March 15, 1949. H. C. BROWN 2,464,669

METHOD FOR CLEANING PERFORATIONS IN WELL LINERS

Filed Oct. 7, 1946

Fig. 1.

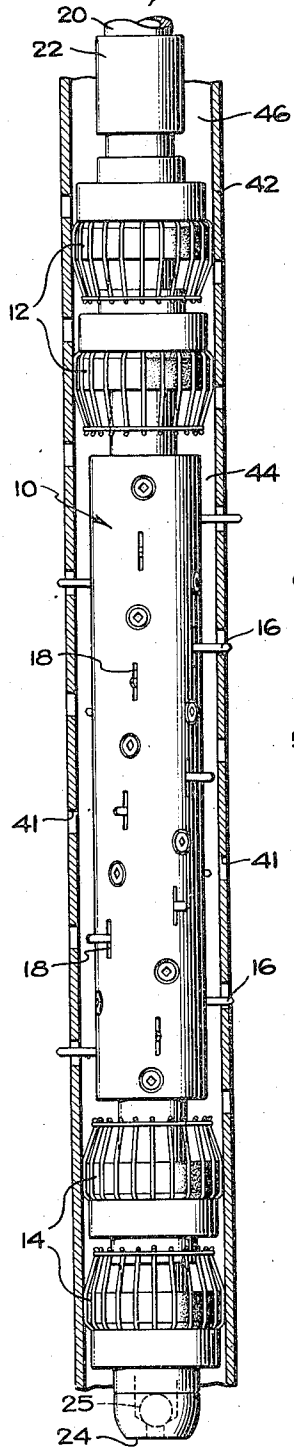


Fig. 2.

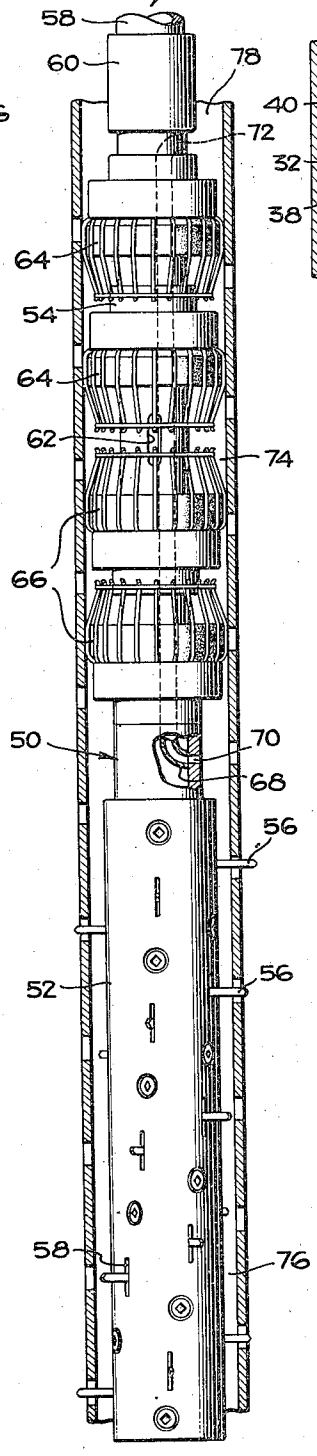


Fig. 3.

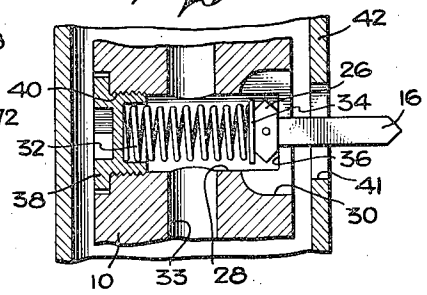


Fig. 4.

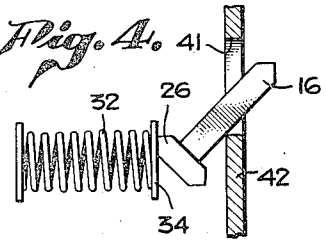
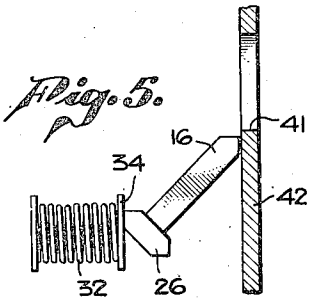


Fig. 5.



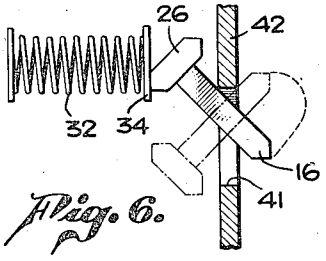


Fig. 6.

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METHOD FOR CLEANING PERFORATIONS IN WELL LINERS

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1 Claim. (Cl. 166—23)

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My invention relates to oil well development and more particularly to an improved method for cleaning perforations in an oil well liner.

In the usual course of producing oil from an oil well, the perforations in the liner which serve to strain undesirable materials from the flowing oil eventually become clogged with such material. The material which clogs the perforations in the liner may originate in any number of different sources such as the rotary circulating mud deposits from the oil strata and scale or corrosion arising from chemical action on the liner. Such accumulative clogging is inevitable even under the most favorable operating conditions, thus necessitating a periodic cleaning of the perforations in order to maintain the production rate and the potential of the well.

The most common classes of procedures for cleaning the liner perforations that have been used heretofore are: methods involving chemical procedures and methods involving hydraulic procedures and methods involving mechanical procedures. Each of these classes of procedures offers its own advantages, but frequently the difficulties of one requires the use of another, thus necessitating an extended shut down period for the well.

Accordingly, it is a general object of my invention to provide a method of cleaning the perforations of an oil well liner which combines a mechanical and a hydraulic procedure in order to clean the perforations effectively.

Another general object of my invention is to provide a method for cleaning the perforations of an oil well liner which combines a mechanical and a chemical procedure in order to clean the perforations more effectively.

In accordance with my invention I provide a perforation cleaner carrying cleaning members such as cutting blades which are bodily movable towards and away from the carrier, with means for forcing fluid through the perforations through which the blades are projected. In one form of my invention the region supporting the cutting blades and the region including the pumping means are coextensive or at least overlap. When using this latter form of my invention the material clogging the perforations of an oil well liner may be subjected to the simultaneous action of mechanical cutting forces and hydraulic forces or to the simultaneous action of mechanical cutting forces and chemical treatment. In another form of my invention the cutting blades are installed in one section of the cleaner and the pumping means in another.

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In this form, the cutting action of the blades and the hydraulic or chemical action of the pumping fluid, or both, are applied to the material clogging some of the perforations alternatively. By combining in a single operation mechanical and hydraulic or chemical action to remove material clogging the perforations of an oil well liner, my invention makes possible more rapid and thorough removal of such materials from the perforations. By subjecting the material clogging the perforations to a combined mechanical and hydraulic action the material broken up by the mechanical action is dislodged and washed away quickly, permitting other material to fall in its place this also being subjected to similar mechanical and hydraulic action immediately thereafter. By subjecting the material clogging the perforations to a combined mechanical and chemical action the effect of each in breaking up or disintegrating such material is greatly accelerated by the other. In particular by penetrating the material blocking the perforations mechanically with the blades at the time that acid is being applied very even distribution of acid throughout the formation is attained. In order to carry out my invention, I have designed perforation cleaners of simple, rugged construction and relatively low cost which permit the attainment of the results desired at a great saving in operating cost and operating time.

The foregoing and other objects and advantages of my invention will be more readily understood by reference to the following description of specific apparatus which is particularly well suited for carrying out my invention. It is therefore to be understood that my method is applicable to other apparatus and that my invention may be embodied in and practiced with other apparatus forms, without departing from the broad principles of my invention, which are illustrated by way of example only in connection with the specific apparatus described herein. While the main features of my invention have been set out in broad terms in the statement thereof above, other features of my invention which are incorporated in the embodiments specifically illustrated and described herein will become apparent from a reading of the following description in conjunction with the accompanying drawings wherein:

Figure 1 is a side elevational view of a preferred embodiment of my invention;

Fig. 2 is a side elevational view of another preferred embodiment of my invention;

Fig. 3 is a detailed sectional view of the barrel forming part of the device of Fig. 1 and illustrating a preferred form of cleaning implement; and

Figs. 4, 5 and 6 are schematic diagrams used in explaining the operation of the cleaning implement.

The well liner perforation cleaning device illustrated in Fig. 1 comprises a carrier in the form of a hollow barrel 10 having opposed upper and lower pairs of packing cups 12 and 14 arranged at opposite ends thereof. A plurality of mechanical cleaning members preferable in the form of rigid blades 16 extend laterally from the barrel through apertures 18 in the side wall thereof. These blades 16 are arranged on the barrel both for pivotal movement in a plane parallel to the axis of the barrel and for bodily shifting towards and away from the barrel. Preferably the blades and the apertures through which they project, are distributed more or less evenly and spirally along the length of the barrel and more or less evenly about its periphery. The blades are of such length that they may be extended to outer positions in which their pointed ends project outwardly beyond the cylindrical surface defined by the peripheries of the packing cups.

The carrier is adapted for attachment to the lowermost end of a string of hollow drill pipe 20 by means of a coupling 22. The lowermost end of the barrel 10 is provided with an orifice 24 which communicates with the interior of the barrel through an inwardly opening ball check valve 25.

Referring to Fig. 3, there is illustrated a preferred arrangement of cleaning implement embodied in this form of my invention. This cleaning implement comprises a cleaning member in the form of a blade 16 having a head 26 thereon which is mounted within an enlarged bore 28 with the blade extending outwardly through a narrow longitudinal slot 30. A coil spring 32 is arranged transversely of the cavity 33 in the interior of the barrel 10 and is provided with an end plate 34 to normally urge the head 26 outwardly against a shoulder 36 formed between the cylindrical bore 28 and the slot 30. The spring is held compressed in that position by means of a threaded plug 38 which is screwed into a threaded bore 40 in the wall of the barrel 10 directly opposite the first mentioned bore 28. The cutting blade 16 is of flat rigid construction terminating in a sharp point at the outer end thereof. The head 26 is of hexagonal cross-section in the longitudinal plane of the barrel, the two vertical sides being elongated and the upper and lower ends being in the form of right angle points. Each of the cleaning implements projecting blades through the apertures of the barrel 10 is of similar construction.

Considering the action of the cutting blades, normally the blades 16 project radially outward and upward from the barrel 10 as the device is lowered in a well liner for the first time, until the tool reaches the bottom of the first downward stroke. Then the tool is elevated and when a blade reaches the edge of a perforation 41 of the liner 42, it may be forced directly outward and upward through the perforation slot, digging into any material directly behind the perforation slot by the combined force of the elevation of the barrel 10 and the action of the corresponding spring 32, if the material is soft enough.

Elevation of barrel 10 causes bore 28 to lift up against the inner end 26 of blade 16, thus

causing blade 16 to be driven into the formation. This is a frictional metal to metal drive which exerts great leverage force against blade 16. As the raising of the device continues the blade 16 may break up such material by a cutting and digging arc action. When the blade reaches the upper edge of the perforation slot the upper edge of this slot arrests further upward movement of the blade and acts as a fulcrum to lever the blade outwardly and in a downward arc, and head 26 is rocked inwardly against the action of the spring 32 until blade 16 is completely withdrawn from the perforation in a downwardly inclined position relative to the axis of the barrel, thus completing the arc. When the downwardly inclined blade next registers with a perforation slot on this upstroke it will rock back to its radial position and dig and cut into the material clogging that second perforation if the material is not too hard. One or both of these cutter actions occurs each time that a blade 16 registers with a perforation slot whenever the device is raised or lowered in the well, the lowering actions, after the first one, being the reverse of the raising actions described above.

This raising and lowering is continued until the perforations being worked on are clean. Ordinarily the preferred method is to clean a pre-determined length of liner by raising and lowering within that length a pre-determined number of times. Then the next section of liner of that pre-determined length is cleaned and this is repeated until the entire perforated area is cleaned and the job is finished.

In using this device to clean the perforations of a well liner 42, which have become clogged by the accumulation of any material in the perforations, the device is lowered into the well upon the bottom of a string of tubing or drill pipe. As it is being lowered, the packing cups establish seals with the inner wall of the liner, thus sealing off an annular ring space 44 between the barrel and the liner and between the upper and lower pairs of packing cups. As the device is lowered into the well, the inwardly opening check valve 25 at the bottom of the barrel opens, admitting fluid into the barrel and thence into the tubing or drill pipe, thus reducing the resistance to the lowering of the device in the well created by the sealing action of the packing cups. As the device is lowered in an unperforated portion of the liner the weight of the drill pipe acting downwardly forces the fluid within the liner below upper cups 12 to flow into the apertures 18 in the side of the barrel 10 from the annular ring space 44 and thence inside the barrel 10 past the upper packing cups 12 into the tubing or drill pipe 20.

If the length of unperforated pipe through which the cleaner has to pass is too long for this mechanism to absorb the fluid resistance a suitable by-pass assembly, not shown, may be inserted in the cleaner to by-pass the excessive fluid past upper cups 12. When the unperforated pipe is passed and the perforations are reached the by-pass is closed by means operated from the surface so as to prevent the fluid from passing upper cups 12 while the washing operation is being performed.

When it is desired to withdraw the cleaner from a well having an excessive length of unperforated pipe a suitable by-pass assembly, not shown, openable at will from the surface of the well, can be inserted to by-pass fluid from above cups 14 to below cups 14 when withdrawing the cleaner from the well, thus preventing the cleaner from

being a swab while it is coming out of the unperforated part of the casing.

As the lowering of the device continues beyond the point where the upper packing cups 12 have passed some of the perforations, fluid is forced outward through the perforation slots 41 into the space behind the liner and thence upwardly and back into upper annular space 46 through the liner perforations above the upper packing cups 12.

When the device is subsequently raised in the well, the check valve 25 closes preventing egress of fluid from the interior of the barrel through its bottom opening 24. Thus, closing valve 25 as the device is raised causes the fluid within the tubing or drill pipe 20 to be discharged outwardly through the apertures 18 in the barrel 10 into the annular ring space 44 between the packing cups and thence outwardly through the perforations 41. At the same time well fluid which is located in the annular spaces 44 and 46 between the tubing or drill pipe and the well liner is forced outwardly through the perforations above the lower packing cups 14 through perforation slots 41 into the space outside the well liner. All of the fluid thus forced out of the perforations above the lower packing cups flows downwardly outside of the liner and back into the liner through perforations below the lower packer cups 14.

This method and result is reversed on each downward stroke.

Thus, as the device is raised and lowered in the well the packing cups and the check valve cooperate to pump fluid through the perforations at the same time that the blades are working in them, and thus they aid the cutting blades in removing material that is clogging the perforations. It is to be noted that both in the raising and the lowering of this device in the well, fluid is forced outward through the perforations 41 in which the blades are working, thus reducing the likelihood of broken up material entering the annular ring space 44 between the packing cups. While the fluid flow action may vary somewhat from time to time, according to circumstances, it will be understood that my invention is not limited to the specific fluid flow action just described; this fluid flow action being set forth merely to facilitate the understanding of the operation of this device in cleaning the perforations.

Also this flow of fluid surging out and in through perforation slots 41 may be effected directly from the surface by forcing fluid under pressure down through pipe 20 and slots 18 in barrel 10 between cups 12 and 14 into space 44 and thence through slots 41 into the space outside the liner and thence up past cups 12 and back through perforations 41 above upper cups 12 into space 46 and on up to the surface if a complete return of circulating fluid is desired.

In a preferred method of utilizing my invention, a chemical substance, such as acid, which is reactive with material likely to be clogging the perforation may be injected into the well by any method described above. When this acid is so positioned within the well, it is forced to flow through the perforations simultaneously with the cutting by the blades 16 of material clogging the perforations by the same method as the non-acid fluid described above.

The material clogging the perforations is thus rapidly disintegrated by the combined mechanical, fluid and chemical action. This throws the acid farther out through perforation slots 41 than

is accomplished by ordinary acid flushing methods.

Thus, instead of the acid being applied at the mouth of the perforation slots 41, as in previous methods, my method projects the acid immediately beyond slots 41 to the sand face outside the liner by the assistance of the combined knife and hydraulic action.

In another embodiment of my invention illustrated in Fig. 2 I utilize a carrier 50 in the form of a solid cylindrical body 52 at the lower end thereof and a hollow tubular portion 54 at the upper end thereof. A plurality of cutting blades 56 is projected outwardly of the cylindrical body 52 through slots 58. These blade assemblies are of the same general type as that hereinbefore described in detail (see Fig. 3) except that the spring is arranged in a single radial bore that extends substantially all the way through the cylindrical body from one side thereof toward the other and there is no central cavity within or passage through the body 52 which intersects this bore. Accordingly these blades 56 likewise are adapted for pivotal movement in a plane parallel to the axis of the cylindrical body and for bodily shifting towards and away from the body, like blades 16, described above.

Th tubular portion 54 is adapted at its upper end for attachment to the lowermost end of a string of tubing or drill pipe 58 by means of a coupling 60. This tubular portion 54 is provided with an orifice 62 in the side wall thereof intermediate its ends and has mounted thereon opposed upper and lower pairs of packing cups 64 and 66, arranged respectively above and below the orifice 62. A by-pass pipe 68 arranged within this tubular position 54 terminates at the lower end in the lower opening 70 beneath the lower pair of packing cups 66 and at the upper end in an upper opening 72 above the upper packing cups 64.

As this device is lowered in an oil well the packing cups contact the liner of the well and seal off an annular ring space 74 between the tubular portion of the carrier and the well liner and cups 64 and 66. This annular space communicates with the interior of the drill pipe through the orifice 62 in the wall of the tubular portion. As the device is lowered in a portion of the liner having no perforations therein, some of the fluid in the space 76 in the liner beneath the device is forced through the by-pass pipe into the annular space 78 between the drill pipe and the liner above the packing cups 64 and 66, and some leaks past the lower packing cups 66 into the annular ring space 74 and thence through the orifice 62 into the tubular member and thence into the drill pipe 58. Finally when the blades 56 of the device encounter perforations in the liner the blades are projected outwardly through the perforations into any material clogging the perforations breaking up this material in the manner hereinbefore described.

Fluid is forced outward through the perforations in the portion of the liner between the two sets of packing cups by pressure from the surface and thence outside the liner and then inwardly through the perforations above or beneath the packing cups. Finally during the raising of the device into a portion of the liner which is not perforated fluid above the packing cups 64 flows into the region below the packing cups 66 through the by-pass pipe 68.

During the reciprocation of this device upward and downward within the perforated portion of

the liner, fluid is forced from the surface through pipe 58 to the perforations in which the blades have worked. This flushing and washing action thus cooperates with the digging and cutting action of the blades to accelerate the removal of material clogging the perforations far beyond the speed with which such removal could be accomplished by either action alone or by both actions in separate consecutive operations, thus effecting a great saving in time and cost. Clearly, of course, chemical action could also be added to accelerate the cleaning of the perforations still further in accordance with the principles hereinbefore set forth.

From the foregoing description of my invention it will be clear that I have provided a well liner perforation cleaner which combines and improves the advantages of mechanical, chemical and hydraulic well liners perforation cleaners heretofore available. The use of my well cleaner is of advantage both in initial completion and subsequent treatment of a well. When used in initial completion of a well the opening and cleaning of all perforations of a well liner is assured through the removal of the mud cake and stray cement from the perforations, thus exposing the complete sand face of the formation from which production is desired to the perforated liner and assuring uniform distribution of flow into the well from the formation. The opening of all of the perforations promotes the even distribution of the washing action through all possible channels throughout the length of the liner rather than through the few channels which happen to be weakest at the outset, thus precluding the possibility of the flow concentrating in a small portion of this liner thereby producing corresponding high velocity of flow in that region with the resultant excessively high debris carrying capacity associated with such high fluid velocity. The form of my invention which involves chemical treatment has the advantage of assuring an even distribution of chemicals through the zone to be treated and the subsequent thorough and rapid removal of the spent chemical after the treatment has been completed.

The use of my perforation cleaning system is particularly advantageous when preparing a well for a potential test as the thorough cleaning of the perforations permits the well to operate at its maximum rate. Cleaning of the space behind the well liner may also be accomplished by my

method, thus facilitating the preparation of a liner for withdrawal from the well. My well cleaning system is also advantageous for use in opening up the perforations of a liner to facilitate the even distribution of cement or plastic in a "C. P." or plugging job.

While particular arrangements and specific details have been set forth in this specification for the purpose of completely illustrating two preferred embodiments of apparatus with which the method of my invention may be used and for completely illustrating the principles involved in its operation, it is to be understood that my invention in its broader aspects is not limited to such details, reference being made to the following claim for a definition of my invention in both its broad and narrow aspects.

I claim:

A method of removing material which is clogging the perforations in an oil well liner positioned within a well, said method comprising isolating a portion of the length of the interior of the liner with spaced sealing means, reciprocating said spaced sealing means, forcing resiliently mounted rigid blades into and through perforations in the isolated portion of the liner, moving said blades within the perforations during reciprocation of said sealing means to break up material clogging such perforations, and simultaneously forcing cleaning fluid into said isolated portion of the liner from which isolated portion the cleaning fluid flows along the blades and through such perforations into the surrounding formation.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
206,242	Jeannerat et al.	July 23, 1878
1,380,517	Bashara	June 7, 1921
1,488,662	Cater	Apr. 1, 1924
1,809,546	Bowman	June 9, 1931
2,059,459	Hund et al.	Nov. 3, 1936
2,151,416	Black et al.	Mar. 21, 1939
2,212,784	McCune	Aug. 27, 1940
2,221,137	Hector	Nov. 12, 1940
2,224,412	Smith	Dec. 10, 1940
2,437,456	Bodine	Mar. 9, 1948