Dec. 7, 1965 J. A. HAEBER 3,222,088

WELLHEAD CONNECTOR WITH DIAGONALLY DIRECTED LATCHES

Filed Oct. 30, 1961 4 Sheets-Sheet 1

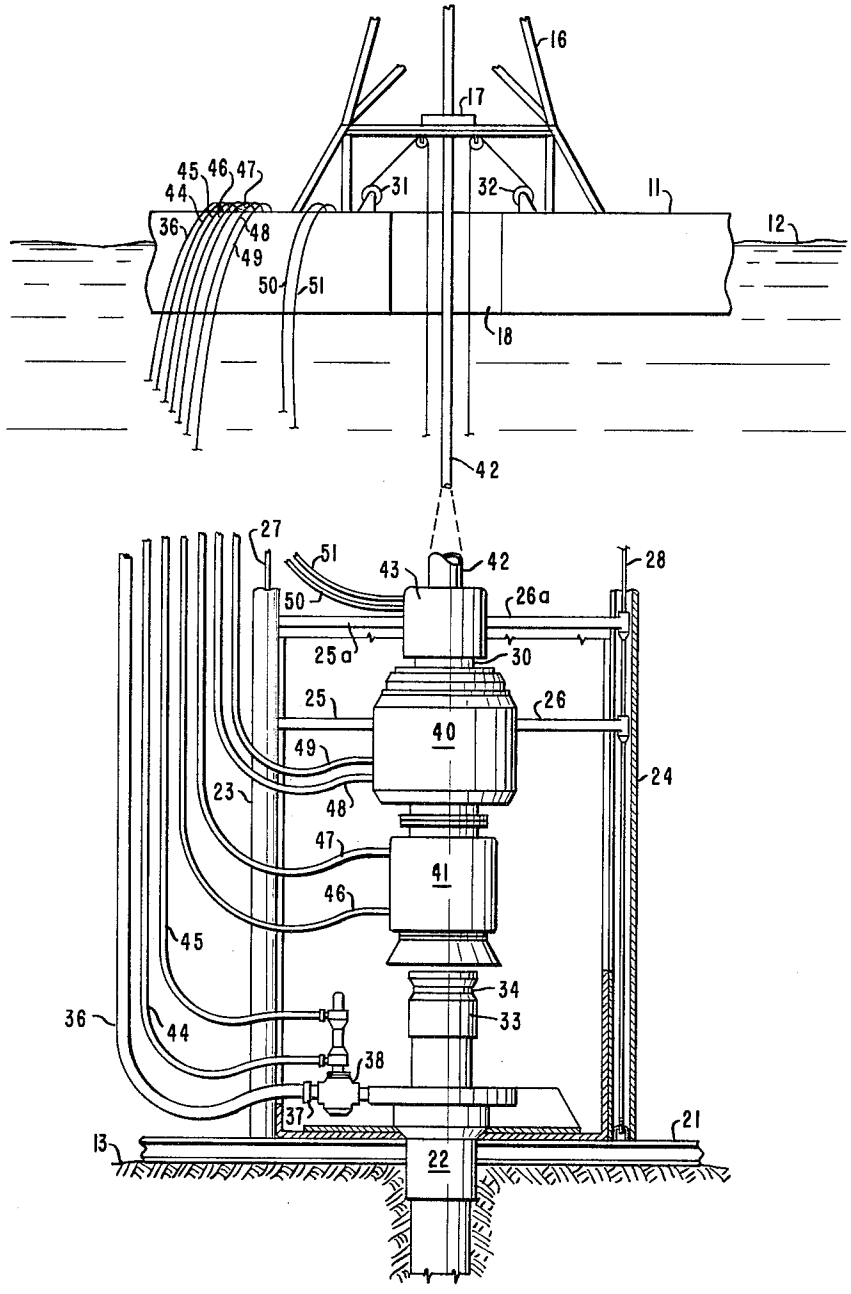


FIG. 1

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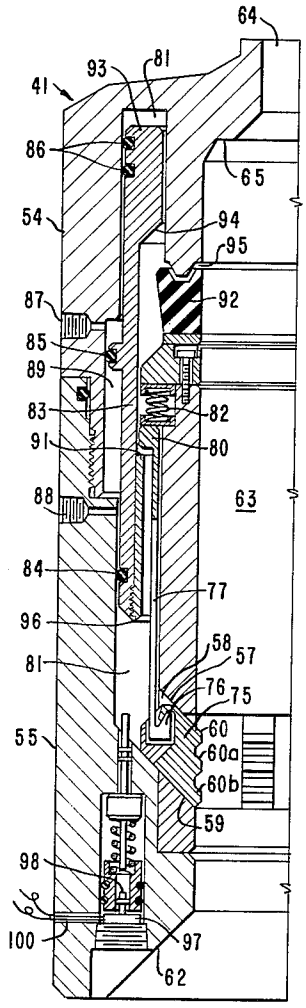


FIG. 2

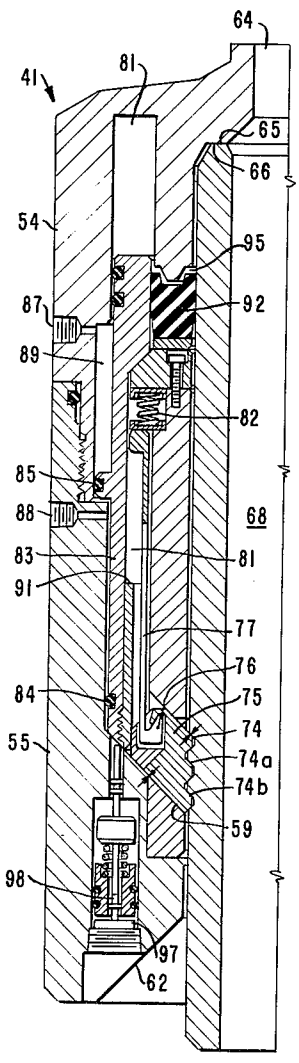


FIG. 3

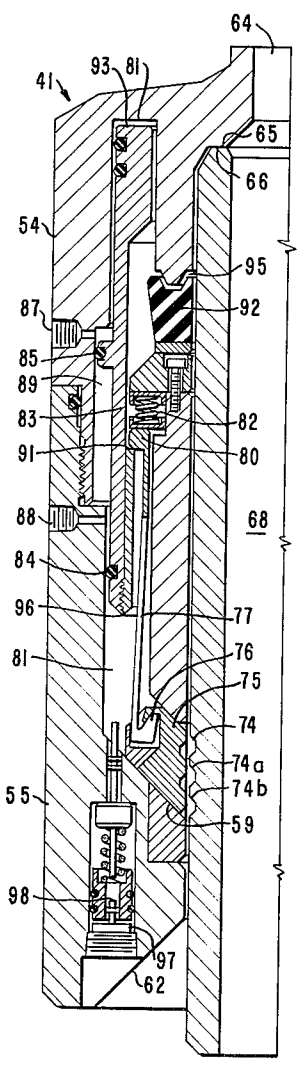


FIG. 4

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WELLHEAD CONNECTOR WITH DIAGONALLY DIRECTED LATCHES

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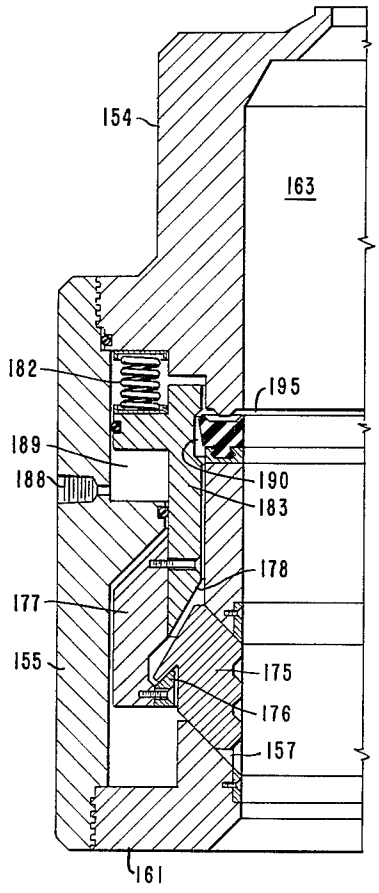


FIG. 5

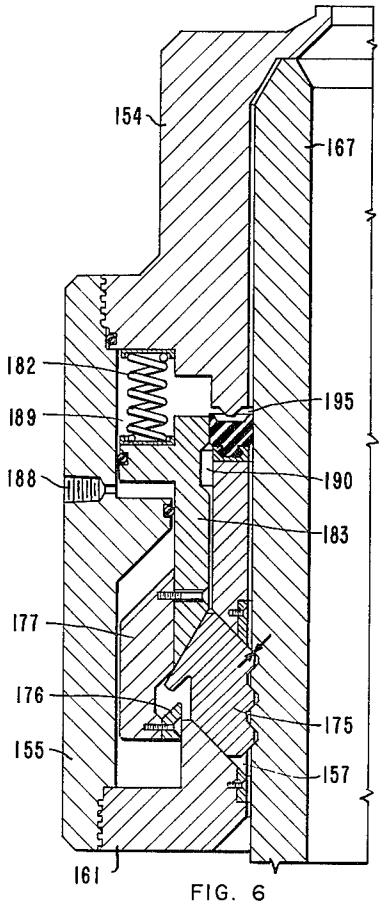


FIG. 6

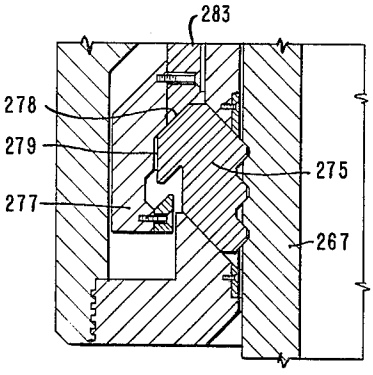


FIG. 7

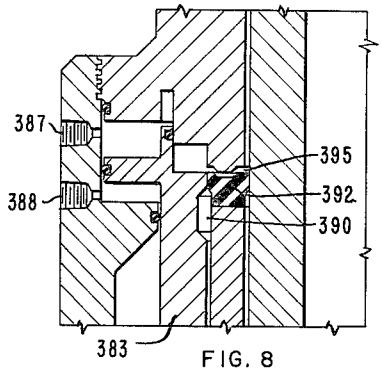


FIG. 8

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WELLHEAD CONNECTOR WITH DIAGONALLY DIRECTED LATCHES

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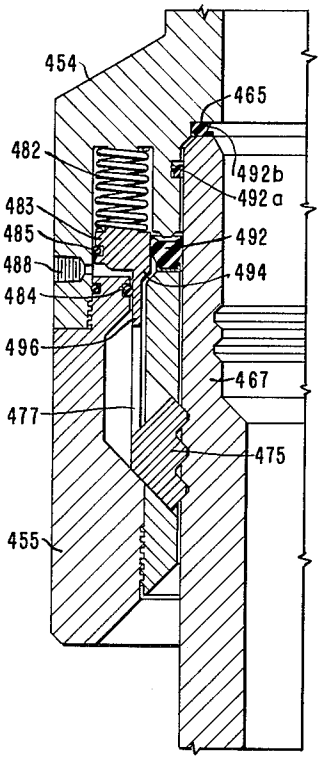


FIG. 9

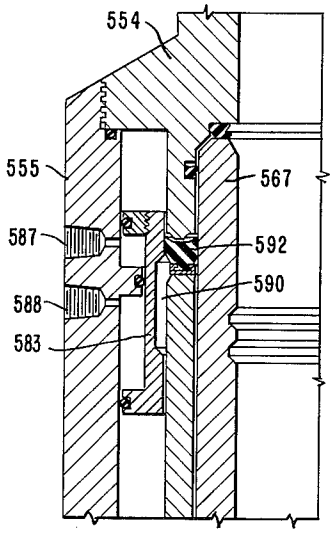


FIG. 10

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United States Patent Office 3,222,088 Patented Dec. 7, 1965

3,222,088

WELLHEAD CONNECTOR WITH DIAGONALLY DIRECTED LATCHES

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Filed Oct. 30, 1961, Ser. No. 148,492
2 Claims. (Cl. 285—18)

This invention relates to apparatus for use in offshore wells and pertains more particularly to a wellhead apparatus adapted to be securely locked on a well casinghead position under water. 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 fluid tight 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 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 casing head and subsequently the wellhead assembly and casing 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 at 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 well or a gas well at an offshore location, the well casinghead may have attached to it pieces of equipment by means of the apparatus of the present invention.

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

It is another object to the present invention to provide a wellhead component, such as a blowout preventer with a connector device, so that after the blowout preventer is lowered and seated on an underwater well casinghead it can be securely locked and sealed thereto in a fluid tight manner with the sealing and locking operations carried out from a remote location.

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

Another object to 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 in any time, even in the event that the hydraulic pressure lines to said apparatus should break, or otherwise become inoperative.

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

Another object to the present invention is to provide a wellhead connector adapted to seat on an underwater

wellhead and be connected to the inside or outside thereof, depending on the particular type of operation to be conducted.

A further object of the present invention is to provide a wellhead connector device and sealing apparatus which may be automatically locked to a wellhead assembly wherein any wellhead pressure is utilized to maintain the connector device in a locked position on the wellhead assembly.

Still another object to the present invention is to provide a wellhead connector and sealing device attachable to a wellhead component and being provided with locking means arranged in a manner to block disengagement of the blocking means when forces are applied to separate the connector device and the wellhead component.

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 floating drilling barge positioned on the surface of the ocean in which a blowout preventer together with the connector device of the present invention is being lowered to the top of the well casing positioned on the ocean floor;

FIGURES 2, 3 and 4 are views taken in longitudinal cross section of one-half of one form of a wellhead connector of the present invention, the wellhead connector being illustrated in its running position, set position, and releasing position, respectively, in the three figures;

FIGURES 5 and 6 are views taken in longitudinal cross section of one-half of another form of a wellhead connector of the present invention shown in its unlocked and locked positions respectively;

FIGURE 7 is a fragmental longitudinal view taken in cross section of a modification of the latching device of the connector illustrated in FIGURE 6;

FIGURE 8 is a fragmental view taken in longitudinal cross section of a modification of a piston of the connector shown in FIGURE 6;

FIGURE 9 is a longitudinal view taken in cross section of one-half of another form of the wellhead connector of the present invention; and,

FIGURE 10 is a fragmental view taken in longitudinal cross section of another piston arrangement for actuating the locking element of the connector device to the present invention.

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 the 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 of 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 be also used while drilling a well from any suitable operational base positioned above the surface of the 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 a large-diameter well casing **22** which extends down into a well, which has been previously drilled, and is preferably 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 guide 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 provided with a latching shoulder **34**, which may be in the form of one or more grooves, and extends preferably around the periphery 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 onto 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 coupling or connector **43** is provided with a pair of guide arms **25***a* and **26***a*. The valve **38**, connector **41**, blowout preventer **40**, and connector **43** are all hydraulically operated and are provided with hydraulic flow lines **44** and **45**, **46** and **47**, **48** and **49**, **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** of FIGURE 1 is shown as comprising a body member having upper and lower portions **54** and **55**, respectively, which are connected together in any suitable manner, as by screw threads **56**. Preferably, the lower end of the body portion **55** is provided with an outwardly flaring skirt **62** which surrounds the bore **63** extending upwardly through the body member **54–55**. The upper body portion **54** has a bore **64** of reduced diameter, thus forming a seating shoulder **65** which is adapted to seat on a landing surface **66** (FIGURE 3) formed on the outside of a vertically-extending well member **67**, preferably at the upper end thereof, as illustrated. The well member **67** is provided with a bore **68** therethrough. Formed on the outer surface of the vertically-extending well member **67** are one or more shoulders **74**, **74***a* and **74***b* which may take the form of grooves extending partially or all the way around the well member. The latching shoulders **74**, **74***a*, and **74***b* formed on the well member **67** are positioned down from the top of the well member **67** a distance equal to the distance that a plurality of latching dogs **75**, carried by the body member **54–55**, are positioned from the seating shoulder **65** in the upper body portion **54**.

In the description of the connectors of the present invention, it is to be understood that the connectors are annular in shape and symmetrical in construction so that it is considered sufficient to describe the actuation of a single latching dog **75** thereof while it is to be understood that the body member **54–55** is provided with a plurality of latching dogs arranged in a spaced relationship around the body member and are mounted for simultaneous actuation therein. For each dog **75** carried by the body member **54–55**, a vertically-extending recess **57** is provided in the body portion **55**, each recess **57** being slightly wider than the latching dog **75** contained therein. The recesses **57** extend out of the housing portion **55** in a downward direction which is governed by the design angle of the upper and lower surfaces, **58** and **59**, respectively, of the recess **57**. While the angle of the diagonally-directed surfaces **58** and **59** is illustrated as being substantially a 45° angle, it is to be understood that any suitable angle say from about 25° to 65° from the horizontal may be selected. Although the upper and lower faces **58** and **59** are illustrated as being at the same angle, the angle of the upper surface **58** is not critical and may be at an angle considerably less than that of the lower surface **59**. The lower surface **59** forms the bearing surface governing the angle of movement for the latching dog **75** and forms a diagonally-directed blocking surface on the body member which blocks movement of the latching dog from engagement with the shoulders **74**, **74***a* and **74***b* when forces are applied to separate the body member **54–55** from the well member **67**.

The shoulder-engaging latching or locking dogs **75**, carried by the body member **54–55**, are arranged for diagonal movement along the diagonally-directed or lower surfaces or walls **59** of the recesses **57** into and out of engagement with the latching shoulders **74**, **74***a* and **74***b* of the well member **67**. Whatever angle is selected for the lower edge of the latching dog **75** or the diagonally-directed mating surface **59** of the recess **57**, the contacting face of the dog **75** is preferably vertical and preferably grooved so as to form a plurality of seating and engaging surfaces **60**, **60***a* and **60***b* which are formed of a size and at an angle to engage shoulders **74**, **74***a* and **74***b*, respectively, of the well member **67**. The angle of the engaging surface **60** on the dog **75** and in the angle of the cooperating shoulder **74** are preferably substantially equal to each other and to the diagonally-directed blocking surface **59**, forming the bottom wall of the recess **57**.

The latching dog **75** may be actuated in several ways. As illustrated in FIGURES 2, 3 and 4 of the drawing, the back or upwardly extending end of each dog **75** is operatively connected, as by any suitable means such as a hook or hinge element **76**, to the lower end of a linkage member **77** which is preferably in a form of a spring-like finger or collet which extends upwardly and is mounted for a limited vertical movement in the housing **54–55**. Fixedly secured to the top of each linkage member **77** and movable therewith is a shoulder element **80** which may be an individual element for each linkage member **77**, or which may be in the form of an annular ring mounted for a limited axial movement within the annular chamber **81** formed within the housing or body member **54–55**. A compression spring **82** is mounted above the shoulder **80** for normally urging at all times the shoulder element **80**, linkage member **77** and latching dog **75** downwardly and outwardly into locking position.

Mounted adjacent the shoulder element **80** on the outside thereof within the annular chamber **81** is an annular piston **83** sealingly engaging the inner wall of the body member **54–55** in a fluid tight manner at points **84**, **85**, and **86** where suitable sealing elements such as O-ring seals are employed. A pressure fluid may be supplied through ports **87** and **88** to piston chamber **89** to drive the piston in opposite directions. If desired, only port **88** may be provided for raising the piston, and engaging shoulder **91** fixedly secured thereto on the inner surface thereof, for contacting and lifting the shoulder element **80** which is operatively connected through linkage member **77** to the latching dog **75**. Since the latching dog **75** is spring-loaded at all times to its operative position, as illustrated in FIGURE 2, it is only necessary to provide actuating means for withdrawing latching dogs to their retracted

position as shown in FIGURE 4. It will be seen that under normal conditions with no hydraulic pressure fluid being applied to the connector means, upon failure of pressure fluid supply the spring **82** would maintain a force on a shoulder **80** (FIGURE 3) and hence on the latching dog **75** to maintain the latching dog in a locked position in engagement with the shoulders **74**, **74***a* and **74***b*, thus preventing a relative axial separation of the body member **54–55** from the well member **67**.

The body member **54–55** is provided with an annular packing element or seal **92** for sealing against the outer wall of the well member **67** (FIGURE 3) in a fluid tight manner. The annular seal **92** extends into the annular chamber **81** in which the piston **83** moves but is normally out of contact with the piston **83** when the piston is in its inoperative position, as shown in FIGURE 2. The upper end of the piston **83** is enlarged, as **93**, and is provided with a camming face **94** which is designed to engage the periphery of the packing element **92** as the piston **83** in its enlarged portion **93** moved downwardly past the packing element **92** to a position shown in FIGURE 3. In this position the enlarged portion of the piston **93** maintains the packing element **92** in sealing engagement with the outer surface of the well member **67**.

Fluid passage means **95** of any suitable design are preferably provided through the wall of the body member **54–55** from the bore **63** thereof at the point above the sealing element **92**. In the present arrangement of the apparatus the fluid passage means is shown in the form of an annular space above the packing element **92** which is open at all times, even when the packing element **92** is in sealing engagement with the outside of the well member **67**, as shown in FIGURE 3. It is to be understood that any suitable form of fluid ports could be drilled through the wall of the body member **54–55** from the interior bore **63** thereof at a point above the packing elements **92** to serve for the same purpose. The fluid passage means **95** permits well pressure to be applied to the enlarged portion **93** of the piston **83**, thus maintaining the piston in its downward position, as shown in FIGURE 3, to keep the latching dogs **75** in engagement with the latching shoulders of the well member **67**. Well pressure would pass up the bore **68** of the well member, across the landing surface **66** at the top thereof, down the outside of the well member **67**, through the fluid passage means **95** above the sealing element **92** and thence into the top of the chamber **81** above the enlarged end **93** of the piston **83**.

In latching the connector of the present invention to a well member which has been exposed to underwater conditions for some time, it may be that marine growth or other deposits partially fill the grooves forming the latching shoulders **74**, **74***a*, and **74***b* on the outer face of the well member **67**. In such a case it may happen that one or more of the latching dogs **75** is not completely seated in the grooves of the well member **67**. Thus, in some arrangements of the connector of the present invention it is desirable to provide a downwardly extending end **96** on the piston **93** which is of a design and size that it fits tightly behind the locking dog **75** when the dog **75** is in its outermost position. If the dog is not in its outermost position, downward movement of the piston **82** causes the downwardly-extending end thereof to force the locking dog **75** outwardly all the way. If it is desired to determine whether the piston **83** has been forced to the bottom of its stroke through pressure being applied through port **87**, the body member **54–55** may be provided with one or more electric switches **97** whose contact stem **98** is actuated by a spring-loaded rod **99** which extends upwardly through the body member **54–55** above the lower face **59** of the recess **57** and into the chamber **81**. When the piston **83** is at the lower limit of its travel, its lower end **96** contacts the top of the spring-loaded rod **99** forcing it downwardly to close the switch **87** which would be indicated above the surface of the water on the operating barge. The electrical leads **100** from the switch **97** may be secured to the outer surface of the connector **41** and run up along the side thereof.

In using the connector of the present invention, it would be run in its normal position (FIGURE 2) onto the top of the well member **67** (FIGURE 3), at which time the outer upper edge of the well member **67** would force the latching dog **75** of the connector upwardly into the recess **57** which is possible due to the diagonal sloping of the recesses **57** and the dog **75**. The latching dog **75** would stay in the recess **57** until the body member **54–55** had been lowered so that its seating shoulder **65** was on the landing surface **66** of the well member, at which time the compression springs **82** and the linkage member **77** would force the dogs **75** to snap outwardly and latch in place on the grooves of the well member. In any attempt to cause relative axial separation of the body member **54–55** from the well member **67** while the latching dogs were in place (FIGURE 3), a force component would be exerted by the well member at the latching shoulders thereof directly across the latching dog **75** and be applied to the body member **54–55** through the diagonally-directed lower face **59** of the recess **57**. Since this force component is exerted across the latching dog **75** substantially perpendicular to the diagonally-directed lower face **59** of the recess **57**, or substantially perpendicular to the diagonal direction of movement of the latching dog **75**, there is no tendency for this force component to unlatch the dogs **75** from the well member **67**.

In FIGURES 5 and 6 a more simplified arrangement of the connector of the present invention is illustrated. The body member **154–155** is provided with an endplate **166** in which the recesses **157** are formed. The latching dogs **175** positioned in the diagonally-directed recesses **157** are secured by suitable hinge means **176** to the lower end of a linkage member **177** which is rigidly connected to the lower end of a single-acting piston **183**. The body member **154–155** is provided with a fluid port **188** through the wall thereof in communication with a piston chamber **189**. A compression spring **182** is mounted above the piston **183** and serves to force the piston **183** and the latches **175** into their operating position, as shown in FIGURE 6, wherein the connector is shown as being positioned on a well member **167**. The inner wall of the piston **183** is provided with a recess **190** into which the sealing element **192** expands in its inoperable position. A fluid passage **195** is provided above the sealing element **192** for permitting well pressures to be applied above the piston **183** to aid the spring **182** in forcing the piston **183** downwardly and the locking dogs **175** outwardly when the present connector is latched onto a well member, as shown in FIGURE 6. In order for the piston in FIGURE 5 to achieve the position illustrated, it is necessary to apply a pressure fluid through port **188** into the chamber **189** to raise the piston **183** and the latching dogs **175** to their inoperative position. The lower end of the piston **183** is provided with a camming face **178** which is adapted to engage the upper end of the latching dog **175** and force it outwardly into its operative position, as shown in FIGURE 6.

In a modification of the connector of FIGURES 5 and 6, the piston **283** is shown in FIGURE 7 as being provided at its lower end with both a camming face **278** to force the latching dog **275** into position, and a blocking face **279** which prevents the locking dog **275** from moving out of its operative position when the piston **283**, and the linkage member **277** attached to the bottom thereof, are in their lowermost positions. Thus, there is no way for the locking dog **275** to be moved out of contact with the well member **267**.

In FIGURE 8 another modification of the connector of FIGURE 6 is illustrated wherein a double-acting piston **383** has been provided with fluid ports **387** and **388** for introducing a pressure fluid to opposite sides of the piston. A recess **390** is formed in the inner surface of the piston **383** into which the sealing element **392** can expand in its

inoperative position. Fluid passage means **395** are also included above the sealing element **392** to permit well pressure to act against the top of the piston **383**. In this arrangement, hydraulic pressure must be employed to actuate the piston and any locking dogs (not shown) connected thereto in both directions, since no spring is employed to load the piston and force the locking dogs to their operative position.

In FIGURE 9, another form of a connector is shown which is provided with latching dogs **475** fixedly secured to the lower end of spring-like linkage members **477** which in turn are secured to the lower end **496** of a piston **483**. The piston **483** is sealed in a fluid-tight manner by means of O-ring seals **484** and **485** against the inner wall of the body member **454–455**. A spring **482** above the piston **483** normally forces the piston downwardly together with the attached linkage member **477** and locking dogs **475**. At the same time the camming face **494** on the piston **483** forces the annular sealing elements **492** against the outer surface of the well member **467**. If desired, additional seals may be provided such as static seal **492***a* and a seal **492***b* mounted in compression between the top of the well member **467** and the seating shoulder **465** of the body member **454–455**. In the operation of the connector of FIGURE 9, a pressure fluid normally would be applied through port **488** to raise the piston **483** upwardly, retracting the dogs **475** and allowing the seal **492** to extend inwardly into the body member **454–455**, prior to lowering the connector onto the well member **467**. When the connector **454–455** was seated on the well member **467**, pressure fluid to port **488** would be discontinued, thus allowing spring **482** to force piston **483** downwardly actuating the annular seal **492** and the locking dogs **475**. However, it is to be understood that the connector of FIGURE 9 could also be attached merely by forcing it down on the well member.

Another arrangement of an operating piston **583** is shown in FIGURE 10 wherein hydraulic fluid may be supplied through ports **587** and **588** to drive the piston **583** in opposite directions without the use of a spring. Recess **590** is provided in the opposite wall of the piston to permit the annular sealing element **592** to expand thereinto. When the piston **583** is raised to its uppermost position prior to removing the body member **554–555** from a well member **567**.

I claim as my invention:

1. A wellhead connector assembly comprising

a body member having a passage extending axially therethrough, said body member being positionable and connectible in axially telescopic relation with a longitudinally projecting well member having an axial passage therethrough forming an unimpeded throughbore passing through said body member and said well member, said well member being of a size to fit within the passage of said body member,

cooperating connector means carried in the adjacent walls of said body member and said well member,

one portion of said connector means comprising shoulder means formed on the outer wall of said well member,

the other portion of said connector means comprising shoulder-engaging locking means carried by said body member in recesses in the adjacent wall thereof in a position for registering with said shoulder means, at least the wall of each recess toward the end of the body member which is first in telescopic relation with said projecting well member being diagonally-directed toward said end of said body member,

said locking means being diagonally movable along said diagonally-directed walls of said recesses into and out of engaging relation with said shoulder means,

a plurality of circumferentially-disposed spring-finger actuating means carried by said body member for radial and axial movement relative to said body member and being operatively connected to said locking means when urging said locking means to a locked position in engagement with said shoulder means whereby said engaged locking means prevents relative axial separation of said body member and said well member,

said diagonally-directed walls of said recess blocking movement of the locking means away from engagement with said shoulder means when forces are applied to separate axially said body member and said well member,

blocking means separate from and independent of said actuating means carried within said body member independently and outwardly of said locking means, said blocking means being movable to a position adjacent said locking means to block movement of said locking means from a locked position thereof,

piston means operatively connected to said blocking means for moving said blocking means relative to and independent of said locking means, said body member having conduit means in the wall thereof which pressure fluid is communicable to said actuating means, and

annular packing means carried by one of said members on the wall carrying a portion of said cooperating connector means and axially-displaced therefrom for sealing off between the adjacent walls of said body member and said well member.

2. The apparatus of claim **1** wherein said body member includes port means through the inner wall thereof in communication above said annular packing means between the axial passage in said body member and the space above said piston means whereby well pressure being applied through said port means urges said piston means and blocking means to the blocked position.

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