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C. M. O'LEARY, JR., ET AL
FLOATING CEMENTING EQUIPMENT

2,116,408

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Fig. 1.

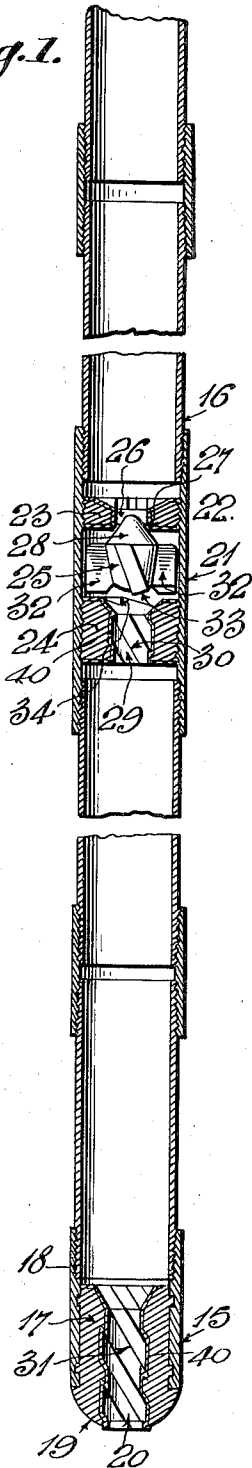


Fig. 2.

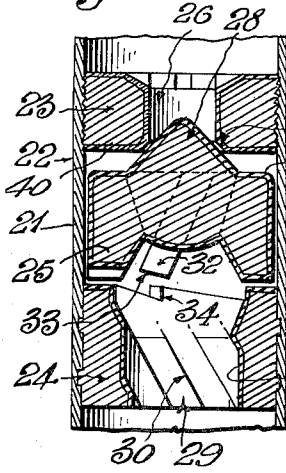


Fig. 5.

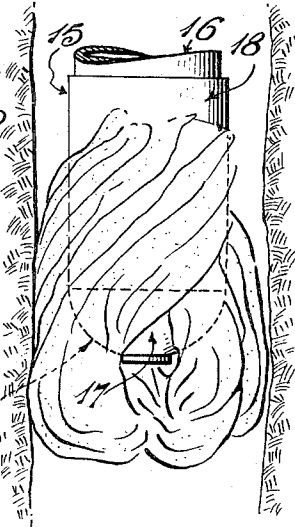


Fig. 3.

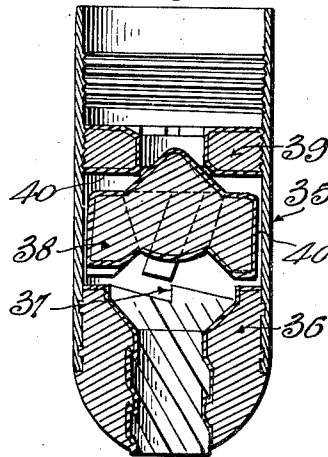


Fig. 6.

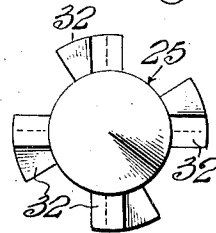


Fig. 4.

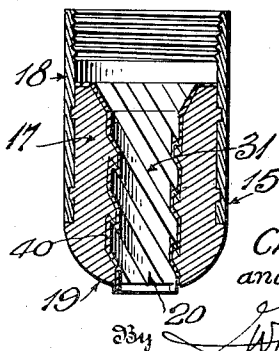
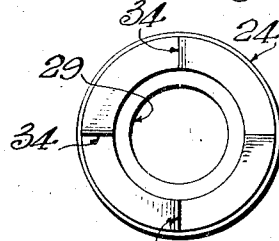


Fig. 7.



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UNITED STATES PATENT OFFICE

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FLOATING CEMENTING EQUIPMENT

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18 Claims. (Cl. 166—1)

The present invention relates to oil well apparatus of the type commonly known as floating equipment for cementing casing in the formation and commonly consisting of a casing string in connection with which a guide shoe or a float shoe is utilized to present a rounded nose at the lower end of the string and a flow passage together with a back pressure valve. The float shoe embodies both the passage and valve while the guide shoe has the passage but no valve and is used with a float collar carrying a valve. At times both a float shoe and float collar are used.

Floating equipment as thus generally outlined is employed to float strings of casing into a well without putting the excessive strain of the weight of the string on the lines, derrick and other surface equipment. The pressure in the well closes the valve and thus the string of casing is buoyant by reason of atmospheric pressure therein above the closed valve. When lowered to the desired point, it is necessary to use very heavy pump pressure to force material downwardly into the casing string for passage through the valve and outwardly through the flow passage and often this becomes necessary, before final positioning of the string, to remove bridges in the well bore.

A usual preliminary step to cementing in the well is the spudding of the string by raising and lowering the same and at the same time pumping through the flow passage drilling fluid whose purpose is to scavenge the well bore and wash away cuttings and bottom hole debris so that the cement, when forced out through the flow passage, will have greater opportunity to form a clean bond with the formation around the casing.

The guide shoe, float shoe and float collar, as well as the valve in either instance, must be of a material which may be readily drilled as the cement core below the casing is drilled through to the production area, and it is obvious the cementing operation must form the cement solidly around the casing in order to be effective in isolating the productive formation from those above.

In some instances effective results are prevented by incomplete or ineffective preliminary washing and in some instances by ineffective outlet of cement resulting in channeling of the cement and incomplete sealing off of the non-productive formations.

It is the primary object of our invention to provide an apparatus having means whereby both operations, that is, the cementing operation and the preliminary washing operation will be materially aided from the standpoint of effectiveness by the emission of the cement and drilling

fluid in a swirling, turbulent mass which breaks in all directions from the lower outlet end of an axial flow passage, and continuous to swirl and scour from the point of emission and as it passes up the outside of the casing.

A further object of our invention is the provision of an arrangement which utilizes the swirling means to similarly affect back pressure movement of material into the casing string and which provides for sure, effective seating of the valve in the collar or shoe as the case may be, the valve in either instance being ground onto its seat as long as there is any flow through the same.

These general statements and objects, together with the other and more specific objects we have in mind, will be better understood and more thoroughly appreciated in the course of the following detailed description of our invention and by reference to the accompanying drawing illustrating the preferred manner of carrying the same into practical effect.

In the drawing, which forms a part of this specification,

Figure 1 is a vertical longitudinal section through a portion of a float string showing the equipment including a guide shoe and float collar.

Figure 2 is an enlargement of a portion thereof including the float collar.

Figure 3 is an enlarged section of the lower end of the string using a float shoe.

Figure 4 is a detail section through the guide shoe of Figure 1, detached.

Figure 5 is a view in elevation of the lower end of the string showing the manner in which material is discharged therefrom into the well bore.

Figure 6 is a detail top plan view of the valve, and

Figure 7 is a cross section taken through either the float collar or float shoe in a horizontal plane immediately below the valve.

Referring now to these figures and particularly to Figure 1, we have shown a float string including a guide shoe 15 at the lower end of a string of casing 16, which is to be cemented in a well bore such as shown in Figure 5, in a manner known in the present-day art. The guide shoe 15 is simply a body of readily drillable material 17 molded or otherwise formed within a cylindrical holder 18 which is threaded or otherwise connected to the lower end of the casing string 16 to form a part thereof. The material 17 may be cement and is formed with a lower rounded nose 19 protruding slightly beyond the lower end of holder 18. It is also formed with an axial

opening 20 therethrough which forms a flow passage communicating at its upper end with the interior of the casing string 16 and at its lower end with well bore.

At a point in the casing string 16, substantially above the guide shoe 15, is connected the cylindrical holder 21 of the float collar generally indicated at 22 and comprising upper and lower spaced apart blocks 23 and 24 in the holder and a valve member 25 between these blocks. Both blocks have axial openings, the opening 26 of the upper block having its lower end opening through a valve seat 27 for the upper conical head 28 of valve member 25.

The axial opening 29 of the lower block is, like the flow passage 20 of the shoe 15, provided with a helically ribbed, grooved or rifled wall, the ribs, grooves or rifling being indicated at 30 and 31, and having the effect in use of causing a rotary movement of material flowing through passages 20 and 29 either into, or out of, the casing string.

The valve member 25 may be of various forms such that when it drops from the seat 27 the way is open for movement of material downwardly and outwardly of the casing string, and when forced upwardly against seat 27 back-flow of material and pressure will be prevented from movement into the casing string above the float collar.

We prefer, however, that the valve member have a series of radially outstanding wings 32 below its head 28 which are inclined axially of the member so that back-flow material will cause rotation of the valve member and thus rotate and grind its upper head 28 tightly against the seat 27, though it is obvious the wings 32 need not necessarily be inclined. They may be straight and still coact with the helically surging return flow material after passage through the rifled lower block and grind or rotate the valve against its seat. The essentials are that the valve shall have the outstanding wings for the above purposes, either straight or, preferably inclined or helical.

It is preferred, moreover, that the lower portions of the wings 32 have angularly inclined ratchet-like edges 33 for cooperation with similar, though oppositely disposed upper edges 34 of the lower block around the upper end of its opening 29, so that when the valve member drops and the edges 33 and 34 come into contact, the valve will be prevented from rotation and its helically inclined wings will then have a tendency to cause rotative movement of the down-flowing material to thus augment the effect of the ribs, grooves or rifling 30, 31 where the latter are used, and operate of itself to impart rotative movement to the down-flowing material in connection with a shoe having the ordinary smooth axial outflow bore. In the latter instance the valve acts as a stationary helically vaned member in the casing, since it is prevented from rotation in its lower position as the material outflows, and in a manner to avoid in many instances the necessity of helical grooves or ribs in the bore of the shoe.

Thus the material will be thoroughly mixed and maintained so even before its swirling, turbulent emission from the flow passage of the shoe 15 axially, downwardly of, and from the lower end of the casing string.

In order that there may be ample flow space for material passing downwardly into the rifled flow passage below the valve member when the latter is in lowered position, the lower portions or ends of the before-mentioned wings of the

valve member preferably depend below the body of said valve member. Thus when the valve is in lowered position the lower ends of the wings, in their engagement with the upper ratchet surface around the flow passage, support the valve body in substantially spaced relation above the upper end of the flow passage so as not to restrict the movement of material into the latter. This is shown clearly in both Figures 2 and 3, and is accomplished according to our invention by a spacing means carried by the valve member itself.

By thus discharging the cementitious material, it is caused to spiral upwardly around the casing with a scouring action against the wall of the well bore which insures an effective bond therewith and a massed condition in the well bore around the casing so as to avoid danger of channeling or other voids of a nature capable of defeating in whole or in part the purpose for which the cement is applied, namely, the sealing off of non-producing areas above the producing areas.

Obviously the same or similar advantages are obtained by thus discharging drilling fluid from the casing string to preliminarily scavenge the well bore, with the result that cuttings and other debris are more thoroughly removed from the well bore, that is, the wall as well as the bottom.

Again, the fact that the material within the casing string can in every instance be discharged axially of, and from, the lower end thereof is a very material consideration, and of very great assistance, in removing or penetrating bridges and like obstructions sometimes encountered in a well bore when floating a casing string into position.

Referring now to Figure 3, the float shoe 35 is merely a combination of guide shoe and float collar, since its lower block 36 is in all respects similar to the guide shoe 15 except that it has around its upper surface the ratchet edges 37 which serve to lock its valve 38 when the latter is lowered from the upper seat block 39. In respect to these latter features, it is precisely like the corresponding features of the float collar 22 as previously described. Either the float shoe 35 of the guide shoe and float collar combination may be used with substantially similar results and certainly with all of the advantages we claim for either.

We have already stated the several parts of our floating equipment including guide shoe body 17, float collar blocks 23 and 24, float shoe blocks 36 and 39, and valve members 25 and 38 may be formed of cement, or other readily drillable material. We prefer to make these parts of hard rubber, but experience has shown that however tough, hard rubber too readily abrades and is deteriorated by the high velocities of the materials with their drilling mud and grit contents and hence, as another substantial feature of our invention, we may form these several parts of hard rubber or of concrete with hard rubber inserts and we may provide such inserts with a thin surface layer 40 of tough, live rubber on all surfaces exposed within and without the casing (see Fig. 3).

We are aware it is not broadly new to cause a swirling, turbulent movement around the casing, but this has not heretofore been accomplished with a discharge axially of, and from, the lower end of the casing in such manner that the velocity and turbulence are obtained and used below the casing string as well as around the same, and such velocity and turbulence rendered effective in washing through bridges and cave-ins.

When a casing is being lowered into a well bore oftentimes the valve chamber is choked with an

accumulation of shale fragments and debris, compacted in this area by very great pressures and forces. The circulation of the well sometimes fails to clean these obstructions out, though with our axially rifled shoe the well bore itself is more thoroughly cleansed and on the reversal of circulation the turbulence cleans the inside of the casing string and the valve chamber. When the cement is pumped down in the ordinary construction it is necessary to use extremely high pressures to break these obstructions, and even then only a small part of the actual area through the valve section might be available for the flowing of cement. When the circulation is reversed, the valve might be jammed open by this debris and the valve rendered inoperative. Should this be the case, the failure of the valve to close rapidly when the casing pressure is relieved, the swift onrush of the mud, cement, etc., driven by their own weight plus the pressure from the formations might cause serious damage to the well by bringing in sand and shale or caving the hole and collapsing the pipe.

With our construction, the agitated returning fluid strikes in all directions and should any debris or shale be lodged on the seat of the valve, whatever its type, it will be dislodged and the valve allowed to seat tightly. If a conventional shoe is used, the fluids go directly up and escape through the valve at the places of the least resistance, while this returning stream in our shoe is so churned up by the return through the rifled passage that it swirls around the valve and is striking from all angles and can therefore more effectively clear the seat and the valve can function properly regardless of whether or not it has vanes to close and seat by a rotary movement.

The rifling imparts a definite motion to the fluids passing through the flow passage and the subsequent turbulence and swirling performs a cleansing action in connection with the valve and seat that can be obtained in no other way. There is a definite result from rifling the flow passages, and the resultant churning scours and cleans the well bore most efficiently, and on the reversal of pressure cleans the valve chamber and tends toward a successful cement job. In other words, when the direction is reversed after the cement is pumped into place, the fluids rush in with the benefit of the pressure differential that was required to pump that cement around outside of the casing, and when it comes through the rifling it is swirling and striking out in all directions and it hydraulically washes and cleans out the valve chamber and eliminates any channels that might have been formed during the cement driving operation, so that the rifling has a definite mechanical function of cleaning and making an effective valve shut off on the bleeding back process, whatever type of valve is used.

What is claimed is:

1. In a well cementing equipment for a casing string, means forming a shoe at the lower end of the casing string having an axial flow passage the lower end of which opens exteriorly and axially of the lower end of the casing string, and inclined means stationarily disposed in the path of outflow of material for causing discharge of material through and from the lower end of said passage exteriorly, axially of the casing in a turbulent, swirling mass.

2. In a well cementing equipment for a casing string, means forming a shoe at the lower end of the casing string having an axial flow passage

the lower end of which opens exteriorly and axially of the lower end of the casing string, the wall of said passage having stationary integral vanes causing rotational movement of material passing therethrough whereby to create a swirling turbulence in the axially discharged material.

3. In a well cementing equipment for a casing string, means forming a shoe at the lower end of the casing string having an axial flow passage the lower end of which opens exteriorly and axially of the lower end of the casing string, the wall of said passage having helically disposed material guiding means creating a swirling turbulence in the axially discharged material.

4. In a well cementing equipment for a casing string, means forming a shoe at the lower end of the casing string having an axial flow passage the lower end of which opens exteriorly and axially of the lower end of the casing string, the wall of said passage being rifled for guiding material and creating a swirling turbulence in the axial discharge thereof.

5. In a floating equipment for cementing casing in wells, means in the casing having a single, continuous flow passage opening exteriorly axially of the lower end of the casing, and means supported in inclined relation stationarily within the path of outflow of material to impart rotational movement to material flowing through said passage.

6. In a floating equipment for cementing casing in wells, valved means, and means having a rifled bore opening to the exterior axially of the lower end of the casing and forming a flow passage for material into and out of the casing.

7. In cementing equipment having a valve chamber, means forming a valve seat above said chamber, means having a flow passage and forming a valve abutment below said chamber, a valve member in said chamber, said valve having outstanding wings and said flow passage having a rifled wall coacting with said wings to force upward rotation of the valve against said seat upon up-flow of material through said passage.

8. In a well cementing equipment having a valve chamber, means forming a valve seat above said chamber, means forming an abutment below said chamber and having a flow passage, and a valve movable in said chamber, said valve having means actuated by back pressure for rotating the valve during its upward movement against said seat, and said valve and said abutment having coacting means to lock the valve against rotation in its lower open position.

9. In a well cementing equipment having a valve chamber, means forming a valve seat above said chamber, means forming an abutment below said chamber and having a flow passage, a valve movable in said chamber having radially outstanding wings inclined vertically thereof and means carried by the abutment and coacting with the valve wings to lock the valve against rotation in its lower open position, whereby in locked position said wings tend to cause swirling turbulence of the material passing through the flow passage.

10. Cementing equipment for well casing including a back pressure valve in the casing, means forming a flow passage axially of the casing beyond the said valve with respect to the outlet of material, and helically inclined members in said flow passage for causing helical swirling turbulence of material outleting from the casing as well as of pressure back-flowing into the casing against the valve said means having a single

outlet port axially of the lower end of the casing.

11. In well cementing equipment, a casing, an outflow shoe at the lower end of the casing having a single, continuous axial outflow bore, and a helically vaned member in the casing above the shoe acting to impart rotative movement to outflowing material and thus cause the same to swirl outwardly through said bore and axially from the lower end of the casing.

12. In well cementing equipment, a casing, an outflow shoe at the lower end of the casing having an axial bore, and a valve member within the casing above said shoe having means which, when the valve is in open position effect rotative movement of material flowing downwardly within the casing to bring about a swirling discharge of such material through said shoe bore.

13. In well cementing equipment including a casing string from which material is discharged into a well bore, means at the lower end of the casing for confining the discharged material to a single solid stream flowing axially of and from the lower end of the casing, and means presenting stationary inclined surfaces in the path of movement of the material adjacent to said first-named means for creating a swirling turbulence in the axially discharged material.

14. In well cementing equipment, including a casing, an upper block within said casing having a central flow passage, a lower block having a flow passage and forming a valve chamber between the same and the upper block, a valve in the chamber between the blocks having inclined wings for effectively seating the valve to check return flow of fluid into the casing and the said inclined wings being engageable with the lower block to hold the valve spaced therefrom and permit free flow of fluid out of the casing.

15. In cementing equipment for use in a well bore filled with mud-laden fluid, a casing string of a smaller diameter than the well bore extending downwardly therein to a point within the fluid, a metal shoe at the lower end of the casing

having a rounded depending nose of a friable material, said shoe having a single axial flow passage and provided with helically inclined vanes projecting into said passage adjacent to the lower end of the nose.

16. In cementing equipment for use in a well bore filled with drilling fluid, a casing string of a smaller diameter than the well bore, extending downwardly therein to a point within the fluid, a shoe at the lower end of the casing having a rounded depending guiding nose of friable material, and having a central flow passage axially of the casing, and helical vanes in the wall of said passage, a valve within the lower end of the casing above the shoe permitting egress of fluid therefrom and preventing ingress thereof, said valve including a seat, and a valve body below the seat provided with wings extending laterally therefrom and inclined thereto for guiding the valve.

17. In cementing equipment for a well bore filled with mud-laden drilling fluid, a casing suspended therein, and a shoe at the lower end of the casing having a rounded depending guiding nose of friable material and also having a single continuous helically vaned flow passage axially, and for the full length, thereof.

18. In well cementing equipment, a casing, an upper block within said casing having a central flow passage, a lower block having a flow passage and having means therein for causing swirling turbulence of material in the course of its flow through said passage, said lower block forming a valve chamber between the same and the upper block, and a valve in the chamber between the blocks having wings for effectively seating the valve to check return flow of fluid into the casing, the said wings being engageable with the lower block to hold the valve spaced from the latter and permit flow of fluid out of the casing.

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