

Dec. 7, 1965

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3,222,075

UNDERWATER BLOWOUT PREVENTER

Filed Aug. 30, 1961

4 Sheets-Sheet 1

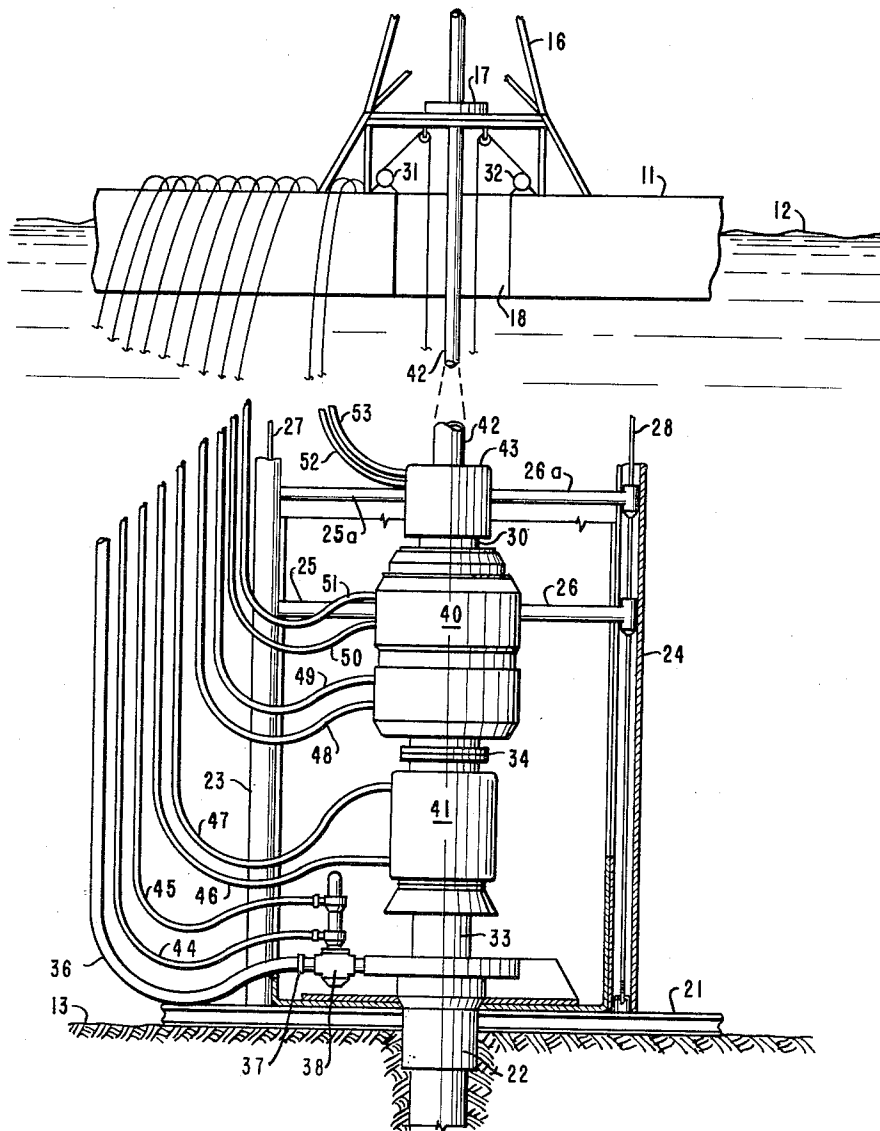


FIG. 1

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4 Sheets-Sheet 2

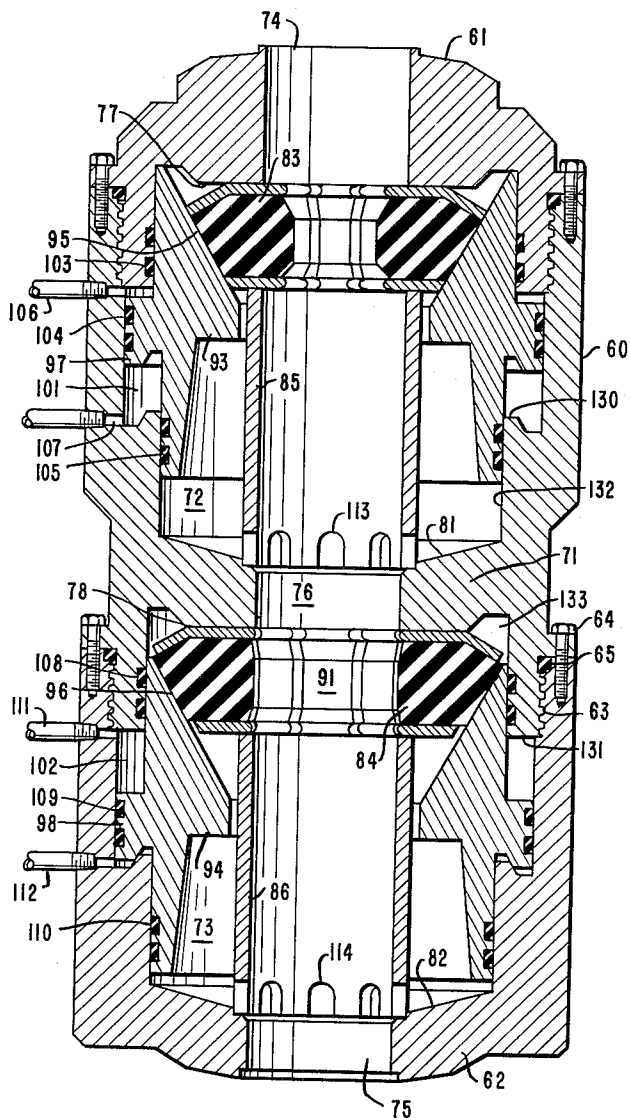


FIG. 2

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4 Sheets-Sheet 3

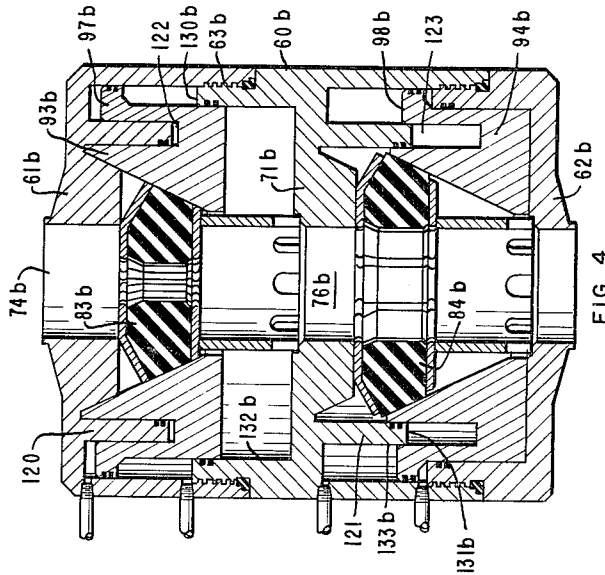


FIG. 4

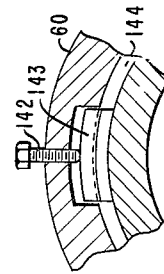


FIG. 9

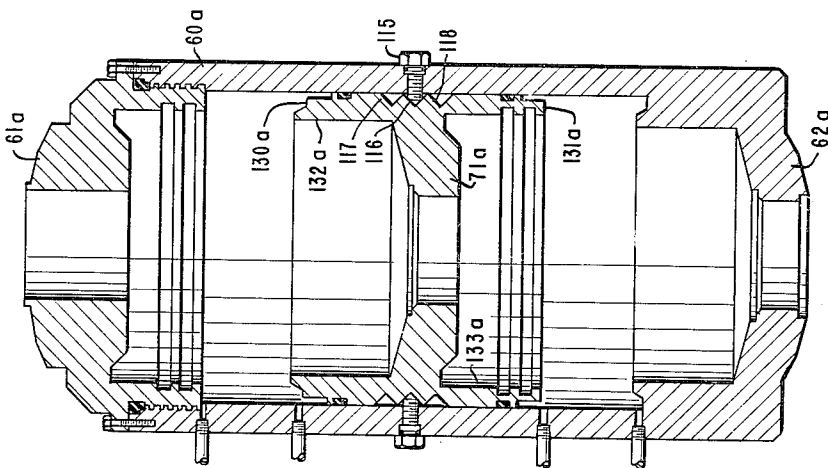


FIG. 3

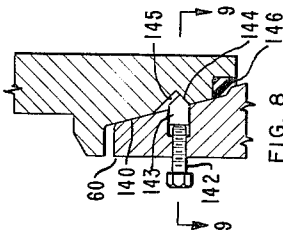


FIG. 8

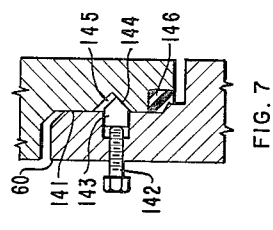


FIG. 7

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4 Sheets-Sheet 4

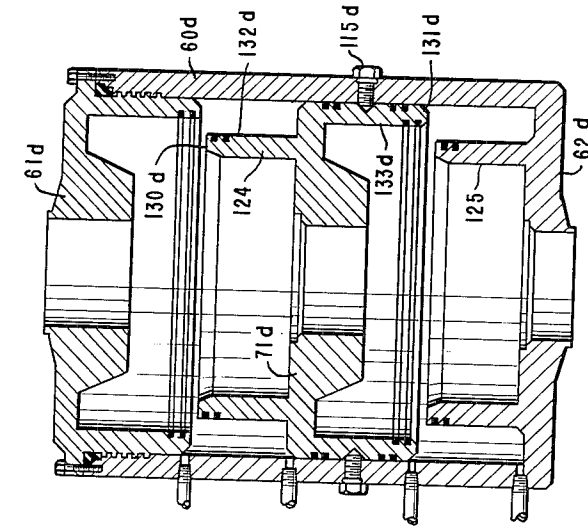


FIG. 6

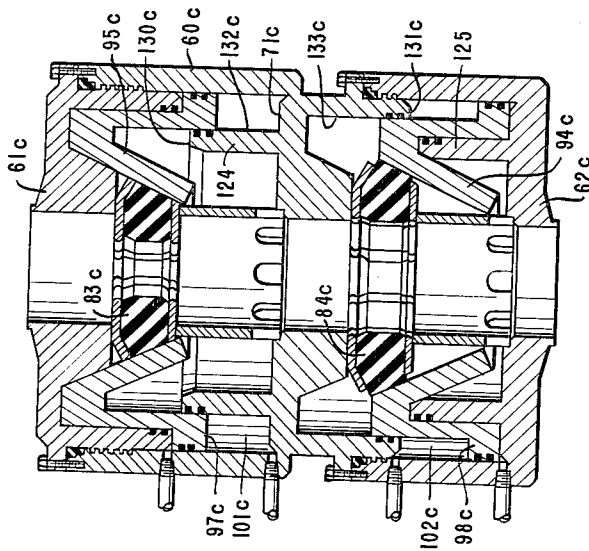


FIG. 5

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1

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UNDERWATER BLOWOUT PREVENTER

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2 Claims. (Cl. 277-9)

This invention relates to apparatus for use on offshore wells and pertains more particularly to a wellhead apparatus adapted to control pressures encountered in an emergency when drilling underwater wells. The present invention is especially concerned with a blowout preventer adapted to be secured to an underwater wellhead assembly in a manner such that pressure control of a well may be controlled during drilling operations from a remote source, such for example, as from a drilling barge located on the surface of the water.

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 casing closure device are located underwater at a depth sufficient to allow ships to pass over them. Preferably, the casinghead and well closure assemblies are located close to the ocean floor. In order to carry out drilling operations 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.

It is, therefore, a primary object of the present invention to provide apparatus for containing well pressures during drilling operations while at the same time providing secondary or auxiliary pressure control apparatus which is remotely actuable at any desired time in the event that the primary control device should fail.

While it is possible when drilling a well on land to change or repair a pressure control device on the wellhead, such action cannot be taken on equipment positioned several hundred feet below the surface of the water after the drilling of an underwater well has been commenced. It is therefore a further object of the present invention to provide an apparatus having independently-operated and remotely-controlled primary and secondary pressure-controlling sealing elements with one of the elements acting as a standby sealing element in the event that the other sealing element should fail.

In the drilling of underwater wells a considerable amount of heavy equipment must be connected together and vertically positioned on a support base on the ocean floor. This equipment during drilling operations may extend from 10 to 30 feet above the support base on the ocean floor during drilling operations. Since this stack of equipment is subjected to horizontal forces, it is desirable to keep the height of this equipment stack to a minimum so as to reduce the moment arm against which forces act tending to break some of the connections or rupture some of the component parts. It is therefore another object of the present invention to provide apparatus having primary and secondary pressure control sealing elements in it in a manner so as to reduce the height of the apparatus as much as possible.

Still another object of the present invention is to provide pressure control apparatus for well drilling operations wherein a minimum number of seals may be em-

2

ployed in the apparatus, thus reducing the chance of leakage during the long periods that the apparatus is submerged in seawater.

A further object of the present invention is to provide a primary and secondary pressure control apparatus having a short, compact design so that they may be used on a land-based drilling assembly where the space beneath the operating floor of a derrick for installing equipment of this type is limited so that only a single pressure control apparatus can generally be used.

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 a connector device has been lowered to the top of a well casinghead positioned on the ocean floor;

FIGURES 2, 3, 4, 5 and 6 are views taken in longitudinal cross-section of various forms of the blowout preventer of the present invention;

FIGURES 7 and 8 are views in cross section of another form of locking for the housing sections; and,

FIGURE 9 is a cross-sectional view taken along 9-9 of FIGURE 8.

Referring to FIGURE 1 of the drawing, a drilling barge 11 of any suitable type is illustrated as floating on the surface of the water 12 and fixedly positioned over a pre-selected 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 equipment of the present invention the slot 18 and the barge 11 may either be centrally located or extend in from the 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 during drilling operations 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 guide arms 25 and 26, and arms 25a and 26a, 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 generally provided with a sealing groove (not shown) cut in the outer wall thereof for securing equipment to 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 illustrated as being rigidly flanged to a wellhead connector 41. Preferably, the blowout preventer 40 of the present invention is welded to the top of the wellhead connector 41 so as to eliminate one flanged connection 34 and reduce the height of the combined units 40 and 41. In FIGURE 1 the wellhead connector 41 is shown in its latched position on the top of the casinghead 33. The combined blowout preventer and wellhead connectors 40 and 41, respectively, are run into position on the top of the well by being lowered through the water from the barge 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. 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, 49, 50 and 51, 52 and 53, respectively. These flowlines, 44 through 53 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 blowout preventer of the present invention comprises a generally cylindrical housing 60 having upper and lower closure plates 61 and 62, respectively. If desired, the housing 60 may be fabricated in two sections which are joined together in any suitable manner, for example by threads 63, or by vertically-extending bolts 64, or the combination of the two. A suitable seal 65 is provided to make the joint watertight. The upper closure plate 61 may be secured to the top of the housing 60 in a similar manner, by threads or bolts or the combination of the two, together with a seal. The lower closure plate 62 is preferably integrally formed as part of the housing 60, as illustrated.

A transverse wall member 71 is integrally formed in the housing or fixedly secured to the inner wall thereof intermediate the ends of the housing 60, thus dividing the interior of the housing into two chambers 72 and 73. The upper and lower closure plates 61 and 62 and the transverse wall member 71 are provided with centrally positioned and aligned openings 74, 75 and 76, respectively. The aligned openings 74, 75 and 76 provide a through bore in the blowout preventer in which drill pipe, casing, tubing, or other well equipment of a diameter less than the openings, may be positioned. The lower surface 77 of the upper closure plate 61 forms the top of the chamber 72 while the lower surface of the transverse wall member 71 forms the upper end of the lower chamber 73. Likewise, the upper surface of the transverse wall member 71 forms the lower end of chamber 72 while the upper surface 82 of the lower closure plate 62 forms the lower end of the chamber 73. The transverse wall member 71 is provided with a pair of upwardly and downwardly-extending shoulder portions 130 and 131, respectively, within the chambers 72 and 73 to form axially extending annular surfaces 132 and 133. The shoulder portions 130 and 131 form one wall of a pair of piston chambers 101 and 102.

Positioned within the upper and lower chambers 72 and 73, respectively, are annular resilient packing members 83 and 84 which are positioned adjacent the tops of the chambers 72 and 73 by means of coaxially-located positioning means in the form of central tubular members 85 and 86. The packing members 83 and 84 may be of any suitable resilient materials such as rubber or neoprene, or any suitable plastic adapted to be deformed which will thereafter readily regain its shape. The packing members should generally be of an oil-resistant material and may be of the type manufactured and used by Hydril Company, Los Angeles, California and described in the 22nd edition of Composite Catalog of Oil Field Equip-

ment and Services, page 2614. Since the use of a particular type of annular resilient packing member, whether reinforced by ribs or not, does not constitute a novel portion of the applicant's invention, the packing members will not be further described here. It will be understood that the normal relaxed form of the sealing element, as illustrated by sealing element 84 at the lower end of the blowout preventer, has a central bore 91 which is substantially equal to that of the aligned openings 74, 75 and 76 through the blowout preventer.

The packing members 83 and 84 are actuated by a pair of annular piston-type packing-actuating members 93 and 94, respectively, which have downwardly and inwardly-tapering faces 95 and 96, at least a portion of which are adapted to engage the sloping outer surfaces of the packing members 83 and 84. Annular pistons 97 and 98 are formed outwardly on the actuating members 93 and 94 and are arranged for limited movement vertically in piston chambers 101 and 102, respectively, which are formed of enlarged-diameter portions of the chambers 72 and 73, respectively, and the axially-spaced shoulders 130 and 131 of the transverse wall member 72. Suitable seals 103, 104 and 105 are provided between the actuating member 93 in the inner wall of the housing 60 so that a pressure fluid supplied through ports 106 and 107, extending through the wall of the housing 60, will not be lost to other parts of the apparatus. In a like manner, the lower actuating member 94 is provided with seals 108, 109 and 110 for sealing off a pressure fluid entering ports 111 or 112. Fluid ports 113 and 114 are provided in the lower end of the tubular positioning members 85 and 86, respectively, to permit well pressure at times to be subjected to the lower surfaces of the actuating members 93 and 94, thus aiding in compressing the seals to a position illustrated by packing member 83 in the upper portion of the blowout preventer. Although not illustrated in FIGURE 2, it is to be understood that the top and bottom of the housing may be provided with flanges (not shown) for connecting the blowout preventer to adjacent units. Preferably, however, the blowout unit of the present invention is often welded to adjacent pieces of apparatus.

In FIGURE 3, another form of a housing 60a of a blowout preventer is shown which is similar in many features to the blowout preventer described with regard to FIGURE 2 in that the upper closure plate 61a is secured to the housing 60a in the same manner while the lower closure plate 62a is integrally formed with the housing 60a. Also, the packing members and packing-actuating members to be installed in the housing of FIGURE 3 would be identical with those shown in FIGURE 2. The main difference in the housing 60a of FIGURE 3 is that instead of the transverse wall members 71a being integrally formed in the housing 60a, as shown with regard to wall member 71 in housing 60 of FIGURE 2, the transverse wall member 71a is in the form of an internal sleeve which is fixedly secured in place within the housing 60a by any suitable means, as by bolts or positioning screws 115 which extend through the wall of the housing 60a and seat in a recess or notch 116 in the outer surface or periphery of the transverse wall member 71a. Other notches 117 and 118 may be provided so that the transverse wall member may be selectively positioned so that a larger packing member may be positioned on one side of the transverse wall plate while a smaller one may be positioned on the other side. Thus, instead of using packing members 83 and 84 (FIGURE 1) of the same size, the lower or primary packing member 84 which is normally used during drilling operations may be smaller or have a shorter length axially than the auxiliary or upper packing member which may be held in reserve for emergency shut-offs. It is to be understood that it would be necessary to vary the lengths of the actuating members 93 and 94, of FIGURE 2, if packing members 83 and 84 of different sizes were to be employed.

In addition to providing the blowout preventer of the present invention with a positionable transverse wall member **71a**, the arrangement of FIGURE 3 with its unitary housing eliminates the need for connecting the two portions of the housing together as shown at **63** and **64** in FIGURE 2. Thus, an additional joint which is subject to leakage when positioned on the ocean floor is eliminated.

The arrangement of FIGURE 4 illustrates a blowout preventer in accordance with the present invention which is extremely compact in design, thus decreasing the height of the unit. The parts of the blowout preventer of FIGURE 4 that are similar to the blowout preventer illustrated and described with regard to FIGURE 2 carry the same numerals. In the arrangement of FIGURE 4, the upper closure housing plate **61b** is integrally formed with the housing **60b** which is formed in two portions and connected at **63b**. The lower closure plate **62b** in turn is screw-threaded to the casing or housing **60b**. In order to reduce the height of the unit, the pistons **97b** and **98b** have been relocated and positioned substantially adjacent and on a level with the upper end of the sloping faces of the actuating members **93b** and **94b**, and vertical guide flanges or bosses **120** and **121** extend downwardly from the upper closure plate **61b** and the transverse wall member **71b**, respectively, and mate with annular slots **122** and **123** which extend downwardly into the actuating members **93b** and **94b** alongside the pistons **97b** and **98b**. This arrangement gives a very short and compact piston arrangement for actuating the annular packing members **83b** and **84b**.

The arrangement of the blowout preventer of the present invention illustrated in FIGURE 5 is very similar to that shown in FIGURE 4 except that the housing **60c** is similar to the housing **60** shown in FIGURE 2 with the upper closure plate **61c** being screw-threaded into the top of the housing while the bottom closure plate **62c** was integrally formed therewith. In the arrangement of FIGURE 5 the transverse wall member **71c** is provided with an upwardly extending boss **124** which forms one wall of the piston chamber **101c** when the piston **97c** is in its raised position, as illustrated. The lower closure plate **62c** is likewise provided with a similar boss **125** located alongside the lower piston **98c** for the same purpose. The arrangement of FIGURE 6 is similar to that shown in the blowout preventer of FIGURE 5 and the pistons, actuating members and packing members of FIGURE 5 would be employed in the structure of FIGURE 6. The arrangement of FIGURE 6 differs from FIGURE 5 in a manner similar to the way the structure of FIGURE 3 differs from that of FIGURE 2 in that the transverse wall member **71d** of FIGURE 6 is fixedly positioned within the unitary housing **60d** by means of a series of horizontally-extending inwardly-locking screws **115d**.

In the operation of the apparatus of the present invention, the blowout preventer **40** (FIGURE 1) may be lowered through the water from a barge **11** in any suitable manner, as by mounting it on the lower end of a running string or marine conductor pipe **42**, until it is positioned over the uppermost tubular member **33** of the wellhead assembly to which it is connected by means of a wellhead connector **41** of any suitable type. During drilling operations both of the packing members **83** and **84** may be in their relaxed or inoperative position as illustrated with regard to packing member **84**. At this time the full central opening **91** in the packing member **84** is available for the insertion or running of tools in or out of the well. In the event that high pressures are encountered in the well, drilling may be carried out with the drill stem (not shown) rotating within or being withdrawn from the well with one packing member, for example, packing member **83** compressed around the drill string to contain the well pressures. While the upper packing member **83** will be subjected to some wear due

to the friction of a member being rotated or moved axially within its central opening while the packing member is compressed around it, in an emergency the lower and unworn packing member **84** is always available for compression around the member in the central bore of the blowout preventer by applying a pressure fluid to port **112** to drive the annular actuating member **94** upwardly along with the annular piston **98** so that the sloping face **96** of the actuating member **94** urges the packing member **84** radially and inwardly to more or less the position illustrated with regard to the upper packing member **83**. When desired one or both of the packing members **83** and **84** can be relaxed and allowed to assume its inoperative position by applying pressure fluid to ports **116** and **111**, respectively, to drive the pistons **97** and **98** downwardly along with the actuating members **93** and **94**.

For land operations, the blowout preventer of the present invention would be manually mounted on and fixedly secured to a conventional wellhead assembly in a manner well known to the art of well drilling and work-over operations. The operation of the blowout preventer itself would be the same as that described hereinabove.

Instead of employing a threaded connection, as at **63** in FIGURE 2, to connect the upper and lower sections of the housing **60** together, other suitable connector means may be employed. For example, the outer section of housing **60** may have a tapered inner face **140** (FIGURE 8) or a vertical face **141** (FIGURE 9) while being provided with a series of locking screws **142** which extend through the wall of the housing **60** to move wedge-shaped locking elements **143** inwardly along the lower surface **144** of a mating locking groove **145** formed in the outer face of the inner section of housing. A plurality of locking screws **142** and locking elements **143** are arranged at spaced intervals around the housing **60**. Suitable annular packing elements **146** are provided between the two sections of the housing **60** so that they form a fluidtight seal when the two sections of housing **60** are pulled together in a tight fit by the action of the lower face of each locking element **143** being forced against the lower surface **144** of the mating groove **145**. Preferably, the groove **145** is annular.

I claim as my invention:

1. A blowout preventer for use on an underwater drilling wellhead assembly comprising a substantially cylindrical unitary housing, upper and lower closure plate members closing the top and bottom of said housing, one of said plate members being removable from said housing to open the associated end, a transverse wall member removably secured within said housing intermediate the ends thereof and removable through said openable end of said housing, connector means operatively securing said transverse wall member to said housing, said plate members and said transverse wall member having centrally-positioned and coaxially aligned openings there-through for passage of a well member therein, said transverse wall member dividing the interior of said housing into first and second axially-spaced annular chambers while forming the bottom of said first chamber and the top of said second chamber, each of said chambers being of a size sufficient to contain a radially-contractible resilient packing member and a packing actuation means therefor, first and second annular resilient packing members carried within said first and second chambers adjacent the tops thereof, each of said packing members having a bore therethrough substantially the size of the aligned openings in said closure plate members, coaxially-located positioning means carried in each of said chambers for positioning said packing members in the upper ends thereof against vertical displacement, an annular piston-type packing-actuating member carried within each of said chambers and having a downwardly and inwardly tapering face at least a portion of which is arranged adjacent and in contact with the outer peripheral face of one of said packing members for applying a radially

7

inwardly directed pressure thereto, an annular piston formed on each of said packing-actuating members as a part thereof, and inlet and outlet pressure fluid port means extending separately through said housing to expansible spaces on either side of each of said pistons within said chambers for introducing a pressure fluid, independently to one side of each of said pistons to force selectively each of said packing members radially inwardly.

2. The apparatus of claim 1 wherein said transverse wall member is provided on the peripheral surface thereof with a plurality of axially-displaced recesses of a size to engage said connector means.

8

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