June 13, 1939. L. A. LAYNE 2,162,261

WELL CEMENTING

Filed March 3, 1936 2 Sheets-Sheet 1

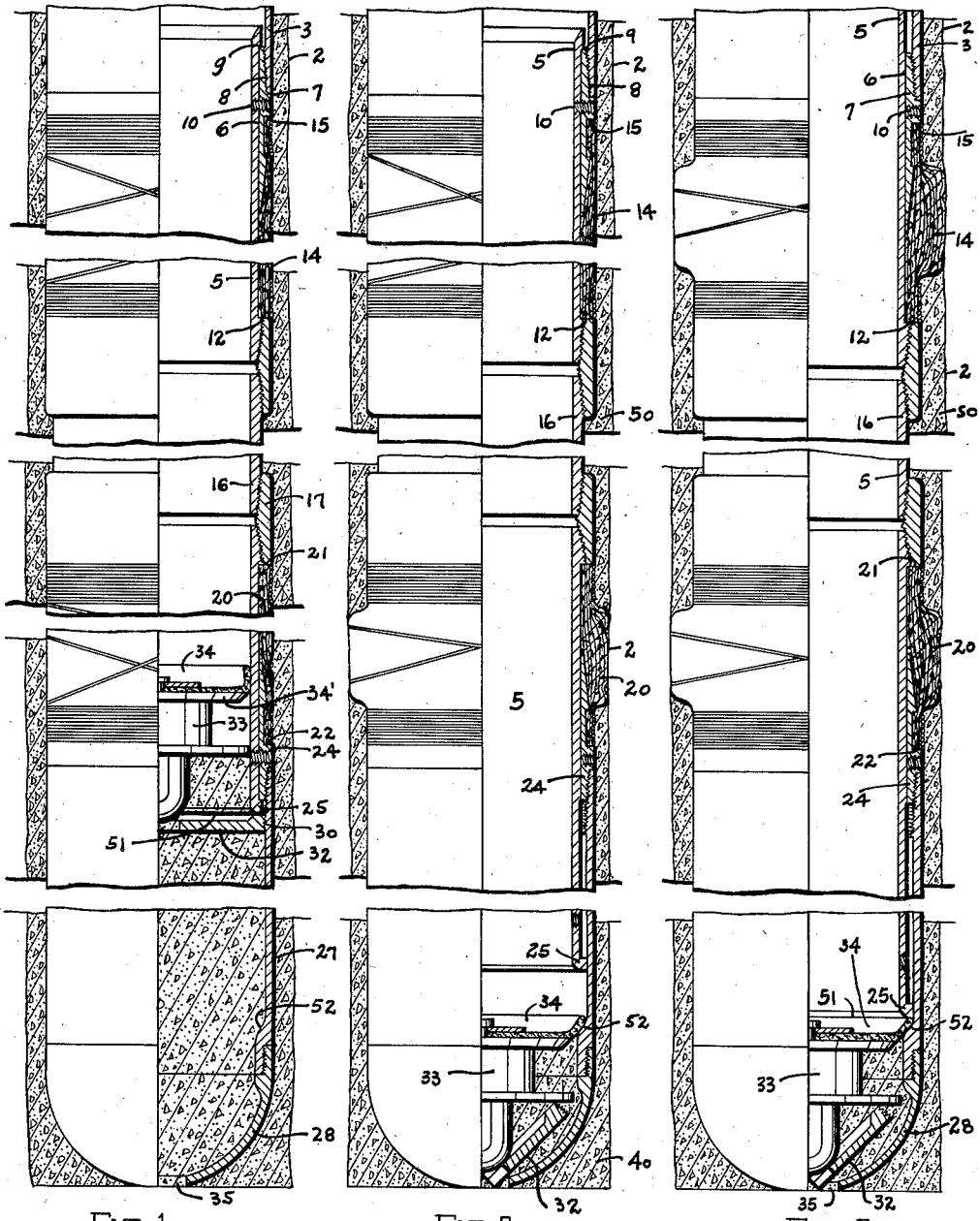


Fig. 1. Fig. 2. Fig. 3.

INVENTOR.
L. A. LAYNE

BY Jesse R. Stone
Lester B. Clark
ATTORNEYS.

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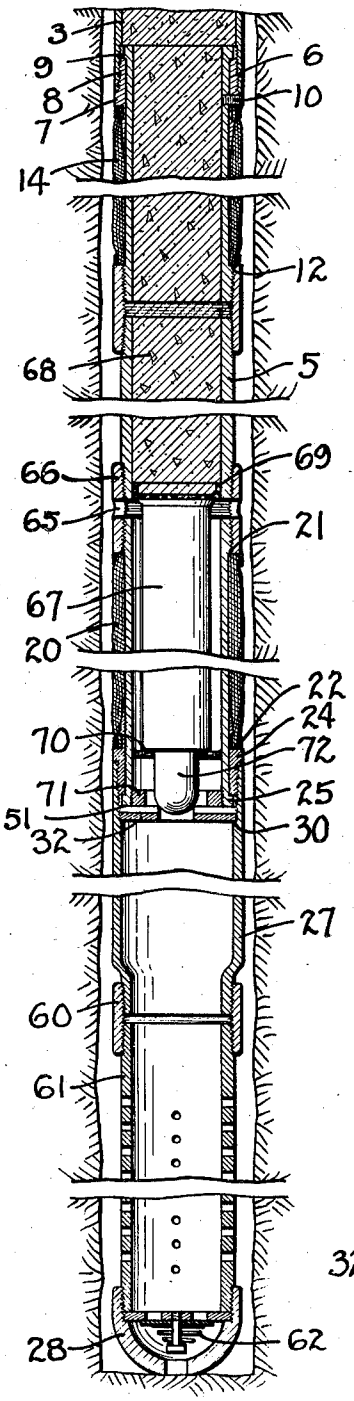


Fig. 4.

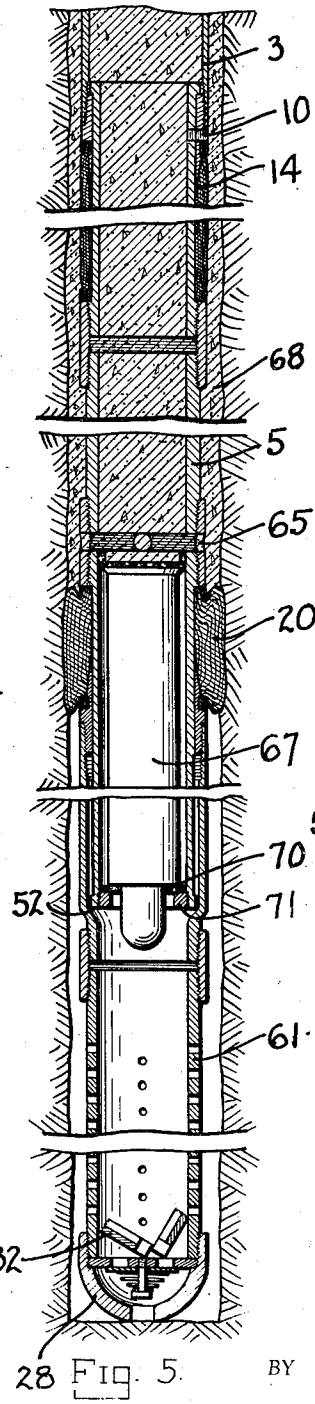


Fig. 5.

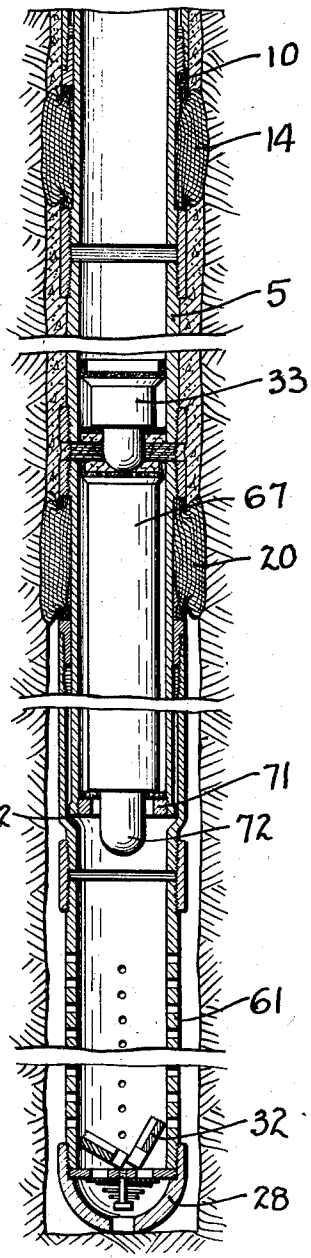


Fig. 6.

INVENTOR.
L. A. LAYNE
BY Jesse R. Stone
Lester B. Clark
ATTORNEYS

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WELL CEMENTING

Leslie A. Layne, Houston, Tex.

Application March 3, 1936, Serial No. 66,780

6 Claims. (Cl. 166—21)

The invention relates to an improvement in the apparatus and manner of packing and cementing the lower end of a string of pipe in wells.

In positioning the string of pipe in a well it is often desirable to form a seal between the outside of the pipe and the well bore. To accomplish this, a packer may be provided around the outside of the pipe so that it may be expanded into contact with the wall of the well, or the usual practice is to pump cement through the pipe so that it passes around the lower end of the pipe and sets in position to form a seal. Both of these practices are not entirely satisfactory because the packer may not form a seal because of the nature of the formation of the wall of the well, and the cement may not form a complete seal because in flowing into position it may form channels and in this manner leave open areas so that a complete seal is not formed. With these conditions in mind it is one of the objects of the present invention to provide a double packer arrangement in which the packers will move longitudinally to some extent while being set so that there will be a compression of the material adjacent the packers so that a seal will be insured regardless of whether the packer engages the wall formation or the cement.

Another object of the invention is to provide an apparatus wherein two packers may be set in the well bore following the positioning of the cement, so that the cement may be compressed adjacent the bottom of the pipe by the lower packer and against the lower packer by the upper packer.

Another object of the invention is to provide a packer on a string of pipe to be cemented so that the expansion of the packer will insure centering of the string of pipe in the well and the consequent uniform distribution of the cement about the pipe.

Another object of the invention is to provide a pair of spaced packers to confine the cement therebetween and to prevent the cement from flowing about the screen.

Other and further objects of the invention will be readily apparent when the following description is considered in connection with the accompanying drawings wherein:

Fig. 1 shows a central vertical section of the device after it has been lowered into the well bore and after cement has been pumped therethrough at a time just prior to the setting of the packers.

Fig. 2 is a view similar to Fig. 1 but showing the device having been actuated to set the lowermost packer, but with the upper packer as yet unseated.

Fig. 3 shows both packers set and in compression against the wall formation and against the surrounding cement.

Figs. 4, 5, and 6 show vertical sections of the invention as applied to a full hole pipe and screen assembly where the screen is set with the pipe.

The well bore which has been drilled in the earth formation is indicated generally at 2 and may be of any desired depth or size. It is desired to position a string of pipe 3 in the well bore. This pipe may be the usual string of well casing, or in fact it may be any string of pipe which it is desired to locate in the well bore. This string of pipe 3 will be lowered into the well bore in combination with an extension pipe 5 which may be connected thereto by means of the telescoping or sliding connection 6. This connection is formed by a coupling 7 which is threaded at 8 or otherwise connected to the lower end of the string or pipe. This coupling 7 is fitted about the extension 5 and is prevented from sliding over the end thereof by the shoulder 9 thereon. One or more shear pins 10 may be provided to normally retain the coupling 7 in the position shown in Fig. 1. The extension 5 tends to support the packer assemblies as will be later described.

The extension 5 is provided with a shoulder 12 which is arranged to provide a seat for a suitable packer 14. This packer may be of any desired type or configuration, the usual form of which constitutes wrappings of fabric about the support in such a manner that when the packer is collapsed it will expand radially as best seen in Fig. 3. The upper seat for this packing is a shoulder 15 on the coupling 7. The extension 5 may be of any desired length and may have additional sections of pipe such as 16 between its upper and lower ends. The lower end is also arranged to carry a packer such as 20 which is confined between the upper shoulder 21 on the extension and the lower shoulder 22 on a coupling 24. The coupling 24 may remain stationary while the extension is slidable therethrough in the same manner as the coupling 7, so that it may move downwardly to cause setting of the packing 20. The enlarged end 25 prevents the coupling 24 from sliding beyond the end of the extension 5.

Connected to the coupling 24 is a setting sleeve 27 which extends down below the end of the extension 5 and may be provided with a guide-shoe 28. This setting sleeve 27 is provided with a reduced portion 30 which is arranged to support

a breakout ring **32**. This breakout ring may be of any suitable material which is fragile but which is arranged to be broken when contacted by any member such as the cement plug **33**. This breakout ring has an opening therethrough to permit the passage of fluid. The lower end of the guide-shoe **28** is open at **35** to permit the discharge of cement.

In operation the device will be lowered into the well bore, assembled as shown in Fig. 1. If cement is to be applied about the lower end of the string of pipe **3** to form a seal, then the cement will be deposited in the pipe **3** and pumped downwardly by applying liquid pressure thereto. It is usual to place a cement plug **33** on top of the cement in the pipe. Liquid pressure is then applied to the column of cement and the plug to force it downwardly through the pipe. The cement will, of course, be discharged through the extension **5**, the sleeve **27**, and the guide-shoe **28**, and out the opening **35** where it will be compelled to move upwardly around the apparatus and about the pipe **3** as best seen in Fig. 1.

The cement plug **33** serves the purpose also of advising the operator when the cement has been discharged from the pipe because it moves downwardly to engage the breakout ring **32**. As previously pointed out the breakout ring prevents telescoping movement between the extension **5** and the setting sleeve **27**, but when the cement plug **33** engages the breakout ring liquid pressure applied thereto will break the ring so that it will move downwardly with the cement plug to the position shown in Fig. 2.

At the same time that the breakout ring is removed if all or part of the weight of the string of pipe **3** is applied to the apparatus the extension **5** will telescope into the setting sleeve **27**. The coupling **24** will remain stationary as the extension **5** telescopes downwardly through it. This movement brings the shoulder **21** toward the shoulder **22** to expand the packing **20** so that it will move outwardly to engage the wall **2** of the well bore as best seen in Fig. 2.

It will be seen by this operation that the shoulder **22** remains stationary, whereas the shoulder **21** moves downwardly to perform a downward movement of the packer during its expansion or setting. During this period the pressure is maintained inside the string of pipe and against the cement plug **33** so that there can be no reverse flow of the cement back into the string of pipe. In other words, the body of cement such as **40** in the well bore outside of the setting sleeve **27** and below the packer **20** is trapped in this area and is subjected to a compressive force by the downward expanding movement of the packer. If the cement plug **33** has merely broken the ring **32** but has not moved all the way down to the Fig. 2 position then the end **25** of the extension **5** will abut against the plug as the pipes are telescoped to set the packer. This contact will push the plug along ahead of the extension **5** and additional compression will be obtained by the continued movement of the cement plug **33** as it moves downward ahead of the pipe. In order that the plug **33** will withstand this pressure the top leather or seal ring **34** may be reenforced at **34'**.

It seems apparent from this operation that the body of cement **40** around the lower end of the device may be subjected to a compression by the simultaneous movement of the packer and plug so that if it has channeled while it was being positioned that the channels will be destroyed and the cement so disturbed and compressed that a positive seal will be created. When the plug **33** has passed below the bottom end of pipe **25** the cup leather **34** on top thereof will expand and thus the plug **33** is kept from moving back into pipe **5**.

Another advantage of expanding the packer while the cement is liquid is that the pipe will be moved by the expanding packer to a central position. It is to be understood that a majority of well bores are not exactly vertical; many of them are inclined up to 5 or 6 degrees so that when the casing is lowered it slides along the low side of the bore. If the pipe were in close contact with one side of the bore no cement would be deposited on that side. With the present arrangement, however, the expansion of the packer will lift the pipe from the low side of the bore to a central position. The liquid cement about the pipe being under pressure will be caused to flow in under the pipe as it is moved away from the side of the bore. In this manner a uniform distribution of the cement will be insured. Any channels which have formed will be destroyed and the cement forced firmly against the pipe and the wall of the well bore.

After the lower packer **20** has been set and the pipe centered it is then desirable to form an additional seal and compression of cement **50** between the packers **14** and **20**.

It is intended that the shear pins **10** will be so calculated and designed that they will withstand a shear force to accomplish the setting of the lower packer **20** but will be of such a strength that when a force exceeding that required to set the packer **20** is applied to them they will shear and permit the setting of the upper packer **14**. The extension **5** may telescope to the position shown in Figs. 2 and 3 and its further movement prevented because of the resistance to further compression of the packer **20**.

If, however, the packer **20** expands a maximum amount, then the lower end **51** of the extension **5** may engage the shoulder **52** in the sleeve **27** so as to provide a definite stop for the extension. Regardless of whether this extension is prevented from downward movement by the stop **52** or by the compression of the packer **20**, the shoulder **12** will remain stationary upon shearing of the pins **10** so that downward movement of the string of pipe **3** will move the coupling **7** downward and expand the packer **14** as seen in Fig. 3.

There will be a certain amount of downward movement of the upper portions of the packer **14** while it is being set in this manner so that the body of cement **50** which is trapped between the two packers will be subjected to a compressive force and insure that any channels therein will be destroyed and that the cement will be forced against the wall **2** of the well.

While the invention has been described in combination with a cementing operation it seems obvious that the double seal may be obtained when no cement is present if such a seal is desired. Under such circumstances any instrument may be dropped into the string of pipe **3** to destroy the breakout ring **32** to permit the setting of the lowermost packer in lieu of destroying the breakout ring with the cement plug **33**.

Figs. 4, 5, and 6 show a slightly modified form of the invention wherein the parts are substantially constructed and arranged the same as in the Fig. 1 form of the invention except that replacing the guide shoe **28** is a coupling **60** which

has connected thereto any desired form of strainer or screen 61. This screen may be of any desired length and will in turn have the guide shoe 28 attached to its lower end. When a screen of this type is embodied in the assembly it is usual to employ a back pressure valve 62 to prevent an inflow of sand or other material at the position of the screen.

This assembly is known as a full hole assembly when the screen is lowered into the well bore at the same time as the casing. This assembly may be used, however, when the pipe 5 is the liner which is to be set in the lower end of a string of well casing. In either instance, it is desirable to form a seal in the well bore above the screen to prevent the discharge flow of extraneous liquid and prevent caving in and around the screen. In this manner the screen is closed off so that it is only open at the prospective formation opposite which it has been located.

With an assembly such as the foregoing the present invention as described in connection with Figs. 1 to 3, inclusive, may be utilized by providing a plurality of ports or openings 65 in the coupling 66 which is the same as the coupling 17 of Fig. 1.

It is through these ports that the cement will be discharged into the well bore outside of the pipe in order to form a seal. The packers are assembled in the same relationship as they are in Fig. 1, but in Fig. 4 a bottom plug 67 has been inserted in the pipe below the body 68 of cement and this plug will be of sufficient length to contact the breakout ring 32 at its lower end while the upper end or sealing portion 69 thereof is at an elevation above the ports 65 as best seen in Fig. 4. With the ports in this position the cement cannot be discharged into the well bore until the ring 32 has been broken out by the plug 67 and by applying pressure to the body of cement 67 the ring 32 will be broken out and fall into the bottom of the screen as seen in Fig. 5. The plug 67, however, carries a shoulder 70 which is arranged to abut against a stop ring 71 in the lower end of the extension 5, so that the plug 67 will remain in the position shown in Fig. 5. The nose 72 of the plug 67 causes the breakout ring 32 to be ruptured and this nose is of a size to pass through the opening in the stop collar 71. It will be noted in Fig. 5 that the upper end 69 of the plug has moved below the elevation of the ports 65 so that the weight of the string of pipe is lowered onto the packer 20 to effect its expansion as the cement begins to discharge when the ports 65 are uncovered, the packer being set by the telescoping movement between the extension 5 and the packer support. In this manner the upper portion of the packer will be bathed in cement as it is set in position and the cement will then flow outwardly and upwardly as best seen in Fig. 5 to any desired elevation depending upon how much cement is to be positioned.

The top plug 33 is seen in Fig. 6 as having moved down through the pipe the same as described in connection with Fig. 1 and advises the operator that all of the cement has been discharged when it abuts against the top of the plug 67. The operator can now lower such additional weight onto the pipe as may be necessary in order to shear the pin 10 in order to release the upper packer 14, the same as described in connection with Fig. 1.

It will be apparent from the foregoing that an arrangement has been provided whereby a suitable body of cement can be discharged above the screen in a well bore and be completely excluded from the screen while being compressed between a pair of spaced packers so as to insure a uniform distribution of the cement and the formation of a perfect seal.

The invention contemplates broadly the provision of a positive double seal about the lower end of a string of pipe and the compression of the liquid which is about the pipe at the time the packers are being set.

What is claimed is:

1. A method of sealing a pipe in a well bore which comprises the steps of pumping cement through the pipe ahead of a cement plug so that it discharges about the pipe and around a packer on the pipe, maintaining pressure on the cement plug to release the packer, and setting the packer by telescoping the pipe so as to compress the cement between the packer and plug and about the pipe.

2. A method of positioning material about a pipe in a well under pressure which consists of the steps of trapping the material about the pipe between a plug inside the pipe and a packer on the outside of the pipe, moving the plug through the pipe by fluid pressure and telescoping the pipe to set the packer simultaneously whereby the trapped material is placed under compression and forced into the formation under pressure.

3. A method of positioning cement about a pipe in wells including the steps of pumping the cement through and around the pipe, setting a packer on the outside of the pipe to trap the cement about the lower end thereof by telescoping the pipe, and simultaneously moving the cement plug downwardly with the pipe to apply pressure to the trapped cement.

4. A method of positioning cement about a pipe in wells which consists in pumping the cement through the pipe, and out around the pipe, trapping a body of the cement about the pipe between a packer on the pipe and the cement plug in the pipe and forcing the cement into the formation upon setting of the packer.

5. A method of positioning cement about a pipe in wells which consists in pumping the cement through the pipe and out around the pipe, trapping a body of the cement about the pipe between a packer on the pipe and the cement plug in the pipe and forcing the cement into the formation upon setting of the packer, trapping a second body of cement with a second packer above the first packer, and setting the second packer to force the second body of cement into the formation.

6. In combination with a well pipe and screen, a pair of packers spaced above said screen on said pipe, two telescoping joints in said pipe, a member to release one of said joints to set the lower packer and ports in said pipe to be uncovered by said member to release cement through said pipe, and shear means to thereafter release the other of said packers.

LESLIE A. LAYNE.