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Orund et al.

[11] **3,766,978**

[45] **Oct. 23, 1973**

[54] **REMOTE CONTROLLED OIL WELL PIPE SHEAR AND SHUT-OFF APPARATUS**

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[73] Assignee: **Shaffer Tool Works,** Brea, Calif.

[22] Filed: **July 2, 1970**

[21] Appl. No.: **60,964**

Related U.S. Application Data

[62] Division of Ser. No. 806,516, March 12, 1969, Pat. No. 3,590,920.

[52] **U.S. Cl.** **166/.5,** 166/55

[51] **Int. Cl.** **E21b 29/00**

[58] **Field of Search** ..... 166/.5, .6, .55, 166/53, 55.2, 72; 175/7

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[57] **ABSTRACT**

In an offshore oil well production system including a surface platform, a submerged wellhead, and a pipe string interconnecting the wellhead and platform, the provision of a pipe shear and shut-off apparatus between the platform and wellhead having a housing with a through-bore with an enlarged intermediate chamber and end bores for receiving a section of the pipe and means within the apparatus for shearing the pipe and closing the fluid passage through the apparatus when the pipe is severed, means for selective actuation of the apparatus and remote control means for the actuating means which is operative at a remote location from the wellhead notwithstanding the loss of physical connection between the platform and wellhead through the pipe string, such as when the pipe string is ruptured.

1 Claim, 9 Drawing Figures

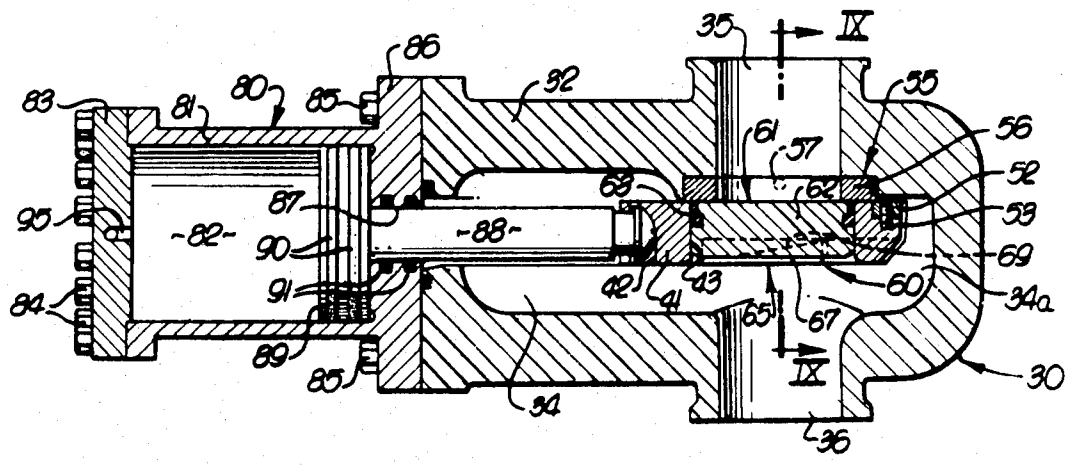


FIG. 2.

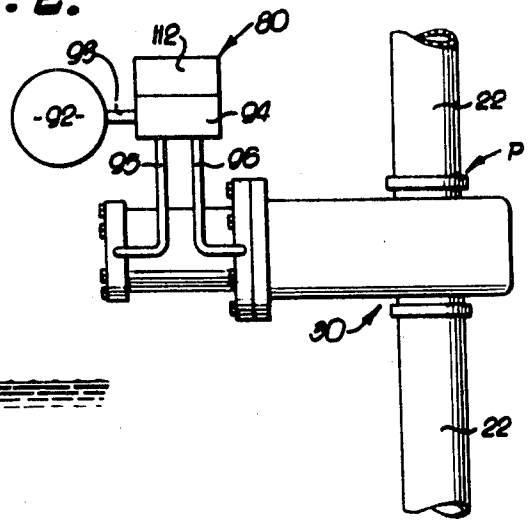


FIG. 1.

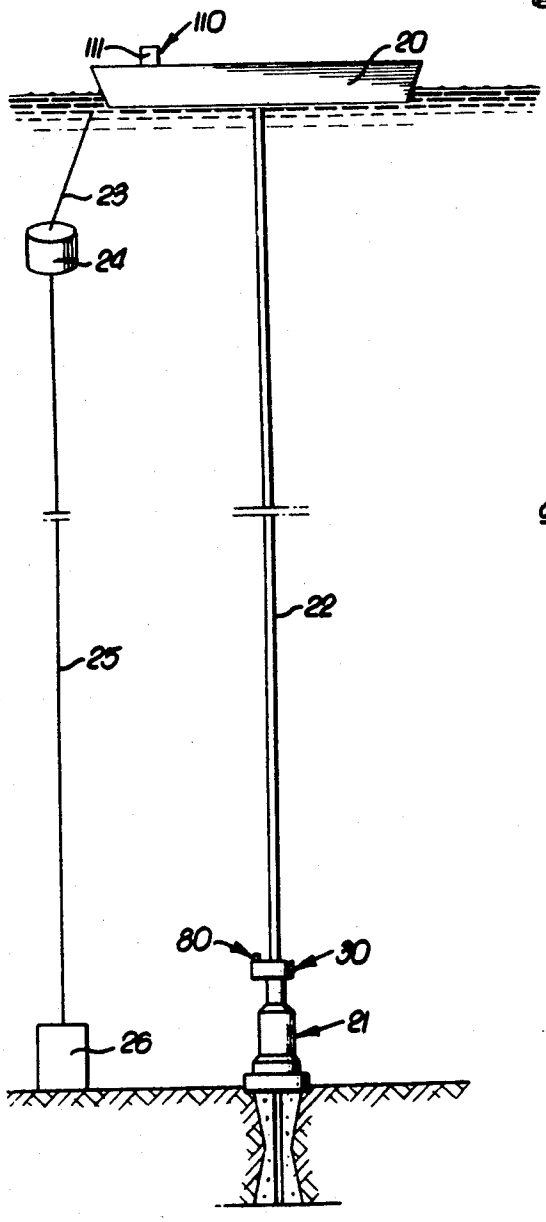


FIG. 3.

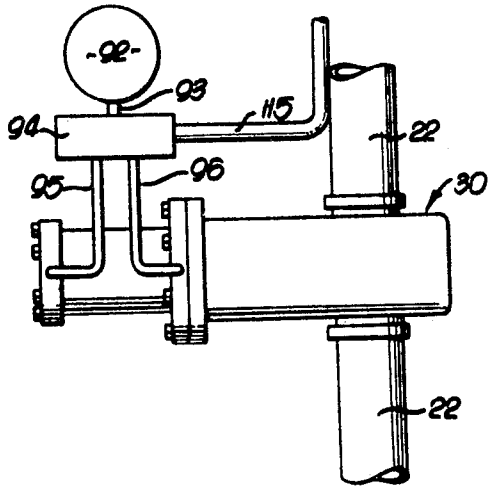


FIG. 4.

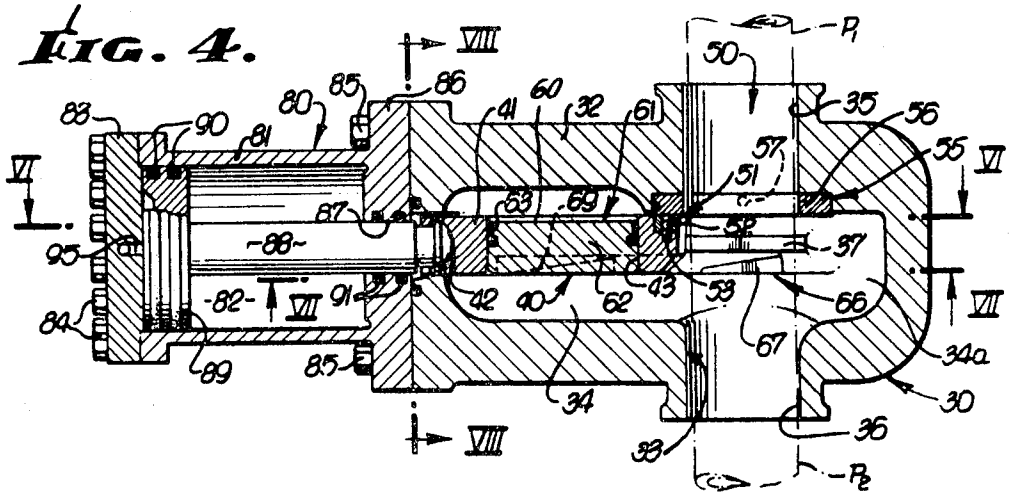
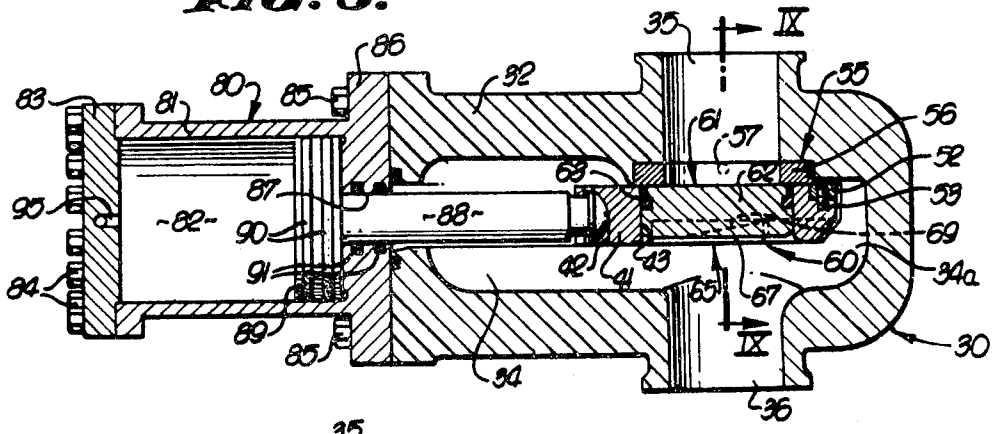


FIG. 5.



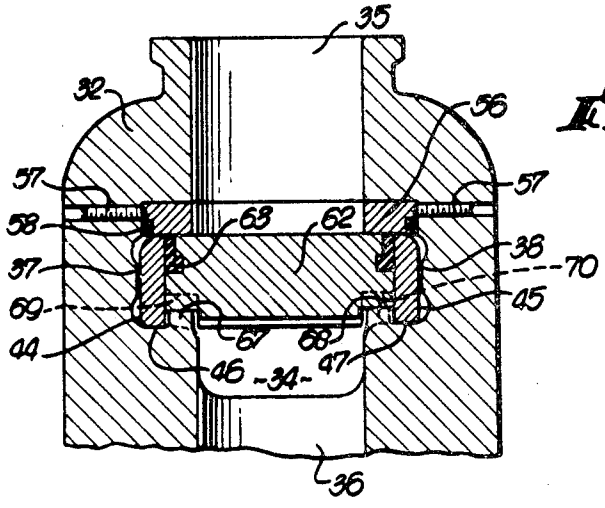


FIG. 9.

FIG. 6.

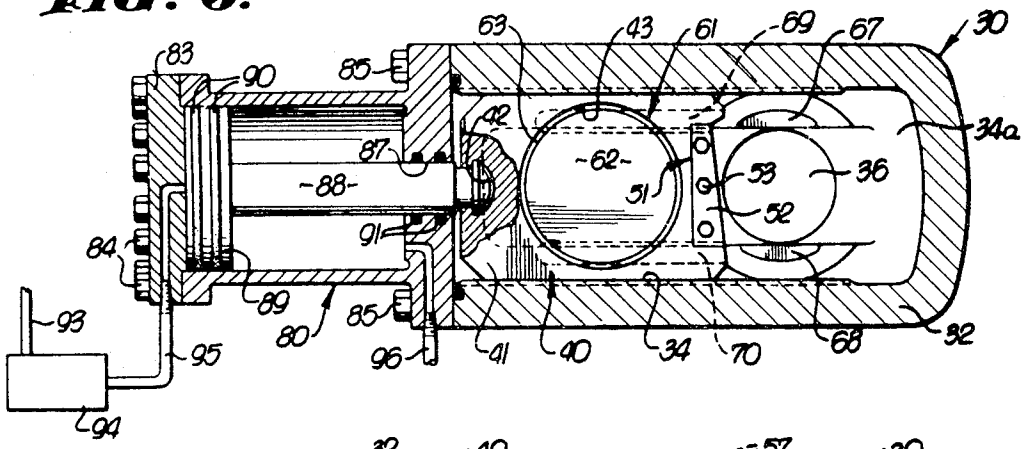


FIG. 7.

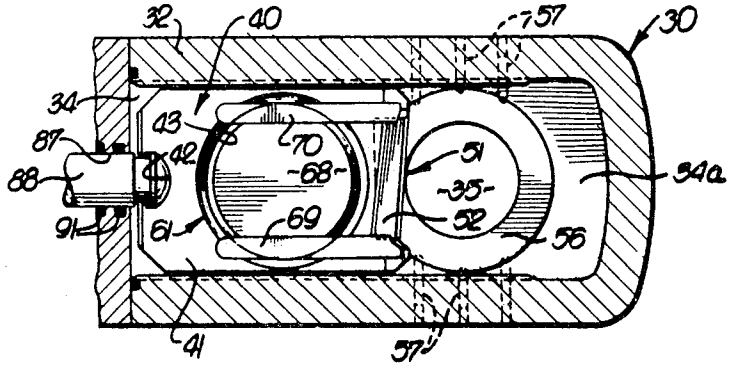
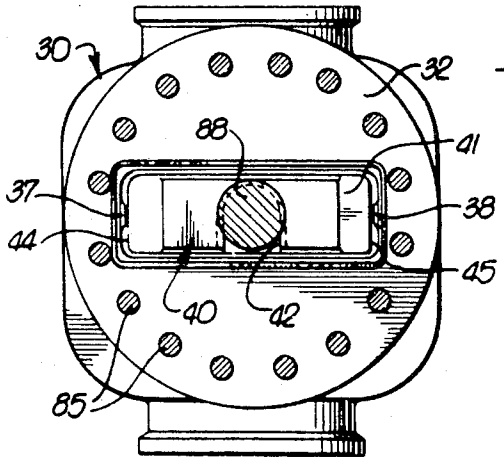


FIG. 8.



REMOTE CONTROLLED OIL WELL PIPE SHEAR AND SHUT-OFF APPARATUS

This is a division of application Ser. No. 806,516 filed Mar. 12, 1969, now U.S. Pat. 3,590,920 issued July 6, 1971.

The present invention relates to an apparatus for use in connection with oil well offshore production systems wherein a surface platform is stationed with respect to a wellhead and is interconnected with the wellhead through at least one pipe string. Generally, the platform or floating vessel is maintained in its relative position to the wellhead by suitably securing the floating vessel to the floor of the ocean or sea through mooring lines.

In the above-described system, as well as in various other types of offshore oil well production systems, there may be provided an apparatus for shearing the pipe string and shutting off the fluid passage in the event of rupture of the pipe string so as to prevent blowout of the well. In operation, it is necessary to actuate such apparatus so as to perform the shearing and shut-off functions. Such operation may be manual, such as by sending down a diver, but the disadvantages of such operation are apparent. In the prior art, the operation of shear and shut-off apparatus has been controlled from the surface platform. However, the defect in such prior art systems is that if the surface platform moves relative to the wellhead so as to rupture the pipe string, it will also likely rupture any other physical means interconnecting the platform and the apparatus to be controlled. For example, if the anchor lines of the surface platform are severed by another vessel, or break because of heavy seas, there is no longer any physical connection between the surface platform and the apparatus.

In the pipe shear and shut-off apparatus known to the prior art, there is also the difficulty of reliably assuring that the fluid flow passage will be completely shut off because of the possibility that the pipe will not be properly severed. In other words, in some prior art apparatus, the shearing means may result in crushing or deforming of the pipe which would interfere with the effective shut-off of the flow passage.

Accordingly, it is a general object of the present invention to provide a remote controlled oil well pipe shear and shut-off apparatus that avoids all of the foregoing disadvantages of similar types of apparatus and offshore oil well production systems used heretofore.

It is another object of the present invention to provide an offshore oil well production system including a surface platform, a submerged wellhead, an interconnecting pipe string, a submerged pipe shear and shut-off apparatus, with means for remotely controlling the actuation of the apparatus so that the fluid flow passage may be shut off in the event of pipe string rupture and movement of the platform relative to the wellhead.

It is still another object of the present invention to provide an offshore oil well production system of the above-described type, wherein the remote control means may include signal transmitting and receiving apparatus carried by the platform and the pipe shear and shut-off apparatus for selective operation by an operator aboard the platform.

It is yet another object of the present invention to provide an offshore oil well production system of the above-described type wherein the remote control means may include fixed length means physically interconnecting the platform and wellhead when the platform is in a preselected location relative to the wellhead which is ruptured when the platform is moved from such preselected location so as to automatically actuate the pipe shear and shut-off apparatus.

One more object of the present invention is to provide a submerged pipe shear and shut-off apparatus wherein a pipe string may be simultaneously sheared and shut off and wherein the shut-off means is maintained in sealing relation to prevent fluid passage flow.

It is yet one more object of the present invention to provide an apparatus of the last-described type wherein the seal is maintained without physical contact between a surface platform and the wellhead which was interconnected by the pipe string prior to rupture.

Other objects and advantages of this invention will be readily apparent from the following description when considered in connection with the appended drawings.

IN THE DRAWINGS

FIG. 1 is a schematic view of an exemplary offshore oil well production system including the present invention;

FIG. 2 is a detailed view of the apparatus shown in FIG. 1 illustrating components of the system schematically;

FIG. 3 is a detailed view as in FIG. 2 showing alternate components for use in the system;

FIG. 4 is a side sectional view of the apparatus shown in FIGS. 2 and 3;

FIG. 5 is a side sectional view as in FIG. 4 showing apparatus in shut-off position;

FIG. 6 is a sectional view taken along the plane VI—VI of FIG. 4;

FIG. 7 is a sectional view taken along the plane VII—VII of FIG. 4;

FIG. 8 is a sectional view taken along the plane VIII—VIII of FIG. 4; and

FIG. 9 is a sectional view taken along the plane IX—IX of FIG. 5. Referring now to FIGS. 1 through 3, there is shown in FIG. 1 an offshore oil well production system generally comprising a surface platform or vessel **20**, a wellhead indicated generally at **21**, and a production line or pipe string generally indicated at **22**. The platform **20** may be fixed or supported by the floor of the body of water, or may be a floating vessel such as that illustrated at **20**. The wellhead **21** is submerged or undersea and is mounted to the floor of the sea in a manner well known in the art. While a plurality of production lines or pipe strings may interconnect the wellhead and surface platform, there is shown for purposes of illustration a single pipe string **22** comprising a plurality of pipe sections which may extend generally vertically from the wellhead to the platform.

The platform **20** may be secured in its relation or position to the wellhead by means of anchor lines **23** which may be connected to a sub-surface buoy **24** connected through a cable **25** to an anchor **26** on the ocean floor. Obviously, other means for maintaining the floating platform **20** in relation to the wellhead **21** may be provided as are well known in the art.

In the present invention, the offshore oil well production system is also provided with a submerged pipe shear and shut-off apparatus generally indicated at **30**, means for selective actuation of the apparatus indicated generally at **80**, and remote control means generally indicated at **110**. The pipe shear and shut-off apparatus is submerged and may be mounted adjacent the

wellhead between the platform and the wellhead. The means **80** for selective actuation of the apparatus may be carried by such apparatus as in the exemplary embodiment.

Remote control means, indicated generally at **110**, in the exemplary embodiment illustrated in FIG. **2**, may comprise a signal transmitting means **111**, such as a radio transmitter, carried by floating platform **20**. The remote control means also includes signal receiving means **112**, as seen in FIG. **2**, carried by means **80** for selective actuation of pipe shear and shut-off apparatus **30**. There is shown a second exemplary embodiment of means for remote control of the apparatus actuating means which comprises a fixed length physical means such as a fluid pressure line **115** in operative communication with the means **80** when the pipe string **22** is intact.

In operation, each of the above-described remote control means automatically renders the actuating means operative, or maintains operative connection between the apparatus and surface platform, upon movement of the platform from its preselected position relative to the wellhead. In the first embodiment, rupture of the pipe string **22** which could occur when platform **20** has broken away from its anchor line **23**, severs all physical connection between the platform **20** and the pipe shear and shut-off apparatus **30**. However, an operator aboard floating vessel **20** may manually transmit a signal from transmitting means **111** to signal receiving means **112** so as to render actuating means **80** operative thereby shearing pipe string **22** and providing fluid flow shut-off. In the second embodiment, movement of the surface platform **20** so as to rupture pipe string **22** will simultaneously cause rupture of fixed length fluid pressure line **115** opening such line to ambient pressure which will render the actuating means operative so as to shear and shut off pipe string **22**.

The submerged pipe shear and shut-off apparatus **30** of the present invention generally comprises a housing **32**, carrier means indicated generally at **40**, pipe shearing means indicated generally at **50**, closing means indicated generally at **60**, means axially urging a shut-off plug into sealing relation indicated generally at **65**, and the actuating means indicated generally at **80**.

Referring now to FIGS. **4** through **9**, there is shown an exemplary embodiment of a pipe shear and shut-off apparatus in accordance with the present invention wherein the housing **32** includes a through-bore **33** which defines a work chamber **34** and top and bottom end bores **35, 36** respectively. Chamber **34** is intermediate the end bores **35, 36** and is enlarged and disposed laterally of the longitudinal axis of the pipe passing through housing **32** and indicated at P. Pipe P comprises a first pipe section **P1** connected to the platform **20** and a second pipe section **P2** connected to the wellhead **21**. The intermediate enlarged chamber **34** may also include a second laterally disposed portion indicated at **34*a*** for receiving the cutting blade and any portions of the pipe which may be crushed after the shearing operation is complete.

Carrier means **40** is slidably mounted for movement transverse to the axis of pipe P and is normally disposed in a zone to one side of the axis of pipe P. In the exemplary embodiment, such carrier means may comprise carrier member **41** having a downwardly directed opening **42** for receiving the actuating rod of the actuating means described hereinafter. Carrier member **41** has a generally cylindrical opening **43** for receiving a shut-off plug and has parallel sidewalls **44, 45** as seen best in FIG. **9**. The carrier member **41** is slidably supported on longitudinally extending tracks **46, 47** disposed transversely to the axis of pipe P and within chamber **34** and preferably integral with housing **32**, as seen in FIG. **9** Housing **32** also includes guideways **37, 38** integral with the vertical walls adjacent the tracks **46, 47** respectively, and extending longitudinally parallel with the tracks on opposite sides of carrier member **41** and in sliding engagement with carrier member sidewalls **44, 45** to guide transverse movement of the carrier member.

The pipe shear and shut-off apparatus **30** also includes pipe shearing means indicated generally at **50** which comprises blade means **51** and anvil means **55**. Blade means **51**, in the exemplary embodiment, is carried by carrier member **41** for movement transverse to pipe P. The blade means comprises a blade or cutting edge **52** fixedly mounted on the forward end of carrier member **41** with fasteners **53**. The cutting edge **52** has a width greater than the diameter of pipe P and has an upper edge in the same horizontal plane as the upper surface of the carrier member **41**, as seen in FIGS. **4** and **5**. In the preferred embodiment, the cutting edge **52** is straight and is angularly oriented with respect to the direction of movement.

The anvil means in the exemplary embodiment is fixedly mounted in the housing **32** and comprises an annular member **56** of hardened steel retained in the housing at the upper surface of the chamber by studs **57**. Annular anvil member **56** is mounted at the periphery of through-bore portion **35** and is sealed within the chamber housing by means of annular sealing ring **58**. The lower plane of anvil member **56** is coplanar with the upper plane of carrier member **41** and cutting edge **52** so as to define a shear plane.

The pipe shear and shut-off apparatus **30** also includes closing means **60** for preventing fluid passage through housing **32** when pipe P has been severed. In the exemplary embodiment, such closing means comprises a shut-off plug **61** carried by carrier member **41** in opening **43** for transverse movement into an operative position (as seen in FIG. **5**) axially aligned with through-bore **33**. Shut-off plug **61** comprises a substantially cylindrical, solid, metallic body **62** having an axis sustantially parallel to the axis of pipe P. The shut-off plug **61** carries an annular sealing member **63** on the peripheral edge of the upper surface for sealing engagement with anvil member **56** when the shut-off plug is in the operative position.

Means **65** for axially urging the shut-off plug **61** is provided in apparatus **30** and in the exemplary embodiment comprises ramp or cam means **66** carried by housing **32** in the path of carrier member **41**. Ramp means **66** includes a pair of ramp members **67, 68** positioned on opposite sides of through-bore **35** within chamber **34** and integral with tracks **46, 47**, as seen best in FIG. **9**. The means for axially urging the shut-off plug into sealing relation with the anvil member **56** mounted in housing **32** also includes ramp surfaces **69, 70** on the lower side of shut-off plug body **62** defined by cut-out portions thereof. The ramp surfaces **69, 70** have the same slope and are complementary with the ramp members **67, 68**. Preferably, the ramp members and ramp surfaces have a slope so as to provide substantial friction through the metal-to-metal contact

thereof so as to maintain the shut-off plug and anvil member in sealing relation.

The pipe shear and shut-off apparatus **30** includes actuating means **80** which in the exemplary embodiment comprises an actuator housing **81** defining a cylindrical chamber **82** open at one end and sealed by an end plate **83** through a plurality of fasteners **84.** The opposite end of housing **81** is secured through studs and nuts **85** to the end of housing **32** of the apparatus. The engaging wall **86** of actuator housing **81** is provided with an opening **87** for receiving the actuator member **88** of a piston **89** slidably mounted in chamber **82.** Piston **89** carries annular sealing members **90** while end wall **86** of housing **81** carries sealing members **91** for sealing engagement with actuator rod **88.** The actuating means also comprises a high pressure fluid source **92** as seen in FIGS. **2** and **3,** in fluid communication with piston chamber **82** through a conduit **93,** valve **94,** and conduits **95, 96.**

In the embodiment illustrated in FIG. **2,** the valve **94** may be a simple single gate valve controlled by signal receiving means **112** so as to allow the high pressure gas to flow from source **92** through the valve through conduit **95** thereby moving piston **89** and carrier member **41** to the right, as viewed in FIGS. **4** and **5.** Conduit **96** is provided for relief and for returning the carrier means to the inoperative position after the shear and shut-off apparatus has been used. In the embodiment illustrated in FIG. **3,** the valve **94** is actuated by rupture of the fluid pressure line **115** opening such line to ambient pressure so that the high pressure gas source may open the gate allowing the high pressure gas to pass through conduit **95** and to move piston **89** as previously described.

In operation, when the carrier means is moved transverse to the pipe, the blade or cutting edge **52** severs the pipe P into portions P_1 and P_2. Simultaneously the shut-off plug **61** is moved into axial alignment with the through-bore **33** and pipe sections P_1 and P_2 and is axially urged through ramp members **67, 68** and ramp surfaces **69, 70** into sealing relation with anvil member **56** so as to prevent fluid flow through the apparatus thereby preventing blow-out of the well. The shut-off plug is maintained in the sealing relation by virtue of the low slope and high friction between the ramp members and ramp surfaces which maintains the shut-off plug and anvil member in contact. Moreover, it is an important feature of this invention that the shut-off plug is maintained in sealing relation by the differential in pressure across the shut-off plug. Specifically, if pipe section P_2 is connected to the wellhead whereas pipe P_1 is connected to the platform and is the pipe that will be ruptured, the pressure acting on the underside of the shut-off plug will be the well pressure whereas the pressure acting on the upper surface will be ambient pressure. This difference in pressure will tend to maintain the shut-off plug in sealing relation with anvil member.

It is also to be understood that the drill string pipe section connections are not easily severable by the apparatus of the present invention, and it is therefore comtemplated that a pair of such apparatus may be employed in spaced relation such that one of such apparatus will necessarily be positioned on a non-connection portion of the drill string.

It will now be seen that all of the above-mentioned objects are accomplished by the invention and the preferred embodiment described and illustrated herein. Other modifications and variations of the present invention are possible in light of the above teachings and it is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

We claim:

1. In an offshore oil well production system, comprising a surface platform, an undersea wellhead, and a pipe string connected to the wellhead and the platform, the provision of:

a submerged pipe shear and shut-off apparatus between said platform and said wellhead including, a housing having a through-bore with an enlarged intermediate chamber and end bores for receiving the pipe, means within said chamber for shearing said pipe, closing means within said chamber for preventing fluid passage through said housing after said pipe is severed;

said sumbmerged pipe shear and shut-off apparatus shearing means including slidably mounted blade means for movement transverse to said pipe to effect cut-off and said closing means includes a shut-off plug slidably mounted for movement transverse to said pipe to an operative position, said apparatus additionally including means urging said shut-off plug into sealing relation with said housing through-bore;

means for selective actuation of said apparatus; and

remote control means for said actuating means operative at a remote location from said wellhead.

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