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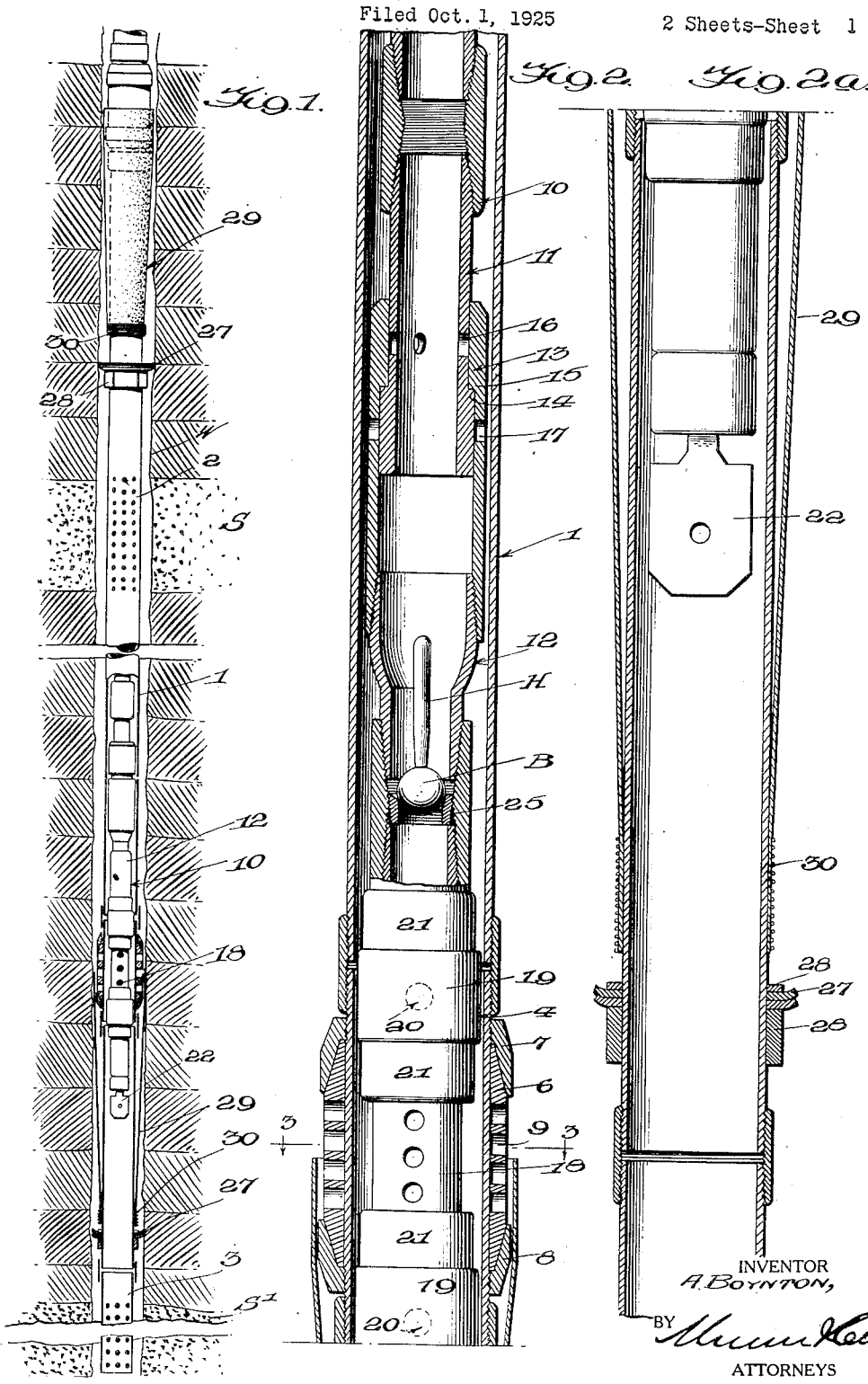
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METHOD OF AND DEVICE FOR CEMENTING WELLS

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2 Sheets-Sheet 1



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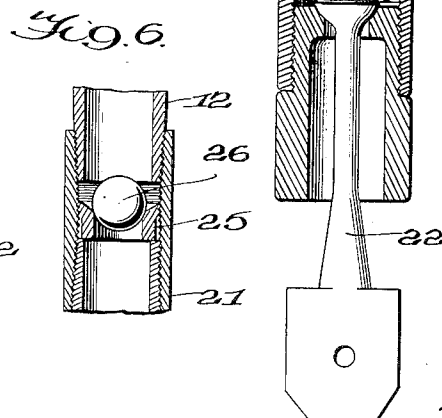
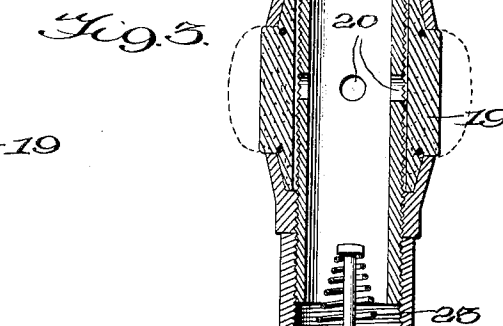
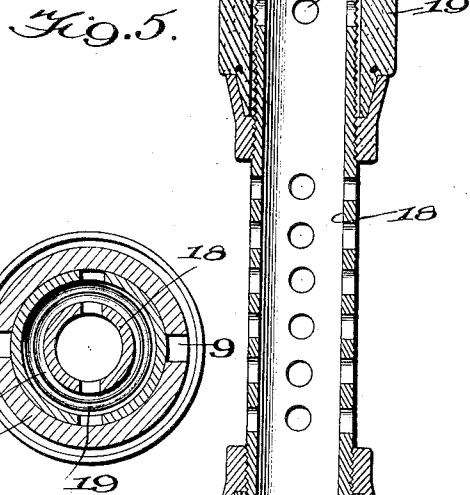
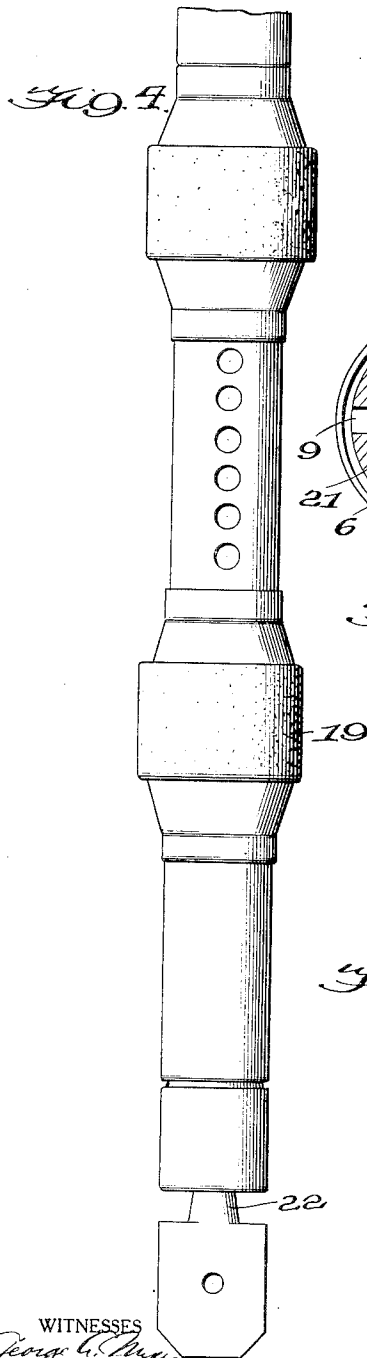
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METHOD OF AND DEVICE FOR CEMENTING WELLS

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2 Sheets-Sheet 2



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METHOD OF AND DEVICE FOR CEMENTING WELLS.

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This invention relates to improvements in devices for cementing well casings and is especially designed for use where a plurality of oil sands are to be protected against cavings, the down flow of water or the like, by means of cementation.

Heretofore in the art it has been proposed to carry out the cementation of wells by the use of a process wherein the cement was spaced from the mud fluid by means of two wooden plugs. In this old process, the well casing is first let down upon the bottom of the well in order to find the bottom, and then picked up a few inches in order that the pump may set up circulation. Just at this point in the process difficulty is not infrequently encountered since it is not always possible to pick up the casing. After the casing has been picked up a bottom plug is inserted, then the cement is pumped into the casing and on top of the cement a top plug is placed. The mud fluid is then pumped in on top of the top plug until the bottom plug strikes the bottom of the well. The casing having been picked up, say six inches from the bottom as above described, and the bottom plug being say twelve inches long, the pump will, of course, stall when the bottom plug strikes the bottom of the well. Then the casing is picked up again to a point say six inches above the top of the bottom plug and the pump is started again and run until the top plug strikes the bottom plug. The casing is apt to stick or freeze at any time. If the casing could not be picked up the second time, the cement is trapped and must be removed. The pump again stalls when the top plug strikes the bottom plug, because the top plug is about twelve inches long, and as just stated, the casing has been picked up to a point six inches above the top of the bottom plug. When the top and bottom plugs come together as stated, the cement is all outside of the casing. Then the casing is lowered to the bottom. Sometimes, however, it cannot be lowered. If no trouble is encountered in picking up the casing twice as set out and then letting it down again, this process works all right unless one or both of the plugs should stick to the casing. Serious difficulty has been encountered due to the plugs sticking. The plugs are made of wood, and the kind of wood of which the plugs are constituted varies. Different

kinds of wood expand to different degrees, but all plugs expand more or less when exposed to the mud fluid, and the amount of expansion depends not only upon the character of the wood, but also upon the moisture contained in the wood at the time the plugs are used. Moreover, sticking of the plugs results not only from swelling and expansion, but may also be caused by any imperfection in the casing, such as dents, slivers or bends. Frequently casings become distorted from great outside pressure, and it is not uncommon in deep wells to have the casing collapse when great pressure of water or mud fluid on the outside comes against the casing and bends it or partially collapses it. Not only must the quality of wood and its moisture content be always observed with care, but the greatest care must always be used to accurately caliper the plugs to the proper diameter in order to avoid sticking of the plugs if too tight on one hand and the leaking by of cement if too loose on the other hand. For these reasons it has been found that the process heretofore proposed in the art is very often unsatisfactory.

The object of the invention is to provide a device of this character which does not involve the necessity of raising or lowering the well casing, and which does not involve the use of wooden plugs or any other kind of plugs that may expand and stick or become lodged against dents or other imperfections in the pipe.

A further object of the invention resides in the provision of a device having these advantages and capacities, and which is readily controllable by the operator for the purpose of easily and effectively carrying out the successive cementation of the well casing at points above the various oil producing sands.

A still further object is to provide a device of this character which is simple and durable in construction, reliable and effective in operation and easy and comparatively inexpensive to manufacture and employ.

Other objects and advantages reside in certain novel features of the construction, arrangement and combination of parts as will be hereinafter more fully described and particularly pointed out in the appended claims, reference being had to the accom-

panying drawings forming a part of this specification, and in which:—

Figure 1 is a view partly in section and partly in elevation illustrating the device constructed in accordance with the present invention.

Figure 2 is a fragmentary view and vertical section showing portions of the device illustrated in Figure 1.

Figure 2^a further illustrates the device shown in Figure 1.

Figure 3 is a sectional view on line 3—3 of Figure 2.

Figures 4 and 5 are detail views of the cementing tool.

Figure 6 is a detail view showing another form of the differential float signal and valve.

In the drawings, the well hole is designated at W and the formation shown has a plurality of oil producing sands designated at S and S'.

The well casing is designated generally at 1 and has perforated liners 2 and 3 opposite the sands S and S'. Above each of the oil producing sands, nipples 4 are incorporated in the well casing and have diametrically opposite perforations 5 controlled by the rubber sleeve valve 6 snugly fitting the nipples and held in place by a relatively small upper retaining cup 7 and a relatively large lower retaining cup 8 threaded onto the nipple. The sleeve valve 6 is provided with discharge openings 9 angularly spaced apart from the perforations 5 of the nipples.

The present invention proposes the use of a cementing tool designated generally at 10 which is suspended by a string of tubing from above the well and which may be vertically adjusted in any suitable way. The cementing tool has an upper section designated generally at 11 and a lower section designated generally at 12 connected by a slip joint designated generally at 13. The slip joint 13 has cooperating shoulders 14 and 15 formed on the sections 11 and 12 respectively, so that when the cementing tool is raised, the section 12 will also be raised. However, when the cementing tool is lowered so far as to permit the lower end of the same to rest on the bottom of the well, the section 12 being supported on the bottom of the well remains stationary, and the section 11 will move down somewhat into the section 12. This permits discharge openings 16 in the section 11 to be brought into registry with discharge openings 17 in the section 12. At all other times, however, discharge openings 16 and 17 are out of registry.

The section 12 has a perforated cylinder or nipple 18 incorporated therein and on each side of the perforations of the cylinder 18, sealing rubbers 19 are provided, the rub-

bers 19 being expanded by the internal pressure exerted through opening 20 on the inner face of the rubbers and being held against axial displacement and reinforced and protected by retaining elements 21. As shown in dotted lines in Figure 5 the intermediate portion of the rubbers 19 may be expanded but the ends are held against expansion and within the retaining elements or cups 21 by virtue of the provision of reinforcing and holding wires 19^a, the wire 19^a being imbedded in the rubbers 19 as shown. The lower end of the section 12 is open and is provided with a dart valve 22 equipped with a spring 23 designed to hold the dart unseated except when the pump is running, the pressure at such times closing the dart valve and sealing the lower end of the cementing tool.

Above the perforated nipple 18 of the cementing tool a valve seat 25 is fixed on the section 12, and with this valve seat 25 a differential float valve and signal 26 is co-operable. As shown in Figure 6 the differential signal and valve 26 may consist simply of a ball of either rubber, hard wood, alloy of aluminum and lead, or of any material provided only that its specific gravity is less than that of the cement mixture and greater than that of the mud fluid, so that the ball will sink in the mud fluid and will float on the top of the cement mixture.

In the event it should be found difficult to make a combined signal and valve with a specific gravity of this character it may be preferable to use the form of combined signal and valve shown in Figure 2 and which comprises a ball B made up of any hard non-compressible metal or alloy or other substance such as guttapercha or an alloy of aluminum and any other light soft metal. A handle H is rigidly and securely connected to the ball B and is constituted of white pine or any other soft wood or similar substance. The handle H is shelled or painted to prevent it from absorbing water and thereby changing its specific gravity while under the great fluid pressures existing in the lower regions of the well. This type of combined signal and valve may be readily varied to cause it to have the exact specific gravity required under the prevailing conditions. The problem is always to use a combined signal and valve of such specific gravity that it will float in the cement and yet sink in the mud fluid used to force the cement down into place. In modifying the combined valve and signal shown in Figure 2 to cause it to have these properties it is placed in the cement which has been mixed in the cement mixing box on the derrick floor. The point at which the handle H becomes submerged is marked. The handle H is then cut off slightly above this mark. It is to be understood that the ball

B is always of a specific gravity heavier than the cement. Cement is usually mixed and used at a specific gravity of about 1.7. The specific gravity of ball B should therefore be about 1.75 so that it will barely sink in the heavier cement. The correct specific gravity to cause the signal ball to float safely in any cement mixture is then determined as described by cutting off the handle just above the point at which it sinks in the cement mixture. In this way the combined valve and signal may be readily adapted to the different cements and different mixtures of the same with water and sand in order to compensate for the varying specific gravities of such cement mixtures. Likewise the combined valve and signal is adapted for use with the mud fluids produced by different wells and different fields and which also have varying specific gravities.

The well casing is provided just below each sleeve valve 6 with a laminated packing or sealing member 27 consisting of washers cut from belting or other suitable material and held in place by retaining rings 28. Above each laminated packing member 27 a Mother Hubbard packer 29 is provided and consists of a tubular structure of fabric having its lower end secured to the well casing by means of a wrapping 30 of wire and having its upper end open and located opposite the intermediate perforations of the sleeve valve.

With this arrangement in cementing wells, the cementing tool is first lowered into the well down to a position opposite the lower perforated liner 3. The pump is then started and circulation is established. At this time cement has not been pumped into the tool and the pump circulates the mud fluid. Then with the pump still running the cementing tool is raised into the imperforate well casing, whereupon the pump stalls and remains stalled until the perforated cylinder 18 of the cementing tool is opposite the perforations of the lower nipple 4 when the pump again starts, since circulation again may be established through the perforations of the lower nipple 4 and out through the valve 6. The operator now knows that the cementing tool is in position to carry out cementation for the protection of the lower sands. The cement is now pumped in until the desired amount has been placed above the bottom sand. This amount is determined by calculating the contents of cement mixing box and of the drill stem or pipe used in the cementing process. When enough cement has been pumped out of the box on the derrick floor to replace all of the mud fluid which the drill stem will hold, then the operator knows that the cement is going out around the casing. The operator knows how much cement he wants to go out at this point. When that amount has been pumped

from the cement box, he is ready to raise the cementing tool to the next place to be cemented. The cement that has been pumped down through the tool passes out through the perforations of the cylinder 18 and out through the lower perforated nipple 4, the sleeve valve 6 permitting the cement to flow out, but preventing it from flowing back. In locating the next place to be cemented, the operator raises the tool until the perforated cylinder 18 is opposite the upper liner 2. This can be readily known since with the pump working, circulation will be had over a vertical adjustment of ten to fifty feet. With the cementing tool known to be opposite the upper perforated liner, the operator continues to raise the cementing tool, with the pump working, until the pump stalls, and with the pump stalled the operator still raises the tool until circulation is again established when it is apparent to the operator that the perforated cylinder 18 is opposite the upper perforated nipple 4. When the perforated cylinder 18 is opposite the perforated nipple 4, an adjustment of the cementing tool a few feet either way will stall the pump.

The dart with a spring under the ball seat to hold the dart unseated except when the pump is running is a desirable feature. If cavings should slip into the well through perforations the same will be washed out by the pump. Under such circumstances, the perforations in the slip valve will also function. The spring under the dart also provides drainage for the cementing pipe or drill stem as the same is slowly being withdrawn from the well, remembering always that any vigorous action from the pump will promptly seat the dart and allow no cement to escape past it. If at any time the operator should carelessly raise the cementing pipe too fast, so that the escaping fluid should seat the dart, he can get the dart unseated again and thereby provide drainage for the pipe by lowering the same a joint or two until the level of the fluid inside the cementing pipe and outside of same equalize. At that point the spring under the dart ball will again unseat the dart. Whereupon, the operator resumes the withdrawal. The importance of having the cementing pipe drain back into the well lies in the fact that if the mud fluid is withdrawn from inside the casing before the cement has set outside the casing, too great a strain would be exerted upon the rubber cylinder. The weight of a thousand feet of liquid cement might blow holes in the rubber cylinder opposite the holes in the perforated nipples and thus allow the cement from the outside to come back to the inside of the casing. The mud fluid must not be withdrawn from the inside of the casing until the cement has set outside the casing.

With the perforated cylinder 18 opposite the upper perforated nipple 4 the cement is again pumped into the cementing tool and on top of the cement the ball 26 is placed.

5 The pump is then again connected up and started and mud fluid is pumped down on top of the cement until the valve 26 seats on the seat 25, whereupon the pump stalls. The cement is held in the position by the action
10 of the valve 6 and sealing members 27 and packers 29. The tool may then be withdrawn from the well since the cementation of the several sands has been completed.

By lowering the drill to the bottom of the
15 well to cause the discharge openings 16 and 17 to register, the drill may be drained and after having been drained of the cement it may be conveniently used as a washing tool. This is a feature which is particularly ad-
20 vantageous should some of the upper sands be inadvertently cemented.

The purpose of the slip valve and joint 13 is to wash out the tubing through which the well was cemented, after the cementing
25 process has been completed. If the tubing should be withdrawn from the well immediately after the signal ball struck and without being washed out, there would be a considerable amount of cement left upon the inner
30 wall of the tubing because the mud fluid in its downward course does not overcome the tendency of the cement to adhere to the tubing. The major part of the cement is, of course, thrust downward and out through the
35 cementing tool. The slip valve is provided in order that the tool may be lowered to the bottom of the well which opens the slip valve, and then by vigorously applying the pump the tubing is thoroughly cleaned of
40 cement, which would otherwise set and foul the tubing. As soon as the cement has been washed out of the tubing, the tubing and cementing device are withdrawn from the well. Signal ball 26 is removed, then if any
45 fear is felt that too much cement has been pumped out at any particular horizon, that is, enough cement to rise up on the outside of the casing to seal off all or part of the sand next above, the cementing tool which now, by
50 removing ball 26, is converted into a washing tool, is lowered to each producing horizon where there is fear that cement might be opposite the pay formation. The washing tool is then raised and lowered in the perforated
55 section of the liner opposite each pay formation. The construction of the washing tool is such that the sealing members of the same cause all of the discharge from the pump to be forced through a limited section of the
60 liner as the washing tool is raised and lowered with the pump applied. In this manner any cement which may have risen to too high a level will be washed out of the well. This process of flushing out the producing
65 horizons after the cementing job has been

finished is the safest and proper practice because there is no way of telling just how much cement will be required to fill the space between the wall and blank section of the liner, between pay formations. 70

The approximate amount of cement required to fill the space between two producing horizons is determined by measuring the amount discharged from the cement box on the floor. This is necessarily inaccurate and
75 not capable of exact determination. Therefore, it is always best to make sure and have enough, even if the cement is forced up upon the sand above. This emphasizes the importance and demonstrates the necessity for
80 going back into the well with the washing tool and washing each sand after the cementing process has been finished. The only difference between the cementing tool and the washing tool is the signal ball 26 and the
85 seat 25. In order to convert the cementing tool into a washing tool, it is, as stated, only necessary to remove the ball 26. The seat 25, of course, does not prevent the device from functioning properly as a washing tool
90 so long as ball 26 is kept away.

It is to be understood that the signal ball 26 is not inserted until the cementing tool has been raised to the uppermost level where cement is to be pumped out. When this
95 uppermost level has been reached and all of the cement which it is desired to place into the well has been pumped into the tubing, then the tubing is unscrewed on the derrick floor and the signal ball is placed upon the
100 top of the cement. The tubing is then screwed together again and the pump started and run until the signal ball 26 becomes seated upon the seat 25. It is unnecessary to use the signal ball on the lower horizons because
105 the operator knows by calculating the displacement in the cement box, the amount of cement that has been forced out of the cementing device at each horizon. The purpose of the signal ball is to stall the pump
110 when the last of the cement has passed out of the tubing. If it were not for the signal ball giving notice when all of the cement has passed out of the tubing, mud fluid would
115 continue to go out and the cement might rise above the point where it was desired to place the cement.

As has been pointed out above the cementing tool may be withdrawn to the upper sand without swabbing the well or raising the
120 fluid by expansible members 19 of the cementing tool due to the action of the spring 23 since this spring holds up the dart valve when the cementing tool is being withdrawn from the well. It should be noted that sub-
125 stantially this same result is achieved even after the ball 26 has seated upon completion of the cementation of the upper sand.

It is true that after ball 26 seats, no fluid can drain back through the tubing, but the 130

fluid on the outside of the tubing will not be withdrawn from the well by expansible members 19, because expansible members 19 will not expand as the tool is being withdrawn after ball 26 has seated for the reason that no fluid pressure can pass by ball 26 and be communicated to the inside of expansible members 19. After ball 26 has seated, all fluid except the comparatively small amount contained in the tubing will drain past expansible members 19. In this manner no great amount of fluid is withdrawn from the well after the upper sand has been cemented.

15 What I claim is:

1. A device for cementing well casing above the several sands of the well, comprising valve controlled outlets in the casing above each of the sands, and a cementing tool shiftable in the well casing and having an outlet adapted to selectively cooperate with the outlets in the casing, said tool having expansible packing means on each side of this outlet, said tool having a valve seat above its outlet and a float ball valve cooperable with said seat.

2. A device for cementing well casing above the several sands of the well, comprising valve controlled outlets in the casing above each of the sands and a cementing tool shiftable in the well casing and having an outlet adapted to selectively cooperate with the outlets in the casing, said tool having packing means on each side of this outlet, said cementing tool including adjustable sections and having draining openings selectively registerable in one adjustment of the sections.

3. A device for cementing wells including a casing having a plurality of perforated

nipples, a rubber sleeve valve fitted on each perforated nipple and having imperforate portions closing the perforations of the nipples, and also having perforations angularly spaced from the perforations of the nipples, retaining cups cooperable with each sleeve valve, and a shiftable cementing tool within the casing adapted to be selectively registered with the nipples of the well casing.

4. A device for cementing well casing above the several sands of the well, comprising valve controlled outlets in the casing above each of the sands, and a cementing tool shiftable in the well casing and having an outlet adapted to selectively cooperate with the outlets in the casing, said tool having packing means on each side of this outlet, and valve means at the lower end of the cementing tool adapted to normally remain open and close with a certain pressure within the tool.

5. The herein described method of cementing a well having a casing including a plurality of perforated liners and valve controlled outlets above the liners which consists in using a shiftable cementing tool in conjunction with a pump, in aligning the tool with the lowermost perforated liner, in establishing circulation through the tool and liner while the tool is aligned with the liner, then raising the last-named tool through the well casing thereby stalling the pump until the tool is aligned with the lowermost valve outlet of the casing whereupon circulation is resumed, in pumping cement through the tool while the tool is aligned with the lowermost valve control outlet and in similarly cementing the liners above the lowermost liner.

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