Sept. 10, 1940. A. ENGLISH 2,214,227

METHOD AND APPARATUS FOR SECURING OBJECTS IN WELLS

Filed March 29, 1939 2 Sheets-Sheet 1

Fig. 1.

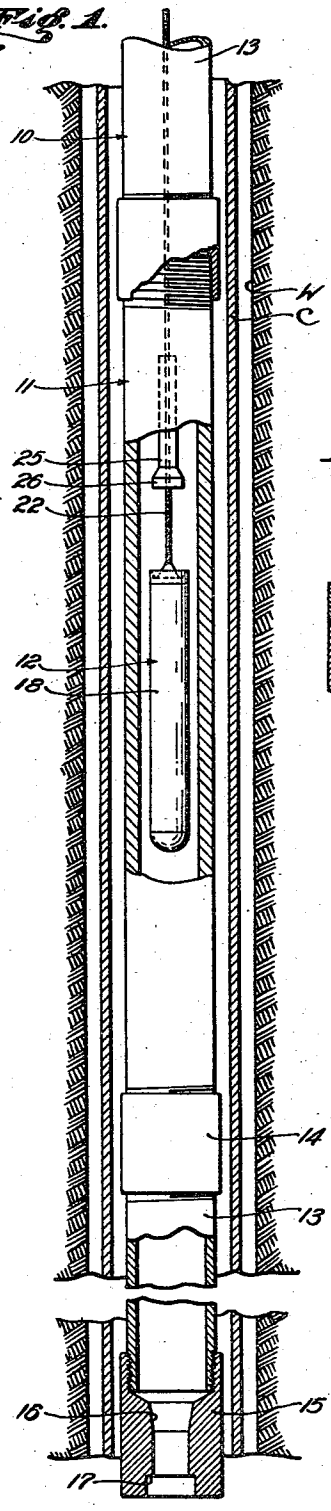


Fig. 3.

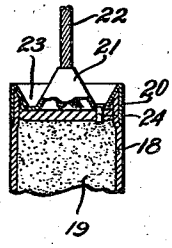
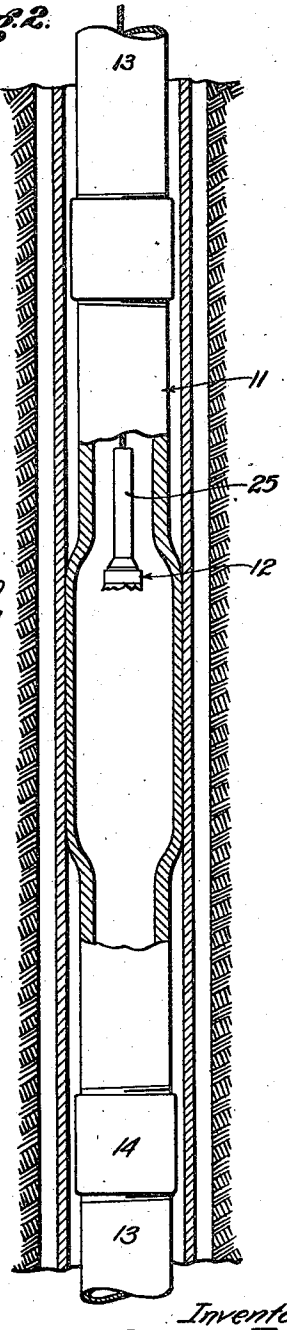


Fig. 2.



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Filed March 29, 1939 2 Sheets-Sheet 2

Fig. 4.

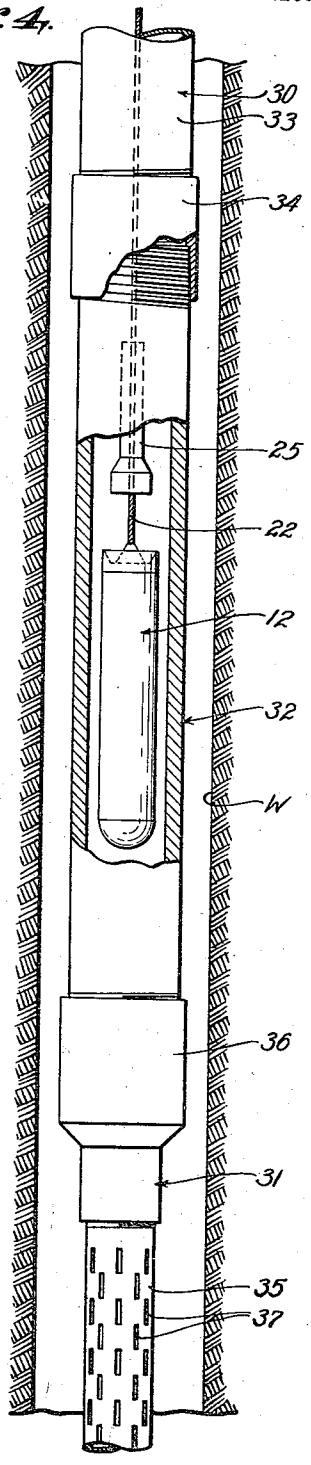
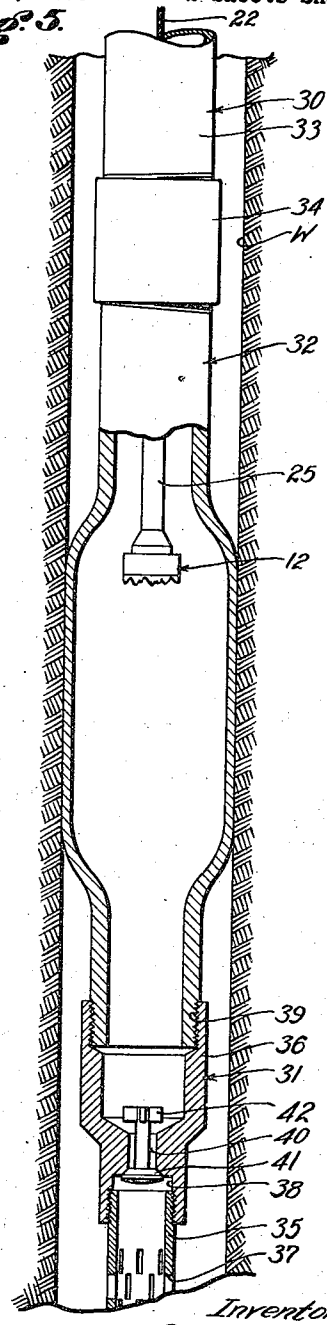


Fig. 5.



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METHOD AND APPARATUS FOR SECURING OBJECTS IN WELLS

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Application March 29, 1939, Serial No. 264,770

7 Claims. (Cl. 166—1)

This invention relates to the testing, equipping and producing of wells and relates more particularly to methods and apparatus for anchoring or securing objects in wells. A general object of this invention is to provide a rapid, practical method and a simple, dependable and inexpensive apparatus for anchoring or securing objects in wells.

It is frequently necessary to anchor or secure tools and pieces of equipment in wells in carrying out the various well drilling and producing operations. For example, well tubing and similar tubular objects must be anchored or secured in the well. It has been the general practice to secure or anchor tubing and like objects by means of gripping devices such as anchors or to cement the objects in place. Anchors are expensive and are not always positive while cement jobs are insecure and in many cases it is difficult to effectively cement an object in a well.

Another object of this invention is to provide a method for anchoring or securing objects in wells that avoids the use of gripping devices and cement.

Another object of this invention is to provide a method by means of which an object such as a section of a tubular string is expanded in the well to obtain a firm hold on the wall of the well.

Another object of this invention is to provide a method of the character mentioned that may be repeated at vertically spaced points along a tubular well string to positively prevent working, creeping and vibration of the string.

Another object of this invention is to provide a method of the character mentioned that may be economically and rapidly carried out with conventional well equipment.

Another object of this invention is to provide means for securing an object in a well that is operable to obtain a firm, dependable engagement with the wall of the well which in some cases may be the earth formation, and in other cases may be the casing lining the well.

Another object of this invention is to provide means for anchoring an object in a well that is readily drillable, that is, the anchoring means may be easily and quickly removed from the well at any time by operating drilling tools to drill it up.

Another object of this invention is to provide means for securing or anchoring an object in a well that assures a fluid-tight engagement between the object and the wall of the well and a firm, secure gripping or holding engagement of the object with the well wall.

A further object of this invention is to provide a novel inexpensive anchor for well tubing, and the like, that is expansible into effective holding or anchoring engagement with the wall of the well.

The various objects and features of my invention will be fully understood from the following detailed description of typical preferred forms and applications of the apparatus and typical preferred manners of carrying out the method of the invention, throughout which description reference is made to the accompanying drawings, in which:

Fig. 1 is a fragmentary sectional view of a portion of a well with one form of apparatus of the invention in position in the well casing preparatory to the expanding of the anchor member, showing portions of the apparatus in vertical cross section. Fig. 2 is a view similar to Fig. 1 showing the anchor member expanded. Fig. 3 is an enlarged fragmentary vertical detailed sectional view of the pressure generating means or explosive means illustrated in Fig. 1. Fig. 4 is a fragmentary sectional view of a well showing an anchor member of the present invention connected with a formation tester and an explosive means in position to expand the anchor member, a portion of the anchor member being in vertical cross section, and Fig. 5 is a view similar to Fig. 4 illustrating the anchor member expanded and showing a portion of the anchor member and the tester in longitudinal cross section.

The method and apparatus of the present invention have many uses or applications, being adapted to anchor, hold or support various objects and tools in wells, and being useful under various different well conditions. In the following detailed description I will describe two typical applications of the invention, it being understood that these typical uses or applications are not to be construed as limiting the scope of the invention.

The apparatus of the invention illustrated in Figs. 1, 2 and 3 may be said to comprise, generally, a tubular well string 10, an expansible anchor member 11 connected in the string 10, and means 12 for expanding the member 11 to anchor the string 10 in the well. The portion of the well illustrated in Figs. 1 and 2 is equipped with a typical casing C. The casing C constitutes the wall of the well W and the anchor member 11 is

expansible to obtain a secure holding or anchoring engagement with the casing.

The tubular well string 10 may be in the nature of a string of well tubing for carrying a well pump and for conducting the well fluid to the ground surface. The string 10 may be made up of a plurality of lengths or sections 13 of tubing connected by threaded collars or couplings 14. The tubing string 10 may be assembled and run into the well casing C in the manner well known to those skilled in the art. In accordance with the usual practice the tubing string 10 is received in the casing C with suitable clearance. In the construction illustrated a shoe 15 is attached to the lower end of the string 10 to support a well pump (not shown). The shoe 15 may be of typical design and may have a tapered internal sealing surface 16 and an internal downwardly facing latch shoulder 17 below the surface 16. The pump anchoring or supporting shoe 15 may be threaded on the lower end of the lowermost tubing section 13.

The anchor member 11 is an important element of the invention. The member 11 is adapted to be connected in or secured to the string 10 at any selected point. In the construction illustrated the member 11 is connected in the string 10 above the lowermost tubing section 13. The adjacent threaded collars or couplings 14 may be employed to secure the member 11 in the string 10. The mating threads on the upper end of the member 11 and the cooperating coupling 14 may be lefthand threads whereby the portion of the string 10 above the member 11 may be readily disconnected from the member and withdrawn from the well if this becomes necessary. The anchor member 11 as initially formed may be a simple cylindrical tubular element of suitable length. The member 11 is generally of the same diameter as the tubing sections 13 although it is preferred to make the wall of the member 11 of greater thickness than the walls of the sections 13.

In accordance with the invention the member 11 is designed to be expansible under the influence of internal pressures. The anchor member 11 is formed of a yielding or ductile material. In most cases it is believed that it will be most practical to form the member 11 of copper, although it may be practical to form the member 11 of other ductile material such as aluminum, aluminum alloys, lead, lead alloys, tin, soft iron such as "Armco" iron, etc. As mentioned above, the member 11 is adapted to have holding or gripping engagement in the casing C when expanded and it may be desired to coat the member 11 with synthetic rubber, or the like, to seal with the inner wall of the casing. The sealing material may be dispensed with as the member 11 is adapted to have effective metal to metal sealing contact with the casing C.

The means 12 for expanding the anchor member 11 is operable to generate or produce fluid pressure in the member to expand the member into secure engagment with the interior of the casing C. The means 12 is preferably in the nature of an explosive means although it may employ or embody fluid combinations or other elements operable to generate fluid pressure more slowly than explosives. In the case illustrated the means 12 comprises a container 18 adapted to be lowered through the string 10 to a position in the member 11. The container 18 is adapted to hold an explosive charge 19 and is frangible. The upper end of the container 18 is closed by a cover 20 shaped to have a central rope socket 21 receiving the lower portion of a cable or line 22. The line 22 is adapted to lower the means 12 down through the string 10 to the selected position in the member 11. The upper end of the cover 20 has an annular upwardly facing groove 23 with downwardly converging walls. The explosive charge 19 in the container 18 may be such that it may be set off by electrical ignition. In the case illustrated, however, it will be considered that the charge 19 is a charge of dynamite, trinitrotoluene, or the like, to be set off by a percussion cap 24. The cap 24 may be set in an opening in the cover 20 to have its pin and upper portion exposed at the bottom of the groove 23.

The pressure generating means 12 further includes a go-devil or weight element 25 for firing the percussion cap 24. The weight element 25 may be a tubular member designed to be dropped or lowered down the line 22 from the ground surface. The lower end of the weight element 25 is provided with a flared flange 26 designed to enter the groove 23 and to strike the cap 24. The walls of the groove 23 are adapted to guide or direct the flange 26 to have the desired impact with the percussion cap 24 to fire the same. The go-devil or weight element 25 may be dropped to freely fall down the line 22 so that its flange 26 fires the cap 24.

The method of the invention as employed with the apparatus illustrated in Figs. 1, 2 and 3, may be said to comprise, generally, the provision of the ductile anchor member 11 in the well string 10, the positioning of the string 10 and member 11 in the well and the expansion of the member 11 by the means 12 to secure the string 10 against vibration and movement.

The expansible anchor member 11 may be easily assembled or connected in the tubing string 10 when the string is assembled and run into the casing C. Where the anchor member 11 is intended to cooperate with the well casing C it is assembled in the string 10 to assume the desired position in the casing C when the string is in its final position in the well. The string 10 embodying or carrying the anchor member 11 may be made up and run into the casing C in the manner well known to those skilled in the art. The depth or position of the member 11 is determined or measured.

To expand the anchor member 11 the container 12 is first secured to the lower end of the line 22 and is then run down through the string 10 on the line. The depth or position of the member 11 having been previously determined the line 22 may be measured as it is run into the well to bring the means 12 to a position between the ends of the anchor member 11. The go-devil or weight element 25 is then dropped down the line 22. The flange 26 on the lower end of the member 25 strikes the percussion cap 24 and the cap fires the charge 19. The charge 19 suddenly generates substantial pressure within the tubular member 11 and this pressure acts outwardly or radially on the wall of the ductile member 11 to expand the same into effective holding and sealing engagement with the internal surface of the casing C. The means 12, that is, the explosive charge 19, may generate sufficient heat to render the material of the member 11 more ductile. The column of liquid that may be standing in the well may serve to confine the explosion so that the generated pressure acts laterally or

radially against the wall of the tubular member 11 to more efficiently expand the member.

The member 11 is expanded against the casing C with great force and the ductile metal of the member 11 is brought into intimate contact with the metal of the casing C. The ductile metal of the anchor member 11 is forced into or flows into the crevices, interstices, etc., of the casing C so that the member obtains a firm, dependable hold in the casing C. The member 11 is expanded throughout its circumference and for a substantial vertical distance to have extensive holding and sealing contact with the casing C.

Following the discharge of the means 12 the line 22 is withdrawn from the string 10. As illustrated in Fig. 2 the cover 20 and the upper portion of the container 18 may remain after the discharge of the means 12 to be withdrawn on the line 22. The weight element 25 is recovered on the line 22. The expanded member 11 securely and dependably anchors the tubing string 10 in the casing C to prevent movement and vibration of the string.

While I have described the method and apparatus employed to secure the string 10 in the casing C at one point, it will be obvious that the method described above may be performed at vertically spaced points along the string 10 to anchor the string in the casing C at several places.

The apparatus of the invention illustrated in Figs. 4 and 5 of the drawings may be said to comprise, generally, a tubular well string 30, a formation tester 31, an expansible anchor member 32 connected with the string 30 and the tester 31, and means 12 for expanding the member 32. The well string 30 is provided to run the tester 31 into the well and to receive or conduct the well fluids produced into the tester 31. The string 30 may be an elongate assembly of pipe or tubing and may be made up of a plurality of sections 33 connected by threaded couplings 34. The string 30 may be assembled and run into the well in the usual manner.

The tester 31 is provided to receive the fluids from the earth formation in the open lower portion of the well. In accordance with the broader aspects of the invention, the tester 31 may be of any selected form and construction. In the embodiment of the invention illustrated in the drawings the tester 31 comprises a tubular screen or perforated liner 35 and a tubular body 36 on the upper end of the liner 35. The liner 35 is provided with longitudinally and circumferentially spaced slots 37 for admitting the fluids from the earth formation. The liner 35 may be of less diameter than the string 30 to enter the open lower portion of the well W or the reduced rathole of a well with suitable clearance. The body 36 of the tester 30 is in the nature of a tubular connector or adapter. A socket 38 is provided in the lower end of the body 36 to receive the threaded upper end of the liner 35. A socket 39 of enlarged diameter is provided in the upper end of the body 36. A reduced passage 40 connects the sockets 38 and 39 and is controlled by a valve 41. The valve 41 may be of any preferred construction or design. In the case illustrated the valve 41 seals upwardly against a seat at the lower end of the passage 40 and has an upwardly projecting head 42 extending into the socket 39. The head 42 may be engaged by a go-devil or other object lowered or dropped through the string 30 to open the valve 41. The liner 35, the body 36 and the valve 41 are preferably constructed of a drillable material such as copper, aluminum or an aluminum alloy so that the tester 31 may be readily drilled up by drilling tools operated in the well W.

The anchor member 32 is provided to anchor the tester 31 in the well W and to close off the lower portion of the well so that the test fluid received by the tester 31 is uncontaminated. In the construction illustrated the anchor member 32 is interposed between the string 30 and the tester 31. The member 32 is an elongate tubular element of substantially the same diameter as the string 30. In accordance with the invention the member 32 is constructed of a ductile metal such as copper, soft iron, aluminum, an aluminum alloy, lead, a lead alloy, tin, or the like. The ductile member 32 may be connected with the string 30 and tester 31 in any suitable manner. In the case illustrated the upper end of the member 32 is connected with the lowermost section 33 of the string 30 by a threaded coupling 34. The cooperating threads of the coupling 34 and the member 32 are preferably left hand threads to permit the easy disconnection of the string 30 from the anchor member 32 when the latter is anchored in the well W. The lower end of the member 32 may be threaded in the socket 39 of the tester body 36. The member 32 is expansible into anchoring and sealing engagement with the wall of the well W and it is preferred to construct the member 32 of substantial wall thickness.

The means 12 for expanding the member 32 may be identical with the means 12 employed in the previously described form of the invention and may be run down through the string 30 on the line 22 to an operative position in the member 32. The above described go-devil 25 may be dropped or run down the line 22 to actuate or discharge the explosive charge 19 of the means 12, as described above.

The method of the invention as employed in connection with the apparatus illustrated in Figs. 4 and 5 may be said to comprise the arrangement of the string 30, the tester 31 and the member 32 in the well W, the expansion of the member 32 by the means 12 to anchor the tester 31 in the well and to seal off the lower portion of the well, the production or recovery of the well fluids received by the tester 31 and the subsequent removal of the equipment from the well W.

The tester 31 and the member 32 are assembled as illustrated in the drawings and are connected with the lower end of the string 30. The string 30 is run into the well W to bring the tester 31 and the member 32 into the open portion of the well W at or above the zone to be tested. The means 12 is then lowered through the string 30 on the line 22 to a position substantially midway between the ends of the ductile anchoring member 32. The weight element 25 is then dropped down the line 22 to actuate or discharge the explosive means 12. The sudden pressure generated by the means 12 expands the ductile member 32 to a condition such as illustrated in Fig. 5 of the drawings where it tightly engages and seals with the wall of the well W. The member 32 being formed of a ductile material conforms to the contour of the well wall and effectively seals with the earth formation. The member 32 is expanded against the wall of the well W with such force that it is securely anchored in place. Following the discharge of the means 12 the line 22 carrying the weight

element 25 and the remaining portion of the means 12 is withdrawn from the well.

The fluid from the adjacent earth formation is allowed to produce into or through the liner 35 and this fluid may flow up through the member 32 and the string 30. If the fluid is produced in sufficient quantities it may flow from the upper end of the string 30. In other instances it may be necessary to pump or bail the test fluid from the member 32 and the string 30. If it is found that the well produces through the tester 31 in paying quantities the well may be allowed to produce through the tester and the string 30. The expanded anchoring and sealing member 32 effectively anchors the tester 31 in the well and fully closes off the producing lower portion of the well so that the produced fluid is uncontaminated.

When the test has been completed or when the well no longer produces in paying quantities an attempt may be made to withdraw the member 32 and the tester 31 by raising or pulling the string 30. If this attempt is successful the equipment may be easily withdrawn from the well on the string 30. On the other hand if it is found difficult or impossible to withdraw the anchor member 32 and the tester 31 by means of the string 30 the string 30 may be disconnected from the anchor member and removed from the well. The expanded anchor member 32 is held against turning through its engagement with the wall of the well W and the string 30 may be rotated to unthread its lowermost coupling 34 from the member 32. When the string 30 has been withdrawn from the well W a suitable well drilling tool may be run into the well and operated to drill up the drillable member 32 and the drillable tester 31. The member 32 and the tester 31 may be drilled into small fragments or cuttings by the drilling tool and these cuttings may be flushed from the well. The drilling up of the member 32 and the tester 31 leaves the well bore open and clear for subsequent operations.

Having described only typical preferred forms and applications of the apparatus and typical preferred manners of carrying out the method of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art or fall within the scope of the following claims.

Having described my invention, I claim:

1. The method of anchoring an object in an oil well or gas well comprising connecting a tubular member of ductile material with the object, inserting the object and member into the well, and expanding the member into anchoring engagement with the wall of the well by discharging an explosive in the member.

2. The method of anchoring an object in an oil well or gas well comprising connecting a tubular member of ductile material with the object, inserting the object and member into the well, lowering an explosive pressure generating means into the member, and then expanding the member into anchoring engagement with the wall of the well by firing said explosive means.

3. The method of anchoring a tubular well string in an oil well or gas well comprising providing a ductile section in the string, arranging the string in the well, and expanding the section into tight engagement with the wall of the well by discharging an explosive in the section.

4. The herein described method comprising connecting a ductile tubular section with a formation tester, arranging the tester and section in a well, and then expanding the section to anchor against and seal with the wall of the well above the tester by discharging an explosive in the section.

5. The herein described method comprising connecting a drillable ductile tubular member with the upper end of a drillable formation tester, running the member and tester into a well on a tubular string, expanding the ductile member into contact with the wall of the well by discharging an explosive in the member, allowing the well to produce through the liner, removing the string from the well, and then drilling up the liner and member.

6. Apparatus of the character described comprising a string of well tubing, a pump anchor on the string, a ductile tubular member connected in the string and expansible to anchor the string in a well, and explosive means to be entered in the tubular member operable to expand the same.

7. Apparatus of the character described comprising a tubular test spring, a formation tester carried by the string, an expansible ductile metal tubular member connected in the string, and explosive means for expanding the member into anchoring and sealing contact with the wall of the well.

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