

Dec. 31, 1963

J. A. HAEBER
APPARATUS FOR INSTALLING AND RETRIEVING
EQUIPMENT FROM UNDERWATER WELLS

3,115,933

Filed Aug. 10, 1960

5 Sheets-Sheet 1

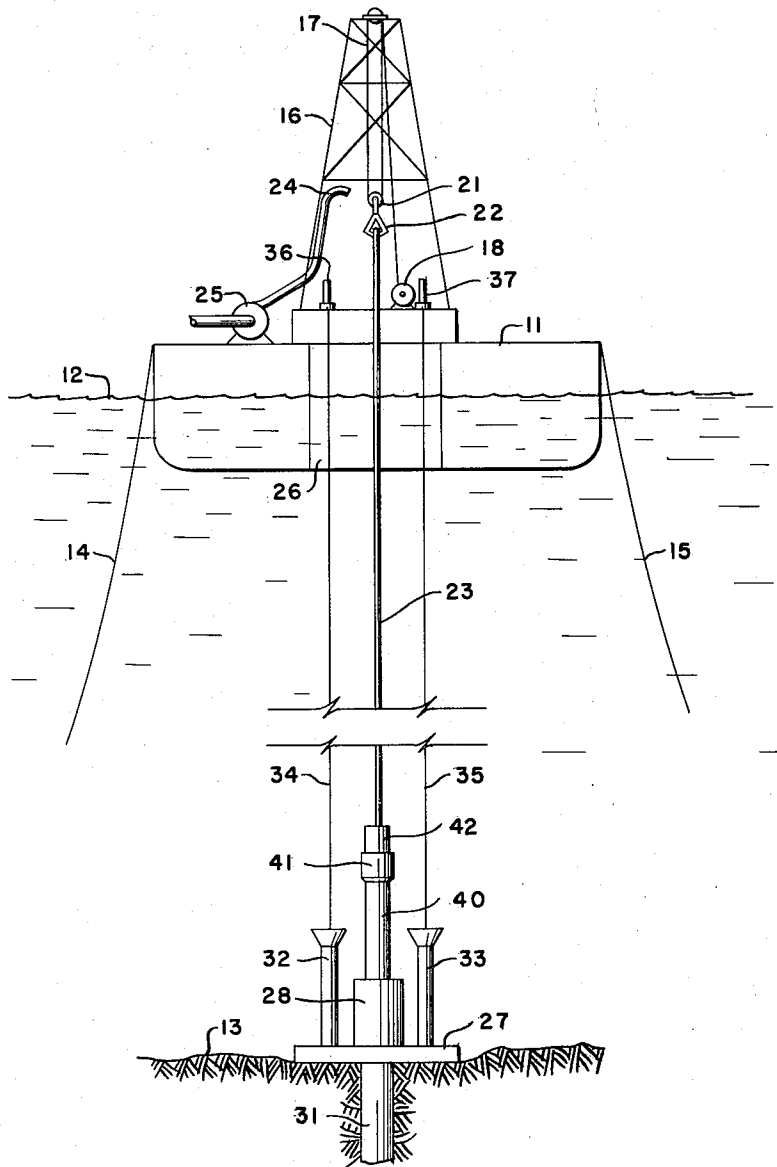


FIG. 1

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5 Sheets-Sheet 2

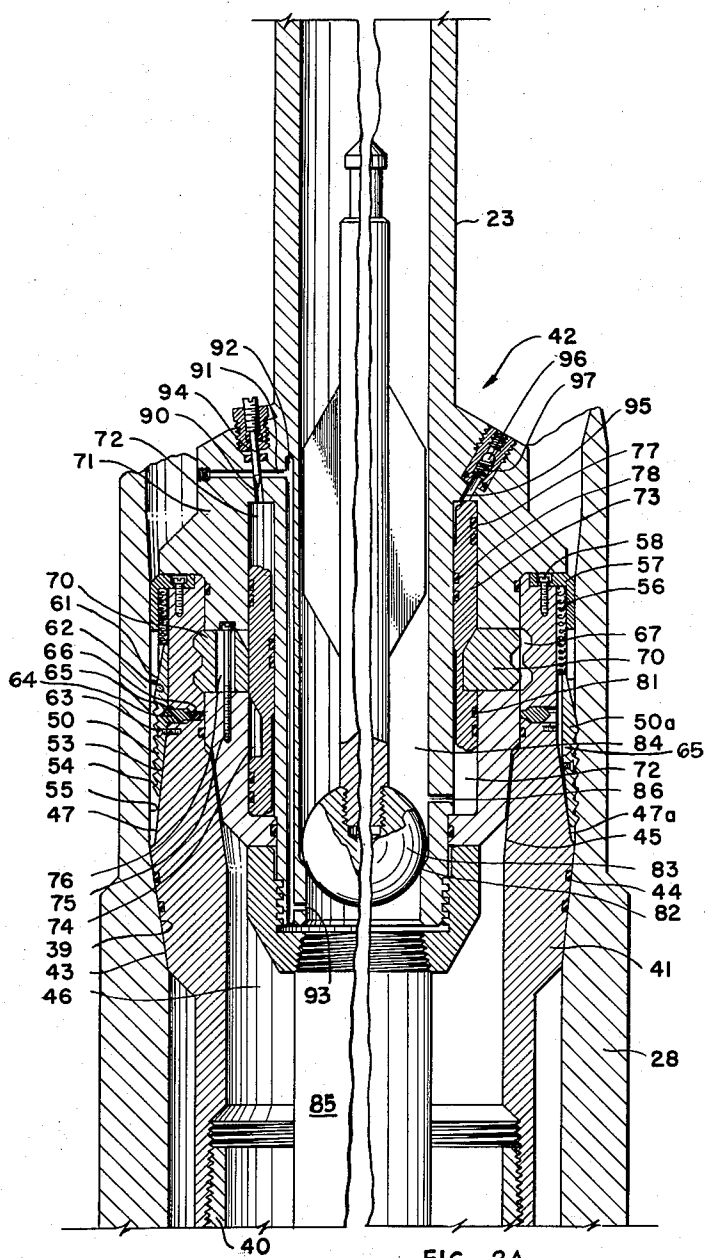


FIG. 2A

FIG. 2

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5 Sheets-Sheet 3

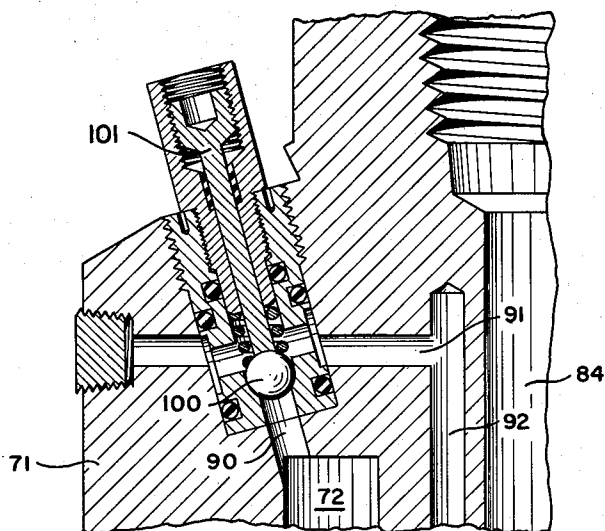


FIG. 3

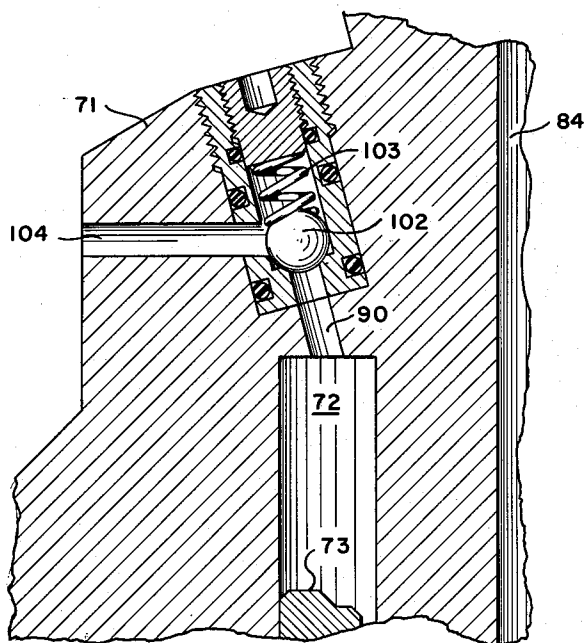


FIG. 4

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5 Sheets-Sheet 4

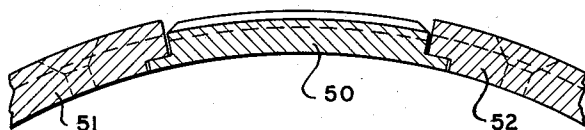


FIG. 6

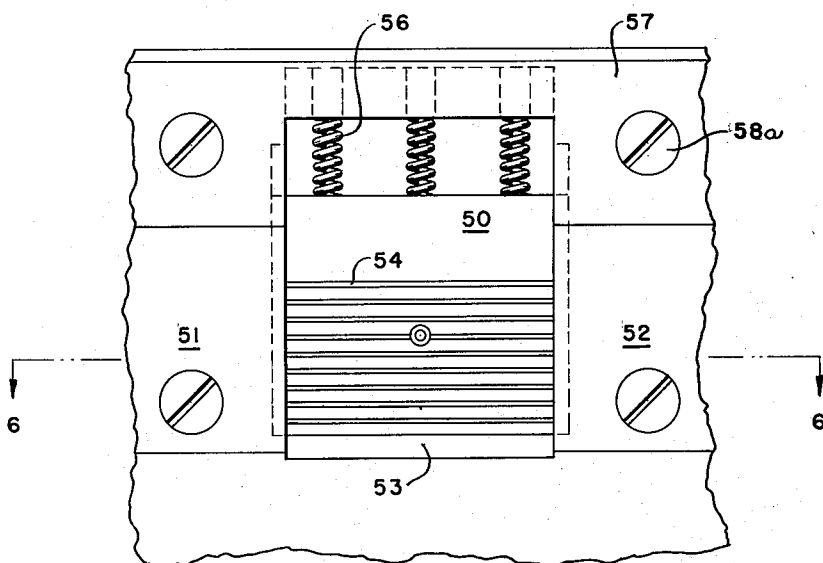


FIG. 5

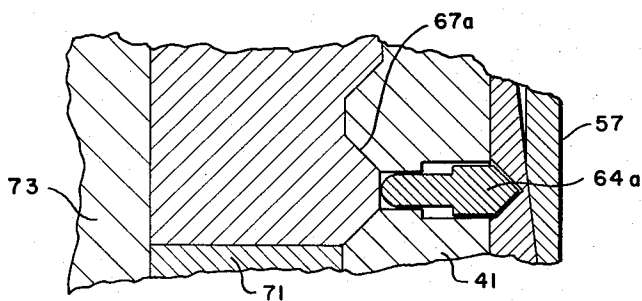


FIG. 7

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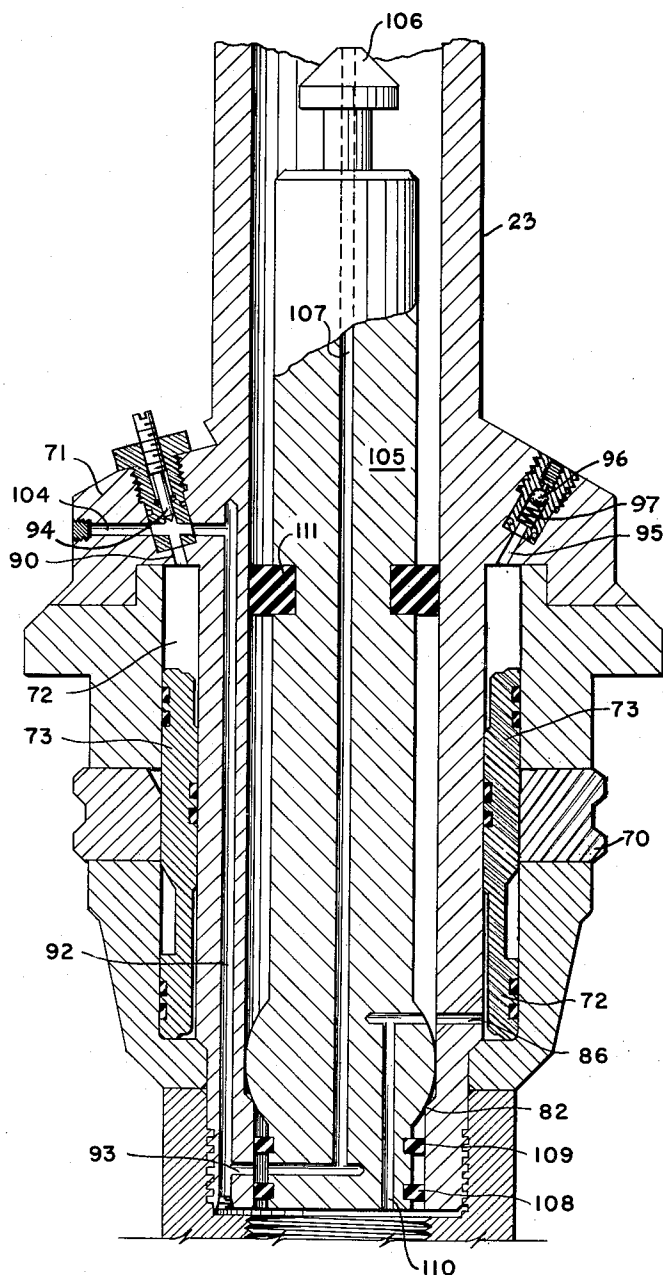


FIG. 8

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3,115,933

APPARATUS FOR INSTALLING AND RETRIEVING EQUIPMENT FROM UNDERWATER WELLS

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Filed Aug. 10, 1960, Ser. No. 48,647
10 Claims. (Cl. 166—66.5)

This invention relates to apparatus for use at offshore well installations and pertains more particularly to a well casing hanger adapted to anchor a string of well casing in an underwater well casinghead, and it further pertains to equipment for lowering and setting a casing hanger or other wellhead equipment within an underwater well casinghead and/or subsequently retrieving various pieces of equipment from the well casinghead.

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 coasts 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 made recently to provide methods and apparatus for drilling, completing and working-over a well wherein both the well casinghead and the various wellhead components secured thereto or suspended therefrom are located underwater at a depth sufficient to allow ships to pass over them. Preferably, the casinghead and its associated equipment is 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, after 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," strings of casing may be run into the well and suspended from the well casinghead by equipment of the present invention.

An object of the present invention is to provide apparatus for installing, from an operational base positioned above a body of water, strings of well casing and tubing in a well drilled in the formation below a body of water wherein the well casinghead is fixedly positioned at a substantial depth below the surface of the water.

A further object of the present invention is to provide apparatus for installing, from an operational base positioned above a body of water, various pieces of equipment on a casinghead or wellhead assembly positioned underwater, during the drilling, completion or maintenance of an offshore well.

A further object of the present invention is to provide apparatus for lowering various pieces of equipment to an underwater wellhead casinghead or wellhead assembly, wherein the lowering apparatus is provided with means for remotely connecting to or being disconnected from a piece of equipment that is to be raised from or lowered to an underwater wellhead assembly.

A still further object of the present invention is to provide a hydraulically-actuated connector apparatus adapted to be secured to the end of a string of pipe and lowered through a body of water to equipment positioned on the ocean floor for engaging hydraulically and retrieving one or more pieces of the equipment therefrom.

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 anchored to the ocean floor over a drill-

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ing location while a string of well casing is being installed in the well;

FIGURES 2 and 2A are views taken in longitudinal cross-section of a casing hanger of the present invention seated within a casinghead with a running tool or connector device being shown as positioned within the casing hanger while being secured to a pipe string;

FIGURES 3 and 4 are views taken in enlarged detail and in longitudinal cross-section of two types of valves arranged to be employed with the running tool connector of FIGURE 2;

FIGURE 5 is a front view of a portion of the slip assembly employed on the casing hanger assembly of FIGURE 2;

FIGURE 6 is a cross-sectional view taken along the line 6—6 of FIGURE 5;

FIGURE 7 is an enlarged detail view of a latching pin of the casing hanger of FIGURE 2; and,

FIGURE 8 is a view taken in longitudinal section of a cross-over dart.

Referring to FIGURE 1 of the drawing, a drilling barge 11 of any suitable fixed or floatable type is illustrated as floating on the surface of the water 12 and substantially fixedly positioned over a preselected drilling location by being anchored to the ocean floor 13 by anchor lines 14 and 15 running to anchors (not shown) sunk in the ocean floor. Equipment of this type may be used when carrying on well drilling, well completion, or well maintenance operations in water varying from about 100 to 1500 feet or more. The drilling barge is equipped with a suitable derrick 16 containing fall lines 17 and a hoist 18, as well as other auxiliary equipment needed during the drilling or servicing of a well. Thus, in this instance the drilling rig is shown as being provided with a traveling block 21 to which is secured a pair of elevators 22 or other suitable means for connecting to the top of a string of pipe 23. A flexible hose 24 is provided and is adapted to be secured to the top of the pipe string 23 at any time it is desired to provide a source of hydraulic fluid through the pipe string 23. The flexible hose 24 is in communication with a pump 25 or any other suitable source of a hydraulic pressure fluid.

The derrick 16 is positioned over a drilling slot or well 26 which extends vertically through the barge 11 in a conventional manner. When using the equipment of the present invention, the slot 26 in the barge 11 may be either centrally located or extend in from one edge. However, operations with the apparatus of the present invention may be carried out over the side of the barge without use of the slot.

A wellhead support structure, which is represented by a horizontally extending support frame 27 having a casinghead secured thereto and centrally positioned thereon, is illustrated as being anchored to the ocean floor by means of a conductor pipe or surface casing 31 which is then installed in and preferably cemented in the ocean floor 13. Secured to the wellhead support frame 27 are two or more guide columns 32 and 33 having guide cables 34 and 35 extending vertically therefrom to the drilling barge 11 where they are preferably secured to the barge by means of constant tension winches 36 and 37. The guide cables 34 and 35 are provided for the purpose of guiding pieces of equipment from the barge 11 into alignment on or in the casinghead 28 positioned on the ocean floor. In FIGURE 1, a string of well casing 40 is shown as being lowered into the casinghead 28 by means of a pipe string 23 which extends to the barge 11 and is suspended by means of the elevators 22. The well casing 40 has a casing hanger 41 fixedly secured to the top thereof whereby the casing may be hung from the casinghead 28. During the lowering operation, the casing hanger 41 is secured to a connector device 42 in a releasable manner, the con-

necter device 42 in turn being fixedly secured to the lower end of the pipe string 23.

Referring to FIGURE 2, the casing hanger body member 41 is shown as being provided with a downwardly and inwardly sloping seating surface or shoulder 39 which is adapted to cooperate with a mating sloping shoulder 43 formed on the inner wall of the casinghead 28 or any other suitable casing and tubing suspension housing. One or more O-ring seals or other suitable packing 44 is preferably carried outwardly on the seating shoulder 39 of the casing hanger for forming a fluidtight seal between shoulders 39 and 43. Another seating shoulder 45 may be provided on the inner wall of the casing hanger body member 41 for seating the lower end of the connector device 42 within the bore 46 of the casing hanger 41, or for seating subsequent concentric casing hangers (not shown) therein.

Formed in preferably a recessed manner on the outer surface of the casing hanger body member 41 is a downwardly and outwardly sloping slip bowl 47 which may extend entirely around the circumference of the casing hanger 41 but is preferably in the form of a series of small slip bowls as will be described hereinbelow with regard to FIGURES 5 and 6. Positioned within each slip bowl 47 or 47a is a slip element or slip plate 50 or 50a, preferably rectangular in shape, as shown in FIGURE 5, and held on the side of the casing hanger 41 in sliding engagement with the slip bowl 47 by means of holding plates 51 and 52 (FIGURE 6) positioned on either side of the slip plate. The holding plates 51 and 52 overlap the edges of the slip plate 50 as illustrated in FIGURES 5 and 6 to hold the slip plate against the casing hanger 51. The lower inner surface 53 of each slip plate 50 is bevelled at the same angle as the slip bowl 47 so that the horizontal teeth or serrations 54 on the outer face of each slip 50 contact the inner surface 55 of the casinghead 28 simultaneously and with substantially equal force when forced thereagainst. As shown in FIGURE 6, the slips 50 are curved along at least their outwardly extending face to conform with the curvature of the inner wall of the casinghead 28.

Mounted above each slip plate 50 is one or more compression springs 56 for normally urging the slip plate 50 downwardly when it is free to move. For ease in cocking the slip plates 50 in a retracted position and compressing the springs 56 thereabove, a removable retainer plate 57 is secured, as by screws 58 to the top of the casing hanger 41 or by screws 58a (FIGURE 5) to the side of the casing hanger. The retainer plate 57 extends downwardly on the outside of the casing hanger 41 so as to cover, at least partially, the springs 56 in their compressed position. Instead of employing a separate retainer plate 57 over each set of springs above each slip plate 50, the retainer plate 57 could be in the form of a circular cap adapted to fit down over all of the slip plates in the casing hanger and surround the entire top of the casing hanger 41. The inner lower face 61 of the retainer plate 57 and the outer upper face 62 of the slip plate 50 are bevelled at the same angle which is equal to that of the slip bowl 47.

In order to lock each slip plate 50 in its inoperative position, for example while shipping the casing hanger 41 to the drilling location, at least one screw 63 is provided which preferably extends through the slip plate 50 and is releasably connected to the body member of the casing hanger 41 in a screw-threaded engagement. Alternatively, instead of the screw passing through the slip plate 50 it could be positioned below the slip plate 50 to hold the slip plate in its raised position. At the same time the casing hanger 41 is provided with latching elements which are remotely operable to release the slips from their retracted position to the outwardly extending position. These latching elements may take the form of a pin 64 having a wedge-shaped or cone-shaped nose adapted to seat in a correspondingly shaped recess 65 formed on the

inner surface of the slip plate 50. Alternatively, the latching pin 64 may be positioned to engage the bottom of the slip plate 50 when it is in its raised position. The latching pin 64 may be in two parts with a rear portion 66 being a separate piece of metal which is merely in contact with the front half of the pin 64 so as to give the entire pin 64—66 a length sufficient so that the pointed nose of the pin 64 extends into the recess 65 when the rear end of the portion 66 is flush with the inner wall of the casing hanger 41. Alternatively, as shown in FIGURE 7, the latching pin 64a may be positioned opposite one of the grooves 67a formed on the inner surface of the casing hanger 41 for latching a connector tool thereto, as will be described hereinbelow.

In cocking the spring-loaded slip segments 50 of the present casing hanger 41 prior to running it in a well, the retainer plate 57 or plates are removed from the casing hanger 41 by removing the screws 58. The locking screws 63 are then inserted through the slips 50 and threaded into the casing hanger of body member 41 in the position shown on the left-hand side of FIGURE 2. The compression springs 56 are then positioned over the slip plate 50 and the retainer plate 57 is forced down along with the springs and is again anchored by installing screws 58 in the top of the body member 41. In this position, as shown in the left-hand side of FIGURE 2 of the drawing, the slips are in their cocked position and would snap downwardly except for the locking screw 63.

At the drilling location the casing hanger 41 is screw-threaded or welded at the top of a section of casing 40 in a conventional manner. Prior to lowering the top of the casing with its casing hanger 41 into the well, the short rear portions of the latching pin 66 are inserted through holes from the inside of the casing hanger 41 and urged against the front portion 64 of the latching pin to force it into the mating recess 65 on the inner surface of the slip segment 50. The connector device 42 of the running tool is then inserted into the bore 46 of the casing hanger 41 and securely latched to the casing hanger 41 by a series of outwardly extendible latching dogs 70 adapted to seat in the grooves 67 on the inner surface of the casing hanger 41. The diameter of the connector housing 71 of the connector device 42 at the point opposite the latching pin 64—66 is substantially equal to the bore 46 of the casing hanger 41 at that point so that the rear portion 66 of the latching pin cannot move into the bore 46. In this condition the locking screws 63 may be removed from each of the slip plates 50 with the latching pin 64 seated in the recesses 65 now holding the slip plates 50 in their raised inoperative position.

With the pipe string 23 connected to the top of the connector device 42, which in turn is latched to the inner surface of the casing hanger 41, the entire assembly is lowered from the barge 11 (FIGURE 1) downwardly, as illustrated, until the casing hanger 41 is seated on the shoulder 43 (FIGURE 2) within the casing head 28. At this time the connector device 42 is unlatched from the casing hanger 41 and withdrawn upwardly therefrom. As the connector housing 71 is withdrawn from the bore of the casing hanger 41 the latching pins 64—66 are forced inwardly by the spring-loaded slip plates attempting to move downwardly to a position shown by slip plate or segment 50a in the right-hand side of FIGURE 2. At this time the connector housing 71 would be raised out of the casing hanger 41 sufficiently so that the rear portion 66 of the latching pin is pushed into the bore 46 of the casing hanger 41 where it drops to the bottom. If desired, this portion 66 of the latching pin may be made of a friable plastic material. In the event that the latching pin 64a is of the type shown in FIGURE 7, no additional portion 64 of the pin is needed and the rear portion of the latching pin 64a merely extends into the grooves 67a where it is out of the way of anything moving down the bore of the casing hanger 41.

Referring to FIGURE 2, the pipe string 23 and the con-

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necter device 42 form a running tool for lowering the casing hanger 41 and the casing 40 suspended therefrom into the well casing head 28. The connector device 42 comprises a connector housing 71 having a plurality of outwardly-extendible latching elements 70 carried in vertical recesses in the side wall of the housing 71. The latching elements or dogs 70 are of a size so that they pass completely through the side wall of the connector housing 71 and have a portion extending beyond the side wall of the housing 41, either into the grooves 67 in the inner wall of the casing hanger 41 or into a piston chamber 72, preferably cylindrical in form, which is formed within the connector housing 71. Mounted for sliding vertical movement within the piston chamber 72 is an annular piston 73 whose height is such as to permit a certain amount of vertical movement within the piston chamber 72. A series of recesses or a circular recess or groove 74 is formed on the outer wall of the piston 73 and is of a size to receive a portion of the latching dogs 70 thereinto, as shown in the right-hand half of FIGURE 2. When the latching dog 70 has entered the recess 74 and the piston 73 as far as it can go, no portion of the latching dog 70 extends beyond the vertical side face of the connector housing 71. Each latching dog 70 is held within the connector housing 71 by means of a holding pin 75 which extends through a slot 76 in the latching dogs 70 that is wide enough to permit the horizontal movement of the latching dog relative to the connector housing 71. The piston 73 is preferably provided with one or more O-ring seals 77, 78 and 81.

Formed on the inner wall of the connector housing 71 is a seat or shoulder 82 adapted to receive thereon a dart 83 or any other suitable type of closure member or plug for closing the bore 84 of the connector housing 71. In the event that cementing operations are to be carried out through the connector housing 71, a pipe string known as a cementing string 85, may have its upper end connected to the lower end of the connector housing 71.

The bottom of the piston chamber 72 is in communication with the bore 84 of the connector housing 71 above the seat 82 by means of one or more ports 86. In one form of the running tool of the present invention, the space in the piston chamber 72 above the piston 73, as shown on the left-hand side of FIGURE 2 is in communication with the bore 84 of the connector housing 71 at a point below the seat 82 through conduits 90, 91 and 92 and port 93. Conduit 90 is arranged to be closed by means of any suitable type of valve, such as a needle valve 94. Another conduit 95 is provided which is normally closed by a check valve 96, the conduit 95 being in communication between the top of the piston chamber 72 and the outside of the tool.

In one mode of operation of the connector device 42, the latching dogs 70 are forced into engagement with the grooves 67 of a casing hanger 41 by applying a pressure fluid through check valve 96 and conduit 95 into the top of the piston chamber 72 at a time when the needle valve 94 is set to close conduit 90. As the piston 73 is pushed downwardly by the fluid pressure, the latching dogs 70 are pushed horizontally outwardly, as shown in the left-hand half of FIGURE 2, while any fluid below the piston 73 is discharged out the port 86. With the connector device 42 engaging the casing hanger 41 it is possible to run the casing 40 and its hanger 41 into a casinghead 28 located on the ocean floor by lowering the connected devices by means of a pipe string 23. When the casing hanger 41 has been seated in the casinghead 28, as illustrated in FIGURE 2, the latching dogs 71 are retracted from the engaging groove 67 in the casing hanger 41 in the following manner. After the piston 73 had been forced downwardly to cause the latching dogs 70 to engage the casing hanger 41, the needle valve 94 is opened manually before the apparatus is run down through the water into position in the casinghead 28. With the needle valve 94 open, a dart 83, or any other suitable type of plug, is

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dropped or circulated down through the pipe string 23 and into the bore 84 of the connector housing 71 where it seats on the shoulder 82. Seating of the dart 83 on the shoulder 83 isolates port 93 from any pressure in the pipe string 23 above the dart 83. Hydraulic pressure fluid is then applied at the top of the pipe string 23 (FIGURE 1) by means of a hose 24 which is connected to the top of the pipe string 23 after which hydraulic pressure fluid is pumped down through the pipe string 23 by pump 25. Since hydraulic pressure fluid is prevented by dart 83 (FIGURE 2) from continuing down the well, the hydraulic pressure fluid enters port 86 and flows beneath the piston 73 to force the piston 73 upwardly to a position shown in the right-hand half of FIGURE 2. When the piston 73 is in this position the latching dogs 70 will be automatically forced into the wall of the connector housing 71 when tension is applied to the pipe string to pull the pipe string 23 and the connector device 42 out of the casing hanger 41. The pipe string 23 and the connector device are then pulled upwardly to the barge 11 at the surface.

In another form of the connector device 42, illustrated in FIGURE 2, the needle valve assembly 94 is replaced by a ball-type spring-loaded check valve 100 (FIGURE 3) which has a locking stem 101 that is adapted to be screwed down and lock the ball 100 of the check valve on its seat at a time when a pressure fluid is being forced through the other check valve 96 (FIGURE 2) to force the piston 73 downwardly and latch the dogs 70 in the groove 67. After the dogs 70 are in their latched position, and prior to running the connector tool down into the water from the barge 11 (FIGURE 1), the locking stem 101 (FIGURE 3) is unscrewed and backed off so that the ball 100 of the check valve is again spring-loaded and opens for fluid to pass outwardly from piston chamber 72 through conduits 90, 91 and 92 in a manner described with regard to FIGURE 2. In general, it is preferred that fluid from the top of the piston chamber 72 be discharged at a point below the seated dart 83, at which point a lower pressure exists than above the dart when a hydraulic fluid is being applied to the underside of the piston 73 to raise it and unlatch the dogs 70. However, at times and in certain operations it may be found sufficient to discharge fluid from the top of the piston chamber 72 directly into the space outside the connector housing 71. At these times, the needle valve assembly 94 of the connector device 42 of FIGURE 2 is replaced by a spring-loaded check valve 102 (FIGURE 4) whose compression spring 103 holds the check valve 96 in place so as to prevent fluid from being discharged out conduit 90 and connecting conduit 104 (FIGURE 4) when a hydraulic pressure fluid is being applied through check valve 96 (FIGURE 2) to force the piston 73 downwardly. Thus, at the time a pressure is applied to the bottom of the piston 73 (FIGURE 4) fluid in the piston chamber 72 above the piston 73 is forced outwardly through conduits 90 and 104, past check valve 102, to be discharged in the space outside the connector housing 71. The spring 103 must be stiff enough to keep ball 96 on its seat and thereby keep the conduit closed when piston 73 is being moved against frictional forces. It must also be stiff enough to overcome cementing pressures.

The running tool of the present invention provides connector means which are adapted to mate with a casing hanger for lowering a casing and its casing hanger into seating position within a casinghead, with the entire apparatus being inserted through a blowout preventer if necessary. Afterwards, the connector means is adapted to be released hydraulically from a remote location such as a barge on the ocean surface.

The connector device 42 of FIGURE 2 may also be used to retrieve a casing hanger 41 and its casing 40 from a well in the event that the casing 40 has not been cemented in the well. This operation is carried out by employing the connector device 42 of FIGURE 2 with the

needle valve 94 in an open position. The connector device 42 is lowered by means of pipe string 23 down through the water from a barge 11 (FIGURE 1) and into the bore of the casing hanger 41. A cross-over dart 105 (FIGURE 8) is then dropped or pumped down through the pipe string 23 until it seats on seating shoulder 82. The dart 105 is provided with a fishing neck 106 at the top thereof whereby the dart may be recovered from the bore of the connector housing 71 in an emergency by a suitable fishing apparatus which may be lowered in a conventional manner, as on a wire line. A conduit 107 extends downwardly through the cross-over dart 105 and out the side of the dart at a level opposite the port 93 in the lower end of the connector housing 71. The lower end of the dart is provided with O-ring seals or other packing elements 108 and 109 mounted in spaced relationship on either side of the discharge end of conduit 107 so as to seal the space between the outer surface of the dart 105 and the inner surface or wall of the bore of the connector housing 71. A second conduit 110 is provided through the body of the dart 105 in communication between the space below the dart and the space above the seat 82 substantially opposite the port 86 in the connector housing 71. A suitable annular packer member 111 is provided on the dart for closing the space between the outer wall of the dart and the inner wall of the bore of the connector housing 71 so that the packer member 111 together with the seat 82 close the space between the dart and the connector housing thus putting port 86 in communication through conduit 110 with the space below the dart 105.

With the dart 105 in place, as shown in FIGURE 8, a pressure fluid is applied through pipe string 23 (FIGURE 2) with the pressure fluid passing downwardly through conduit 107 (FIGURE 8) of the dart 105 and thence through port 93, conduits 92 (FIGURE 2), 91 and 90 to the piston chamber 72 above the piston 73. Pressure is thereby applied to the piston 73 forcing it downwardly and causing the latching dogs 70 to be forced outwardly into the circumferential grooves 67 of the casing hanger 41 or any other suitable piece of equipment that is to be recovered from a well. As the piston 73 moves downwardly within the piston chamber 72, fluid below the piston 73 is forced out through port 86 and thence through conduit 110 (FIGURE 8) of the cross-over dart 105 to be discharged down the well. Pressure fluid can then be cut off from the pipe string 23 and the pipe string 23 with its connector device 42 (FIGURE 1) and the equipment secured thereto pulled to the surface if hold-down slips are not employed or if they have not functioned and set properly. While the present invention has been described with regard to lowering a well casing and casing hanger into a well, it is clear that the same running tool and connector device may be employed to run other pieces of equipment down to an underwater well or retrieve them from the well, as desired.

I claim as my invention:

1. Apparatus for installing, from an operational base positioned above a body of water, a well member in a well drilled in the formation below the body of water and hanging said well member within a well casinghead fixedly positioned at a substantial depth below the surface of the water, said apparatus comprising an operational base positioned above a body of water and above a well casinghead covered with water, an elongated pipe string normally supported from said operational base and adapted to extend to said casinghead, hydraulically-actuated connector means having a bore therethrough and carried at the lower end of said pipe string, said bore being adapted to receive first closure means therein outwardly-extensible latching elements carried by said connector means for engaging a member at least partially surrounding said connector means, pressure responsive actuating means carried by said connector means and operatively engaging said latching elements during the actuation thereof, first conduit means in said connector means in com-

munication between the bore thereof and the actuating means for introducing a pressure fluid thereto to move said actuating means in one direction, second conduit means through the wall of said connector means in communication between the space outside thereof and said actuating means for admitting fluid pressure to move said actuating means and said latching elements in another direction, and closure means in said second conduit means for selectively closing said second conduit means.

2. Apparatus for installing, from an operational base positioned above a body of water, a well member such as a string of casing and tubing in a well drilled in the formation below the body of water and hanging said well member within a well casinghead fixedly positioned at a substantial depth below the surface of the water, said apparatus comprising an operational base positioned above a body of water and above a well casinghead covered with water, an elongated pipe string normally supported from said operational base and adapted to extend to said casinghead, hydraulically-actuated connector means having a bore therethrough and being secured to the lower end of said pipe string, outwardly-extensible latching elements carried by said connector means for engaging a member at least partially surrounding said connector means, pressure responsive actuating means carried by said connector means and operatively engaging said latching elements during the actuation thereof, first conduit means in said connector means in communication between the bore thereof and the actuating means for introducing a pressure fluid thereto to move said piston means in one direction and allow said latching elements to be retracted, second conduit means through the wall of said connector means in communication between the space outside thereof and said actuating means for admitting fluid pressure to move said actuating means and said latching elements in another direction, closure means in said second conduit means for selectively closing said second conduit means, a seating shoulder formed within the wall forming the bore of said connector means below said conduit means, and plug means positionable on said seating shoulder for closing the bore of said connector means.

3. Apparatus for installing, from an operational base positioned above a body of water, a well member such as a string of casing and tubing in a well drilled in the formation below the body of water and hanging said well member within a well casinghead fixedly positioned at a substantial depth below the surface of the water, said apparatus comprising an operational base positioned above a body of water and above a casinghead covered with water, an elongated pipe string normally supported from said operational base and adapted to extend to said casinghead, a source of pressure fluid adapted to be connected in fluid communication to the upper end of said pipe string when said pipe string extends to said casinghead, hydraulically-actuated connector means having a bore therethrough and being secured to the lower end of said pipe string, said bore being adapted to receive first closure means therein, said connector means being of a diameter to fit within the vertical bore of said casinghead, outwardly-extensible latching elements carried by said connector means for engaging cooperating recesses in the adjacent surface of a member at least partially surrounding said connector means, pressure responsive actuating means carried by said connector means and operatively engaging said latching elements during the actuation thereof, first conduit means in said connector means in communication between the bore thereof and the actuating means for introducing a pressure fluid thereto to move said actuating means in one direction, second conduit means through the wall of said connector means in communication between the space outside thereof and said actuating means for admitting fluid pressure to move said actuating means and said latching elements in another direction, and closure means in said second conduit means for selectively closing said second conduit means.

4. Running tool connector device for connecting the lower end of a pipe string to a casing hanger affixed to the top of a string of casing to be run into a well and seated in a well casinghead positioned underwater, said connector device comprising a connector housing having a vertical bore therethrough, said bore being adapted to receive first closure means therein, an annular piston chamber formed within said housing, a plurality of outwardly-extendible latching elements carried in recesses within said housing on the outer surface thereof, said latching elements being of a size to extend into said piston chamber in their retracted position and outwardly from said housing in their operative position, piston means slidably positioned within said chamber for actuating said latching elements, conduit means in said housing in communication between the outside of said housing and the piston chamber to one side of said piston means for introducing a pressure fluid thereto and discharging said pressure fluid therefrom, first conduit means in said housing in communication between other side of said piston and said bore of said housing for introducing a pressure fluid thereto to move said piston means in one direction, second conduit means through the wall of said connector means in communication between the space outside thereof and said actuating means for admitting fluid pressure to move said actuating means in said latching elements in another direction, and closure means in said second conduit means for selectively closing said second conduit means.

5. Running tool connector device for connecting the lower end of a pipe string to a casing hanger affixed to the top of a string of casing to be run into a well and seated in a well casinghead positioned underwater, said connector device comprising a connector housing having a vertical bore therethrough, an annular piston chamber formed within said housing, a plurality of outwardly-extendible latching elements carried in recesses within said housing on the outer surface thereof, said latching elements being of a size to extend into said piston chamber in their retracted position and outwardly from said housing in their operative position, piston means slidably positioned within said chamber for actuating said latching elements, first and second conduit means in said housing in communication between the outside of said housing and the piston chamber to one side of said piston means for introducing a pressure fluid thereto and discharging said pressure fluid therefrom, closure means in said first and second conduit means for selectively closing said first and second conduit means, third conduit means in said housing in communication between the other side of said piston means and said bore of said housing for introducing a pressure fluid thereto to move said piston means and allow said latching elements to be retracted, a seating shoulder formed on the wall forming the bore of said housing below said third conduit means, and plug means positionable on said seating shoulder for closing the bore of said housing against free flow there-through.

6. Running tool connector device for connecting the lower end of a pipe string to a casing hanger affixed to the top of string of casing to be run into a well and seated in a well casinghead positioned underwater, said connector device comprising a connector housing having a vertical bore therethrough, an annular piston chamber formed within said housing, a plurality of outwardly-extendible latching elements carried in recesses within said housing on the outer surface thereof, said latching elements being of a size to extend into said piston chamber in their retracted position and outwardly from said housing in their operative position, piston means slidably positioned within said chamber for actuating said latching elements, first conduit means in said housing, said first conduit means being in communication between the outside of said housing and the piston chamber to one side of said piston means for introducing a pressure fluid there-

to, third conduit means in said housing in communication between other side of said piston means and said bore of said housing for introducing a pressure fluid thereto to move said piston means and allow said latching elements to be retracted, a seating shoulder formed on the wall forming the bore of said housing below said third conduit means, plug means positionable on said seating shoulder for closing the bore of said housing against free flow therethrough, check valve means in said first conduit means preventing the escape of fluid pressure from said piston chamber, and normally open valve means in said second conduit means, said second conduit means being in communication between the piston chamber to the one side of said piston means and the bore of said housing below said seating shoulder.

7. Running tool connector device for connecting the lower end of a pipe string to a casing hanger affixed to the top of a string of casing to be run into a well and seated in a well casinghead positioned underwater, said connector device comprising a connector housing having a vertical bore therethrough, an annular piston chamber formed within said housing, a plurality of outwardly-extendible latching elements carried in recesses within said housing on the outer surface thereof, said latching elements being of a size to extend into said piston chamber in their retracted position and outwardly from said housing in their operative position, piston means slidably positioned within said chamber for actuating said latching elements, first and second conduit means in said housing in communication between the outside of said housing and the piston chamber to one side of said piston means for introducing a pressure fluid thereto and discharging said pressure fluid therefrom, third conduit means in said housing in communication between other side of said piston means and said bore of said housing for introducing a pressure fluid thereto to move said piston means and allow said latching elements to be retracted, a seating shoulder formed on the wall forming the bore of said housing below said third conduit means, plug means positionable on said seating shoulder for closing the bore of said housing against free flow therethrough, check valve means in said first conduit means preventing the escape of fluid pressure from said piston chamber, and spring-loaded relief valve means in said second conduit means set to open and discharge fluid from said piston chamber.

8. The apparatus of claim 7 including locking means on said relief valve for selectively locking said valve in a closed position.

9. A running tool connector device for connecting the lower end of a pipe string to a casing hanger affixed to the top of a string of casing to be run into or withdrawn from a well casinghead positioned underwater, said connector device comprising a connector housing having a vertical bore therethrough, piston chamber means formed within said housing, a plurality of outwardly extendible latching elements carried in recesses within said housing on the outer surface thereof, said latching elements being of a size to extend into said piston chamber means in their retracted position and outwardly from said housing in their operative position, piston means slidably positioned within said piston chamber means for actuating said latching elements, first conduit means in said housing in communication between the outside of said housing and the piston chamber to one side of said piston means for introducing a pressure fluid thereto, second conduit means in said housing in communication between the same side of said piston means and the bore of said housing for discharging pressure fluid therefrom, third conduit means in said housing in communication between the other side of said piston means and said bore of said housing for introducing a pressure fluid thereto to move said piston means and allow said latching means to be retracted, a seating shoulder formed on the wall forming the bore of said housing below said third conduit means and above one end of said second conduit means, and plug means positionable

on said seating shoulder for closing the bore of said housing against free flow therethrough.

10. The apparatus of claim 9 wherein said plug means is provided with axially spaced sealing means mounted on the outer surface thereof for sealing against the bore of said housing at points above and below the second and third conduit means where they enter the bore of the housing, said plug means being provided with a first fluid passageway in communication between the space outside the uppermost sealing means and the second means of said housing while a second passageway is provided in commu-

nication between the space below the plug means and the third conduit means.

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