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WELL CEMENTER OR THE LIKE

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Fig. 2.

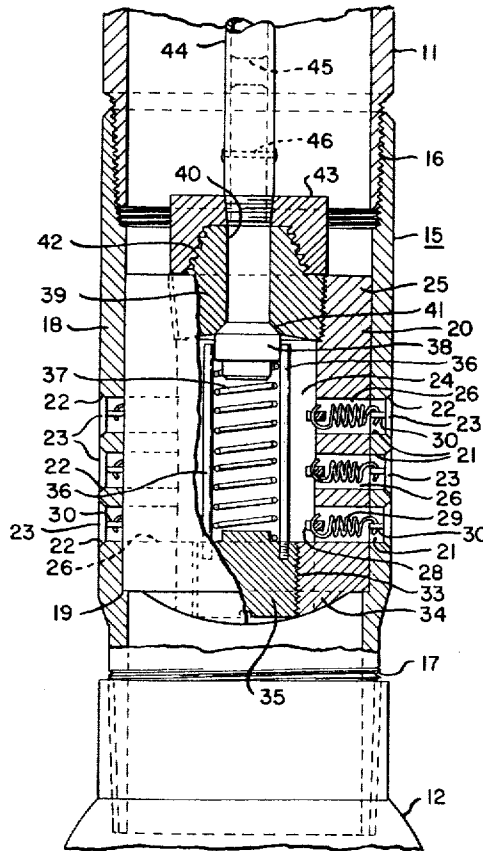


Fig. 1.

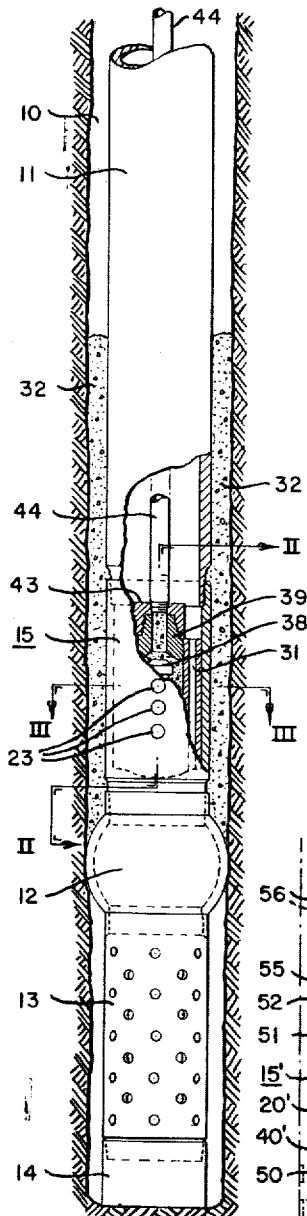


Fig. 4.

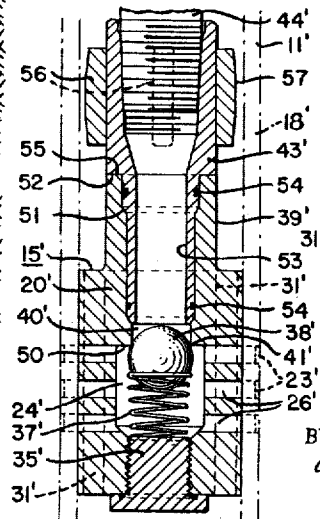
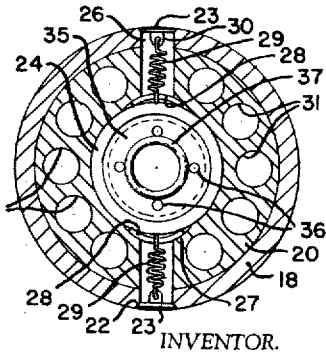


Fig. 3.



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WELL CEMENTER OR THE LIKE

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This invention relates to a well cementer or the like to be interposed in a well casing string, generally at or near the bottom thereof. More particularly, this invention pertains to such a device which will permit cementing or other treatment around the casing, to be performed in a well after the casing string has been run and without blocking any hydrocarbon fluids, water, or other fluids, rising within the casing.

In the dry drilling especially of certain natural gas, gas and other hydrocarbon fluid and some water wells, as a rule it is often not desirable to drill directly into the production horizon because of the high rock pressure which one may expect to encounter, capable in some cases of blowing the drilling tools entirely out of the well or of jamming them in the well. Where such is the case, it is common practice to stop drilling short of the anticipated production horizon and run in the casing string so that it may be cemented in place before the remainder of the drilling is performed. However, that practice may result in unnecessary delay and expense if there has been some miscalculation as to the location of the production horizon. On the other hand, when drilling is conducted too close to such production, some hydrocarbon and/or other fluids may rise in the well and interfere with the cementing of a casing string after it has been run in and landed because of the difficulty or impossibility of getting the cement to set when it is being disturbed or agitated by the passage of hydrocarbon fluids therethrough. Further, such cementing practice heretofore usually has involved using the whole of the interior of the casing for cement to be forced downwardly by hydraulic pressure of water above a separator. Such an operation required a lot of cement and was messy and left the water inside the casing to be subsequently removed.

The device of the invention can be attached as a normal part of a casing string and utilized in conjunction with a packer, for example, to direct any flow of hydrocarbon fluids or water into the interior of the casing and away from the annulus between the outside of the casing and the side wall of the well bore. Thus, those fluids will rise inside the casing and pass through the device while at the same time a tubing connection is made with the device after the casing has landed so that the outside of the casing may be cemented in and such cement allowed to properly set and cure. In this way, a driller looking for natural gas, for example, can continue his drilling until he has a satisfactory "show" to indicate the nearness of the production horizon with the assurance that he may then quickly and conveniently place his casing string and cement it so that the production he does obtain when he does the final drilling will rise in the casing through the well head and meters and pass to the feeder and collecting lines for distribution, or other disposition. In other areas, it may be desirable to drill into the anticipated production horizon before undertaking the labor and expense of casing the well. This would be advisable and desirable generally only where the operator could

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anticipate relatively small initial flows of gas, oil or other fluids.

Other objects, features and advantages will be apparent from the following description and the accompanying drawings, which are illustrative only, in which

FIGURE 1 is a view partly in section illustrating the bottom of a well bore and of a casing string in which one embodiment of this invention is being employed for a cementing operation;

FIGURE 2 is a view partly in section taken along line II-II of FIGURE 1;

FIGURE 3 is a view in section taken along line III-III of FIGURE 1, and

FIGURE 4 is a schematic view partly in vertical section of a modified embodiment of this invention.

Referring to the drawings, a well bore 10 has been drilled in a likely location, let it be assumed, into a position just short of but adjacent a production horizon, or into the horizon itself, and that hydrocarbon fluids are present in bore 10. In the illustration, the driller has removed the drilling tools and run in his casing string comprising lengths of casing 11, a cementer embodiment 15 of this invention, a packer 12, a perforated collector 13 and a shoe 14, all connected in end-to-end relation by the usually threaded joints provided thereon. Thus, cementer 15 is interposed in such string and shown as having a female casing thread 16 at one end and a male casing thread 17 at the other end for such joinder. In that embodiment 15, the fabrication thereof may be facilitated by making the device in a number of parts and assembling them, or the device may be constructed in other ways.

As shown, an outer case 18 having the outside diameter and wall strength of regular casing 11 may be utilized as the outer or case portion of cementer 15. The interior of case 18 may be shouldered at 19 for the seating thereon of a snugly fitted or press fitted body portion 20. Case 18 is provided with a plurality of horizontal ports 21, one set of which is in vertical alignment on one side and another set of which is in vertical alignment on the opposite side of said case. Such ports have their respective outer edges 22 flared outwardly and finished off flush with the exterior of case 18. Normally, such ports 21 are closed by snugly fitting caps 23 until those caps are displaced outwardly by a sufficient pressure exerted within the inside of body 20.

Body 20, comprising the inner portion of cementer 15, is a vertically positioned member having a central cavity 24 opening upwardly and a relatively thick wall 25, the exterior of which is machined to fit tightly against the inside of case 18 with the bottom of member 20 engaging the shoulder 19. Body 20 is provided with sets of horizontal openings 26 in alignment with the respective ports 21 and the inner ends of those openings may each be intersected by a retainer slot 27 to hold a snap clip 28. Each clip 28 passes through an eye at one end of a retainer spring 29 and the eye at the other end is engaged by a lug 30 on the inside of the respective caps 23, to hold the caps 23 in normally closed position.

A plurality of circumferentially spaced vertical passages 31 are provided in the wall 25 between the openings 26 and are sufficient in area to accommodate all the hydrocarbon fluids flowing into the interior of the casing string through the perforated pipe 13 after the packer 12 has been expanded. Such expansion of a

packer may be accomplished by letting the string down to rest on the shoe 14, or by rotating the casing somewhat, or otherwise, to cause the expansion of the packer until it seals against the wall of bore 10 as illustrated in FIGURE 1. In that way, such hydrocarbon fluids will not pass upwardly through bore 10 around the outside of the casing string and hence will not disturb the placing and setting of cement 32 used to cement the string in place.

An opening 33 may be provided and threaded in the bottom 34 of body 20 to accommodate a closure plug 35 therein in connection with the fabrication of such device. As shown, plug 35 threadably engages and supports circumferentially spaced vertical rods 36 which act in cavity 24 as a cage for a check valve spring 37, the upper end of which presses a check valve 38 into normally closed position against its seat. Hence, flow cannot occur in an upward direction through cavity 24.

The upper portion of body 20 comprises a cylindrical flange 39 with a narrower vertical opening 40 there-through forming a portion of the cavity. For ease of construction, the flange 39 in the embodiment of FIGURES 1 to 3 has been made as a separate piece and threadably fixed to the remainder of body 20 as shown. The lower edge of the narrower opening 40 is finished to provide a downwardly facing valve seat 41 to coact with check valve 38. The outside of flange 39 is provided with a left-hand thread 42 for quick engagement and disengagement thereof by a corresponding female threaded portion of a removable connector 43 used when the device 15 is to be operated. Such connector 43 is normally attached to the lower end of a string of tubing 44 through which cement or other material is passed after coupling is effected between body 20 and connector 43. By making such a connection in the form of a left-hand thread, the disconnection thereof in the course of which more resistance tends to be encountered, can be effected because such disconnection tends to tighten the right-hand threaded joint between the lengths of tubing in tube string 44 and between such tubing string and the connector 43.

In operation, after well bore 10 has been drilled and the drilling tools removed, a casing string is lowered into the well bore with a cementer of this invention interposed therein at whatever location is desired for the particular purpose to be achieved. At that time, there is no tubing 44 or connector 43 in the casing. Upon landing of the casing at the bottom of the hole and release of the lowering rig, the packer 12 becomes or is expanded, effectively sealing the annulus between the outside of the casing and the sides of the well bore above the packer against intrusion by bottom hole fluids which, if present, can rise inside the casing ascending through the vertical passage 31. When everything is otherwise in readiness for cementing, a tubing string 44 with a connector 43 is lowered and rotated counterclockwise when viewed in plan to effect a ready engagement between connector 43 and the threaded portion 42 of body 20 for rapid relatively tight coupling. As soon as the connection so made is sufficiently tight to enable material to be supplied through the interior of the tubing 44 under sufficient pressure, it will open check valve 38 and the caps 23, thereby allowing the material to be forced out into the annulus above packer 12 surrounding the outside of the lower end of the casing string as illustrated in FIGURE 1.

In some cases, it may be desirable in starting a cementing operation, to circulate first water or a heavier liquid down through the tubing 44 and the interior of cementer 15 before the cement slurry is introduced into the top of tubing 44. In that way, when the water or other liquid appears at the well head exterior of the casing string, or the operator is otherwise satisfied that circulation has been accomplished, it will indicate that there

is no impediment to the commencement of a successful cementing operation.

The cementing itself occurs when a mixture of cement and water is pumped down through the tubing 44. When enough of the cement slurry has been introduced into the top of the tubing, a chaser plug 45 is inserted in the tubing string on the top thereof and forced downwardly thereupon by water pressure until the movement of the plug is stopped by a crosspin 46 preferably in the lowest section of tubing 44. In that way, a predetermined quantity of cement, sufficient to do the job, may be substantially entirely introduced into the annulus between the outside of casing 11 and the wall of bore 10 above packer 12 to provide a clean, economical operation. In addition, the arrest of the downward motion of plug 45 by crosspin 46 will seal the bottom of the tubing and hold water therein during disconnection and lifting of the tubing string with the water therein so that such water does not thereafter have to be bailed out of the inside of casing 11.

Upon completion of the foregoing, a rotation of tubing 44 and connector 43 in a clockwise direction will detach them from body 20 and permit the tubing and connector to be lifted out of the casing, whereupon as the lengths of tubing are separated above ground the water will drain therefrom readying it for further cementing service. As for the cement in place around the casing, such will set and harden properly as a consequence of the freedom therefrom of well bottom fluids in any detrimental quantity. With the tubing and connector removed, a further drill can be inserted inside the casing to drill through the body to provide a full-line opening within the case portion 18. Presumably, case portion 18 might be made of the same steel composition as that used for the casing lengths 11 while body portion 20 might be made of a softer material such as cast iron or other metal readily destroyable by a further drilling operation after the cementing operation as aforesaid has been completed and the cement has set. Such drill may be used to remove body 20, or used, if necessary or desirable, both to do that and to continue on down through the members 12, 13 and 14 to penetrate into a desired lower level in the earth formation. As the drill destroys body 20 in the course of its removal, the springs 29 will likewise be destroyed. As a consequence, the person drilling the well will know if the cement has hardened because if it has not, the caps 23 will move away from their respective ports and admit plastic cement to the interior of case 18 and of the casing string; this in turn will interfere with or interrupt the flow of hydrocarbon fluids upward through the casing. Thus, the caps 23 act to keep foreign matter out of the interior of body 20 during the descent and placement of the casing 11 and cementer 15; open as cement is forced into the annulus around the cementer and casing; and normally reclose under the pull of the springs 29 to remain in that position as the cement sets and hardens in the course of a normal satisfactory cementing operation utilizing an embodiment and the cementing system of this invention.

A modified embodiment of a device of this invention is illustrated in FIGURE 4 and parts thereof corresponding generally in construction and functioning to those of the prior described embodiment are provided with the same reference numerals with the addition of a prime accent thereto, respectively. In that modified embodiment, no cage in the form of rods 36 is utilized and the check valve 38' itself is illustrated in the form of a ball which will seat on the inner corners 41' of a downwardly facing shoulder 50 in the upper portion of body 20'. Further, cylindrical flange 39' may be made integral with the remainder of body 20' with the bore 40' thereof provided with upwardly facing shoulders 51 and 52 to act as seats for an axially movable connector 43', said

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bore 40' being progressively widened somewhat adjacent the top thereof to provide a relatively good fit for the lower end 53 of connector 43'. Annular recesses 54 are provided in part 53 for sealing O-rings, further sealing being effected, for example, by the seating of downwardly facing shoulder 55 of connector 43' against upwardly facing shoulder 52 of flange 39'. A slidable guide 56 consisting of four vertically extending, circumferentially spaced runners, each with a vertically convex face 57 may be fastened around the exterior of connector 43'. The overall span of the runners of guide 56 and the transverse spacing thereof are sufficient to guide the descent of the tubing string 44' inside the casing string without obstructing such descent, or the upward flow of any well fluids, and at the same time to steer lower end 53 into the opening therefor in flange 39' until it is in place and the tubing string can be let down to rest on member 20'. Thereupon, the initiation and carrying out of a cementing operation may be performed as in the case of the other embodiment of this invention previously described. When that operation is completed, tubing string 44' and connector 39' with its guide 56 are simply removed by axial lifting thereof away from device 15', following which the body portion 20' is preferably removed as by further drilling described above.

Although the illustrated embodiments have been disclosed in connection with a cementing operation, such devices may be utilized for other purposes in well casing strings or the like, such as the supplying of formation stabilizing compounds or other materials to the well bore annulus outside of a casing. In some situations, also, the device may be utilized without requiring caps on the transverse body openings and case ports. And, the devices of this invention may be utilized without packers as in cases where the shoe member of the casing string is tight against the bottom or ledge on which the string lands when the casing is run. Still further, various changes may be made in details of the illustrated embodiments, or other embodiments provided, without departing from the spirit of my invention or the scope of the appended claims.

I claim:

1. A well cementer adapted to be a part of a well casing string in a position above a packer or the like and well fluid intake means therebeneath leading into the interior of said well casing string below said cementer, comprising, in combination, a tubular case threaded at at least its upper end for placement in and with a well casing string or the like, a plurality of laterally opening ports extending through said case, said ports being in angularly spaced arrangement, caps to close said ports without projecting beyond the outside of said case, a body portion in said case extending across the inside thereof having a central cavity opening upwardly and a plurality of laterally extending openings extending from said cavity in alignment with said ports, said body portion being disintegratable in situ, resilient retainers to keep said caps in closed position operable under the pressure of a cementing operation, a plurality of circumferentially spaced generally vertical passages for hydrocarbon fluids extending through said body portion spaced from said laterally extending openings, said cavity having a generally downwardly facing valve seat, a check valve to close said cavity against flow upwardly through and out of said cavity, and coupling means connected to said body portion for ready attachment of a tube thereto through which cement or other material may be pumped under pressure to the outside of said case via said cavity and ports.

2. A well cementer as set forth in claim 1, in which said coupling means are shaped for coupling engagement by a connector at the lower end of said tube.

3. A well cementer adapted to be a part of a well casing string in a position above a packer or the like and well

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fluid intake means therebeneath leading into the interior of said well casing string below said cementer, comprising, in combination, a circular case threaded at at least its upper end for placement in and with a well casing string or the like of about the same outside diameter, at least a pair of sets of generally horizontal ports extending through said case in diametrically opposite arrangement with the ports in each set generally vertically aligned, the outer edges of said ports being flared and terminating flush with the outside of said case, outwardly operable caps to close said ports flush with the outside of said case, a vertical cylindrical body in snug fitting relation to the inside of said case having a central cavity opening upwardly and a wall surrounding said cavity, said body further having at least a pair of horizontal openings respectively in alignment with said sets of horizontal ports, said body still further being disintegratable in situ by a drilling bit or the like, spring retainers in said openings to keep said caps in closed position operable under the pressure of a cementing operation, a plurality of circumferentially spaced drilled or cored vertical passages for hydrocarbon fluids through said body spaced from said horizontal openings, said cavity having a downwardly facing internal shoulder around an upper part thereof forming a valve seat, a ball check valve to close said cavity against flow upwardly through and out of said cavity, a spring to keep said ball check valve against said seat in normally closed position, and coupling means at the upper end of said body for the relatively quick attachment and detachment of a tube thereto through which cement or other material may be pumped under pressure to the outside of said case via said cavity and ports.

4. A well cementer as set forth in claim 3, in which the bottom of said body is provided with a removable plug to provide access to said cavity and check valve.

5. A well cementer adapted to be a part of a well casing string in a position above a packer or the like and well fluid intake means therebeneath leading into the interior of said well casing string below said cementer, comprising, in combination, a tubular case connectable at at least its upper end to a well casing string or the like, a plurality of horizontal ports through said case in angularly spaced relation, caps to close said ports from the outside without projecting beyond the outside of said case, a vertical body portion comprising the inside of said case having a central cavity opening upwardly, said body portion further having lateral openings from said cavity to said ports, extensible retainers inwardly of said caps to keep said caps in normally closed position except when opened under pressure of a cementing operation, a plurality of angularly spaced vertical passages for hydrocarbon fluids spaced outwardly of said cavity and angularly from said lateral openings, said passages being formed in said body portion, an internal valve seat in said cavity around an upper part thereof, and means at the upper portion of said cementer within said case for ready coupling of a tube thereto through which cement or other material may be supplied to the outside of said case via said cavity and ports.

6. A well cementer as set forth in claim 5, having a check valve in said cavity to coact with said seat and close said cavity against flow upwardly out of said cavity, and a compressible means to keep said check valve in normally closed position.

7. A well cementer as set forth in claim 5, in which said body portion is provided with an upwardly extending cylindrical flange, said flange having an annular shoulder facing upwardly, and there is a hollow cylindrical connector for the lower end of said tube for insertion in said flange and direct metal-to-metal seating upon said shoulder, said connector further having peripheral means to seal against the inside of said flange.

8. A well cementer as set forth in claim 7, in which there is an external guide connected to said connector to facilitate said coupling.

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9. A device as set forth in claim 5 including, in combination therewith, said tube, means at the lower end of said tube for said ready coupling, a relatively close-fitting cylindrical chaser plug adapted to be placed against the last portion of said cement or other material in said tube and to slide downwardly under pressure to force said cement or other material downwardly through said tube and through said body and case portions, and means to arrest the extent of downward movement of said plug ad-

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jacent the bottom of said tube, said plug being compressible sufficiently to substantially seal said tube.

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