Feb. 24, 1942. D. RAGLAND ET AL 2,274,093

APPARATUS FOR COMPLETING SUBMARINE WELLS

Filed Oct. 19, 1938 3 Sheets-Sheet 1

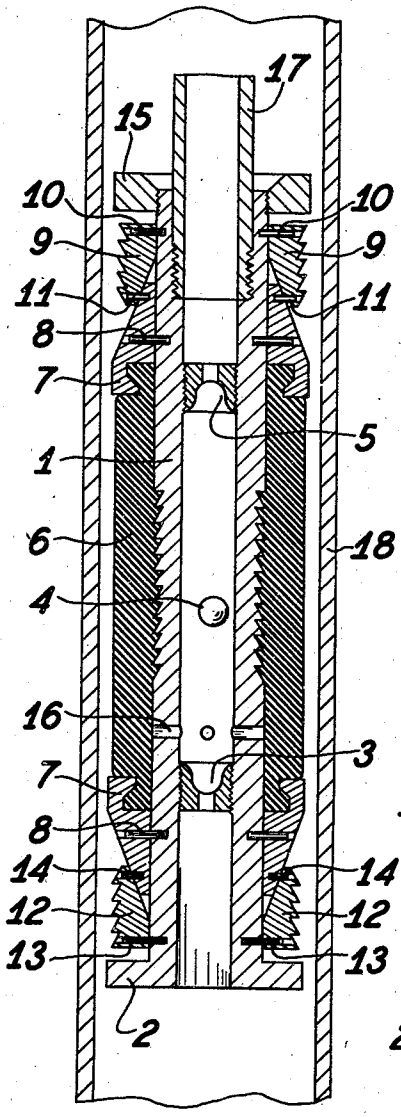


FIG_1_

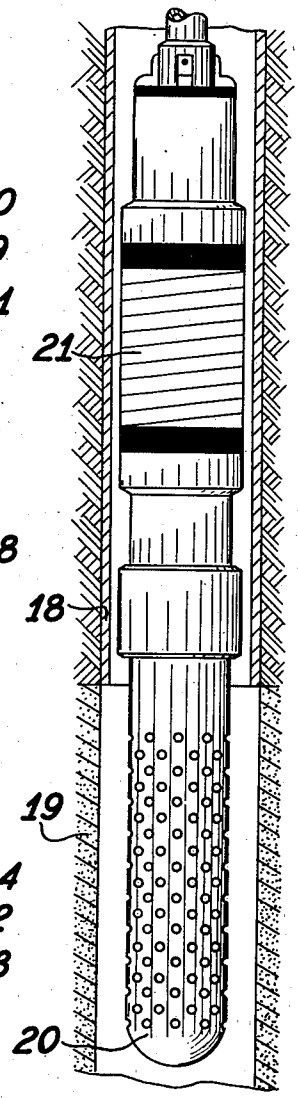


FIG_2_

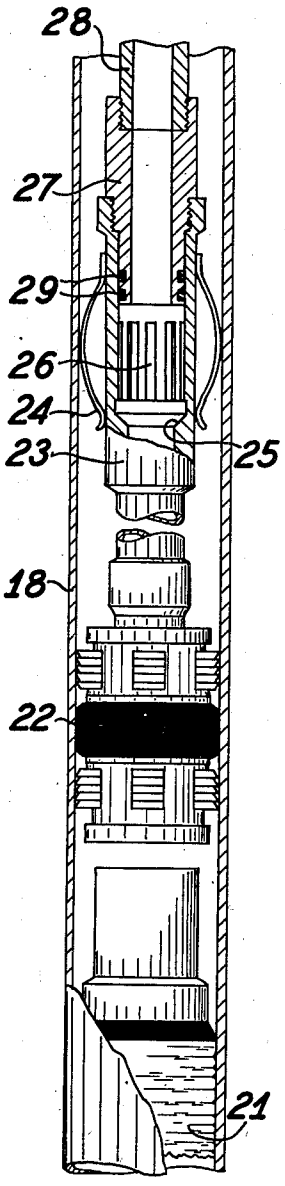


FIG_3_

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APPARATUS FOR COMPLETING SUBMARINE WELLS

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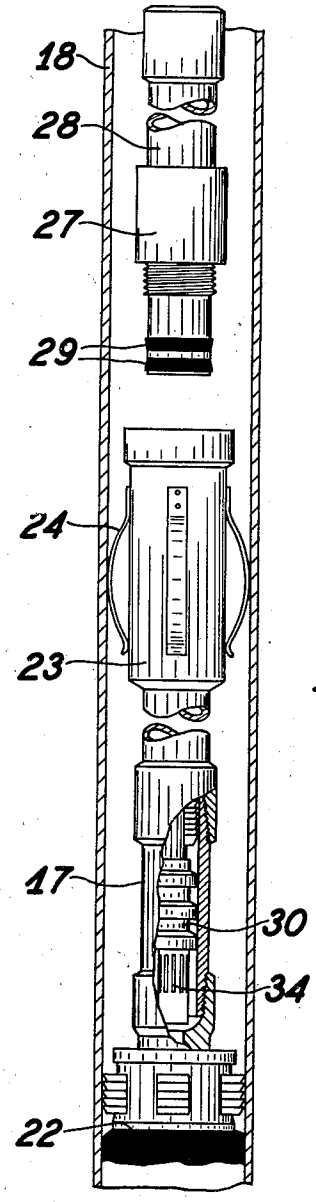


FIG_4_

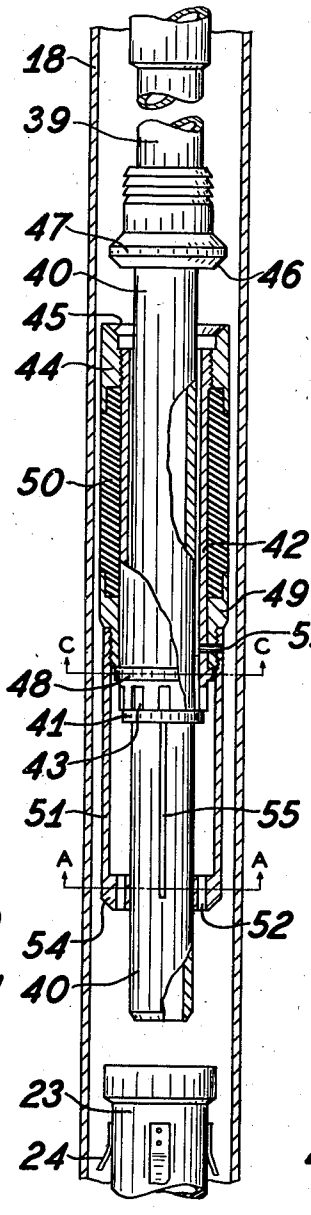


FIG_5_

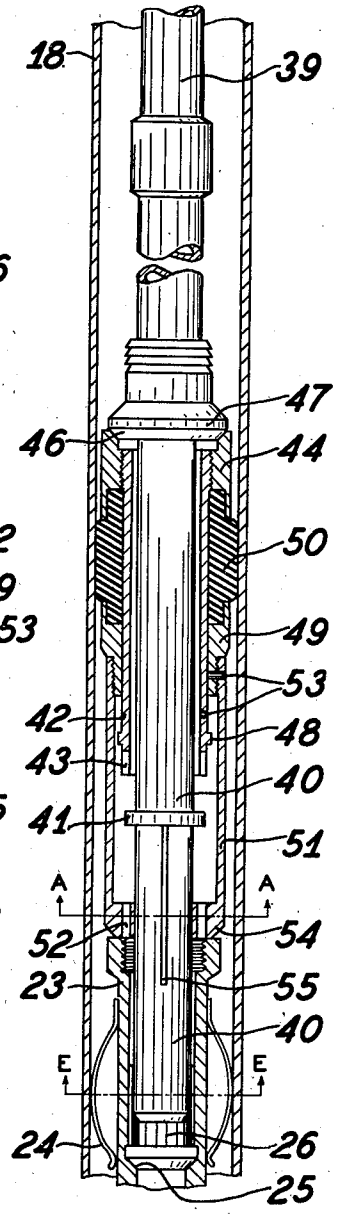


FIG_6_

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Feb. 24, 1942. D. RAGLAND ET AL 2,274,093

APPARATUS FOR COMPLETING SUBMARINE WELLS

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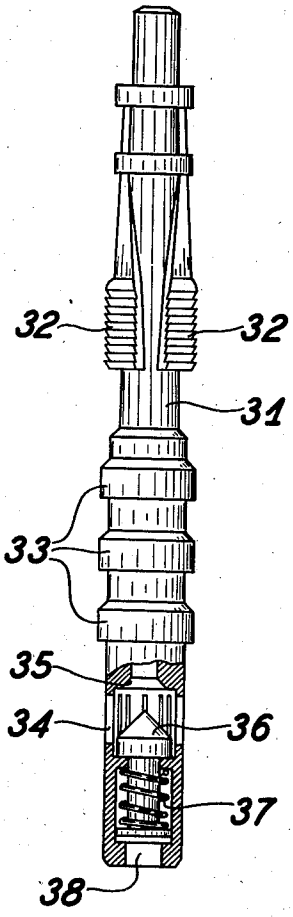


FIG_7_

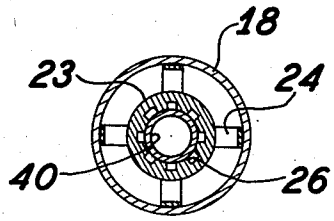


FIG_8_

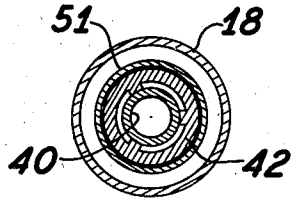


FIG_9_

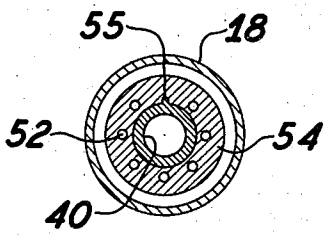


FIG_10_

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Patented Feb. 24, 1942 2,274,093

UNITED STATES PATENT OFFICE

2,274,093

APPARATUS FOR COMPLETING SUBMARINE WELLS

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Application October 19, 1938, Serial No. 235,750

5 Claims. (Cl. 166—2)

The present invention is directed to an apparatus for completing submarine wells. More specifically, it relates to an apparatus for preventing the blowout of submarine wells when the surface connections of said wells are destroyed. It will be understood, however, that the present invention is equally applicable to inland wells, although the need for the invention is of primary importance for submarine wells.

In the completion of submarine wells the Christmas tree and other connections are placed at the surface of the water. In tidal waters the danger arises that heavy objects carried by the tide may strike and destroy the surface connections and in some cases even heavy seas will cause this damage. In shipping waters there is always the danger that a boat will run afoul the surface connections and open the producing formation to atmospheric pressure. As dangerous and difficult as is the task of killing a blowout on an inland well, the problem is magified many fold in submarine wells. In fact, at the present time, no suggestion as to how this could be accomplished has been ventured. Thus, it can be readily seen that it is of paramount importance to insure against blowouts in submarine wells.

The essence of the present invention lies in the step in the completion of a submarine well of arranging in the casing between the producing formation and the surface a seal provided with a passage for the normal flow of oil and with means for shutting off the flow of oil when the velocity of flow becomes greater than that for which the well is set. In its preferred embodiment, the present invention contemplates the arrangement of such a device in the casing wholly independent of the tubing through which the oil is produced. Some of the advantages of the present invention are attainable, however, when the aforesaid device is rigidly secured to the tubing.

According to a more specific embodiment of the present invention, a device of the aforesaid character is arranged in the casing, the casing is sealed off at the lower end of the tubing and the casing above the seal is filled with a heavy mud which in the event of a blowout can be released so as to flow down in the casing and help smother the blowout.

The present invention will be more fully understood from the following detailed description of the accompanying drawings in which

Fig. 1 is a vertical section of a device suitable for the practice of the present invention in its essential form;

Figs. 2, 3, 4, 5, and 6 are successively higher sections of casing, partly in vertical section of a well completed according to the method of the present invention;

Fig. 7 is a side elevation, partly in section of a shutoff device used in the section of casing shown as Fig. 3;

Fig. 8 is a cross section along the line E—E of Fig. 6;

Fig. 9 is a cross section along the line C—C of Fig. 5; and

Fig. 10 is a cross section along the line A—A of Figs. 5 and 6.

In Figure 1 is illustrated a cement retainer of the general type shown in Figures 8, 9 and 10 of Patent #2,121,051, issued June 21, 1938, to C. M. Ragan, et al., modified as hereinafter described and with the parts secured to lower flange 2 of tube 1 omitted. Fixed near the lower end of tube 1 is a seat 3 for a ball 4 so as to prevent the downward flow of liquid. Arranged higher in tube 1 is a second seat 5 for the ball 4 so constructed as to seat the ball against an upward flow of liquid. The ball is so selected as to remain unseated during the normal flow of the well, that is, it is of such a weight that with the velocity of flow which obtains during the ordinary or allowable rate of production the ball will seat neither on seat 3 nor on seat 5. When the velocity of flow of liquid, however, increases beyond a certain desired point, the ball 4 will be seated on seat 5 and will be held there by the pressure of liquid from the producing formation.

As will be apparent from a reference to the above cited patent, the device shown in Fig. 1 is a packer adapted to be locked against movement in either an upward or downward direction. Without discussing in detail the operation of this packer, which is familiar to those skilled in the art, it may be briefly stated that the packing material 6 surrounds pipe 1 and is connected at either end with a collar 7, each of which is connected to pipe 1 by a shear pin 8. Slips 9 are connected by shear pins 10 to pipe 1 and by shear pins 11 to upper collar 7. Slips 12 are connected by shear pins 13 to pipe 1 and by shear pins 14 to lower collar 7. The pipe 1 is provided with an upper flange 15 and intermediate its ends at a point covered by the packing element 6 with liquid passages 16.

With the parts in the position shown in Fig. 1 the assembly is lowered into the casing at the

end of a string of tubing 17 until it reaches the point where it is desired to set it. Liquid is then forced under pressure down through tubing 17 causing ball 4 to seat on the seat 3. The high pressure liquid passes through openings 16 and distends the packing material 6 until it seals against the walls of the casing. Further introduction of high pressure liquid causes packing material 6 to elongate. Shear pins 8, 10 and 11 are made weaker than shear pins 8, 13 and 14. Accordingly, the longitudinal movement of the packing material under the influence of the high pressure liquid shears the upper pin causing the upper slips 9 to fall into place. Further exertion of pressure causes the upper slips to bite into the casing. An upward strain is then exerted upon the tubing 17 causing the lower shear pins to shear and lifting the lower slips up into place thereby squeezing the packing material until it completely fills the annular space between the casing and pipe 1 and the upper and lower collars 7. The seal is then effectuated.

When the packer is set the tubing 17 may be left in place to conduct the oil to the surface. Alternatively, this tubing may be replaced by a tubing having fluid connection with pipe 1 so that any drag on the equipment at the surface will not have a tendency to destroy the packing assembly. Again, the oil may be produced through the casing above packer 6. In any event, if there is a sudden increase in flow of oil through pipe 1 due to destruction of the surface equipment, the ball 4 will be forced upwardly onto seat 5 and will stop the flow of oil.

As previously indicated, a complete assembly for the completion of an oil well is shown in Figs. 2–10, inclusive. Referring to Fig. 2, numeral 18 designates the casing terminating at the producing sand 19 into which is set the usual screen 20 which, it will be understood, is provided with conventional equipment for permitting the washing out of the well. This screen is carried by a conventional packer 21.

Set in the casing above packer 21 is the locked packer 22 which, in this case, may be identical with the packer described in the Ragan et al. patent supra, or which may be the same as that shown in Fig. 1 with the upper seat 5 omitted. In this case, the tubing 17 may be several sections in length and is connected at its upper end with a so-called safety joint which comprises a cylinder 23 provided around its circumference with leaf springs 24 for centering it in the casing. The inner surface of cylinder 23 is provided intermediate its ends with a circumferential seat 25 above which the inner wall of cylinder 23 is fluted as at 26 for the purpose hereinafter specified. The pipe, which is shown in screw threaded arrangement with the upper end of cylinder 23 is employed only for seating purposes, being in screw-threaded connection with setting tube 28. It will be noted that the lower end of pipe 27 is provided with packing rings 29. It is to be understood that the space between the lower threads and the uppermost packing ring may be made sufficiently great so as to permit the disengagement of the threads while maintaining the packing rings in sealing engagement with the inner wall of cylinder 23. In this case the well can be produced through the setting string 28.

In Fig. 4 is shown the position assumed by the parts after the withdrawal of the setting string 28 with the setting tool 27. In this figure tube 17 is shown partly cut away to reveal a bottom hole choke 30 of conventional design. This bottom hole choke is shown in greater detail in Fig. 7. Briefly, it consists of a cylinder 31, provided with slips 32 for setting it in place in tubing 17. The cylinder is provided with packing cups 33 adapted to seal against the inside of the tubing. Below the sealing cups the cylinder is provided with slots 34 for the entry of liquid into the interior of the cylinder. Just above the slots on the inside wall of the cylinder is a seat 35 adapted to receive a tapered valve 36 which is normally held off its seat by a spring 37. The bottom end of cylinder 31 is provided with an opening 38 whereby the pressure of the fluid coming up through tubing 17 acts against the lower end of the valve assembly 36. When this pressure exceeds a point for which the valve assembly is set, the valve is closed by the pressure of the fluid and prevents further flow of fluid upwardly through tubing 17.

In Fig. 5 is shown the next step of the completing operation according to which a packer is let down into the safety joint. This packer is carried by a setting string 39, which may be the producing string of tubing. The packer assembly comprises an inner tube 40 which is of a diameter such as to slide into the cylinder 23 and slidingly engage the inner surfaces of the fluted portion 26 and come to rest some distance above the shoulder 25.

Intermediate its ends tube 40 carries an external ring 41 upon which rests a sleeve 42 the lower edge of which is provided with notches 43. Screw-threaded to the exterior of the upper end of sleeve 42 is a collar 44 the upper edge of which is provided with a sloping seat 45 adapted to receive the sloping edge 46 of a ring 47 carried by the upper end of tube 40. The lower end of sleeve 42 is provided with an exterior flange 48 upon which rests a collar 49. Between collars 44 and 49 is arranged a sleeve 50 of resilient material such as rubber. Screw-threaded to the lower end of collar 49 is a cylinder 51 the lower edge of which is adapted to abut against the upper edge of cylinder 23. The lower end of cylinder 51 is thickened as at 54 so that its inner surface slidingly engages tube 40. This thickened portion is provided with longitudinal passages 52 which establish fluid connection between the interior of cylinder 51 and the annular passages between tube 40 and cylinder 23. Cylinder 51, collar 49, and sleeve 42 are pinned together by one or more shear pins 53. The inner surface of thickened portion 54 is also provided with a key way, not shown, to receive a key 55 carried by tube 40. The purpose of this is to prevent relative rotation between tube 51 and tubing 39.

With the parts in the position shown in Fig. 5, the packer assembly is lowered until cylinder 51 abuts cylinder 23. Further downward movement seats collar 47 on collar 44. Then, continued pressure from above shears off pin 53 causing tube 40 to move downwardly and causing collar 44 to approach collar 49, thereby compressing packing material 50 until it assumes the position shown in Fig. 6. In Fig. 6, the upper end of the completion assembly is shown in its final position. In the completion of the well the space between tube 39 and the casing is preferably filled with a heavy mud. In the event of a blowout, collar 47 is moved off its seat, thereby permitting the mud to pass through the annular space between tube 40 and sleeve

42, through slots 43, through the annular space between tube 40 and sleeve 51, through passages 52, through the annular space between tube 40 and cylinder 23, through the fluted section 26 of cylinder 23 and into tubing 17. If, with the parts in the position shown in Fig. 6, it is desired to withdraw the upper packer assembly, it is simply necessary to pull up on tubing 39. The resulting upward motion of tubing 40 will cause collar 41 to engage sleeve 42 which, in turn, will carry the upper collar 44 upward, thereby relieving the compression on packing material 50.

In completing a well according to the second embodiment of the present invention, the casing is set and cemented; the cement plug is drilled out and the screen and packer 21 are set in place; packer 22 is then set in place followed by safety string 17; packer 50 is then set in place on top of the safety string; the tubing 39 is then lowered into the well until its lower end is in the packer 50, but with bevel edge 46 off of seat 45; water is then forced down the tubing in such volume that the mud below the packer 50 is displaced and forced into the casing above packer 50; bevel edge 46 is then forced onto seat 45. At this stage the only liquid above the producing formation is water which is not heavy enough to overcome the pressure of the formation, whereby the well begins to produce. Mud is retained in the casing above the packer 50 as a safety measure, as hereinbefore described.

It is to be understood that the above described specific embodiments are merely illustrative of applicant's invention and are not intended to circumscribe its full potentialities. Many changes in these embodiments will be apparent to one skilled in the art without the exercise of invention. It may be noted here that in the second embodiment the packer 50 and its accompanying parts are not necessary to the realization of a very substantial portion of the advantages inherent in such second embodiment. Likewise, it will be apparent that different types of packers and choke valves from those shown could be employed without altering the principle of operation of the assembly constituting the present invention. All such changes and modifications are contemplated within the scope of the appended claims in which it is intended to claim the present invention as broadly as the prior art permits.

We claim:

1. A submarine oil well comprising a casing connecting the producing formation with the surface, a packer having a central passage locked in place in said casing at a point intermediate its ends, a tubing connecting the passage in said packer to a point above the surface water level, said tubing being arranged for free longitudinal movement relative to said packer, and means for shutting off the upward flow of fluid through said passage when it exceeds a predetermined velocity.

2. A submarine well comprising a casing extending from the producing formation to the surface, interior equipment including a packer fixed in said casing intermediate its ends and defining a central passage the lower end of which is normally in communication with said casing below said packer and the upper end of which is normally in communication with said casing above said packer, tubing extending from a point above the surface water level to the passage defined by the packer, said tubing being arranged for free longitudinal movement with respect to said passage, means carried by the lower end of said tubing for sealing off the passage defined by the packer from the casing above the packer, and means arranged in said passage defined by the packer for stopping the upward flow of fluid through said passage when it attains a predetermined velocity.

3. A device in accordance with claim 2 in which the annular space between the casing and tubing above the packer is filled with a heavy fluid.

4. A well comprising a casing extending between a producing formation and the surface of the earth, a packer provided with a central passage locked in place in said casing at a point intermediate said formation and the earth's surface, means for shutting off the upward flow of fluid through said passage when it exceeds a predetermined velocity, a tubing arranged in said casing connecting the passage of said packer with the surface of the earth, said tubing being arranged for elevation to disrupt said connection without disturbing said packer.

5. A well comprising a casing connecting a producing formation with the surface of the earth, a packer provided with a central passage locked in place in said casing at a point intermediate said formation and the earth's surface, means for shutting off the upward flow of fluid through said passage when it exceeds a predetermined velocity, a tubing arranged in said casing connecting the passage of said packer with the surface of the earth, and a heavy fluid filling the annular space between said tubing and said casing above said packer, said tubing being arranged for elevation to disrupt said connection and allow the heavy fluid to flow downwardly through said packer to kill said well.

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