Nov. 1, 1955 W. B. COLLINS 2,722,279

WELL TREATING TOOL

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Fig. 1.

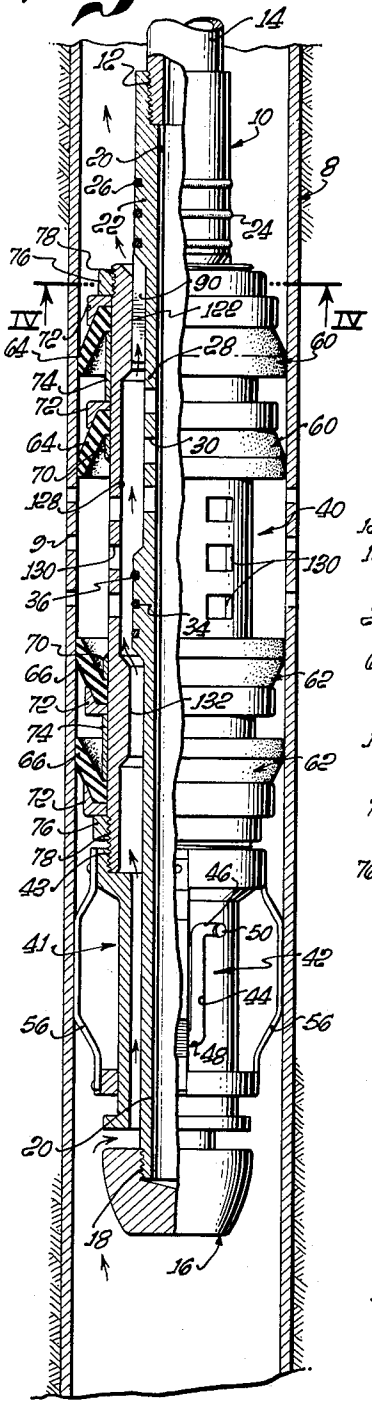


Fig. 2.

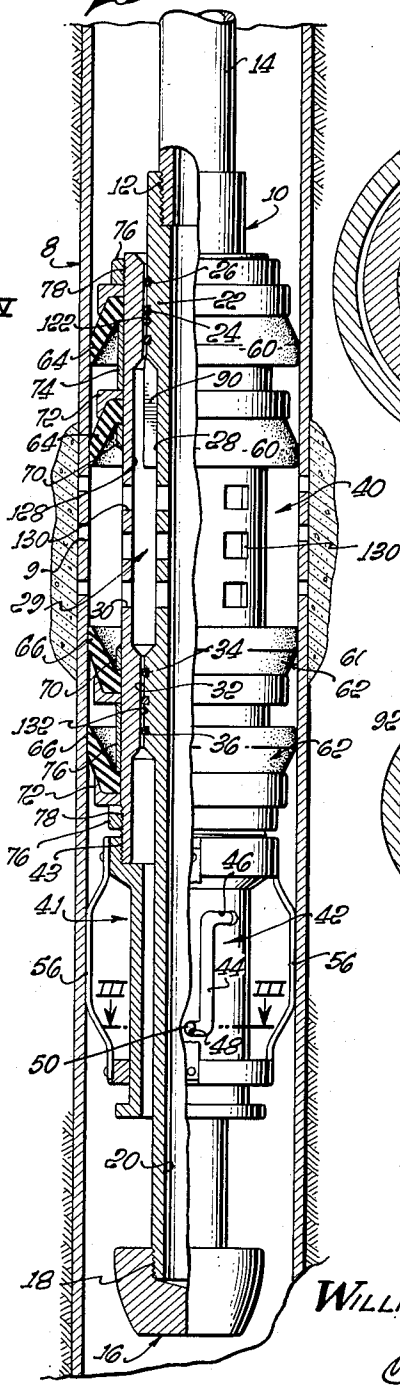


Fig. 4.

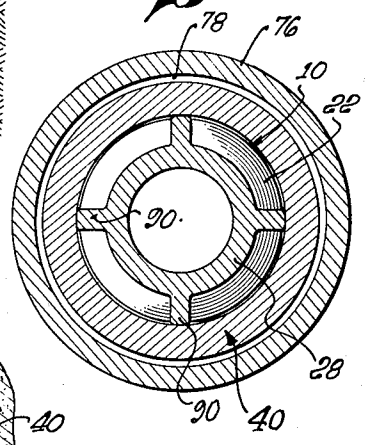
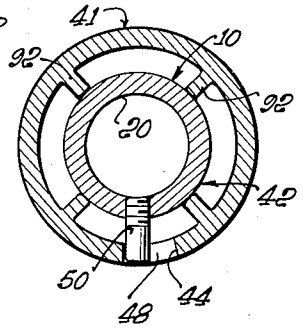


Fig. 3.



INVENTOR

WILLIAM B. COLLINS,

ATTORNEY

United States Patent Office

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WELL TREATING TOOL

William B. Collins, Inglewood, Calif.

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4 Claims. (Cl. 166—147)

This invention pertains to a tool adapted for use in cementing and other fluid treating operations carried out in oil and water wells and is particularly directed to a tool which can be attached to the lower end of a string of tubing and lowered into a casing for the purpose of directing the application of a cement slurry to a desired portion of the casing or for properly directing and localizing acid treatment in a particular zone in the well, although other uses will readily occur to those skilled in petroleum technology and production engineering.

Cementing and acid treating operations, as carried out heretofore, have required the use of tools which were rather complicated, bulky (preventing their use in casing of small diameter) and difficult to operate in a foolproof manner. One of the characteristics of these prior devices lay in that they were provided with various valves which isolated the interior of the tube from the annular space around the tool. It can be readily appreciated that the operation of the valves on a tool which may be from 5,000 to 14,000 feet deep in a well hole is fraught with difficulties by reason of the depth, pressures encountered, stretch of tubing and inability to sense the operation or position of the tool from the surface.

The present invention distinguishes from the prior art in that it relates to a novel arrangement whereby obturating devices or valve elements which present surfaces transverse to the axis of the tool and give rise to forces directed axially of the tool are not employed; the valve employed herein is of a sliding, sleeve type with fluid pressures acting virtually transversely to the axis of the tool. The tool can be readily lowered into a well hole through a casing and readily permits the passage of fluid from a zone below the tool to a zone above the tool. Throughout such lowering operation, there is communication between the center of the tubing and the space within the casing, thereby permitting the operator to readily determine whether the tool is at a desired position by observing the pressure response on liquid in the tube. When a desired level is reached, the tool is easily and firmly positioned within the casing, fluid pressure within the tubing or drill pipe being then utilized to isolate a desired zone in which a cementing, acid treating or well cleaning operation is to be carried out.

Generally stated, the device of the present invention consists of a hollow mandrel body arranged to be attached to a spring of tubing or pipe, such hollow mandrel being surrounded by a longitudinally movable sleeve, suitable means being provided to limit longitudinal motion of the sleeve upon the mandrel. The sleeve is provided with spaced packers capable of sealingly contacting the interior wall of the casing. Between the spaced packers, the sleeve is provided with ports and other ports are provided in the mandrel. In all positions of the sleeve, with respect to the mandrel, communication exists between the ports of the sleeve and of the mandrel from the interior of the tubing or mandrel to the space exteriorly of the sleeve and between the packers. In one position of the sleeve upon the mandrel, fluid from beneath the tool may

flow readily between the sleeve and mandrel; in another position of the sleeve upon the mandrel, readily attained by partial rotation and longitudinal displacement of the mandrel with respect to the sleeve, the fluid beneath the tool (or above the tool) is isolated from the interior of the tube so that cement slurry, solvent solutions, acid or other suitable slurries or treating liquids may be pumped down the tube and discharged into the space between the packers. Since the space between the packers may be limited as desired, pressure of treating liquid may be most effectively utilized and, in cleaning perforations or when using acid or mud solvents, detergents and flocculating agents, jetting action through the perforations effectively opens the formation surrounding the perforated casing.

It is an object of the present invention, therefore, to disclose and provide an economical, readily manufactured and valveless tool adapted for use in various operations which need be carried out in a well hole.

A further object of the invention is to disclose and provide a novel combination of elements whereby a simple valveless tool adapted for use in well cementing and treating operations is attained.

A still further object of the invention is to disclose and provide a valveless tool adapted to be lowered into a well hole as a part of a string of tubing, such tool comprising a ported mandrel and a ported sleeve, the sleeve being longitudinally movable upon the mandrel, the ports being in communication with each other and with the interior of the tubing at all positions of the sleeve.

These and various other characteristics of the invention, objects and advantages will become apparent to those skilled in the art from the following description of an exemplary form thereof, it being understood that numerous changes, modifications and substitutions may be made without departing from the invention as defined in the claims.

In the subsequent description, reference will be had to the appended drawing in which:

Fig. 1 is a longitudinal view, partly in section and partly in elevation, illustrating the arrangement of elements used in an exemplary form of the device while it is being lowered into a well hole.

Fig. 2 is a view similar to Fig. 1 but showing the position of the elements during a cementing, washing, or treating operation.

Fig. 3 is a transverse section taken on the plane III—III of Fig. 2.

Fig. 4 is a transverse section taken on the plane IV—IV of Fig. 1.

The sealing or packing means illustrated in the example are generally referred to as cup-shaped packers and are well known in the trade although various other types of basket or expanding type of packers may be used (see for example, pages 896 to 901 of the Composite Catalog of Oil Field and Pipe Line Equipment for 1942).

Referring now in detail to the drawing, in Fig. 1 is shown a mandrel indicated generally at **10** and attached by suitable means such as threaded connection **12** to the lower end of a hollow pipe or tubing **14**. Pipe or tubing **14** is supported at the surface by suitable means (not shown) and extends downwardly into a well hole lined in conventional manner with casing **8** which may be provided with radial ports or slots **9** formed therein. Means are provided for preventing the flow of fluid out of the lower end of mandrel **10**, the means in the present illustration taking the form of a cap indicated generally at **16** and attached to the lower end of mandrel **10** as by threaded connection **18**. Mandrel **10** is hollow and its inner bore **20** is desirably, although not necessarily, constant in diameter throughout the length of the mandrel.

Near the upper end of mandrel **10** is a portion **22** of substantially constant outside diameter and preferably in-

cluding one or more sealing means such as circumferential O-rings 24 seated in complementary peripheral grooves 26 formed on the outer surface of the mandrel. The portion 22 together with its sealing means 24 constitutes an upper seating surface.

Extending below upper seating surface 22 the mandrel includes a recessed portion 28 having a smaller outside diameter than that of seating surface 22. Recessed portion 28 has formed therein a plurality of radial slots or ports 30 in communication with the inner axial bore 20 of mandrel 10.

A lower seating surface is provided on mandrel 10 below the recessed portion 28, this lower seating portion being indicated at 32. Sealing means are provided on lower seating surface 32 similar to the sealing means 24 of upper seating surface 22. Such sealing means includes O-rings 34 received in peripheral grooves 36 formed in lower seating surface 32. Desirably, the outside diameter of lower seating surface 32 is virtually equal to that of upper seating surface 22 and it will be observed that the longitudinal extent of recessed portion 28 is defined by said seating surfaces 22 and 32.

A hollow longitudinally extending sleeve coaxially embraces the major portion of the length of mandrel 10, the sleeve being indicated generally at 40. Sleeve 40 is longitudinally movable relative to mandrel 10, and at the lower end of the mandrel, I provide a sleeve extension 41 and means indicated generally at 42 for limiting such movement between two extreme positions. Sleeve extension 41 is attached to sleeve 40 as by threaded connection 43. Means 42 include a longitudinally extending radial slot 44 formed in sleeve extension 41. At its upper and lower ends slot 44 communicates with short circumferentially extending slots 46 and 48 respectively. A radially extending pin 50 (see Fig. 3) is carried by mandrel 10 and extends into and is slidable within slot 44 and the two communicating circumferential slots 46 and 48.

Any suitable means for centering sleeve extension 41, and thereby sleeve 40, within casing 8 or the well hole may be provided. Such means may include bowed resilient strap members 56 extending longitudinally of sleeve extension 41 and mounted thereon, the members 56 resiliently contacting the inner surface of casing 8. As will be readily understood a number of resilient strap members 56 may be circumferentially spaced about sleeve extension 41.

Sleeve 40 desirably has a substantially constant outside diameter and packing means are carried on the outside of the sleeve adjacent either end thereof. The packing means desirably take the form of cup-shaped packers, the upper and lower packers being indicated generally at 60 and 62 respectively. Packers 60 and 62 are formed of resilient material such as rubber or suitable substitute and include annular skirts 64 and 66 respectively, the outer edges of the skirts being in slidable sealing contact with the inner surface of casing 8. As will be observed, upper packers 60 are disposed so that their skirts 64 extend downwardly into contact with the casing whereas packers 62 are oppositely oriented. It will be seen that fluid pressure in the zone between the packers will tend to increase the sealing contact between the outer ends of the skirts 64 and 66 and the casing 8. Upper packers 60 are retained in position by conventional means including ring 70 fixed to sleeve 40, annular flanged retainers 72, a spacer ring 74 and a collar 76 threadedly connected at 78 to the outer surface of sleeve 40. The lower packers 62 are held in position by similar means.

On the inner surface of sleeve 40 are formed a pair of spaced seating surfaces arranged to selectively engage and seal with the upper and lower seating surfaces 22 and 32 of mandrel heretofore described. The upper seating surface of sleeve 40 is indicated at 122 and the lower seating surface at 132. It will be seen that the two seating surfaces just described constitute portions of sleeve 40 of decreased inside diameter, and between the two

seating surfaces extends a recessed portion 128 of greater inside diameter than that of the seating surfaces. In the recessed portion 128 of the sleeve are formed a number of radial ports 130 extending through the sleeve.

Any suitable means for maintaining sleeve 40 in coaxial alignment with mandrel 10 may be provided. Such means may include a member of circumferentially spaced, outwardly extending lugs 90 (see Fig. 4) carried on mandrel 10 beneath upper seating surface 22. Lugs 90 are arranged to slidably engage the upper seating surface 122 of sleeve 40 when the parts are in the position shown in Fig. 1 and during movement of the parts to the position shown in Fig. 2. Similarly I may provide means near the bottom of the mandrel 10 for insuring that the sleeve extension 41 and thus sleeve 40 are maintained in coaxial relationship. Such means desirably include inwardly extending lugs 92 (see Fig. 3) carried by sleeve extension 41 and slidably engaging the outer surface of mandrel 10.

The operation of my tool will be readily understood from a study and comparison of Figs. 1 and 2 of the drawings. In Fig. 1 the mandrel is shown in its extreme upper position relative to sleeve 40 whereby a continuous path of fluid flow is provided from one end of the tool to the other. Thus, with the tool in the position of Fig. 1 it may be lowered into a well hole filled with fluid, the fluid passing through the tool as indicated by the several arrows of Fig. 1. When the tool has been lowered to a point in the well which is desired to be treated, as by cement slurry, acid treatment or other operations well known in the art, the pipe or tubing 14 together with the attached mandrel 10 is twisted slightly clockwise (as seen looking downwardly) so that pin 50 is moved into longitudinal slot 44. Pipe 14 together with mandrel 10 is then lowered as far as possible, pin 50 moving downwardly in slot 44 to the lowermost extent of the slot. Thereupon an additional clockwise twist of pipe 14 moves pin 50 into the lower slot 48 formed in sleeve extension 41 and the mandrel and sleeve are thus fixed in the relationship shown in Fig. 2.

In the operating position shown in Fig. 2 it will be observed that the lower seating surface 32 of mandrel 10 is in sealing contact with lower seating surface 132 of sleeve 40, this contact being assured by the resilient O-rings 34 heretofore described. Similarly, upper seating surface 22 of mandrel 10 is in sealing engagement with upper seating surface 122 of sleeve 40, this sealing engagement also being achieved by resilient O-rings 24 of seating surface 22. Thus the recessed portion 28 of mandrel 10 is disposed adjacent recessed portion 128 of sleeve 40, and the two recessed portions cooperate in forming an annular chamber 29 sealed at top and bottom by the sealing engagements just described.

Liquid may now be pumped downwardly from the surface through pipe 14 into the hollow interior of mandrel 10 passing outwardly from the center of mandrel 10 through ports 30 into chamber 29. The fluid then continues to move outwardly through ports 130 of sleeve 40 and through ports 9 of casing 8. Packers 60 and 62 carried on the outside of sleeve 40 prevent movement of such treating fluid upwardly or downwardly within casing 8, with the result that all of such fluid passes through the ports 9 as above described to accomplish the desired treatment of the casing or well hole.

As part of the washing, cementing or treating process, the operation of "back-scuttling" may be necessary and this is easily accomplished with the present invention. Fluid is pumped downwardly from the surface in the annular space between the pipe 14 and the casing 8. Such fluid will pass the upper cup packers 60 because of the downward orientation of skirts 64, but is prevented from downward movement beyond cup packers 62 by the upward orientation of skirts 66. Thus fluid so pumped downwardly to the tool in the position of Fig. 2 cannot move past the tool. If passage of the fluid outwardly

into the well hole proper is not possible (as is the case when back-scuttling) then the fluid is forced through the ports **130**, the ports **30** and into the hollow bore **20** of mandrel **10**. Since the end of the tubular mandrel is provided with a fixed cap or closure **16**, the fluid, together with cement slurry or other treatment composition, is forced upwardly at high velocity within pipe **14** and the entire tool is thus washed.

For clarity and conciseness of reference, the upper and lower seating surfaces **22** and **32** on mandrel **10** may be identified as "inner" seating surfaces, and the corresponding seating surfaces **122** and **132** of sleeve **40** may be identified as "outer" seating surfaces, the terms thus defining the relationship of the parts when in the position indicated in Fig. 2.

Accordingly it will be seen that I have provided a novel and useful tool for use in well hole operations, the tool being of simple and rugged construction to withstand hard usage at considerable depths beneath the surface. Many modifications and changes from the illustrative form herein shown and described will occur to those skilled in the art, and all such modifications and changes not departing from the spirit of the invention are intended to be embraced within the scope of the appended claims.

I claim:

1. A tool adapted for use in well cementing and treating operations comprising: a tubular, hollow mandrel body adapted to be attached to a string of pipe in a casing in a well hole; a sleeve slidably mounted on the tubular mandrel; cooperating means on said sleeve and mandrel limiting longitudinal movement of the sleeve to two extreme positions with respect to the mandrel; centering means carried by the sleeve arranged to frictionally contact a casing in a well hole; a circumferentially recessed zone in the outer surface of the tubular mandrel; a plurality of ports in said recessed zone in communication with the hollow interior of the mandrel; a circumferentially recessed zone on the internal surface of the sleeve virtually equal in longitudinal extent to the recessed zone of the tubular mandrel; ports extending through said sleeve in said recessed zone; sealing means carried by the tubular mandrel body above and below the recessed zone thereof and adapted to contact the inner surface of the sleeve in one position thereof on the mandrel, said recessed zones and ports in the tubular mandrel and sleeve being in communication with each other in all positions of the sleeve on the mandrel; and resilient packing members carried by the outer surface of the sleeve above and below the ports and adapted to sealingly contact the internal surface of a well casing, the recessed zone of the sleeve straddling one of said sealing means in another position of the sleeve on the mandrel to permit free movement of fluid from below the tool to above the tool exteriorly of the mandrel.

2. A tool adapted for use in well cementing and treating operations comprising: a tubular, hollow mandrel body adapted to be attached to a string of pipe in a casing in a well hole; a sleeve slidably mounted on the tubular mandrel; cooperating means on said sleeve and mandrel limiting longitudinal movement of the sleeve to two extreme positions with respect to the mandrel; centering means carried by the tool arranged to frictionally contact a casing in a well hole; a circumferentially recessed zone in the outer surface of the tubular mandrel; a plurality of ports in said recessed zone in communication with the hollow interior of the mandrel; a circumferentially recessed zone on the internal surface of the sleeve virtually equal in longitudinal extent to the recessed zone of the tubular mandrel; ports extending through said sleeve in said recessed zone; resilient packing members carried by the sleeve above and below the ports thereof and adapted to sealingly contact the internal surface of a well casing; and sealing means carried by the tubular mandrel above and below the recessed zone thereof and adapted to contact the inner surface of the sleeve in one position thereof on the mandrel, whereby fluid in the well below the tool is prevented from passing into the recessed zone and to a zone above the tool when the tool is in said position, fluid from below said tool passing between said mandrel and sleeve when the sleeve is in another position on the mandrel, said recessed zones and ports in the tubular mandrel and sleeve being in communication with each other in all positions of the sleeve on the mandrel.

3. A tool as stated in claim 1, wherein the tubular mandrel, below said sleeve and packing members, is provided with fixed means preventing inflow of fluid into said mandrel from below said packing members.

4. A tool as stated in claim 2, wherein the tubular mandrel, below said sleeve and packing members, is provided with fixed means preventing inflow of fluid into said mandrel from below said packing members.

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