June 26, 1945. L. H. HAYWARD 2,379,079

WELL CEMENTING DEVICE

Filed May 18, 1942 2 Sheets-Sheet 1

Fig. 1.

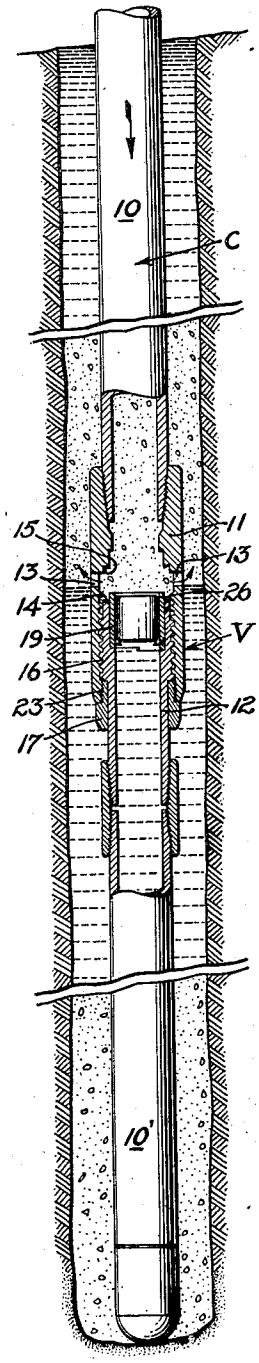

Fig. 2.

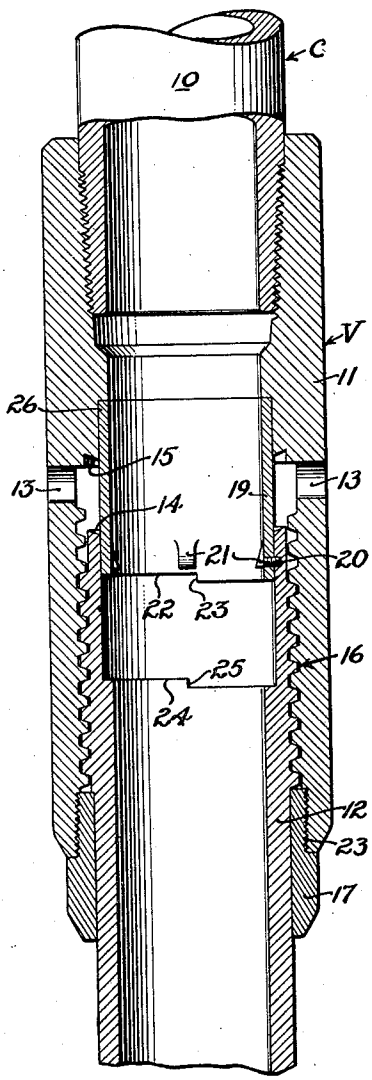

Fig. 3.

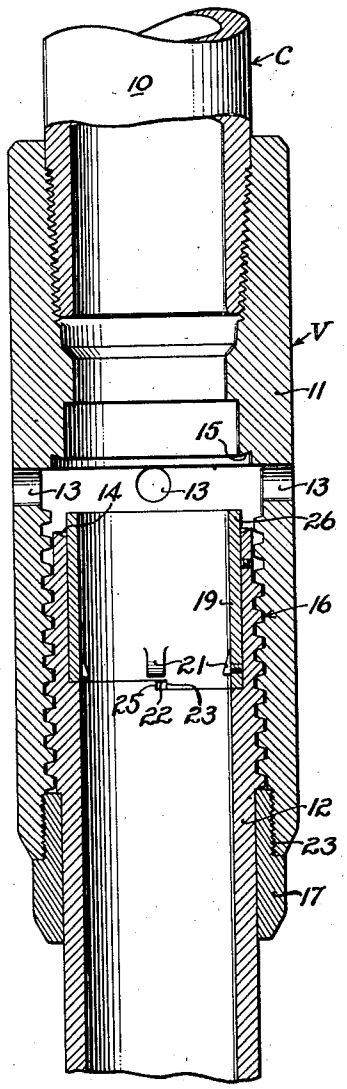

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Fig. 4.

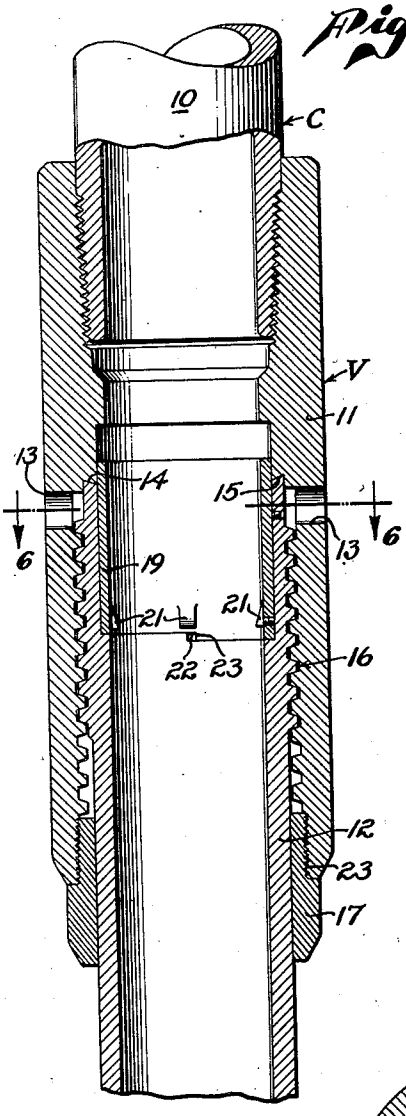


Fig. 5.

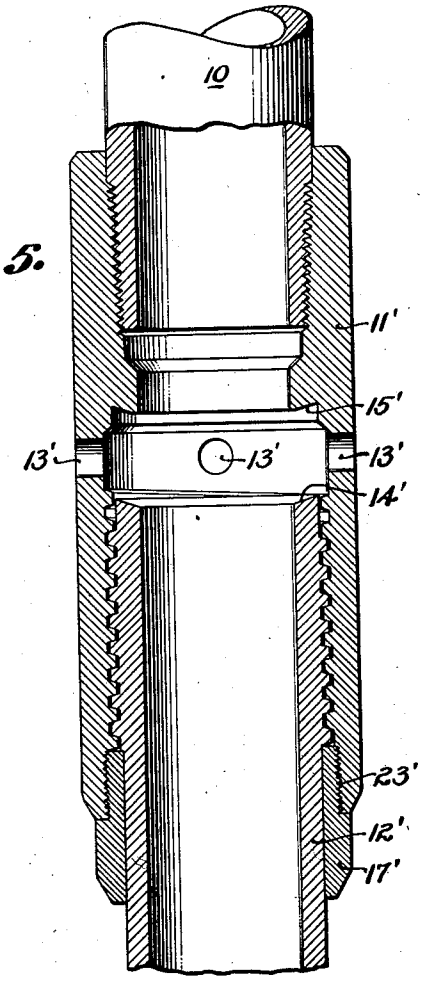
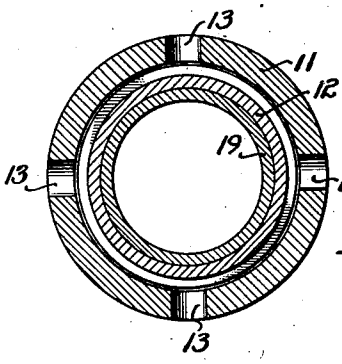


Fig. 6.



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UNITED STATES PATENT OFFICE

2,379,079

WELL CEMENTING DEVICE

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Application May 18, 1942, Serial No. 443,386

8 Claims. (Cl. 166—1)

This invention relates to the cementing of wells, and more particularly to the provision of an opening in the casing for introducing cement behind the walls of the casing, which opening can be controlled from the surface of the well.

An opening through a casing wall can be controlled by movement of the portion of the casing which extends to the surface. Previous devices which utilize the movement of the casing for controlling the opening through the wall of the casing suffer various disadvantages. Some of them require that the casing be rotated through a certain definite angle in order that ports through relatively rotating members be brought into alignment to permit the flow of cement through the openings into the space behind the casing. With a long string of casing extending to the surface it is oftentimes difficult to assure that the part secured to the casing rotates the required amount to open and close the port in the required manner.

It is therefore an object of the present invention to provide a valve in the length of the casing which can be controlled without accurate control of the rotative movement of the casing extending to the surface.

It is a further object of the present invention to eliminate the necessity for soft packing or sealing means in a casing valve.

It is a further object of this invention to provide a casing valve which is reliable despite upward and downward movement of the casing from the surface during cementing operation at a stage below the valve.

It is a further object of the present invention to provide a casing valve which is not effected by changes in temperature along the length of the casing causing the casing to expand and contract.

It is another object of the present invention to produce a casing valve which can be opened without requiring that part of the casing be fast in the well.

It is another further object of the present invention to provide a casing valve in which alignment and proper mating of the sealing surfaces is at all times assured.

It is another object of the present invention to provide a valve wherein the sealing surfaces are so arranged that they cannot be abraded by the passage of cement and other abrasive fluids through the device.

Casing valves which have been used in the past involve enlargements in the diameter of the casing string. That is to say, the outside diameter of the valve is greater than the outside diameter of the casing couplings. This is primarily due to the fact that the inside diameter of the valve must be equal to that of the casing in order to permit introduction of the producing equipment into the well and the design of these valves requires that the outside diameter of the valve be greater than that of the casing collars. If the outside diameter of the valve is too great, as for instance, if it is much greater than the outside diameter of the couplings employed to join the casing together, the mere size of the valve prevents easy insertion into the well bore and, what is even more important, causes channeling and improper distribution of the cement introduced around the casing which defeats the purpose of the cementing, and causes eddying of cement and other fluids passing the valve.

It is therefore an object of the present invention to provide a casing valve which has the necessary tensile strength but which does not depart appreciably in outside diameter from an ordinary coupling used in the casing.

It is still a further object of the present invention to provide a valve structure which does not present freely rotated parts to the drill when the plug is being drilled out.

This invention possesses many other advantages and has other objects which may be made more easily apparent from a consideration of the embodiments thereof, shown in the drawings accompanying and forming part of the present specification. These forms will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring now to the drawings:

Figure 1 shows one form of the present invention in use in cementing a well, the parts being in position to cause the cement to flow to the space behind the casing;

Figure 2 is an enlarged fragmentary section of a device embodying the present invention with the parts in position to maintain the valve closed for lowering of the casing into the well and for performance of various operations on the well prior to introduction of cement behind the casing through the valve;

Figure 3 is a view similar to Figure 2 showing the valve in an open position for the passage of cement therethrough, this position being identical with that shown in Figure 1;

Figure 4 is a similar view showing parts in final

closed position which they assume after cement has been introduced behind the casing;

Figure 5 is a sectional view showing a modified form of the present invention; and,

Figure 6 is a transverse section taken along line 6—6 of Figure 4.

Referring to Figure 1, a valve of the type illustrated in Figures 2 to 4 is shown connected in a casing string C located within a well bore. The valve, generally designated V, comprises a pair of telescopically related members 11 and 12, the outermost member 11 being threadedly connected to the length of casing 10 extending to the surface and the innermost member 12 being threadedly connected to the section of the casing 10' extending below the valve V. In order to provide means for discharging cement from the interior to the exterior of the casing through the valve, one of the telescoping members is provided with a plurality of discharge ports extending through its walls. In the present form these ports 13 are provided in the outermost member 11. The end of the unported member 12 is formed at 14 with a sealing surface which is adapted to cooperate with a complementary sealing surface 15 on the interior of the outermost member 11 to form a fluid tight seal between the ports and the interior of the casing. It can be seen from mere inspection that relative telescopic movement between the valve members 11 and 12 will bring the sealing surfaces 14 and 15 into engagement, to prevent passage of fluid through the ports 13. The engagement of the surfaces 14 and 15 is the only sealing necessary to close the valve. For this reason, the seal need not be of yielding material and there are no sliding surfaces which need be made tight by packing or the like.

As hereinbefore mentioned, it is desirable to preserve the sealing surfaces from erosion by the abrasive fluids discharged through the ports 13. This is accomplished by locating the sealing surfaces 14 and 15 on the high pressure side of the ports 13. The high velocity through the ports 13 thus does not affect the surfaces 14 and 15 inasmuch as the high velocity is not attained until the fluid enters the ports 13.

The axial movement between members 11 and 12, which is necessary to operate the valve by bringing the sealing surfaces 14 and 15 together, can be most readily attained by the utilization of a threaded connection 16 between the members 11 and 12. This threaded connection has been shown as consisting of an exterior thread on the member 12 engaging a corresponding thread on the interior of member 11. Such a connection is preferably made closely adjacent the sealing surfaces 14 and 15. Otherwise, the great weight of the casing above the valve might tend to throw the sealing surfaces 14 and 15 out of line if the threads 16 were a little loose, which would render more difficult the attainment of a tight seal. It can be seen that all that is required to close the ports 13 is rotation of the casing 10 with respect to the casing 10', which can be readily done from the surface of the ground. In order to prevent the two members 11 and 12 from coming apart when the device is being lowered into the well, a collar 17 may be secured to the member 11, as by means of threads 23 or the like, the collar preventing the member 12 from unscrewing from within the member 11.

The above described structure is operative to close the valve after cement has been discharged through the ports. However, when it is desired to first conduct cement to a point below the valve or to the bottom of the casing, the valve must be closed while cement is passing through the casing to the point below the valve. It is also desirable that, after such cementing below the valve has been completed, the valve be operative to open without the necessity of waiting until the cement introduced into the well below the valve is hardened. In the present instance the valve is kept closed during this cementing below the valve by means of a sleeve 19 which bridges the space between the sealing surfaces 14 and 15, as shown in Figure 2. This sleeve 19 is intended to be moved downwardly to thus open the ports 13 by a plug or the like driven down from the surface of the well ahead of the cement which is to be introduced through said ports 13 to the space around the casing. As shown in Figure 2, the sleeve 19 is held in a position to bridge the gap between the sealing surfaces 14 and 15 by means of a shear pin 20 passing through the sleeve 19 and into an opening drilled part way through the wall of the member 12. This pin is sufficiently small that it may be sheared upon the application of a downward force to the sleeve 19. Projections 21 extend inwardly from the interior surface of the sleeve 19, so that a plug may engage these projections and upon its further downward travel shear the pin 20 causing downward movement of the sleeve 19. The sleeve will thus be moved from a position shown in Figure 2 to the position shown in Figure 3. The plug also serves the purpose of preventing cement or other fluids from passing down the interior of the casing to a point below the valve V. After cementing has been completed, this plug may be removed by milling it up with a bit lowered from the surface on a drill pipe. As such milling operation requires that the plug and sleeve be held against rotation while the milling tool rotates, the lower end of the sleeve 19 is furnished with a non-continuous end 22 providing shoulders 23. The interior of the member 12 is provided with a discontinuous shoulder 24 which is engaged by the bottom of the member 19 upon downward movement. The shoulder 23 abutting against the corresponding shoulder 25 serves to prevent rotation of the member 19 under the influence of the drill acting upon the plug.

The operation of this form of device should now be clear. The valve is secured in the length of the casing at the position desired, and lowered with the casing into the well with the parts of the valve in a position shown in Figure 2, that is, with the sealing surfaces 14 and 15 separated but bridged by the sleeve 19. After the casing has reached its desired position in the well, cementing operations below the valve V may be carried out in any conventional manner, whether these cementing operations be carried on through the bottom of the casing or through some valve intermediate the valve V and the bottom of the well. It then being desired to cement through the ports 13, a plug is driven down the casing from the surface, which plug, upon striking the member 19, drives it downwardly to the position shown in Figure 3. Cementing can then be commenced through the ports 13. After completion of this cementing operation, which usually takes sufficient time to permit the hardening of the cement placed below the valve, the uppermost portion 10 of the casing is rotated, the cement surrounding the lower portion 10' of the casing effectively holding it against rotation. This rotation of the casing 10 closes the ports 13 by causing the sealing surfaces 14 and 15 to come in

contact with each other. The only further operation which must then be done on the casing is the removal of the plug within the member 19.

The above described series of operations is made with the assumption that the sealing surfaces 14 and 15 will be preserved from abrasion, and furthermore that there will be no mishap preventing them from successfully forming a fluid tight joint. Protection from abrasion is achieved by the position of the sealing surfaces 14 and 15 and also by the presence of the upper end 26 of sleeve 19 above the sealing surface 14. This uppermost edge of the sleeve protects the surface 14 and also tends to prevent flow of cement onto the threads 16. In the event that some mishap prevents the valve from closing completely to bring the members 14 and 15 into sealing engagement, it is still possible to seal the valve by rotating the upper section 10 of the casing relative to the lower section thereof. The upper end 26 of the sleeve will pass the shoulder 15 before the surfaces 14 and 15 are brought into contact. Under these conditions the inner surface of the member 11 and the outer surface of the sleeve 19 will form a seal which prevents the passage of fluids between the outside and inside of the casing.

When a surface casing string is set, the regulatory bodies require that cement be pumped down around the bottom of the casing in sufficient quantities to come to the surface of the ground in order to prevent leakage around the outside of the casing. Although the surface string is comparatively shallow, being less than fifteen hundred feet and usually only a few hundred feet, channels can develop in the cement during its passage from the bottom of the casing to the surface. It is thus often desirable to install one of the described valves in the surface string, pumping a portion of the cement charge around the bottom of the casing in the usual manner and pumping the rest of the charge through the casing at a point intermediate the surface of the ground and the bottom of the casing. When such a procedure is followed it is not necessary to employ the sleeve 19. The device of Figure 5 can then be utilized. This device is identical in every respect to the device of Figures 1 to 4 and 6, except for the omission of the sleeve 19. It will therefore not be necessary to describe it in full detail. The corresponding parts are indicated by primed numerals. This type of valve can be operated by rotating the casing at the surface in one direction which opens the valve after the casing has been set. After cement has been introduced through the ports 13' to the space around the casing, the valve can be shut by rotation of the upper part of the casing. It will be understood that there are only a few joints in the casing above the valve, and, as the bottom of the casing rests on the bottom of the hole, there is no danger of unscrewing the relatively few joints in the casing above the valve during the rotation of the upper part of the valve in a direction tending to loosen the couplings, if that operation is performed with caution.

I claim:

1. A valve structure for insertion in a casing string, comprising a pair of tubular members telescoping one within the other, one of said members being adapted to be secured to the casing extending above the valve, the other member being adapted to be secured to the casing extending below the valve, means connecting said members for relative axial movement, one of said members having a port through its wall for permitting communication between the interior of said casing and the exterior thereof, a pair of coengageable sealing surfaces, one respectively on each of said members and operative upon relative axial movement between the members to separate to open and coengage to close the port, and an axially movable sleeve within said members initially closing said port and movable to uncover the port by means actuated from the mouth of the well.

2. A valve structure for insertion in a casing string, comprising a pair of tubular members telescoping one within the other, one of said members being adapted to be secured to the casing extending above the valve, the other member being adapted to be secured to the casing extending below the valve, means connecting said members for relative axial movement, one of said members having a port through its wall for permitting communication between the interior of said casing and the exterior thereof, a pair of coengageable sealing surfaces, one respectively on each of said members and operative upon relative axial movement between the members to separate to open and coengage to close the port, an axially movable sleeve within said members initially closing said port and movable to uncover the port by means actuated from the mouth of the well, and means releasably maintaining said members in port opening position.

3. A valve structure for insertion in a casing string, comprising a pair of tubular members telescoping one within the other, one of said members being adapted to be secured to the casing extending above the valve, the other member being adapted to be secured to the casing extending below the valve, means connecting said members for relative axial movement, one of said members having a port through its wall for permitting communication between the interior of said casing and the exterior thereof, a pair of coengageable sealing surfaces, one respectively on each of said members and operative upon relative axial movement between the members to separate to open and coengage to close the port, an axially movable sleeve within said members initially releasably secured in an extended position with respect to one of said members, closing said port, and movable to a restricted position with respect to said member to uncover the port by means actuated from the mouth of the well, and means on the other member engageable with said sleeve when said sleeve is in extended, port closing position, whereby said sleeve maintains said members positioned to separate said sealing surfaces to open said port.

4. A valve structure for insertion in a casing string, comprising a pair of tubular members telescoping one within the other, one of said members being adapted to be secured to the casing extending above the valve, the other member being adapted to be secured to the casing extending below the valve, means connecting said members for relative axial movement, one of said members having a port through its wall for permitting communication between the interior of said casing and the exterior thereof, a pair of coengageable sealing surfaces, one respectively on each of said members and operative upon relative axial movement in one direction between the members to separate to open the port, and upon relative axial movement in the opposite direction between the members to coengage to close the port, said surfaces being initially spaced apart to

open the port, an axially movable sleeve within said members initially closing said port and movable to uncover the port by means actuated from the mouth of the well, and means forming a frangible connection between said sleeve and one of said tubular members for releasably maintaining said sleeve in port closing position.

5. A valve structure for insertion in a casing string, comprising a pair of tubular members telescoping one within the other, one of said members being adapted to be secured to the casing extending above the valve, the other member being adapted to be secured to the casing extending below the valve, means connecting said members for relative axial movement, one of said members having a port through its wall for permitting communication between the interior of said casing and the exterior thereof, a pair of coengageable sealing surfaces, one respectively on each of said members and operative upon relative axial movement in one direction between the members to separate to open the port, and upon relative axial movement in the opposite direction between the members to coengage to close the port, means initially releasably maintaining said surfaces spaced apart, comprising a sleeve seated in one member and joined to the other member by a frangible connection, said sleeve serving when maintaining said members apart to close the port and being movable to uncover the port and release said members for optional movement to close the port, by means operated from the mouth of the well.

6. A valve structure for insertion in a casing string, comprising a pair of tubular members telescoping one within the other, one of said members being adapted to be secured to the casing extending above the valve, the other member being adapted to be secured to the casing extending below the valve, means connecting said members for relative axial movement, one of said members having a port through its wall for permitting communication between the interior of said casing and the exterior thereof, a pair of coengageable sealing surfaces, one respectively on each of said members and operative upon relative axial movement between the members to separate to open and coengage to close the port, and means forming an annular wall on one of said members between the surface on said member and the interior of said members and extending part way to the other sealing surface when said members are in port opening relation, for shielding said one surface from contact with fluid flowing from the casing through the port.

7. A valve structure for insertion in a casing string, comprising a pair of tubular members telescoping one within the other, one of said members being adapted to be secured to the casing extending above the valve, the other member being adapted to be secured to the casing extending below the valve, means connecting said members for relative axial movement, one of said members having a port through its wall for permitting communication between the interior of said casing and the exterior thereof, a pair of coengageable sealing surfaces, one respectively on each of said members and operative upon relative axial movement between the members to separate to open and coengage to close the port, said surfaces being initially spaced apart to open the port, an axially movable sleeve within said members and between said surfaces and the interior of the casing, initially closing said port and movable to uncover the port by means actuated from the mouth of the well, and means limiting movement of said sleeve in port uncovering direction whereby said sleeve extends beyond one of said sealing surfaces for shielding said surface from contact with fluid flowing from the casing through the port.

8. A valve structure for insertion in a casing string, comprising a pair of tubular members telescoping one within the other, one of said members being adapted to be secured to the casing extending above the valve, the other member being adapted to be secured to the casing extending below the valve, means connecting said members for relative axial movement, one of said members having a port through its wall for permitting communication between the interior of said casing and the exterior thereof, a pair of coengageable sealing surfaces, one respectively on each of said members and operative upon relative axial movement between the members to separate to open and coengage to close the port, said surfaces being initially spaced apart to open the port, an axially movable sleeve within said members initially closing said port and movable to uncover the port by means actuated from the mouth of the well, and interengaging means respectively on said sleeve and one of said tubular members for maintaining said sleeve against rotation with respect to said member while in port opening position.

LANDES H. HAYWARD.

Patent No. 2,379,079. CERTIFICATE OF CORRECTION. June 26, 1945.

LANDES H. HAYWARD.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 50, claim 3, for the word "restricted" read --retracted--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 27th day of November, A. D. 1945.

Leslie Frazer

First Assistant Commissioner of Patents.

(Seal)