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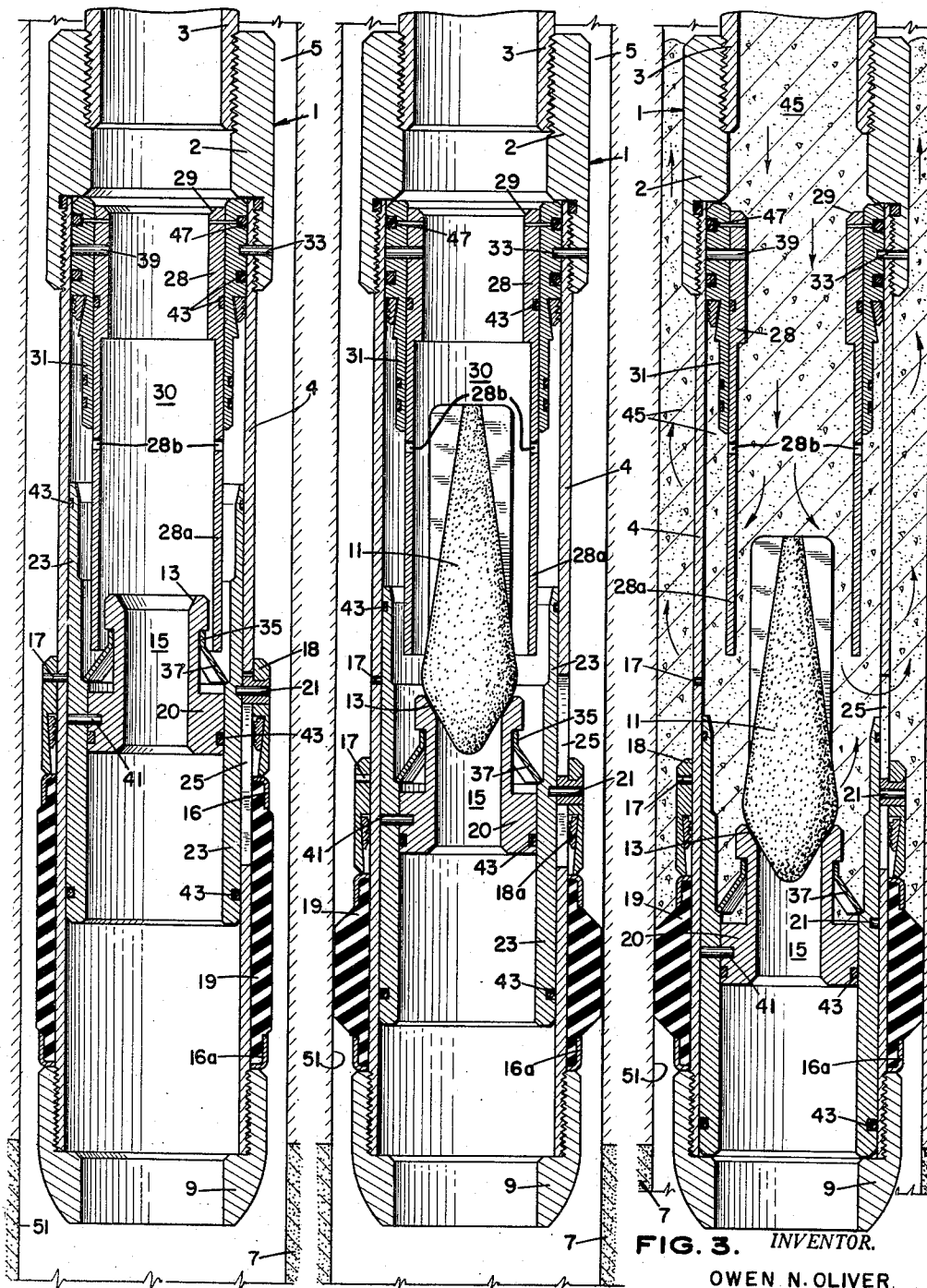
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FULL FLOW PACKER CEMENTING SHOE

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2 Sheets-Sheet 1



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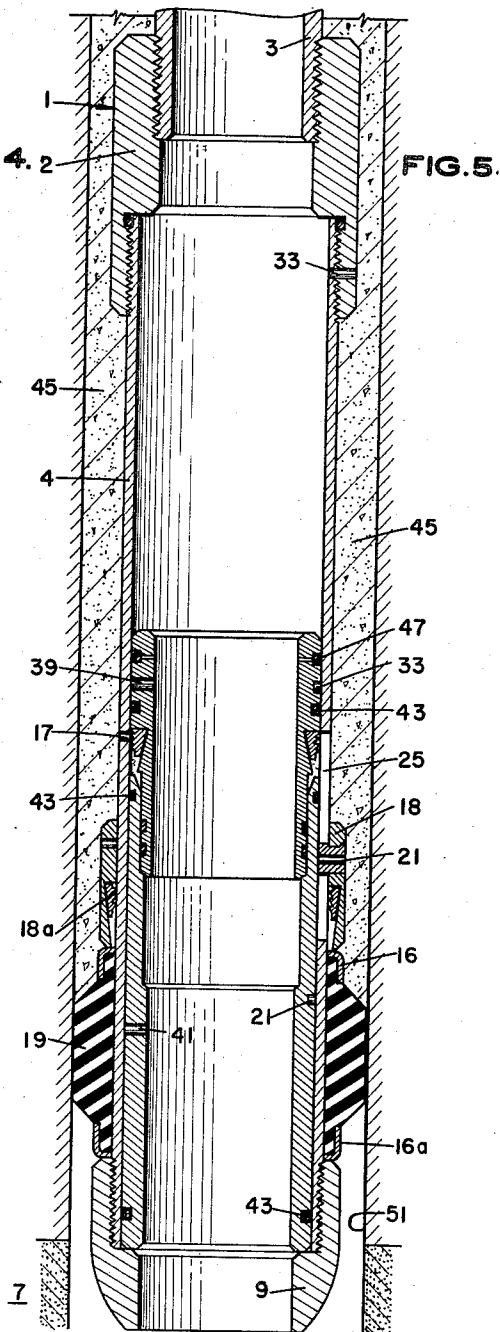
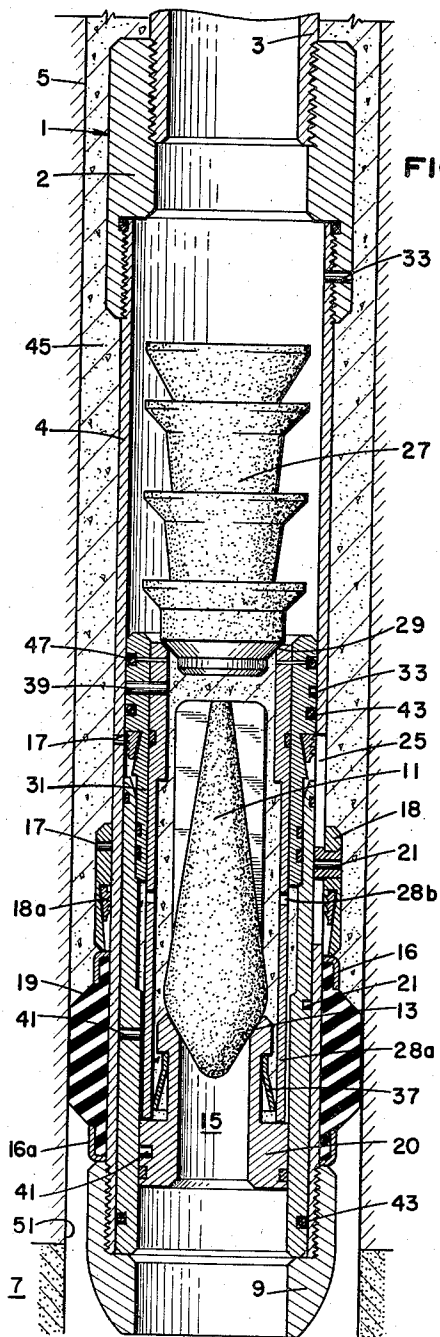
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FULL FLOW PACKER CEMENTING SHOE

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2 Claims. (Cl. 166—154)

This invention relates to an apparatus employed in the cementing of casing in the bore hole of a well.

In cementing casing in well bores, various methods and apparatus are employed. Ordinarily, the cement slurry is introduced into the annulus between the outer wall of the casing and the walls of the bore hole by pumping it from the surface down through the casing and out through the bottom, from which it flows up and around the casing. In other instances, as disclosed in the patent to Pitts, No. 2,435,016, granted January 27, 1948, the cement slurry is pumped out through a tool having ports, valve sleeves, and plugs incorporated in the casing some distance off bottom. In employing either of these methods, the plugs, sleeves, and excess cement must be drilled out, which involves considerable time and expense, and in addition, the oil producing formation is subjected to contamination by the slurry, since it is exposed to the slurry while pump pressure is applied to move the slurry.

The present invention relates to a novel construction of a tool which embodies a packer, a body member having cementing ports, sleeves and plug receiving members disposed inside said body for the operation and the control of a cementing operation, wherein there remain no obstructions to be drilled out. The tool is attached to the bottom of a string of casing and positioned in a bore hole just above a producing formation. By pumping a plug down through the casing onto a seat in the tool and applying a predetermined pressure the packer is set. Continued application of pressure moves a sleeve and opens the ports in the tool. The ports are above the packer. A slurry of cement is pumped down through the casing and out through the ports into the annulus between the casing and the bore hole but the producing formation is not subjected to this slurry. Then another plug is pumped down the casing onto another seat which moves a sleeve upon the application of pressure, which sleeve closes the ports in the tool. Then continued application of pressure pumps the seats, the plugs, and any excess cement into the bottom of the bore hole, thereby leaving a fully opened passageway for the well fluids to be produced from the formation below the packer. As far as is known this tool is the only one which employs the unique feature of pumping out the obstructions, instead of the time consuming and costly process of drilling out same.

Therefore, it is an object of the invention to provide a full flow packer cementing tool, employed to cement the casing above the producing zone, wherein the plugs and seats are pumped out in order to provide a fully opening free flowing passageway for the production of the formation fluids.

Another object is to eliminate the costly and time-consuming process of drilling out the seats, plugs, and excess cement.

Another object is to eliminate the time loss and cost involved in cleaning out the well bore and perforating the producing zone after the casing has been cemented in place.

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Another object is to prevent water and other fluids in the well bore below the packer from contaminating the cement in the annulus around the casing.

Still another object is to prevent contamination of the oil producing formation of the well bore below the packer.

These objects and unique features of the invention are described in detail below to illustrate the general principles of the invention. Referring to the drawings:

Figure 1 is a sectional view of the tool as attached to the casing and placed in the well bore at the desired location.

Figure 2 is a sectional view of the tool showing the packer set and the position of the various components at this stage.

Figure 3 is a sectional view of the tool showing the position of the component parts during the cementing operation.

Figure 4 is a sectional view of the tool showing the position of the component parts after the cementing operation and positioned so that the plugs and seat members may be pumped out.

Figure 5 is a sectional view of the tool showing the conditions in the well after the seats and plugs have been pumped out.

Figure 6 is a view of a lock ring employed in the invention.

Referring to Figure 1, of the drawing, it will be seen that a tool 1 is there shown as attached to a casing 3 located in a bore hole 5 above a producing formation 7.

The tool designated generally at 1 includes a number of elements which coact to accomplish the objects of the invention. It consists essentially of a collar 2 adapted to be screw-threaded on the lower end of the casing 3, a depending tubular or cylindrical body 4 adapted to be screw-threaded to the collar 2, a packer 19 mounted on the cylindrical body 4, together with means for controlling the setting of the packer 19 and means for controlling the flow of fluid either through or around the tool. There is also a conventional guide means 9, adapted to be screw-threaded to the bottom of the cylindrical body 4.

The packer 19 encircles the cylindrical body 4 and consists of a cylinder of a resilient compressible material. It is provided with conventional shoes 16 and 16a. Engaging the upper shoe 16 and remaining in intimate contact therewith is an external sleeve 18. The sleeve 18 is connected to the cylindrical body 4 and maintained in the position shown in Figure 1 by a shear pin 17, and in the position shown in Figures 2, 3, 4 and 5 by a slip 18a. The lower shoe 16a engages and remains in intimate contact with the guide means 9.

The cylindrical body 4 is provided with ports 25. These are adapted to be covered by a lower internal sleeve 23. The sleeve 23 is closely fitted inside the bore of the cylindrical body 4, and is maintained in the position shown in Figure 1 by the shear pins 21 which extend through the ports 25 and constitute shearable means connecting the internal sleeve 23 to the external sleeve 18. Since the sleeve 18 is attached to the body 4 by the pins 17, the internal sleeve 23 is also attached to the body 4 where the parts are in the position shown in Figure 1. There are three such pins 21, spaced 120 degrees apart. As illustrated in the drawing, the sleeve 23 is packed off by suitable means, such as O-rings 43. Positioned inside of the sleeve 23 is a slidable member 20 having a passageway 15 and a seat 13. A shear pin 41 holds the sleeve 23 and the slidable member 20 in intimate contact. A locking means, such as a lock ring 35 with fingers 37, is provided to prevent pressure from being exerted on the shear pin 41 prematurely. The lock ring 35 encircles the slidable member 20 and the fingers 37 engage a shoulder provided in the sleeve 23. The seat 13 is adapted to receive and position an object to seal off the passage-

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way 15, such as a plug 11. Plug 11 may be of any conventional design, such as a boat tailed plug, as illustrated, or a sphere. The slidable member 20 is also packed off, as illustrated in the drawings by suitable means, such as O-rings 43.

An upper sleeve 31 is closely fitted inside of the cylindrical body 4 and maintained in the position shown in Figures 1, 2, and 3 by a shear pin 33. The sleeve 31 is packed off by suitable means, such as O-rings 43 and is provided with a suitable pressure equalizing check valve 47. This valve 47 is illustrated as consisting of a groove fitted with an O-ring with a number of small holes drilled through the sleeve 31 into the bottom of the groove. Fluid can thus flow outwardly but not inwardly through the valve 47. Positioned inside of the sleeve 31 is a slidable cylindrical member 28 having a passageway 30, a seat 29, and a depending extension 28a having ports 28b therein. An arrangement of three shear pins 39, spaced 120 degrees apart, holds the sleeve 31 and the slidable member 28 in intimate contact. The seat 29 is adapted to receive and position an object to seal off the passageway 30, such as a conventional cementing plug 27 of the type, for example, shown at page 3102, volume 2, Composite Catalogue of Oil Field and Pipeline Equipment, 1955-56 edition, as illustrated in Figure 4. The plug 27 may be of any conventional design. The slidable member 28 is also packed off by any suitable means, such as O-rings 43.

Thus it will be seen that the slidable members 20 and 28, together with the parts which coact with them, constitute a fluid pressure responsive system releasably connected to the internal sleeves 23 and 31 for moving these sleeves in the desired sequence to set the packer 19 and control the flow of fluid through the port 25. An illustration of the operation and coaction of the elements of the invention is as follows: The tool 1 is attached to the bottom of the casing 3. It will be understood that the casing extends to the top of the well and that the entire assembly is lowered into the bore hole 5 in a conventional manner. The tool 1 is positioned in the bore hole 5 just above a producing formation 7. As shown in Figure 2, the packer 19 is then set to firmly engage the well bore wall 51 and thereby seals off the producing formation 7 below the packer 19. Said packer 19 is set by pumping the plug 11 down through the casing 3 onto the seat 13 of the slidable member 20. By any conventional means at the surface, pressure is exerted on the fluid in the casing 3. Resulting fluid pressure is transmitted by the plug 11, to the seat 13 of the slidable member 20. The downward thrust thus created is transmitted to the sleeve 23 by the fingers 37 of the lock ring 35. The sleeve 23 is at this time coupled to the sleeve 18 by the shear pins 21. The thrust thus transmitted to the sleeve 18 causes the pins 17 to shear. The amount of pressure required to shear the pin 17 is determined by the shear strength of the said pin 17. The sleeve 18 then moves downwardly whereby the resilient packer 19 is squeezed so that the packer 19 expands and firmly engages the wall 51 of the well bore 5, as shown in Figure 2. The slip 18a holds the sleeve 18 in intimate contact with the body 4, thereby maintaining the packer 19 in the expanded position.

Increased pressure on the well fluid increases the downward thrust on the member 20, and this causes the pins 21 to shear, whereby the sleeve 23 and the slidable member 20 are moved downward until the sleeve 23 rests on the guide means 9, whereby the ports 25 are uncovered. A slurry of cement 45 is then pumped through the casing 3 and out through the ports 25 into the annulus between the wall 51 of the well bore 5 and the outside of tool 1 and the casing 3. The cement slurry 45 is prevented from going down through the tool 1 into the well bore hole 5 below the tool by means of the packer 19 and the plug 11.

After the desired amount of the cement slurry 45 is displaced, the ports 25 are closed in the following manner:

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The plug 27 (see Figure 4) is pumped down the casing 3 onto the seat 29 of the slidable member 28. Since the plug 27 is still in the casing 3 when it initially seats, there is produced, in effect, two pistons of different diameter traveling together, the smaller diameter being that of the plug 27 and the larger being that of the sleeve 31. Downward movement of these elements results in a lowering of pressure between them due to the differences in diameter and the sealing effect surrounding both pistons. The lowering of pressure must occur because the volume occupied by fluid between the two pistons is increasing the further down the plug 27 moves before it leaves the casing 3. Although the apparatus is operative without relieving this partial vacuum, more efficient operation is achieved if the partial vacuum is relieved. The manner of relief will be explained below. Pressure is applied to the fluid in the casing 3 until the pin 33 is sheared. This permits the slidable member 28 and the sleeve 31 to move downwardly. The bottom portion 28a of the slidable member 28 engages and compresses the fingers 37 of the lock ring 35, whereby the slidable member 20 is released from the sleeve 23. The presence of the ports 28b in the member 28a is to prevent any pressure build up during the downward movement of the members 28 and 31 to insure that the lower extension 28a of member 28 will engage the seat of the member 20 immediately below the member 35 to insure that the member 35 will be contracted. Pressure then shears pin 41, thus releasing the slidable member 20 from intimate contact with the sleeve 23. The sleeve 31 moves downwardly until its shoulder comes to rest on top of the sleeve 23 (as shown in Figure 4) whereby the ports 25 are closed. The pressure equalizing check valve 47 prevents the creation of a partial vacuum between the flanges of the plug 27 and the top of the member 28, and thereby eliminates the necessity of excessively high pressure to move the sleeve 31 and the slidable member 28.

Application of additional pressure then shears the pins 39, whereby the slidable member 28 is released from the sleeve 31. Then the slidable members 20 and 28, and the plugs 11 and 27 are pumped downwardly into the bottom of the bore hole 5. Any excess of the cement slurry 45 remaining in the passageway 30 is also pumped out. The tool 1 is cemented into the well bore 51 and forms an unobstructed passageway with the casing 3, without the necessity of drilling out as in previous methods.

Although the invention has been described in terms of a specific embodiment, it should be understood that this was by way of illustration only and that the invention is not limited thereto. Alternate embodiments and techniques will be apparent to those skilled in the art.

For example, the tool may be modified for use any place in a string of casing by modifying the guide shoe 9 into a suitable collar. Accordingly, modifications of the invention are contemplated without departing from the spirit of the described invention or the scope of the appended claims.

I claim:

1. Apparatus for cementing casing in a well comprising, in combination, a tubular body adapted to be made up with the casing, said body having a port in its wall for discharging cement slurry therethrough, expandable packer means mounted on the outside of said body beneath said port, an external sleeve slidably mounted on the outside of said body above said packer for setting said packer when downward force is applied thereto, shearable means connecting said external sleeve to said body to prevent the setting of said packer until a predetermined amount of downward force is applied to said external sleeve, a lower internal sleeve mounted for sliding movement inside said tubular body and cooperating with the port to serve as a sleeve valve, a shear pin extending through the port and connecting said lower internal sleeve to said external sleeve, said shear pin having greater strength than the shearable means, whereby downward

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force may be transmitted from said lower internal sleeve to said external sleeve, by said shear pin, to set said packer, as said lower internal sleeve is moved downwardly to uncover the port, an upper internal sleeve mounted for sliding movement inside said tubular body and adapted to move downwardly and cooperate with said lower internal sleeve to prevent the flow of slurry outwardly through the port, releasable means for temporarily holding said upper internal sleeve against downward movement, a member provided with a passageway and a seat mounted in said lower internal sleeve, latching means temporarily connecting said member to said lower internal sleeve, a depending extension mounted on said upper internal sleeve adapted to engage and release said latching means when the upper internal sleeve is moved downwardly to prevent outward flow of fluid through the port, said upper internal sleeve having a seat therein larger than the seat in said member, whereby upon the passage of first a small actuating object adapted to engage said seat and then a large actuating object adapted to engage said upper internal sleeve down through the casing, said sleeves may be successively operated to set the packer and control the flow of fluid through the port.

2. Apparatus for cementing casing in a well comprising, in combination: a tubular body adapted to be made up with the casing, said body having a port in its wall for discharging cement slurry therethrough; expansible packer means mounted on the outside of said body beneath said port; an external sleeve slidably mounted on the outside of said body above said packer for setting said packer when downward force is applied thereto; shearable means connecting said external sleeve to said body to prevent the setting of said packer until a predetermined amount of downward force is applied to said external sleeve; a lower internal sleeve mounted for sliding movement inside said tubular body and cooperating with the port to serve as a sleeve valve; a shear pin extending through the port and connecting said lower internal sleeve to said external sleeve, said shear pin having greater strength than the shearable means, whereby downward force may be transmitted from said lower internal sleeve to said external sleeve, by said shear pin, to set said pack-

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er, as said lower internal sleeve is moved downwardly to uncover the port; a first upper internal sleeve mounted for sliding movement inside said tubular body and adapted to move downwardly and cooperate with said lower internal sleeve to prevent the flow of slurry outwardly through the port; a second upper internal sleeve mounted for sliding movement within said first upper internal sleeve; releasable means for temporarily holding said upper internal sleeve against downward movement in said body; a member provided with a passageway and a seat slidably mounted in said lower internal sleeve; latching means temporarily connecting said member to said lower internal sleeve; an extension depending from said second upper internal sleeve adapted to engage and release said latching means to release the same when said upper internal sleeves are moved downwardly to prevent outward flow of fluid through the port, said second upper internal sleeve having a seat therein larger than the seat in said member; second shearable means connecting said upper internal sleeves and shearable only under higher pressure than said releasable means; whereby upon the passage of a first plug into said body to sealingly engage the seat on said member, and the application of fluid pressure thereabove, said lower internal sleeve and member and lower external sleeve are moved downwardly to set the packer, next the lower internal sleeve continues downwardly to open the port, so that cementing operations can be effected, a second plug larger than the first is engaged with the seat in said second upper internal sleeve and when pressure is again applied said upper internal sleeves are moved downwardly to reclose the port and a final increase in pressure is effective to carry said plugs, said second upper internal sleeve and said member completely out of said body and into the hole below the casing.

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