

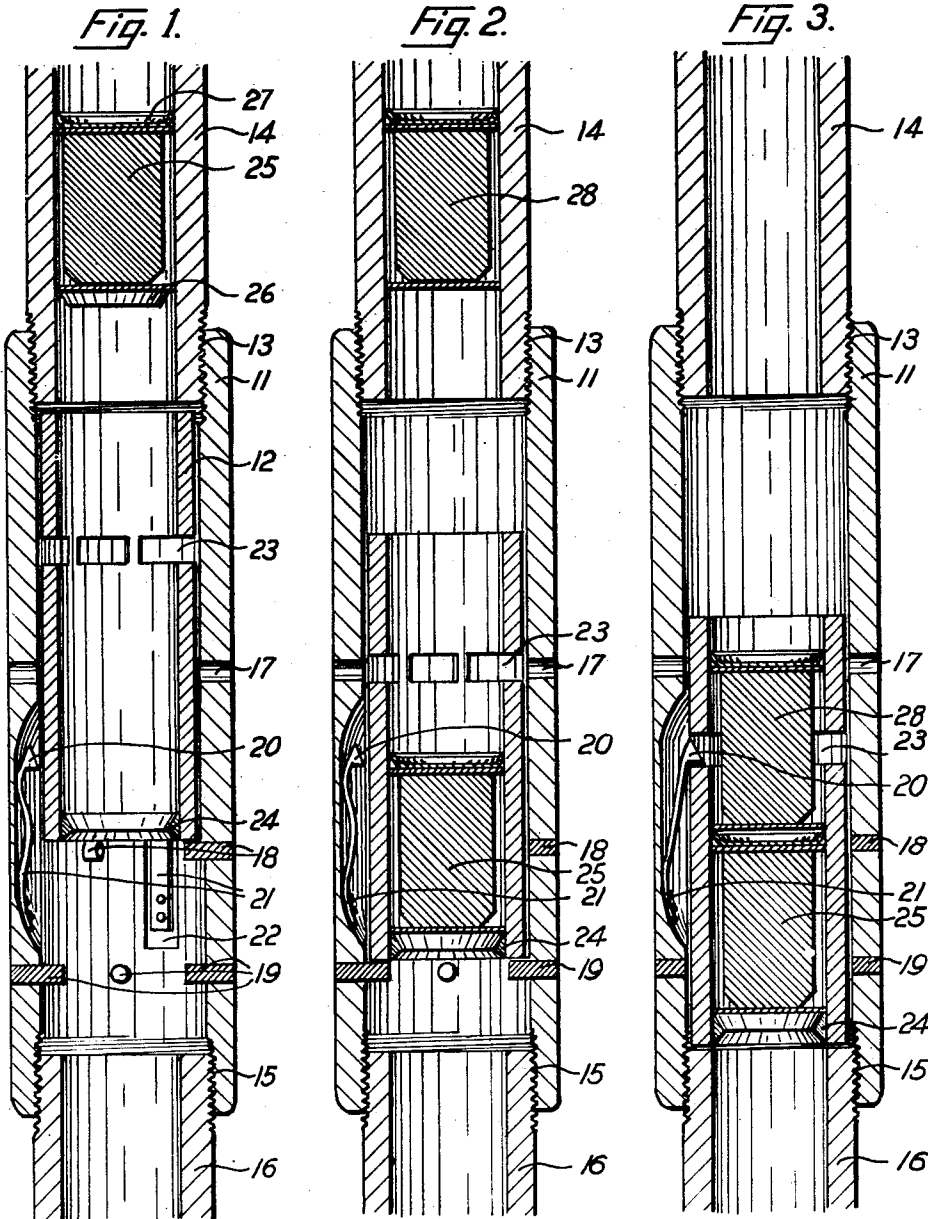
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MULTIPLE STAGE CEMENTING

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MULTIPLE STAGE CEMENTING

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This invention relates to the cementing of oil wells or the like, and more particularly to an arrangement for cementing long strings of casing or pipe in stages so that all the cement which fills the annular space surrounding the casing may be supplied thereto without passing around the bottom of the casing.

The multiple stage cementing of wells is now well known to those skilled in the art. A method and apparatus for accomplishing this is fully disclosed in the U. S. patent to Halliburton, No. 1,860,669, granted May 31, 1932, and in the reissue thereof, No. 19,570, reissued May 14, 1935.

In the multi-stage cementing of wells a valve structure, usually called a multi-stage unit, is made up with the casing. The arrangement is such that at the proper time the valve in this unit is opened so that cement can flow outwardly therethrough to the annular space surrounding the casing. The valve may be a sleeve valve, as taught in the patents mentioned above, and may be opened by one of the cementing plugs used in the multiple stage cementing operation.

As taught in the above mentioned patents, a multiple stage cementing operation may employ several plugs. Thus, for example, in the illustration of Figs. 9 and 10 of the Reissued Patent No. 19,570, two plugs travel through the multi-stage unit without affecting it, a third plug enters the multi-stage unit and opens the valve and a fourth plug follows the upper slug of cement, this being the cement which flows through the multi-stage unit.

After the cement has passed through the multi-stage unit some means should be provided for preventing that cement from flowing back into the casing. The Reissued Patent 19,570 discloses spring-pressed valve 37 on the multi-stage unit for this purpose.

It is an object of the present invention to provide a sleeve valve arrangement for preventing cement from flowing back into the casing after it has passed outwardly through the multi-stage unit incorporated therein.

It is another object of the invention to provide a multi-stage cementing unit in which valve means will be opened and then closed by action of the cementing plugs used in the cementing operation.

It is a further object of the invention to provide a novel method of multi-stage cementing in which the plugs used in the operation actuate means which opens and then closes valves in the multi-stage unit.

Other objects and advantages reside in certain

novel features of the arrangement and method, as will be more apparent from the following description taken in connection with the accompanying drawing, in which:

Fig. 1 is a vertical cross-sectional view of the casing of an oil well with a multiple stage unit constructed in accordance with the present invention incorporated therein and showing the parts in their relative position as they are lowered into the well.

Fig. 2 is a vertical cross-sectional view of the arrangement of Fig. 1, but illustrating the relative position of the parts during the time that cement is flowing outwardly through the multiple stage unit; and

Fig. 3 is a vertical cross-sectional view of the same apparatus as that shown in Fig. 1, but showing the parts in their final position after the cement has been placed around the casing through the multiple stage unit.

The various parts in the drawing are shown with certain elements exaggerated in size for the purpose of better illustrating the principles of the invention, but it will be understood by those skilled in the art that the various parts will be of the proper size to bear the strain for which they are designed and yet not occupy any more space than is necessary.

Referring to the drawing in detail, it will be seen that a multiple stage unit is there shown as consisting essentially of a collar or casing member 11 within which a sleeve 12 is positioned for longitudinal movement therethrough.

The upper end of the member 11 is provided with screw threads 13 adapted to receive and be secured to a stand or section of the casing 14 while the lower end of the member 11 is provided with similar threads 15 adapted to receive and support a lower section or stand of casing 16. Thus the member 11 may be made up with the casing of the oil well.

The casing member 11 has a number of openings or ports 17 circumferentially spaced therearound approximately midway between its ends. These ports are adapted to be opened and closed by movement of the sleeve 12 into successive positions.

Normally the sleeve 12 occupies the position shown in Fig. 1. It is held in this position by means of shear pins 18 welded or swaged to the casing member 11. In the arrangement illustrated in the drawing three pins 18 are used but it is obvious that their number and also their size may be varied to make them have the requisite strength.

Located beneath the shear pins 18 are a second set 19 which are preferably somewhat larger than the pins 18 and also greater in number. In the arrangement of the drawing four shear pins 19 are employed.

The casing member 11 also is provided with latching means 20, these consisting merely of catch members mounted on leaf springs 21 secured on the inside of the casing member 11 in recesses 22 as illustrated. The sleeve 12 is provided with circumferentially spaced ports 23 which serve the double purpose of allowing fluid to flow through the ports 17 in the member 11 when the ports 17 and 23 are in alignment and also as means for cooperating with the latch members 20 to hold the sleeve 12 in one position as will be explained further hereinafter.

The lower end of the sleeve 12 is provided with a valve seat or "doughnut ring" 24, as it is called in the trade, for cooperating with one of the cementing plugs to maintain a seal and cause the sleeve 12 to move downwardly in its initial movement with respect to the casing member 11. The cementing plug which seats on the ring 24 is shown at 25 in the drawing. This plug may be of known construction and consist of a body of wood having an aluminum or other metallic valve member 26 mounted on its lower end and adapted to seat in the ring 24. The plug 30 may also be provided with one or more rubber cups 27 for maintaining a seal between the plug and the casing.

The drawing also shows another plug 28 which may be similar to the plug 25 except that it does not have a valve member on its bottom.

In cementing an oil well by means of the multiple stage process and using the apparatus shown in the drawing, one slug of cement will be pumped to the bottom of the casing and there distributed in accordance with known practices. If cementing plugs are used with this slug of cement they will pass right through the multiple stage unit without moving the sleeve 12 or otherwise altering the same. Since apparatus for this purpose is well known it has not been shown herein.

The first slug of cement is followed by a body of mud or other fluid and then the plug 25 is placed in the well and the second slug of cement is pumped in on top of this plug. The second slug of cement is followed by the plug 28. As the second slug of cement and the plugs 25 and 28 are pumped downwardly through the well the first slug of cement is forced outwardly around the bottom of the casing. When the plug 25 reaches the ring 24 it seats therein and the pressure of the pump at the surface is raised sufficiently to cause the pins 18 to shear. This causes the sleeve 12 to move downwardly to the position shown in Fig. 2, thus bringing the ports 17 and 23 into alignment and causing the second slug of cement to flow outwardly through the member 11. The second set of shear pins 19 are designed to prevent the sleeve 12 moving downwardly further at this time and are preferably of larger diameter than the pins 18 and greater in number. However, there is but slight pressure exerted on the pins 19 at this time due to the fact that as soon as the ports 17 are opened the fluid pressure tending to move the sleeve 12 downwardly is released, the cement flowing outwardly through the ports. The ports are preferably opened before the sleeve 12 reaches the pins 19.

After all of the second slug of cement has

flowed outwardly through the casing 11 the plug 28 enters the sleeve 12 and rests upon the plug 25. The cups on the plug 28 maintain a seal with the sleeve 12. Upon raising the pressure at the pumps the second time the pins 19 will shear and cause the sleeve 12 to move into the position shown in Fig. 3. This will close the ports 17 by bringing the upper portion of the sleeve 12 into alignment therewith. This will effectively seal the casing and prevent the flow of any cement back through the ports 17 into the casing. Additional sealing means may, of course, be provided by poppet valve on the outside of the ports 17 in accordance with known practices.

The sleeve 12 is caught in its final position by the upper end of the stand of casing 16. To hold the sleeve 12 in this position the latch members 20 interlock with the ports 23 in the sleeve as shown in Fig. 3. It sometimes happens that changes in pressure within the casing tend to cause the sleeve to move upwardly, and to avoid the danger of the ports 17 becoming accidentally opened again the latch members 20 are provided.

The number of ports 17 and 23 may be varied in number and spacing in accordance with the requirements but the arrangement is preferably such that some of the ports 23 will match up with some of the ports 17 when the members are in the proper alignment longitudinally, irrespective of relative rotation. There should also be a sufficient number of latch members 20 to insure at least one catching in a port 23 at the proper time.

While only one embodiment of the invention has been shown and described herein, it is obvious that the arrangement may be modified in a variety of ways and still accomplish the purposes set forth. The sleeve 12 may be made of two parts, one of which is actuated to open the ports 17 and the other of which is actuated to close the same, and the arrangement may cooperate with the plugs in various ways to bring about the desired action. To facilitate drilling out the plugs 25 and 28 after the cementing operation is completed, it is preferable to provide some means for preventing the sleeve 12 from rotating with respect to the casing member 11 but this has not been shown in the drawing because its use is obvious. One way of accomplishing this is to provide inter-engaging teeth on the bottom of sleeve 12 and the top of the section 16 of the casing. The latches 20 will ordinarily be sufficient to prevent rotation as well as longitudinal movement of the sleeve, however. Various other changes may be made without departing from the spirit of the invention or the scope of the annexed claims.

We claim:

1. Apparatus for use in the multi-stage cementing of oil wells or the like which includes a cylindrical member adapted to be made up with the casing of the well, said member having ports therein, a sleeve within said member, said sleeve having ports therein adapted to be aligned in one position of the sleeve, with the ports in said member, releasable means cooperating with said member and sleeve to hold the ports thereof out of alignment, and releasable means cooperating with said member and sleeve to hold the ports in alignment.

2. Apparatus for use in the multi-stage cementing of oil wells or the like which includes a cylindrical member adapted to be made up with the casing of the well, said member having

ports therein, a sleeve within said member, said sleeve having ports therein adapted to be aligned, in one position of the sleeve, with the ports in said member, releasable means cooperating with said member and sleeve to hold the ports thereof out of alignment, and latching means for locking the member and sleeve in such a relative position that the ports are out of alignment.

3. Apparatus for use in the multi-stage cementing of oil wells or the like which includes a cylindrical member adapted to be made up with the casing of the well, said member having ports therein, a sleeve within said member, said sleeve having a portion provided with ports and a portion without ports on each side of said ported portion, and means cooperating with said member and sleeve to hold the sleeve in relative positions so that the ports of the member will be successively aligned with an un-porting portion of the sleeve, then the ported portion and then the un-porting portion.

4. Apparatus for use in the multi-stage cementing of oil wells or the like which includes a cylindrical member adapted to be made up with the casing of the well, a sleeve in said member and means for releasably holding the sleeve in different positions with respect to the member, said sleeve having ports therein whereby the

ports in the member may be closed by the sleeve, then opened by movement of the sleeve to a different position to bring the ports in the sleeve in alignment with the ports in the member and then again closed by the sleeve.

5. Apparatus for use in the multi-stage cementing of oil wells or the like, including, in combination, a cylindrical member made up with the casing of the well, said member having ports therein, a sleeve in said member adapted to open and close the ports in said member and a plurality of cementing plugs, said sleeve having ports therein whereby one of said plugs may engage the sleeve and cause the same to move to such position that the ports in the sleeve are in alignment with the ports in the member to open said ports in said member and another of said plugs may cause the sleeve to move to another position to close the ports in said member.

6. Apparatus for use in the multi-stage cementing of a casing in an oil well including a sleeve valve adapted to be made up with the casing, a plurality of cementing plugs, means cooperating with one of said plugs to open the valve and means cooperating with another of said plugs to close the valve positively and permanently.

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