Nov. 23, 1943. C. M. O'LEARY 2,334,788

HYDRAULIC BORE CLEANER AND CEMENT SHOE

Filed Aug. 12, 1940 2 Sheets-Sheet 1

Fig. 1.

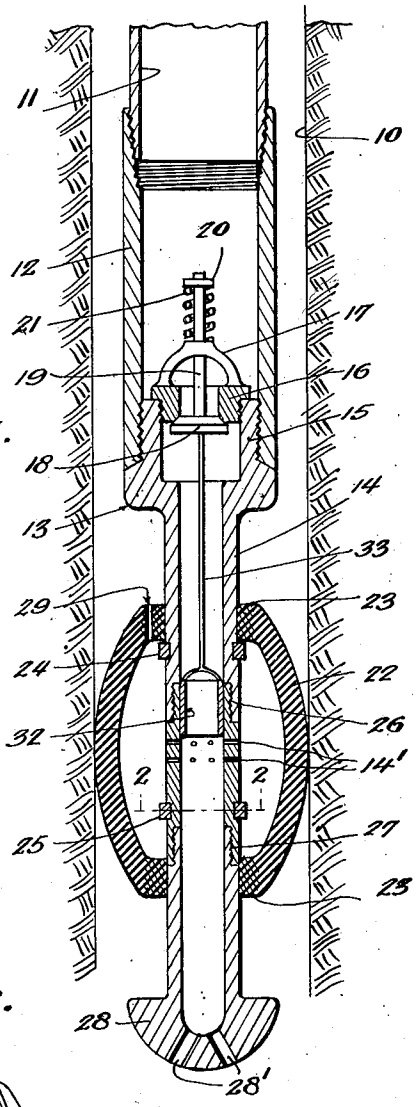


Fig. 3.

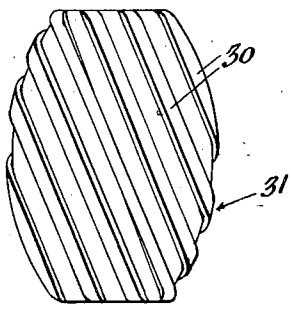
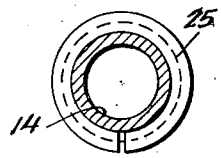


Fig. 2.



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Fig. 4.

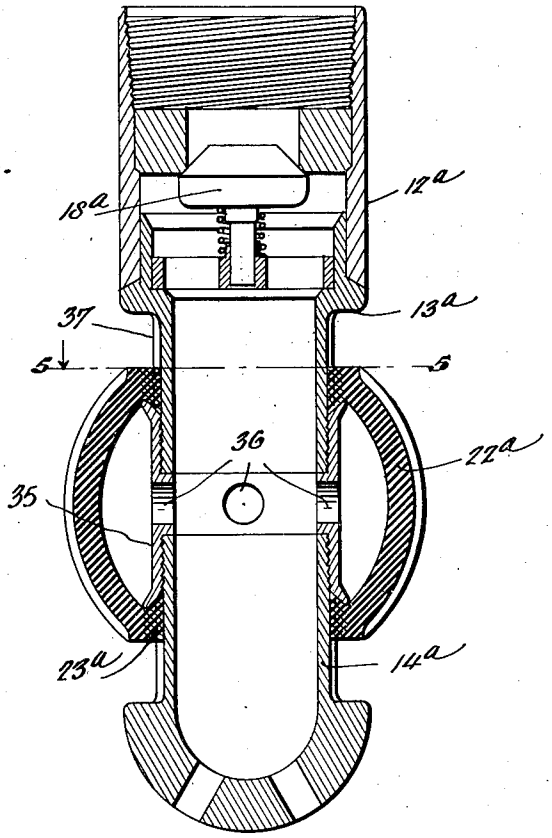
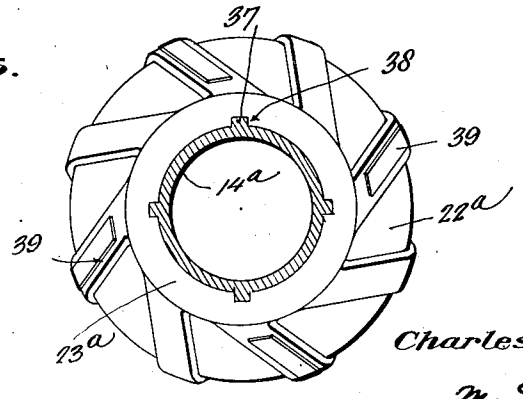


Fig. 5.



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HYDRAULIC BORE CLEANER AND CEMENT SHOE

Charles M. O'Leary, Houston, Tex.

Application August 12, 1940, Serial No. 352,290

8 Claims. (Cl. 166—1)

The present invention relates generally to devices for use in cementing the lower end of a well casing within a well bore at a point selected for the setting of the casing. It is well known that in setting casing within a well bore which has been drilled by the rotary method, certain difficulties are encountered, particularly as regards effective bonding of the cement, resulting from the use of drilling fluid, commonly called mud, in the drilling operation in which the mud is relied upon to circulate out the cuttings and sheath the bore wall to prevent its caving above the drill bit.

In the rotary drilling operation, the whipping action of the speedily rotating drill pipe plasters the mud against the bore wall so as to effectively bind the formation against cavings, but when it comes to cementing, this mud sheath is a decided disadvantage in that it tends to prevent such an effective bond between the cement and the bore wall as is necessary to insure the desirable effective water shut-off.

It is, for the above reasons, the primary object of this invention to provide a cement shoe for run in with the casing to be set in the well bore, carrying therewith a wall scraper whose purpose is to properly condition the bore wall for the bonding of cement therewith, by cleaning the bore wall of all excess mud and the like during the run in, whereby to insure an effective bond and an even distribution of cement and thus the desirable effective water shut-off.

A further object of the invention is to provide a bore wall conditioner or cleaner which is of the nature of a reamer and is expansible from casing size to full bore size and is capable of conforming to the bore wall within this range throughout the length of the wall bore.

Another object is the provision of an expansible reamer or scraper which will be so held in close relation to the bore wall as to cause high velocity of fluid flowing past its outer surface for eroding and washing away the mud sheath.

Another object is the provision of an expansible reaming or scraping member at the lower end of the casing, capable of freely rotating with respect to the casing under actuation of fluid displaced by the casing in its lowering movement as well as by pump pressure during circulation.

Still another object of the invention is the provision of an expansible reaming or scraping and cleaning member as part of a cement shoe, along with means whereby pressure expansion thereof may be eliminated during a cementing operation so as to avoid the pressure distention of the member during the flow of cement past the same.

With the above and other objects in mind, the invention resides in the apparatus to be now described in detail in its form believed to be best adapted to successful practise, and as shown in the accompanying drawings, forming a part of this specification, and wherein,

Figure 1 is a vertical sectional view through a well bore and the present apparatus as carried on the lower end of the casing therein.

Figure 2 is a detail cross section, partially therethrough, taken on line 2—2 of Figure 1.

Figure 3 is a side view of the expansible wall cleaning member illustrating a slight modification thereof.

Figure 4 is a detail vertical sectional view through a casing shoe, illustrating a modified form of the invention, and,

Figure 5 is a detail enlarged cross section taken substantially on line 5—5 of Figure 4.

Referring now to the drawings, and particularly to Figure 1, the wall of a well bore is indicated at 10, and shown with a casing 11 suspended therein at the point selected for setting the lower end of the casing. Carried on the said lower end of the casing 11, for run in therewith, is the cement shoe of the present invention, comprising a collar portion 12 and a body or nose portion 13 including an elongated hollow stem 14 whose particular construction will be detailed in the following.

The nose portion 14 of the shoe has an upper neck 15 threaded within the lower end of collar 12 and this neck 15 is shown in the present instance as supporting a valve seat ring 16 and valve cage 17, said ring having an opening in line wtih the axial flow passage through the shoe with a valve seat at the lower end of said opening.

Thus, while a back pressure valve may be disposed at any point within the casing 11, the above arrangement, as shown, provided for such a valve 18 to seat upwardly against the lower seat of ring 16 to close the flow passage against upflow, the stem 19 of which valve extends upwardly through cage 17. The upper end of stem 19 has a head 20 between which, and the cage 17, is a spring 21 to normally hold valve 18 in upper seated position in a manner permitting it to yield downwardly for allowing outflow of circulating fluid as well as cement through the flow passage of the shoe.

On the hollow stem 14 of the shoe nose portion is a reaming, scraping and cleaning member 22 in the form of a hollow, expansible oval-shaped

body, the major portion of the wall of which, from one end to the other, is of rubber, with its ends 23 of rubber bound fabric closely surrounding longitudinally spaced points of the stem and of non-expansible nature. This member 22 is preferably formed in the first instance with its curving wall presenting a normal outside diameter of approximately the same diameter as that of the well bore, so that even without pressure in the member its normal shape and tension will adapt the same for use as a flexible, elastic wall scraper or cleaner.

The above described hollow expansible member 22 is free to rotate on the stem 14 and, it will be particularly noted, may collapse laterally to approximately the outside diameter of casing collar 12, being thus effective, for the present purposes, to conform to any irregularities of the bore wall between the diameter of the casing and the drilled diameter of the bore.

The member 22 is, for the above reason, shiftable lengthwise of the stem 14 so that it may lengthen as it contracts laterally and shorten as it expands, and this lengthwise shifting may be limited by snap rings 24 and 25 similarly seated in longitudinally spaced annular external grooves of the stem. The stem, for convenience in assembly of the parts, may be in three sections, as seen in Figure 1, which sections are threadedly connected at 26 and 27 so that the snap rings may be placed within the substantially inelastic ends 23 of the member 22.

To provide for expansion of member 22 under pressure, the stem 14, which is provided at its lower end with a guide nose 28 of the diameter of the collar 12, has small ports or openings 28' inclined through said guide nose, and also has small ports or openings 14' through its wall within said member 22. Thus during run in of the casing, fluid in the well may flow through said openings or ports 28' and 14', into the member 22 so as to pressure expand the latter into close contact, and conformable, with the bore wall, whereby to adapt the same to uniformly scrape excess mud therefrom and cause the well fluid to pass through a greatly reduced area of the bore around the member 22, whereby the velocity of such fluid in so passing said member is greatly increased and will be continuously effective to cooperate, by its washing action, with the scraping action of said member, to thus clean the bore wall in an extremely efficient manner.

Furthermore, the above action will similarly take place when the point at which the lower end of the casing is to be set, has been reached, and when wash water or fluid is forced by pump pressure down the casing and circulates upwardly past the scraping or reaming member to thoroughly clean that portion of the bore wall where the casing setting cement is to be placed. During this operation the guide nose openings 28' form jetting apertures, and may obviously be of a combined area less than that of the stem bore, so that when pumping down through said stem bore in washing or cementing, pressure may be caused to back up therein and thus expand member 22 more snugly against the wall of the bore to effectively centralize the lower end of the casing, which is particularly important in cementing.

It must be remembered that, when running in, the back pressure valve prevents the well fluid from passing upwardly within the casing 11, so that it must squeeze past the member 22, and that the same pressure passes into said member, through the stem openings 14', to expand the same. However, it may be desirable to temper somewhat the internal pressure tending to expand the member 22, and for this reason the latter may have one or more openings 29 by which its internal pressure may discharge. One opening 29 is shown in Figure 1, preferably located through one of the inelastic end portions 23, and preferably sufficiently larger than the pressure inlet openings 14' to insure the discharge of any cuttings or other debris in the well fluid capable of passing into the member through openings 14'.

As thus far described it has been contemplated that the external surface of the expansible reamer or scraper 22 may be smooth, or substantially smooth. However, as seen in Figure 3, it may have external helical vanes or ribs 30 whose contact with the bore wall will divide the fluid passing upwardly there between into high velocity jets impinging against the mud sheath for channeling the same and rapidly eroding it to the point of easy removal. At the same time the member 31, so vaned or ribbed, will be rotated by the fluid so that its scraping action will be increased by the peripheral sweep of its vanes or ribs.

After the bore wall has been cleansed by the removal of its mud sheath during the run in by the fluid squeezed upwardly past the expansible reaming or scraping member, and subsequently by the wash water or fluid circulated by pump pressure, cement may be forced down the casing to flow upwardly past the said member around the lower end of the casing and is assured of an effective bond with the bore wall.

Since, in cementing, it may be desirable to prevent the cement from entering the expansible member and thus strongly opposing the upflow of cement past the exterior of the member, a sleeve valve member 32 may be disposed within the shoe stem 14, as seen in Figure 1, connected to the lower end of a rod 33 depending from the back pressure valve 18 so that said sleeve is positioned above the openings or ports 14' into the expansible member when valve 18 is closed as during the run in.

When, however, cement is forced down the casing and opens valve 18, the sleeve member 32 is also lowered in the shoe stem to a point where it covers the openings or ports 14'. Thus cement cannot pass into the expansible member and it may readily contract so as to reduce its opposition to the upflow of cement therearound.

Obviously if it is desired to supplement the before described cleaning of the bore wall prior to cementing, the casing may be raised and lowered after the selected point of setting thereof has been reached. During such alternate raising and lowering movements, the travel of fluid will be reversed past the scraper or reamer 22, and the bore wall may thus be scoured, either with or without circulating fluid.

It will be understood that by employing the helically vaned or ribbed member 31 of Figure 3, the upflowing cement may, during the cementing operation, be given a swirling movement calculated to reduce the danger of the formation of channels in the cement, and to thus increase the effectiveness of the cement job.

It will also be understood that, since in its rotation, the ribbed or vaned member 31 is in frictional engagement with the shoe stem, its helical vanes or ribs will be inclined in a direction tending to tighten, rather than loosen, the threaded joints of the parts thereabove.

Furthermore, as it is necessary after cementing, to drill out the nose portion of the shoe, all of the

parts thereof will be constructed of readily drillable material.

Referring now to the modified form of construction shown in Figures 4 and 5, it will be noted that the collar portion 12ª of the shoe is much the same as previously described, there being shown a slightly different form of back pressure valve therein at 18ª. The nose portion 13ª of the shoe is likewise much similar to that previously described, though its stem 14ª is in two sections, threaded into the ends of an intermediate coupling collar or section 35, ported at 36 and on which the hollow scraper or reamer 22ª may be molded with its fabric or reenforced ends 23ª disposed beyond the externally upset end portions of said intermediate section 35. Here the member 22ª, instead of being oval, is globular, or substantially globular, its outer surface being either smooth or provided with helically inclined vanes or ribs, as desired.

In the modified construction, it is contemplated that if it is desired to communicate rotary movement to the member 22ª by rotation of the casing, the stem 14ª may have longitudinal splines or keys 37 to be received in conformable grooves 38 in the end portions of said member.

Such an arrangement as just above described will rotatively couple the member 22ª and the stem without curtailing the relative lengthwise movements of the former in expanding and collapsing in conformity with the irregularities of the bore wall, and thus it is possible, by providing the ribs or vanes of this form with metallic inserts 39 and the like, it may be used as an hydraulically expansible underreamer.

It is, of course, contemplated that member 22ª, like member 22 of Figures 1 and 3, will be of a normal diameter and tension adapting the same to contact the bore wall without pressure therein, and that it will be capable of contracting to the diameter of the collar portion 12ª of the shoe.

Having thus fully described the invention, what is claimed is:

1. A bore wall scraper or reamer consisting of a hollow hydraulically expansible body, and a hollow stem on which said body is rotatable and lengthwise shiftable, having pressure ports through the wall thereof opening into said body.

2. In a device of the character described, a bore wall reaming and scraping member consisting of a hollow body having contracted end portions, the wall of said body being hydraulically expansible and having external helically inclined ribs or vanes, and the said end portions being relatively inelastic.

3. In combination, a cement shoe for the lower end of a casing during run in and setting thereof within a well bore, having a hollow depending stem, and an hydraulically expansible bore wall scraper or reamer supported on said stem, said stem having a pressure port through its wall opening into the hollow of said scraper or reamer, and said scraper or reamer having a pressure relief port through its wall.

4. In combination, a cement shoe for the lower end of a casing during run in and setting thereof within a well bore, having a hollow depending stem, and an hydraulically expansible bore wall scraper or reamer supported on said stem, said stem having a pressure port through its wall opening into the hollow of said scraper or reamer, and said scraper or reamer having a pressure relief port through its wall of a diameter larger than that of the pressure port of the stem.

5. In combination with well casing for setting in a well bore and having a back pressure valve, a bore wall scraper or reamer supported in connection with the lower end of said casing and including an hydraulically expansible body, means supporting said body and having an opening for inlet of well pressure into said body, and means controlled by the opening of said back pressure valve for closing said pressure inlet opening.

6. In combination with well casing for setting in a well bore and having a back pressure valve, a bore wall scraper and reamer supported in connection with the lower end of said casing and including an hydraulically expansible body, and means controlled by the closing and opening of said back pressure valve to respectively place said body internally in communication with, and cut the same off from, the pressure in a well during run in of the casing.

7. A bore wall scraper and reamer adapted to be run into a well bore on well pipe, consisting of a bulbous, hollow, flexible member normally of an external diameter greater than said pipe and to engage the bore wall, and a support on which said member is axially slidable, said support having stop means within the said member effective to internally engage the leading end of the member upon sliding movement thereof in either direction, to thus cause bodily elongation of the member upon lateral compression thereof.

8. A bore wall scraper and reamer adapted to be run into a well bore on well pipe, consisting of a bulbous, hollow, flexible member normally of an external diameter greater than said pipe and to engage the bore wall, said member having contracted end portions, and a support for said member slidably embraced by said end portions, said support having an externally projecting element within said member forming an abutment for an end portion of the member upon sliding movement of the latter on the support.

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