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SQUEEZE TOOL FOR WELLS

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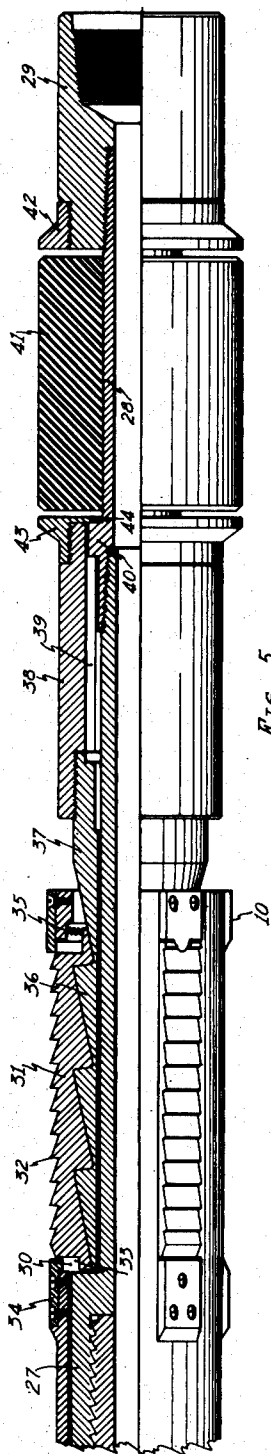


FIG. 5

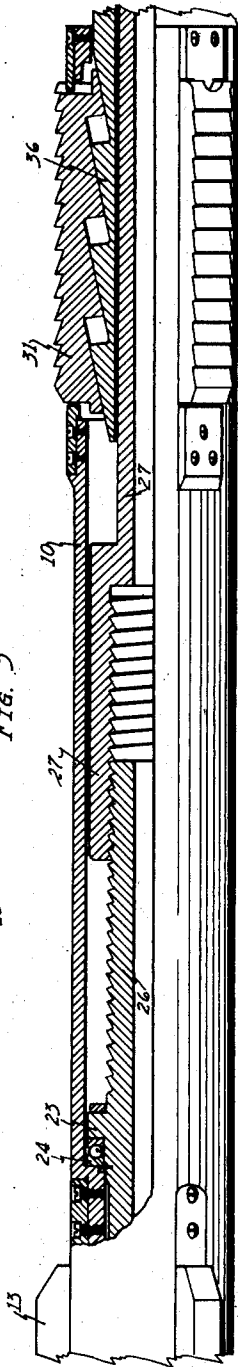


FIG. 6

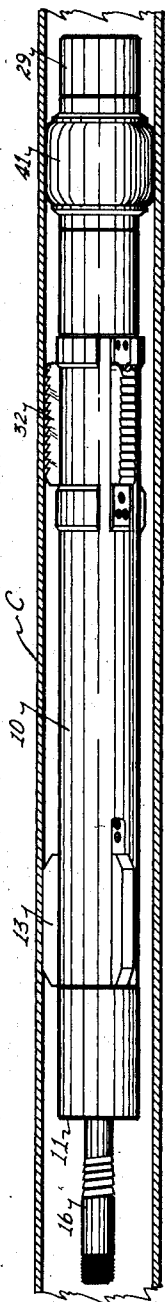


FIG. 7

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SQUEEZE TOOL FOR WELLS

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4 Claims. (Cl. 166—139)

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The present invention relates to well tools and more in particular to what is known in the oil field art as a squeeze tool.

In the process of drilling and preparing an oil well for production, many circumstances are encountered which are not and cannot be shown by even the most careful geological surveys. For example, a strata calculated to produce oil at a calculated depth may, when the well is drilled to that depth, produce only water or a mixture of oil and water in quantities and quality insufficient to merit the actual "bringing in" of the well. If, after reaching this depth, it is decided that another strata either above or below the depth actually drilled would prove better in production, it becomes necessary to close off the flow from that particular strata and resume operations at the point desired. Should the new strata be below that which is not producing, it is necessary to force a quantity of cement into the undesirable formation to close off all flow into the hole, and then drill through the cement to the lower strata. If the new strata is above that to which has already been drilled, it is necessary to close off the flow from the undesirable strata with cement up to the point where the new strata begins. Another condition encountered in drilling is that in reaching the oil producing formation, the drilling may have to extend through a water strata which it is desired to isolate to prevent the same from flowing into the hole and becoming mixed with the oil.

While the prior art discloses many types of well tools arranged for use under the above briefly mentioned circumstances, none of these tools have the combined features embodied in the present invention. These tools are usually arranged for the single purpose of providing a block above the cement while the same is being forced into the formation. After the cement has set and the drilling is continued to the desired depth, another type tool must be inserted into the hole in order that production tests might be made. Should it be necessary to swab the hole of collected foreign matter to increase the flow, still another type tool must be used.

It is therefore an object of the present invention to provide a squeeze tool arranged to assist in the isolation of an earth formation encountered in drilling the well by being expanded against the inner side walls of the well casing while a cement is forced through the tool and into the strata, the operation of expansion and contraction of the tool being performed at the earth's surface.

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It is another object of the invention to provide a squeeze tool of the character described which permits pumping a production flow through the same while being anchored to the well casing by its expansible packer member.

Another object of the invention is to provide a squeeze tool which may be set and anchored to the walls of the casing into which it is extended by rotating the string of pipe to which the tool is attached. The tool is further provided with a feature by which the tool may be dislodged from the well casing without having to rotate the pipe string opposite to the direction required for setting.

A further object of the invention is to provide a squeeze tool having a pair of threadedly joined, inner mandrels which permit certain thrusts to forcibly dislodge the same from the well casing should the same become accidentally stuck or frozen. These thrusts are applied by rotating the pipe string to which the tool is attached, and in a continuous direction with that required to set the tool.

A still further object of the invention is to provide a squeeze tool of the character described which is relatively inexpensive to manufacture and maintain and which may be arranged for use on all of the various diameters of well casing.

Further objects and advantages of the invention will become apparent in the course of the following detailed description when viewed together with the accompanying drawing in which:

Fig. 1 is a quarter-sectional view of the upper portion of an embodiment of my invention in a squeeze tool.

Fig. 2 is a broken side view of a split nut used in anchoring the tool against a well casing.

Fig. 3 is a cross sectional view taken along lines 3—3 of Fig. 1.

Fig. 4 shows the entire tool in a contracted position in a well casing.

Fig. 5 is a quarter-sectional view intended as a continuation of the view illustrated in Fig. 1.

Fig. 6 is a broken view illustrating the manner of forcibly breaking the tool from a frozen contact with the well casing.

Fig. 7 is a view of the complete tool in an operative position in a well casing.

In the drawings, numeral 10 designates the main body member of the tool having its upper end provided with external threads to receive a retaining cap 11. The body is provided with blind slots 12 machined longitudinally along the same toward its upper end and spaced circumferentially around the periphery thereof. Into

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these slots are positioned wiper blocks 13, the purpose of which will be described later in this specification. These wiper blocks 13 are provided with lips on each end thereof to prevent them from coming out of their respective slots. The upper lips on the blocks are positioned under the lower rim of the top retaining cap 11 and the lower lips are positioned under removable keys 14 set into the sides of the body. Each wiper block is provided with a series of compression springs 15 positioned in holes drilled from the bottom side of the block and having their bottom ends resting on the flat surface of their respective slots 12. These springs urge the wiper blocks outwardly so that the outer surfaces thereof press against the inner side walls of a casing into which the tool is lowered and with a pressure offering a slight resistance to the tool being moved either upwardly or downwardly in the casing. The engaging surface of the wiper blocks are hard faced for maximum resistance to wear as the blocks are slid into and out of a well casing.

A hollow mandrel 16 is positioned for longitudinal movement in the body 10 with the upper end protruding beyond the retaining cap 11 and provided with external threads suitable for engagement with a string of drill pipe or tubing by means of which the tool is lowered into a well for use.

The upper end of the body 10 is provided with internal counterbores arranged to receive a split nut 17 more clearly illustrated in Fig. 2 of the drawing. This nut 17 is provided with internal threads of the buttress type with a matching thread turned on the upper end of the mandrel 16 as shown. The nut 17 is provided with a single slot 18 which splits the same from one end to the other and allows it to expand. To further facilitate this expansion, the nut is provided with several similar slots 19 cut from one end and extended for a short distance along the nut length. In the present instance, the nut is positioned in the counterbores of the body as shown, with the single, through slot embracing a pin 20 positioned through a side wall of the body. Thus the nut is held from rotational movement but is permitted to move slightly longitudinally. The forward end of the nut is provided with an enlarged head 21 and a cone-shaped face 22 adapted for engagement with a tapered surface provided on the upper retaining cap 11. Thus when the thrust is upward against the nut 17, the tapers are held tightly together and the mandrel 16 may be screwed with considerable force by means of the threads. If, however, the mandrel is lowered, the tapers between the nut 18 and the retaining cap 11 are broken and the nut is free to expand to such an extent that the mandrel may be dropped through the threaded portion of the nut without the necessity of using the threads in the opposite direction. The threads on the nut 18 and the mandrel 16 are of a left-hand helix so that in rotating the pipe string the lengths of pipe making up the string are not disjoined.

The upper mandrel 16 is provided with a flange 23 near its lower end cooperating as a support for a thrust bearing 24. Both the upset flange 23 and the bearing are positioned within a counterbore 25 formed in the lower portion of the body member 10. The lower end of the mandrel 16 is provided with an externally threaded stem 26 threadedly engaging the box end of a hollow intermediate mandrel 27. The upper box end of this intermediate mandrel 27 is considerably larger than the main body diameter thereof.

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The lower end of this intermediate mandrel 27 threadedly engages a short, lower mandrel 28 which, in turn, is attached to a bottom adapter member 29, having internal threads by which a length of tail pipe may be attached to the tool.

The lower end of the main body 10 is provided with radially spaced slots 30 cut through the side walls thereof and adapted to receive a set of "slip" members 31. These slip members are positioned into their respective slots 30 in the manner illustrated in Fig. 5, with their outer surfaces provided with serrations or teeth 32, facing in the direction shown. The slips are further provided with projecting lips 33 on the bottom side similar to those of the wiper blocks 13 and which prevent the same from coming out of their slots 30. The upper lips are engageable with a specially prepared, removable keeper 34, while the lower lip is positioned into a counterbore in the main body 10. It will be noted that the lower lip of each slip is provided with a compression spring 35 which assists in returning the slips from an expanded to a contracted position.

The underside of each slip is turned in saw-tooth fashion as shown and adapted to lie in a contracted position against circular tapered steps 36 formed on a special sleeve 37. This sleeve 37 is slidably mounted on the main body diameter of the intermediate mandrel 27 and has its lower end threadedly engaged with a hollow spacer member 38. The hollow spacer member 38 is provided with two diametrically opposite keyways 39 arranged to slidably receive a pair of keys 40 formed on the upper end of the lower mandrel 28. The lower mandrel 28 further carries a rubber packer member 41 adapted to be engaged at its end by stops, one 42 being mounted on the upper end of the bottom adapter 29 and the other 43 being mounted on the lower end of the spacer member 38. As shown in the drawings, the upper stop 43 is provided with an inner flange 44 of a diameter sufficient to prevent the keys 40 of the lower mandrel 28 from coming out of the keyways 39.

From the above description, it can now be seen that any upward pull given to the upper end of the upper mandrel 16, will cause a corresponding pull to the intermediate mandrel 27 and also to the lower mandrel 28. The pull is then transferred from the lower mandrel 28 to the adapter 29, which, in turn, is urged upwardly against the packer member 41, the spacer 38, and the stepped sleeve 36. It will be remembered that the clearance between the lower end of the main body member 10 and the upper end of the spacer member 38 is calculated, together with the height of the steps 36, so as to push the slips 31 only to their maximum, expanded position. When this position is reached, the end of the spacer member 38 is abutting the end of the body 10 to serve as a definite stop for the slip expansion.

It can also be seen from the above description and drawings, that the slack between the packer member 41 and the upper and lower stops 42 and 43, together with the space between the upper end of the spacer 38 and the main body 10, is sufficient to allow the slips 31 to expand first and engage the side walls of a casing before the rubber packer member 41 is squeezed by the upward pull of the mandrels as described. As shown in Fig. 1, the counterbore 25 of the body 10 is sufficiently long to permit the mandrels to be pulled upwardly for a short distance even after the slips 31 have engaged the side walls of the casing.

This permits the rubber packer member 41 to be expanded tightly against the casing also to prevent any liquid or gas flow by the tool.

As a typical example of operation of the invention, let it be assumed that in the drilling of a well, the strata calculated to produce oil is undesirable according to the tests made, and it is desired to drill to a deeper strata. It becomes necessary now to close off all flow of water and other fluids from the strata reached in order that the new, deeper strata might be tested for production.

In such case the present invention is attached to the lower end of a string of drill pipe or tubing and lowered into the well hole to a point where the packer member 41 is just above the strata to be isolated.

As the present tool enters the casing of the well, the upper wiper blocks 13 are forced into the casing C in the manner illustrated in Fig. 4, as above described, the wiper blocks being urged against the walls of the casing C by their several springs 15 and offering a frictional resistance to the lowering or raising of the tool.

When the proper depth has been reached for the operation, the upper string of pipe to which the tool is attached is rotated to the right with a simultaneous upward pull applied to the pipe string. Since the wiper blocks hold the body of the tool from any longitudinal or rotative movement, the upper mandrel 16 is drawn upwardly by the lefthand threads of the split nut 18. The length of these threads and the number of turns necessary to release the upper mandrel is known to the operator who ceases to rotate the pipe string as soon as the threads are freed. It will be noticed that during this rotative movement of the upper mandrel 16, the intermediate mandrel 27 and all of the parts supported by it are also made to rotate due to the keys 40 in their keyslots 39. Having freed the upper threads, the operator is now permitted to pull upwardly on the pipe string without any rotation. With the wiper blocks 13 still holding the tool, the operator raises the pipe string still further to firmly set the teeth 32 of the expanded slips 31 against the side walls of the casing. As soon as the slips have been firmly set to prevent any upward movement in the tool, the operator raises the pipe string still further to expand the rubber packer member 41 against the casing. The maximum movement of the upward pull is finally stopped with the engagement of the thrust bearing 24 at the bottom of the counterbore 25 in the main body member 10.

The tool is now set for operation as illustrated in Fig. 7 of the drawing, with the slips 31 affixed to the side walls of the casing and the packer member 41 arranged to prevent passage of any fluid upwardly by the tool. The cement is then poured into the pipe string where it passes downwardly through the string and through the common passageway provided through the tool and flows into the drilled well hole. Usually pump pressure is then applied which forces the cement well into the formation so as to render it inactive. The tool is left in this position until the cement has fully set and is then withdrawn from the well.

Let it be further assumed now, that after the tool has been in this position for several hours to allow the cement to set, the rubber packer member 41 has become frozen to the well casing or the slips are stuck in their position against the casing. Normally the pipe string would be lowered with no thought given to rotation of the

string, since the upper threads on the mandrel 16 will simply expand the split nut 18 and reenter the body member 10. The lowering of the mandrel would also normally force the stepped sleeve 36 downwardly and contract the slips 31 from their engaged position against the casing. Under the present circumstances it becomes necessary to apply another force which is done by rotating the upper mandrel still further to the right.

In Fig. 6, it can be seen that in the fully expanded position, the thrust bearing 24 is resting against the bottom of the counterbore provided in the body member 10. Thus, by rotating the pipe string, use is made of the lefthand threads provided on the upper mandrel 16 and the intermediate mandrel 27 to force the stepped sleeve 36 and the lower mandrel 28 downwardly to disengage both the slips 31 and the rubber packer 41 from their frozen position against the well casing. When the tapered surfaces are engaged, or held tightly together, rotation of the pipe string to the right causes the left hand threads to act as a jack screw to force the lower mandrel downwardly to disengage the slips 31 and the rubber packer 41 from their position against the well casing in the event they should be frozen or stuck in position.

When the tool has been freed, it is withdrawn from the well, and the operations continue by drilling through the cement and on down to the lower strata calculated to produce oil.

Where the strata to be isolated is well below that calculated for testing, the present invention may be left in the well after the cementing operation and the pump installed in the upper pipe string. The test may then be made by pumping directly through the tool without withdrawing it from the well or a swabbing operation could also be performed in the same manner.

As stated in the objects of the invention, the present tool can be made in various sizes for the different diameters of well casings. By exchanging the wiper blocks 13, the slips 31 and the rubber packer 41, the tool may be used in casing having a considerable difference in inside diameters.

While I have described in detail, the construction and operation of the invention as disclosed by the embodiment shown in the drawing, it is to be understood that this has been by way of example only, and that other embodiments and constructions may be made without departing from the spirit and scope of the invention as defined by the following claims.

I claim:

1. A squeeze tool for wells comprising, a main hollow body member, spring actuated wiper blocks set into the outer walls of said body member and adapted to frictionally engage the inner side walls of a casing into which said tool is lowered, an upper hollow mandrel slidably extended through the upper end of said body member, a top retaining cap positioned on the upper end of said body member, a split nut loosely mounted in said retaining cap and provided with internal threads engageable with matching threads provided on said mandrel, said nut permitting an unscrewing of said mandrel out of said body member when said mandrel is rotated in one direction and expanding over the threads to permit said mandrel to be re-lowered into said body member without rotation thereof in the opposite direction, an intermediate mandrel extended through the lower end of said body member and engaged with the lower end of said first mentioned mandrel, a

sleeve slidably and rotatably mounted on a portion of said second mentioned mandrel having steps on the periphery thereof, slip members positioned in circumferentially spaced slots formed through the side walls at the lower end of said body member, said slips having steps in conformity with the steps of said sleeve, said slips being further provided with serrations on their outer faces adapted to grip the walls of a casing upon being expanded by an upward movement of said sleeve, a splined spacer member supported by said stepped sleeve, a bottom mandrel affixed to the lower end of said second mentioned mandrel, keys formed on said bottom mandrel operatively engaged with the splines of said spacer member, a bottom adapter connected to the lower end of said bottom mandrel, a packing ring mounted on said bottom mandrel between said bottom adapter and said spacer member, said slip members being expanded into engagement with the casing into which said tool is lowered by rotating the pipe string to which said tool is attached, said packing ring being expandable subsequently by an upward pull to said pipe string, said slips and said packing ring being disengageable from said casing by lowering said pipe string without imparting a rotative movement thereto.

2. A well tool for isolating an earth strata by a cementing process, comprising a main hollow body member, a series of spring actuated wiper blocks slidably positioned in circumferentially spaced slots set into the outer walls of said body member and adapted to frictionally engage the inner side walls of a casing into which said tool is lowered, an upper hollow mandrel slidably extended through the upper end of said body member, a top retaining cap positioned on the upper end of said body member, a split nut loosely mounted in said retaining cap and provided with internal threads engageable with matching threads provided on said mandrel, said nut permitting an unscrewing of said mandrel out of said body member when said mandrel is rotated in one direction and expanding over the threads to permit said mandrel to be re-lowered into said body member without rotation thereof in the opposite direction, an intermediate mandrel extended through the lower end of said body member and threadedly engaged with the lower end of said first mentioned mandrel, a sleeve slidably and rotatably mounted on a portion of said second mentioned mandrel having a series of tapered steps formed on the periphery thereof, a set of slip members positioned in circumferentially spaced slots formed through the side walls at the lower end of said body member, said slips having tapered steps formed on the undersides thereof in conformity with the steps of said sleeve, said slips being further provided with turned serrations on their outer faces adapted to grip the walls of a casing upon being expanded by an upward movement of said sleeve, a splined spacer member supported by said stepped sleeve, a bottom mandrel affixed to the lower end of said second mentioned mandrel, keys formed on said bottom mandrel operatively engaged with the splines of said spacer member, a bottom adapter connected to the lower end of said bottom mandrel, a rubber packing ring mounted on said bottom mandrel between said bottom adapter and said spacer member, means for expanding said slip members into engagement with the casing into which said tool is lowered by rotating the pipe string to which said tool is attached,

means for expanding said rubber packing ring by a subsequent upward pull to said pipe string, and means for disengaging said slips and said rubber packing ring from said casing by lowering said pipe string without imparting a rotative movement thereto.

3. A squeeze tool for wells comprising, a main hollow body member, spring mounted wiper blocks circumferentially spaced around said body member and set into the side walls of the same, said wiper blocks being adapted to frictionally engage the inner side walls of a casing into which said tool is lowered to offer resistance to both rotative and longitudinal movement thereof, a hollow mandrel extended through the upper end of said main body member, means on the upper end of said mandrel for attaching the same to a string of pipe by which said tool is lowered into the well hole, a second mandrel extended through the lower end of said main body member and threadedly attached to the lower end of said first mentioned mandrel, a sleeve slidably mounted on a portion of said second mandrel and also extended into the lower end of said main body member, said sleeve being provided with tapered steps on the periphery thereof, slip members slidably positioned in slots cut through the side walls of said body member, said slip members being provided with tapered steps in a manner to correspond to the steps on said sleeve whereby upward and downward movements of said sleeve will respectively expand and contract said slip members, an internally splined spacer member threadedly attached to said stepped sleeve, a hollow lower mandrel threadedly affixed to the lower end of said second mentioned mandrel and provided with spaced external keys slidably positioned in the splines of said spacer member, an expandable packer ring mounted on said lower mandrel with upper and lower stops therefor, threaded means on the upper end of said first mentioned mandrel for imparting an upward movement to said stepped sleeve to expand and anchor said slip members against the inner side walls of a casing, said packer ring being expandable subsequently against the casing walls by an extended upward pull to the string of pipe to which said tool is attached.

4. A well tool for isolating an earth strata by a cementing process, comprising a main hollow body member, a series of spring mounted wiper blocks circumferentially spaced around said body member and set into the side walls of the same, said wiper blocks being adapted to frictionally engage the inner side walls of a casing into which said tool is lowered to offer resistance to both rotative and longitudinal movement thereof, a hollow mandrel extended through the upper end of said main body member, means on the upper end of said mandrel for attaching the same to a string of pipe by which said tool is lowered into the well hole, a second mandrel extended through the lower end of said main body member and threadedly attached to the lower end of said first mentioned mandrel, a sleeve slidably mounted on a portion of said second mandrel and also extended into the lower end of said main body member, said sleeve being provided with tapered steps formed on the periphery thereof, a series of slip members slidably positioned in slots cut through the side walls of said body member, said slip members being provided with tapered steps formed on the underside thereof in a manner to corre-

spond to the steps formed on said sleeve whereby upward and downward movements of said sleeve will respectively expand and contract said slip members, an internally splined spacer member threadedly attached to said stepped sleeve, a hollow lower mandrel threadedly affixed to the lower end of said second mentioned mandrel and provided with spaced external keys slidably positioned in the splines of said spacer member, an expansible packer ring mounted on said lower mandrel with upper and lower stops therefor, threaded means on the upper end of said first mentioned mandrel for imparting an upward movement to said stepped sleeve to expand and anchor said slip members against the inner side

walls of a casing, and means for subsequently expanding said expansible packer ring also against the casing walls by an extended upward pull to the string of pipe to which said tool is attached.

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