May 30, 1950 J. E. HALL 2,509,922

CEMENTING PLUG

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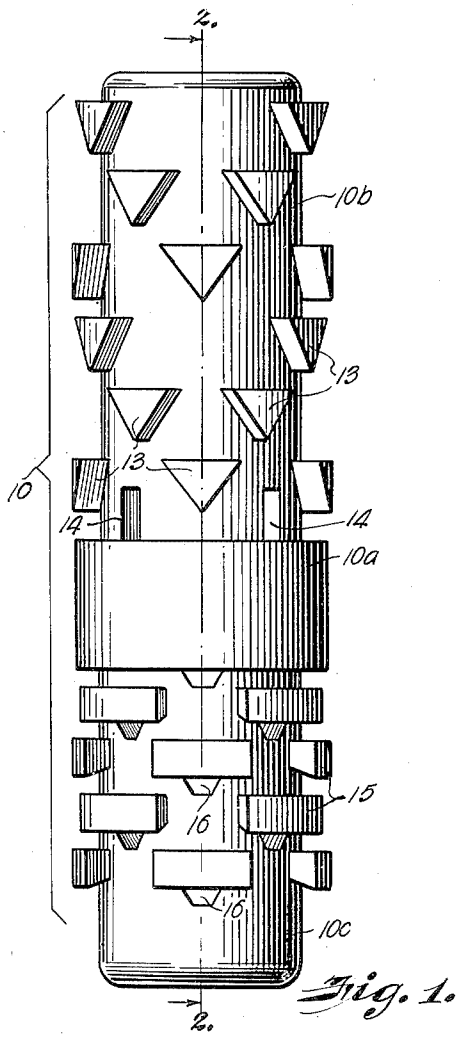

Fig. 1.

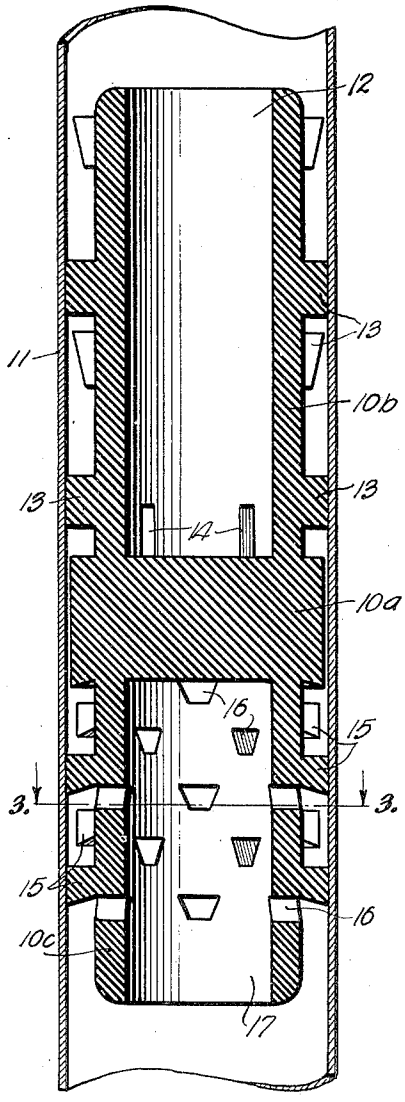

Fig. 2.

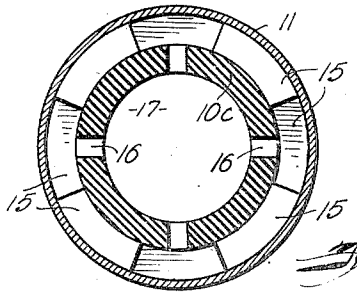

Fig. 3.

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CEMENTING PLUG

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8 Claims. (Cl. 166—1)

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This invention relates to improvements in a wall cleaning and cementing plug and refers more particularly to a traveling plug used in the cementing operations of an oil or gas well.

The inventive novelty resides in the construction of the plug and particularly in the structure which provides wall scraping elements distributed over its periphery and permits separate circulation of the well fluids above and below a central plug portion.

In the cementing of an oil and gas well, after the well has been drilled to the desired depth it is often advantageous to introduce cement into the annular space between the casing and the well bore in order to prevent influx of water and gas, and to isolate the producing strata.

To place the cement mix between the casing and well bore it is charged at the wellhead into the casing in a predetermined amount. The quantity of cement supplied is determined by the height to which the cement is to rise in the well bore. To force the cement out of the casing and into the annular space surrounding the casing a plug is inserted into the top of the casing behind the cement charge and is forced downwardly through the casing by pressure of well fluid or mud introduced behind the plug. Near the bottom of the casing the plug is stopped by suitable obstruction such as a shoulder or the casing shoe. When it reaches its destination it has forced the charge of cement out of the bottom of the casing through the casing shoe causing it to rise and fill the well bore to the desired height.

Plugs heretofore used for this purpose have usually been of the piston type constructed either of solid rubber or of wood with disks of resilient material attached to each end, or bands of rubber about the body of the plug. The diameter of the solid rubber plug and the disks or bands of the wooden plug are slightly greater than the inside diameter of the casing, producing a relatively pressure-tight fit.

Numerous difficulties have been encountered where plugs of this type have been used. Among the most objectionable features is the film of cement which is left by plugs of this type on the walls of the casing. This film, after setting, produces scale which is objectionable throughout the life of the well, particularly to producing equipment. A further hardship often encountered is the fact that as the plug moves downwardly in its travel it extracts fluid from the cement mix causing a concentration of relatively dry cement to build up in front of the plug. This effect in certain instances has been known to lodge the

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plug permanently in the casing and prevent its travel to its ultimate destination. If the plug is not driven to the bottom of the casing a charge of cement remains in the casing below the plug and an inadequate amount of cement mix is charged into the well bore. Thus the cement is improperly placed and the cementing job becomes wholly ineffective.

An object, then, of the present invention is to provide a plug by which agitation and mixture of the cement is constantly kept up in front of the plug during its downward travel. Likewise, behind the plug the fluid mud is continuously circulated from a central compartment through the plug wall to be intimately intermingled with any cement film which may have passed the plug and which is plowed up from the surface of the inner wall of the casing by abrading elements.

A further object of the plug construction is to prevent loss of fluid from the mixture in front of the plug by local circulation set up through the plug wall as the plug advances. In other words, the viscosity of the fluid in front of the plug is kept relatively constant.

Other and further objects will appear from the following description.

In the accompanying drawings which form a part of the instant specification and are to be read in conjunction therewith, and in which like reference numerals indicate like parts in the various views,

Fig. 1 is a side view of a plug embodying the invention,

Fig. 2 is a central vertical section taken along the line 2—2 in Fig. 3 in the direction of the arrows, and

Fig. 3 is a view taken along the line 3—3 in Fig. 2 in the direction of the arrows.

Referring to the drawings, the wall cleaning plug consists of a body portion designated as a whole by the numeral 10. Centrally of the body is a cylindrical portion 10*a* having a diameter which fits snugly within the well casing 11. Above the cylindrical portion is an upper hollow circulating tube 10*b* enclosing an upper cylindrical chamber 12. Upon the outer periphery of the upper tube 10*b* arranged at different heights and staggered circumferentially about the tube surface are a plurality of diamond shaped abrading plows 13. Since the outside diameter of the upper circulating tube is somewhat smaller than the cylindrical portion 10*a*, an annular shoulder is formed at the base of the tube. The diameter through the tube, including the plows, is slightly greater than the diameter of the cylindrical por-

tion 10a. The upper circulating tube including the plows has a somewhat greater diameter than the cylindrical portion causing the plows to scrape or abrade the inner surface of the casing during the plug travel.

In the wall of the upper circulating tube adjacent the shoulder where it joins with the cylindrical portion 10a are a plurality of circumferentially arranged ports 14. Below the cylindrical portion 10a is a similar hollow circulating tube 10c. This tube, like the upper tube, has scraping elements 15 of rectangular shape. Beneath each of the scrapers are ports 16 which communicate with the hollow central chamber 17 of the circulating tube and permit the passage of fluid from the outer periphery of the lower circulating tube into its hollow interior. The lower surfaces of these scrapers are preferably inclined upwardly to facilitate fluid flow from the scraping edges into the ports 16.

Describing the operation of the plug, after the cement has been introduced at the casing head the plug is inserted. The cementing head into which the plug enters may be slightly enlarged to permit its easy admittance. After the plug is inserted, the cementing head is closed and pressure is imposed behind the plug by pumping mud fluid into the casing under sufficient pressure to move the plug downwardly. The plug then acts as a piston between the cement mix and mud fluid and during its travel forces the cement mix downwardly and out through the bottom of the casing into the annular space between the casing and well bore.

During its downward travel the cement mix in front of the plug and adhering to the casing wall is circulated through ports 16 in the wall of the lower circulating tube by the action of scrapers 15 and is discharged into the central portion of the casing. Scrapers 15 not only create circulation of the mix from the annular space between the casing and circulating tube through ports 16, but maintain a relatively clean surface ahead of the plug due to their scraping action.

The cylindrical portion 10a fitting snugly within the casing acts as a piston separating the cement mix and mud fluid, forcing the cement mix ahead of the plug and preventing intermingling of the two fluids. Any film of cement adhering to the inner surface of the casing which passes the cylindrical portion of the plug will be disintegrated by members 13. These diamond shaped elements around the upper tube fit tightly against the casing and plow furrows through any film that may be formed. Removal of the film by members 13 also causes the cement mix to be disseminated through the mud body surrounding the upper circulating tube. The proportion of mud and cement behind the plug is such that the cement becomes a part of the mud fluid and is prevented from setting.

Hereinbefore circulation of the mud through the upper circulating tube has been described. This circulation is downwardly through the central hollow chamber 12 and out through the lower ports 14 located immediately above the shoulder formed by the cylindrical portion 10a. Contact between the inner surface of the casing and plow members 13 during the plug's travel causes an upward movement of the mud at the inner casing surface. Also frictional contact between the outer periphery of the mud column with the inner surface of the casing will retard the travel of the mud fluid at the inner casing surface which will draw fluid from the center of the column through the ports.

Circulation of the mud and cement fluids above and below the plug during its travel reduce the possibility of accumulation of cement and mud on the inner casing surface by remixing partially set fluids adhering to the inner surface of the casing.

Thus it will be seen that the objects of the invention have been accomplished. There has been provided a wall cleaning plug particularly adapted for use in cementing oil wells for removing solid and film accumulations on the inside surface of the casing. It will be appreciated that the plug is adapted as well for cleaning pipe lines or removing solid accumulations from pipes of any kind through which fluid is moved.

As suggested, the novelty resides primarily in the construction of the plug comprising a central cylindrical piston portion, upper and lower circulating tubes having abrading elements for disruption of the film or accumulations on the inner surface of the pipe.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims. It should be obvious that various changes may be made in the details of the plug construction within the scope of the claims without departing from the spirit of the invention. It is, therefore, understood that the invention is not limited to the specific details shown and described.

Having thus described my invention, I claim:

1. A cementing plug having a central cylindrical section with an outside diameter at least that of the inside diameter of the casing in which the plug is to be run, a pair of open ended circulating tubes smaller in diameter than the inside diameter of the casing, said tubes connected respectively to the top and bottom of the central cylindrical section and having circulating ports through their peripheral walls, and casing wall scraping members distributed upon the exterior walls of the respective tubes, in circumferentially spaced relationship.

2. A cementing plug as in claim 1 in which the scraping members on the upper tube constitute a plurality of plow shaped elements raised in relief sufficiently above the tube surface to contact the inner casing wall and arranged in staggered relationship circumferentially about the tube, the circulating ports positioned adjacent the top of the central cylindrical section.

3. A cementing plug as in claim 1 in which the scraping members on the lower tube are raised in relief sufficiently above the tube surface to contact the inner casing wall and arranged in staggered relationship circumferentially about the tube, the circulating ports in the lower tube positioned beneath the scraping members.

4. A cementing plug as in claim 1 in which the scraping members on the lower tube are raised in relief sufficiently above the tube surface to contact the inner casing wall and arranged in staggered relationship circumferentially about the tube, the lower surfaces of said members inclined upwardly from front to rear and the circulating ports positioned beneath the scraping members.

5. A cementing plug comprising a central section at least as large in diameter as the inside diameter of the casing to be run, with smaller end sections projecting forwardly and rearwardly

from said central section, a plurality of lugs on each end section adapted to engage the inside wall of the casing, said lugs arranged in circumferential rows, the lugs in each row being spaced circumferentially from one another and the lugs in adjacent rows being staggered relative one another.

6. A cementing plug comprising a central section at least as large in diameter as the inside diameter of the casing to be run, with smaller end sections projecting forwardly and rearwardly from said central section, a plurality of lugs on each end section adapted to engage the inside wall of the casing, said lugs arranged in circumferential rows, the lugs in each row being spaced circumferentially from one another and the lugs in adjacent rows being staggered relative one another, the forward section of the plug having a hollow bore, substantially radial ducts through the forward section connecting the bore thereof with the space outside of the plug, each duct disposed forwardly of one of the lugs.

7. A cementing plug comprising a solid central section at least as large in diameter as the inside diameter of the casing to be run with smaller end sections projecting forwardly and rearwardly from said central section, a plurality of circumferentially spaced scraping lugs on each

end section adapted to engage the inside wall of the casing, the forward section of the plug having a hollow bore, substantially radial ducts through the forward section connecting the bore thereof with the space outside the plug, each duct disposed forwardly of one of the lugs.

8. A cementing plug comprising a solid central section at least as large in diameter as the inside diameter of the casing to be run with smaller end sections projecting forwardly and rearwardly from said central section, a plurality of circumferentially spaced scraping lugs on each end section adapted to engage the inside wall of the casing, the lugs on the rearwardly projecting section comprising forwardly tapering plows.

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