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WELL LINER SETTING APPARATUS

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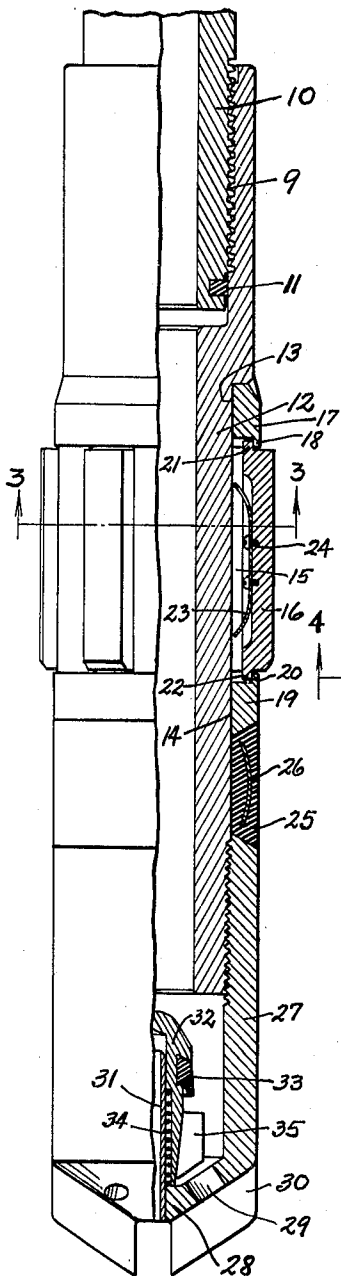


Fig. 1.

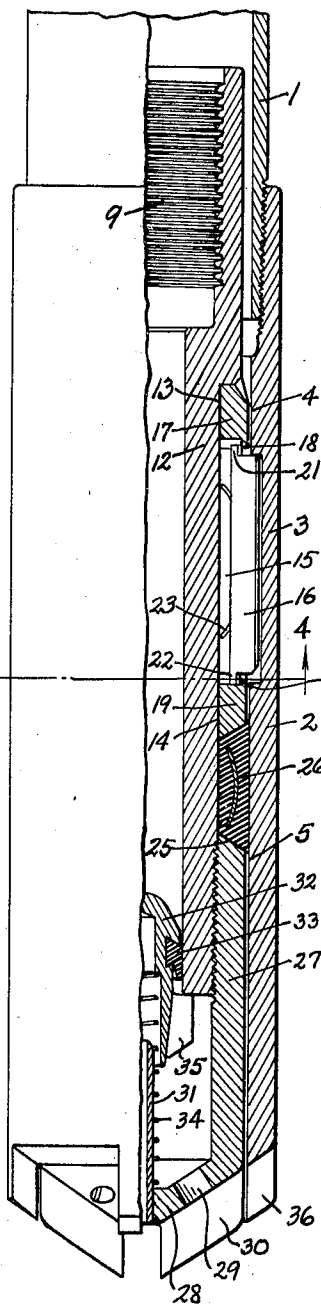


Fig. 2.

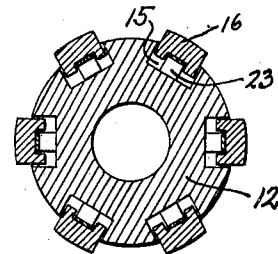


Fig. 3.

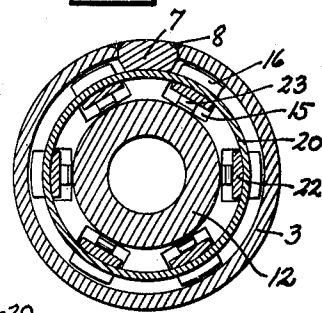


Fig. 4.

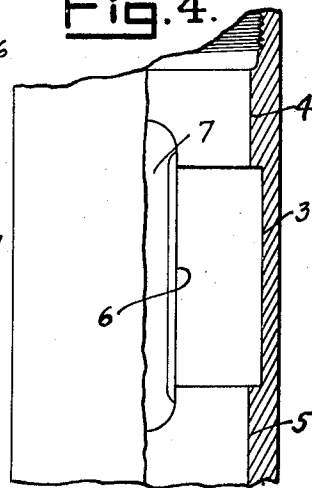


Fig. 5.

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WELL LINER SETTING APPARATUS

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4 Claims. (Cl. 166—1)

This invention relates to a well liner setting apparatus and has for its general object the provision of such an apparatus which will make it possible to set the liner of a well in a section of open hole which does not have a coating of heavy mud obstructing the passages from the formation.

In many oil or gas fields production is found under considerable pressure in very fine silty sand or the like which must be screened before the well is allowed to produce. Even then the oil must be prevented from passing through the screen at high velocity if the greatest ultimate production is to be recovered.

It has been customary in the past to set a casing with its lower end at the top of the producing zone. A hole is then drilled below the lower end of the casing down through the producing formation while a very heavy column of mud is used in order to prevent the heavy pressure in the formation from causing a blowout. A screen liner is then run in the hole which has thus been drilled beyond the lower end of the casing and an effort is made to wash the mud from the face of the formation on which it has become plastered so that the well can produce. A number of methods have been employed in connection with this washing operation. One of such methods is to connect a wash pipe to a shoe at the lower end of the liner, which shoe has an opening therein so that water or oil may be circulated down through the shoe at the lower end of the liner and up around the outside of the liner in an effort to wash the mud from the walls of the hole. Such a washing method has been found to be highly inefficient and to be fraught with many difficulties because it is extremely difficult to force a washing fluid down through the relatively small wash pipe to the lower end of the liner to cause a velocity upward outside of the liner sufficient to completely remove the mud from the wall of the hole. If a sufficient velocity of such washing fluid is established there is always the danger that the washing fluid will come back in through the openings in the screen liner and will cause washing through said openings and damage to the screen. It is also possible that an attempt to wash outside the screen might tend to clog up the screen itself and thus prevent an efficient production after the washing operation has been completed.

It is an object of this invention to provide a device which will make it possible to drill a hole down through the producing formation without the use of heavy mud in the final drilling of the hole so as to produce a hole which is not plastered up with heavy mud, and to then run a liner in said hole.

It is a further and more specific object of this invention to provide such a device in the form

of a set shoe and setting tool for a liner which will make it possible to rotate the set shoe and clean the hole of any debris which might be contained therein during the time the liner is being set.

It is a further object of this invention to provide such a structure in which a fluid may be washed down through the shoe at any time during the use of the apparatus.

Another object of this invention is to provide a liner with a set shoe having an opening therein sufficiently large to permit a reaming or drilling tool to be lowered therethrough and actuated below the liner while the liner is hung in the well and the well is maintained under pressure, and to provide a setting tool which may after withdrawal of the drilling tool be inserted into the liner to close the opening in the set shoe and to enable the liner to be lowered and set.

Another object is to provide a setting tool by which a drill pipe or tubing may be connected to the shoe of a liner while the well is under high pressure not compensated for by weighted mud, the liner having been suspended from the head of the well below the master valve before the well was under pressure.

Another object is to provide a device which will make it possible to lower, push down, pull up, or rotate with or without circulation during the running of the liner into a well, without placing upon the liner stresses which might damage it.

Other objects and advantages of this invention will become apparent from the following description taken in connection with the accompanying drawing wherein is set forth by way of illustration and example one embodiment of this invention.

In the drawing:

Fig. 1 is a view partly in longitudinal cross section and partly in side elevation illustrating a setting tool constructed in accordance with this invention.

Fig. 2 is a view similar to Fig. 1 showing the setting tool inside of a liner set shoe constructed in accordance with this invention.

Fig. 3 is a horizontal cross section taken along the line 3—3 of Fig. 1.

Fig. 4 is a horizontal cross section taken along the line 4—4 of Fig. 2.

Fig. 5 is an enlarged fragmentary section of the liner setting shoe constructed in accordance with this invention, showing the same partly in side elevation and partly in longitudinal cross section, and illustrating that portion of the setting shoe with which the setting tool is adapted to cooperate.

Referring now more particularly to the drawing, the numeral 1 designates a liner, portions of which will be perforated to provide a screen

through which the well may be produced. Threaded to the lower end of this liner 1 is a setting shoe 2. This setting shoe is provided with a zone 3 of larger internal diameter than the zones 4 and 5 immediately above and below the said zone 3 respectively. The zone 3 is interrupted at one point of its circumference by a slot 6 adapted to receive a key 7 which is welded therein as indicated at 8. This key 7 extends radially inwardly to such an extent that its inner surface is substantially flush with the inner wall of the setting shoe in the zones 4 and 5.

The setting tool constructed in accordance with this invention is shown provided at its upper end with coarse threads 9 of the Acme type by which this setting tool is adapted to be connected to the lower end of a drill stem 10. A suitable packing 11 may be provided for the purpose of forming a seal between the lower end of the drill stem and the upper end of the setting tool.

Below its upper end the body of the setting tool which may be indicated by the numeral 12 is formed with two zones 13 and 14 of reduced external diameter. Between these zones the body 12 is not reduced in diameter but is provided with a series of slots or keyways which preferably extend inwardly so that their bottoms are substantially flush with the reduced portions 13 and 14. These slots or keyways are indicated by the numeral 15 and are adapted to receive the keys 16.

The only purpose of the upper reduced zone 13 is to give clearance for the purpose of permitting a milling cutter to mill the slots or keyways 15. After these slots or keyways have been milled the reduced portion 13 is enclosed by means of a split ring 17 which is then welded in place. This ring 17 has adjacent its outer surface an overhanging lip 18 which extends in an axial direction toward the keyways 15.

Surrounding the lower reduced portion 14 of the body 12 is a solid ring 19 which likewise has an overhanging lip 20 that extends upwardly in an axial direction toward the keyways 15. This last mentioned ring is slidably mounted upon the body 12 and the keys 16 are inserted between the split ring 17 and the solid ring 19 before the solid ring 19 is moved upwardly. Each of these keys 16 has an upwardly projecting lip 21 and a downwardly projecting lip 22 said lips being adapted to engage behind the lips 18 and 20 respectively of the rings 17 and 19. Thus, when the ring 19 is pushed upwardly after the keys 16 have been inserted in place, the keys 16 will be limited in their radially outward movement. Each of the keys 16 is however provided with a spring which may be of leaf spring form such as indicated at 23 for constantly urging the key in a radially outward direction. Each of these springs 23 is secured to the rear face of its key 16 by means of screws 24 or the like.

The lower end of the ring 19 is tapered and telescoped over the lower end of the body 12. Below the ring 19 is a sealing member comprising a body of a suitable rubber like substance such as certain synthetic oil resisting rubber substitutes 25 having embedded therein a ring of stiffening material 26. This ring 26 is preferably a rather stiff strong material but is of such a nature that it has very little elasticity so that once it is crushed it will retain its crushed shape and will not regain its original shape. The purpose of this will be presently set forth.

Below the sealing ring 25 there is threaded on to the body 12 the setting tool head 27, which head is substantially closed at its lower end as

shown at 28 but is provided with openings 29 therethrough for the passage of a washing fluid. This head may also be provided with vanes or blades 30 on its lower end which may be employed by rotation of the tool in clearing away debris encountered during the setting of a liner.

In the central portion of the head and on the inside thereof there is provided an upstanding valve stem 31 which is adapted to receive slidably a valve element 32 having a sealing cup 33 thereon. This valve head is normally urged in an upward direction by means of a spring 34 and is of such a size that it may enter the lower end of the body 12. The sealing cup 33 is arranged to face downwardly so that it will prevent any upward flow of fluid when the head 32 is within the bore of the body 12. The movement of this head 32 into the bore of the body 12 is limited by means of the veins 35.

It is noted that the lower end of the shoe 2 is provided with blades 36 which may in substance form continuations of the blades 30 when the setting tool is in place within the shoe.

It will be appreciated that the head 27 may if desired be provided with a threaded connection at its lower end so that a wall scraper or reamer may be secured thereto and employed in removing any excess material from the wall of the hole during the time that the screen liner is being run into place.

In operation, the well will be drilled in the usual manner and the casing set adjacent the upper limits of the producing formation while heavy mud is employed in the hole in order to prevent any pressure encountered from blowing out.

An appropriate length of screen liner with the shoe 2 on the lower end thereof is then made up and hung within the upper end of the well on a blowout preventer. On top of the blowout preventer will be a control valve and above the control valve a sufficient length of casing or pipe long enough to accommodate a drill or reamer is employed and a stuffing box is placed on the upper end of this length of pipe which may be termed a riser. Before making up the liner and placing the riser referred to on the well it may be desirable to drill a rat hole or small hole down through the producing formation taking cores in order that the nature and extent of the producing formation may be determined for the purpose of making up the liner. During this rat hole drilling heavy mud will be employed in the well for the purpose of preventing a blow-out.

With the liner made up and hung on the blow-out preventer as above described a drill or reamer may be inserted through the liner and through the riser after which the stuffing box at the upper end of the riser will be closed and that portion of the hole which extends through the producing formation may be enlarged. During this enlarging procedure water or oil may be employed as a drilling fluid and the act of reaming or enlarging the hole will serve to remove from the walls of the hole the cake of mud which will have been deposited thereon during the initial drilling of the rat hole. A blowout will be prevented during this reaming or scraping operation by maintaining a back pressure on the return from the well. This may be done in any ordinary manner by use of a flow bean or a choke. It will be seen furthermore that by this procedure all of the weighted column of fluid which has previously been employed in the well will be

removed by the lighter oil or water used as drilling fluid.

After the lower portion of the hole has been enlarged as just described the reaming or wall scraping tool may then be drawn up past the control valve which will then be closed. The stuffing box may then be opened and this drilling equipment removed from the well. There will then be inserted into the riser on the lower end of the drill pipe the setting tool illustrated in Fig. 1. When the setting tool is in place within the riser the stuffing box at the upper end of the riser may be closed and the setting tool moved downwardly through the control valve which may then be open. Appropriate lengths of drill pipe are added as the setting tool is moved downwardly until the setting tool reaches the lower end of the screen liner hanging in the well. When the proper position has been reached, the keys 16 will snap outwardly into the zone 3 of enlarged diameter in the liner setting shoe and further downward movement of the setting tool with respect to the liner will be arrested. The liner setting tool will likewise be prevented from rotation with respect to the setting shoe by virtue of the engagement between the keys 16 and the key 7 that is carried by the setting shoe.

If an upward pull be now exerted upon the drill pipe, this upward pull will be transmitted to the head 27 at the lower end of the setting tool. The upward pull on this head will serve to compress the packing 25 in a longitudinal direction and cause it to expand in a radial direction to form a seal with the inner surface of the liner setting shoe. During this compression of the packing body the element 26 will be deformed in the manner illustrated in Fig. 2 so that it will thereafter hold the sealing body in expanded position and in sealing engagement with the inner surface of the setting shoe.

The blowout preventer rams upon which the liner has been suspended may now be opened and the entire liner suspended on the drill pipe may be lowered into the well. In the event any obstruction is encountered which makes it desirable to rotate the device during the lowering thereof into the well, this may be done because the setting shoe cannot rotate with respect to the setting tool. At the same time, if it should become desirable to pump down through the device and wash up around the outside of the liner, this may be accomplished by merely pumping down through the drill pipe past the valve 32 and out through the openings 29. The blades 30 and 36 may be employed for light drilling operations if found desirable.

When the liner has been landed on bottom and it is desired to release the drill stem from the setting tool, this may be accomplished by a left-hand rotation of the drill stem. During this releasing operation the setting tool will be held against rotation by engagement of the blades 30 with the lower end of the hole.

It will be appreciated that by means of the above described tool it is possible to set a liner in a well in the manner described without necessity for washing mud from the face of the formation behind the liner after the liner has been set. It will further be appreciated that the liner under such circumstances will be set in a hole which is not only free from a mud cake on the walls of the formation but which will be free from the

presence of heavy mud that might otherwise clog up and impair the efficiency of the screen liner.

It will also be seen that when a screen is set in the manner described above and with the tool illustrated and described, the entire face of the producing formation will be free of any obstruction and a comparatively even flow may take place therefrom. The flow thus being distributed and not concentrated will be at a lower velocity than it would be if it were concentrated and there will not be tendency that would otherwise exist to wash through the screen at a high velocity and cause a cutting out and/or other damage to the screen.

Having described my invention, I claim:

1. In a device of the character described, a liner shoe adapted to be connected to the lower end of a well liner, a liner setting tool adapted to be secured to the lower end of a setting string and to fit within said shoe, means for nonslidably connecting said shoe and setting tool, and means for forming a seal between said shoe and setting tool, said last mentioned means comprising a body of deformable elastic material and a deformable nonelastic stiffening member adapted when expanded to hold said first part expanded and to form a permanent seal between said shoe and setting tool.

2. In a device of the character described, a liner shoe adapted to be connected to the lower end of a well liner, a liner setting tool adapted to be secured to the lower end of a setting string and to fit within said shoe, means for nonslidably connecting said shoe and setting tool, said last mentioned means comprising a radially movable key on said setting tool and a keyway for receiving said key formed in said shoe, and means for forming a seal between said shoe and said setting tool, said last mentioned means comprising a deformable elastic part extending about said setting tool, a deformable nonelastic part for stiffening said elastic part and for holding said elastic part expanded to form a permanent seal, and telescoping parts on said setting tool one of which is adapted to be moved longitudinally with respect to said setting tool after said key has been engaged in said keyway to expand said elastic part and to deform said nonelastic part to hold said elastic part expanded and form a permanent seal between said shoe and setting tool.

3. In a device of the character described, a liner shoe adapted to be connected to the lower end of a well liner, a liner setting tool adapted to be secured to the lower end of a setting string and to fit within said shoe, said tool having an opening therethrough, and a back pressure valve mounted in said opening for permitting flow downwardly through said tool but preventing flow upwardly through said tool, and means for nonslidably connecting and forming a seal between said shoe and setting tool.

4. In a device of the character described, a liner shoe adapted to be connected to the lower end of a well liner, a liner setting tool adapted to be secured to the lower end of a setting string and to fit within said shoe, said tool having an opening therethrough, and a valve mounted in said opening for controlling flow therethrough, and means for nonslidably connecting and forming a seal between said shoe and setting tool.

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