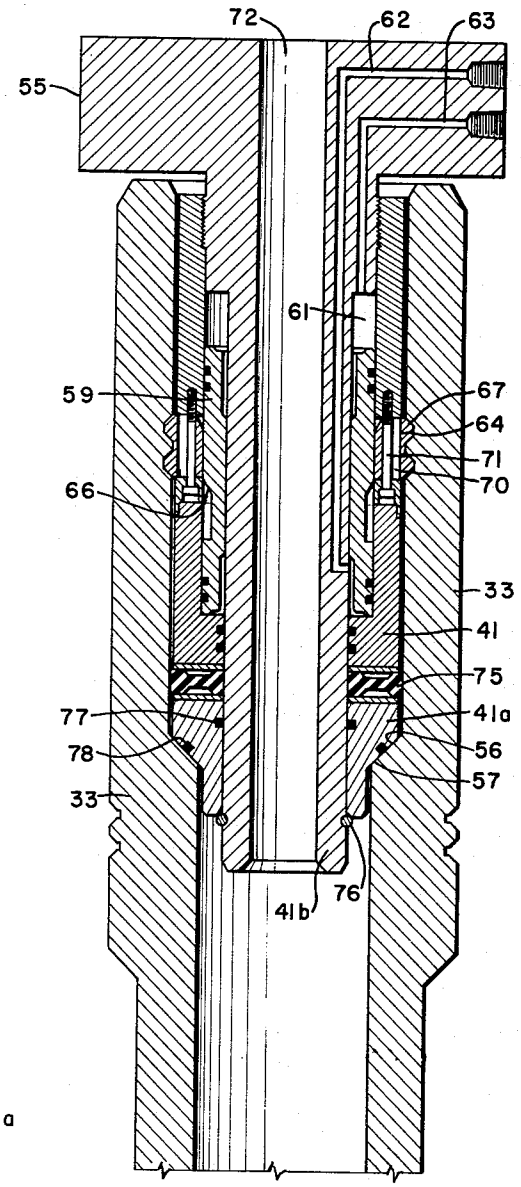

FIG. 4

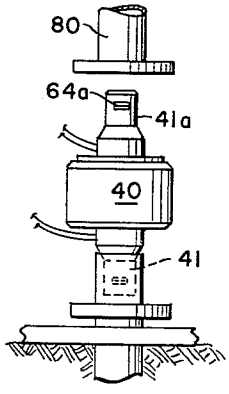

FIG. 5

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WELLHEAD CONNECTOR

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4 Claims. (Cl. 166—66.5)

This invention relates to apparatus for use on offshore wells and pertains more particularly to a wellhead apparatus adapted to be securely locked on a well casinghead positioned underwater. The present invention is especially concerned with apparatus for connecting a wellhead component, such for example as a blowout preventer, to a vertically-extending wellhead component in a securely locked and fluidtight manner so that the wellhead component could not be accidentally separated from the vertically-extending well member.

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 recently made 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 depth at which a diver can easily operate, it has been necessary to design entirely new equipment for this purpose. Thus, when 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," the well casinghead may have attached thereto various pieces of equipment by means of the apparatus of the present invention.

It is therefore a primary object of the present invention to provide apparatus for connecting a wellhead component to an underwater wellhead assembly while operating the apparatus from a remote location.

It is another object of the present invention to provide a wellhead such as a blowout preventer with a connector device so that the blowout preventer may be lowered on guide lines and seated on an underwater well casinghead and securely locked thereto in a fluidtight manner with the sealing and locking operations being carried out from a remote location.

A further object of the present invention is to provide a remotely operable connector apparatus adapted to lock on to an underwater wellhead and pack off the annulus between the connector device and the wellhead.

Another object of the present invention is to provide a remotely-controlled hydraulically-operated connector device and sealing apparatus for holding a wellhead component on a wellhead against pressures which might be encountered therein at any time, even in the event that the hydraulic pressure lines to said apparatus should break, or otherwise become inoperative.

A still further object of the present invention is to provide a wellhead connector device and sealing apparatus which may readily be unlocked from an underwater wellhead and withdrawn to an operational base at the surface, such for example to a drilling barge or platform.

Another object of the present invention is to provide a wellhead connector device adapted to seat on an underwater wellhead and be connected to the inside thereof, rather than the outside thereof, so that the seating and latching surfaces of a well casinghead are isolated in a manner such that they are protected from corrosion, from sea water and from marine growth that would prevent a tool being telescoped over a well casinghead and latched thereon.

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 illustrating a floatable drilling barge positioned on the surface of the ocean from which a blowout preventer together with the connector device of the present invention is being lowered to the top of a well casinghead positioned on the ocean floor; and

FIGURES 2, 3 and 4 are views taken in longitudinal cross-section of several forms of a wellhead connector illustrated as being positioned in a vertically-extending well member in its sealed and latched position.

Referring to FIGURE 1 of the drawing, a drilling barge 11, of any suitable floatable type is illustrated as floating on the surface of the water 12 and fixedly positioned over a preselected drilling location by being anchored to the ocean floor 13 by suitable anchors (not shown). Equipment of this type may be used when carrying on well drilling operations in water depths varying from about 100 to 1500 feet or more. The drilling barge is equipped with a suitable derrick 16 and a rotary table 17 as well as other auxiliary equipment needed during the drilling of a well. The derrick 16 is positioned over a drilling slot or well 18 which extends vertically through the barge in a conventional manner. When using the equipment of the present invention the slot 18 and the barge 11 may be either centrally located or extend in from one edge. However, drilling operations may be carried out over the side of the barge without the use of a slot. Additionally, it is to be understood that the equipment of the present invention may also be used while drilling a well from any suitable operational base positioned above the surface of a body of water, such for example as from a drilling barge having feet extending to the ocean floor, or from a platform permanently positioned on the ocean floor.

A typical underwater wellhead structure is illustrated in FIGURE 1 as comprising a base member 21 which is positioned on the ocean floor 13 and is fixedly secured to a conductor pipe or large-diameter well casing 22 which extends down into a well, which has been previously drilled, and is cemented therein. Thus, the base structure 21 is rigidly secured to the ocean floor in order to support two or more vertically-extending guide columns 23 and 24 adapted to receive and guide therein arms 25 and 26 which are arranged to slide along vertically-extending guide cables 27 and 28. The lower ends of the guide cables 27 and 28 are anchored to the base structure 21 within the guide columns 23 and 24 while extending upwardly through the water to the drilling barge 11 where they are preferably secured to constant tension hoists 31 and 32.

Centrally positioned above the base plate 21 and fixedly secured thereto, or to the conductor pipe 22, is a well casinghead 33 which is also provided with a latching shoulder 34, which may also be in the form of one or more grooves, and extend around the inner wall of the casinghead. The wellhead is also shown as being provided with a cement circulation or kill line 36 which is connected preferably by means of a quick-disconnect coupling 37 to a flow-control valve 38.

The guide arms 25 and 26 are illustrated as being connected to a blowout preventer 40 which is rigidly flanged to a wellhead connector 41 of the present invention. In FIGURE 1 the wellhead connector 41 is shown as it is being lowered into the top of the casinghead 33. The combined blowout preventer and wellhead connector 40 and 41, respectively, are run into position on the top of the well by being lowered through the water from the barge 11 by means of a pipe string 42, commonly known as a running string, the blowout preventer 40 being connected to the lower end of the running string 42 by means of a suitable coupling or connector 43 which may take the form of the wellhead connector 41. The valve 38, connector 41, blowout preventer 40 and connector 43 are all hydraulically operated and are provided with hydraulic flowlines 44 and 45, 46 and 47, 48 and 49, and 50 and 51, respectively. These flowlines, 44 through 51, extend upwardly from the wellhead equipment to the barge 11 where they are connected to a suitable source of pressure fluid.

Referring to FIGURE 2 of the drawing, the wellhead connector 41 is illustrated as being seated in the casinghead 33. A seal 54 may be provided at the top of the casinghead 33 to seal the space between the top of the casinghead 33 and the flange 55 by which the wellhead connector 41 is secured to the bottom of the blowout preventer 40 (FIGURE 1). The sealing element 54 keeps the sea water out of the apparatus. The body of the wellhead connector, preferably near the lower end thereof, is provided with a shoulder seating surface 56 adapted to mate with a landing shoulder 57 formed on the inner wall of the casinghead 33. Alternatively, the seating surface 56 may be formed close to the flange 55, or the flange 55 itself may seat directly on the top of the casinghead 33.

An annular seal 58 is preferably carried on the outer surface of the wellhead connector 41 and is expandable against the inner surface of the casinghead 33 by means of a tubular-shaped piston element 59. The piston 59 is slidably mounted within an annular chamber 61. A pair of conduits 62 and 63 extend through the wellhead connector 41 and are in communication with the upper and lower ends of the chamber 61.

The wellhead connector 41 is also provided with a series of outwardly-extendible locking dogs 64 which are adapted to be forced outwardly into one or more annular grooves 65, cut in the inner face of the casinghead 33, upon downwardly movement of the piston 59. The piston element 59 is provided with a downwardly and inwardly sloping face 66 which forces the dogs 64 into their locking position. The outer upper edge of the locking dogs 64 are preferably bevelled, as at 67, so that the dogs 64 are readily retracted into the wellhead connector 41 upon an upward pull of the wellhead connector 41 with respect to the casinghead 33, after the piston element 59 has been raised to its uppermost position. Although the camming surface 66 of the piston 59 can be utilized to actuate sequentially first the annular seal 58 and then the locking dogs 64, the piston 59 is preferably provided with a second downwardly and inwardly sloping face 68 spaced above face 66 a suitable distance so that the seal 58 and the locking dogs 64 are simultaneously actuated. By using two camming surfaces 66 and 68, the stroke of the piston 59 can be materially shortened.

In order to operate the locking dogs 64 of the present apparatus, it is necessary that a pressure fluid be supplied from the barge 11 (FIGURE 1) down through conduit 46 which is in communication with conduit 63 (FIGURE 2) of the wellhead connector 41. The pressure fluid forces piston 59 downwardly, which in turn actuates the seal 58 and the locking dogs 64. The locking dogs 64 are premitted to extend outwardly a distance equal to the width of a vertical slot 70 in each dog, minus the diameter of a retaining pin 71 which prevents the dog 64 from falling out of the apparatus. To unlock the dogs and unseal the wellhead connector, pressure fluid would be supplied

through conduits 47 and 62 to the bottom of the piston 59 to force the piston upwardly to the top of the chamber 61. The wellhead connector is provided with a vertical bore 72 through which drilling operations may be carried out, or equipment run into the well.

Another form of the present wellhead connector is illustrated in FIGURE 3. This arrangement differs from that described with regard to FIGURE 2 in that the dogs 64 are positioned above the annular seal 58, and the piston 59 has a single camming face 66 which is adapted to actuate sequentially both the locking dogs 64 and the annular seal 58.

A third modification of the wellhead connector of the present invention is illustrated in FIGURE 4. In this embodiment, an annular seal 75 is provided which is expanded against the inner wall of the casinghead 33 when the lower end of the wellhead connector 41*a*, which is slidably mounted on a reduced diameter portion 41*b* of the wellhead connector 41, is forced upwardly. A suitable stop member 76 or anchoring ring is provided on the outer surface of the lower end portion 41*b* of the wellhead connector 41 for preventing the slidable portion 41*a* from dropping off as the apparatus is inserted into a casinghead. If desired, additional seals 77 and 78 may be provided in the vertical wall in the seating shoulder of slidable element 41*a*.

While the blowout preventer 40 (FIGURE 1) of the present invention has been described with regard to having a wellhead connector 41 secured to the lower end thereof for locking the blowout preventer into the top of a well casinghead, it is to be understood that the blowout preventer could have a similar wellhead connector 41*a* (FIGURE 5) extending upwardly therefrom to receive and lock thereon the lower end of a large diameter pipe string or marine conductor 80 which would extend from the wellhead to a point above the surface of the water, as to a barge. Use of a second wellhead connector at the top of a blowout preventer which was already positioned in a well, would greatly simplify running additional pipe strings down into communication with the top of the blowout preventer since it would eliminate the necessity of running additional hydraulic lines down with the pipe string.

This application is a continuation-in-part of copending patent application, Serial No. 834,096, filed August 17, 1959, now Patent No. 3,064,735.

We claim as our invention:

1. An apparatus for facilitating underwater wellhead operations which in assembly compirses a vertically projecting tubular well member, a blowout preventer adapted to be mounted on the upper end of said tubular well member, a blowout preventer lock-down apparatus secured to at least one end of said blowout preventer coaxial therewith, said lock-down apparatus comprising a cylindrical body member having an axial bore therethrough and being of a size to fit into the open upper end of said vertically projecting tubular well member, outwardly extending shoulder means formed on the outside of said body member, said shoulder means having a diameter greater than that of at least a portion of the bore of said tubular well member in which it fits, locking means movably carried by said body member and being bodily movable outwardly thereof so that a portion of said locking means projects beyond the surface of said body member toward and into contact with seating groove means in the inner surface of said well member, annular seal means carried outwardly on said body member adapted to form a fluidtight seal with a surrounding well member, and actuating means carried by said body member for operatively engaging said locking means, said actuating means being movable with respect to said body member in response to fluid pressure application thereto to move said locking means outwardly of said body member into locking position with a surrounding well member thereby preventing separation of said body member and said well member, said apparatus containing pressure fluid port

means in fluid communication on one end with the actuating means in said body member with the other end extending through the wall of said body member and adapted to communicate with a source of pressure fluid.

2. An apparatus for facilitating underwater wellhead operations which in assembly comprises a vertically projecting tubular well member, a blowout preventer adapted to be mounted on the upper end of said tubular well member, a blowout preventer lock-down apparatus secured to at least one end of said blowout preventer coaxial therewith, said lock-down apparatus comprising a cylindrical two-piece body member having upper and lower portions with an axial bore therethrough and being of a size to fit into the open upper end of said vertically projecting tubular well member, the upper portion of said body member having a downwardly extending tubular element, the lower portion of said body member being mounted on said downwardly extending tubular element for limited axial slidable movement relative to said upper portion, an annular resilient seal carried by said body member between the upper and lower portions thereof, said seal being of a diameter to project beyond the outer surface of said body member when compressed between said upper and lower portions thereof, outwardly extending shoulder means formed on the outside of the lower portion of said body member, said shoulder means having a diameter greater than that of at least a portion of the bore of said tubular well member in which it fits, locking means carried by said body member and being bodily movable outwardly thereof so that a portion of said locking means projects beyond the surface of said body member toward and into contact with seating groove means in inner surface of said well member, and actuating means carried by said body member for operatively engaging said locking means, said actuating means being movable with respect to said body member in response to fluid pressure application thereto to move said locking means outwardly of said body member into locking position with a surrounding well member thereby preventing separation of said body member and said well member, said apparatus containing pressure fluid port means in fluid communication on one end with the actuating means in said body member with the other end extending through the wall of said body member and adapted to communicate with a source of pressure fluid.

3. An apparatus for facilitating underwater wellhead operations which in assembly comprises a vertically-projecting tubular well fitting, a blowout preventer adapted to be mounted on the upper end of said tubular well fitting, a blowout preventer lockdown apparatus secured to each of the upper and lower ends of said blowout preventer coaxial with the bore therethrough, each said lockdown apparatus comprising a cylindrical body member having an axial bore therethrough and being of a size to fit into the open end of said vertically-arranged tubular well fitting, outwardly extending shoulder means formed on the outside of said body member, said shoulder means having a diameter greater than that of at least a portion of the bore of said tubular well fitting in which it fits, locking means carried by said body member and being bodily movable outwardly thereof so that a portion of said locking means projects beyond the surface of said body member toward and into contact with seating groove means in inner surface of said well fitting, and actuating means carried by said body member for operatively engaging said locking means, said actuating means being movable with respect to said body member in response to fluid pressure application thereto, apparatus containing pressure fluid port means in fluid communication on one end with the actuating means in said body member with the other end extending through the wall of said body member and adapted to communicate with a source of pressure fluid.

4. An apparatus for facilitating underwater wellhead operations which in assembly comprises a vertically projecting tubular well member, a blowout preventer adapted to be mounted on the upper end of said tubular well member, lockdown apparatuses secured to the top and bottom of said blowout preventer coaxial therewith, the lower lockdown apparatus comprising a cylindrical body member having an axial bore therethrough and being of a size to fit into the open upper end of said vertically projected tubular well member, the upper lockdown apparatus comprising a cylindrical body member having an axial bore therethrough and being of a size to fit into the open lower end of a vertically-disposed well member, outwardly extending shoulder means formed on the outside of each of said body members, said shoulder means having a diameter greater than that of at least a seating portion of the bore of said tubular well member, locking means carried by each of said body members and being bodily movable outwardly thereof so that a portion of said locking means projects beyond the surface of said body member toward and into contact with seating groove means in inner surface of said well member, and actuating means carried by each of said body members for operatively engaging said locking means, said actuating means being movable with respect to said body member in response to fluid pressure application thereto to move said locking means outwardly of said body into locking position with a surrounding well member thereby preventing separation of said body member and said well member, said apparatus containing pressure fluid port means in fluid communication on one end with the actuating means in said body member with the other end extending through the wall of said body member and adapted to communicate with a source of pressure fluid.

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