Nov. 28, 1950 F. H. LEE 2,531,943

COLLAR APPARATUS FOR CEMENTING CASINGS IN WELLS

Filed Feb. 24, 1947

FIG. 1

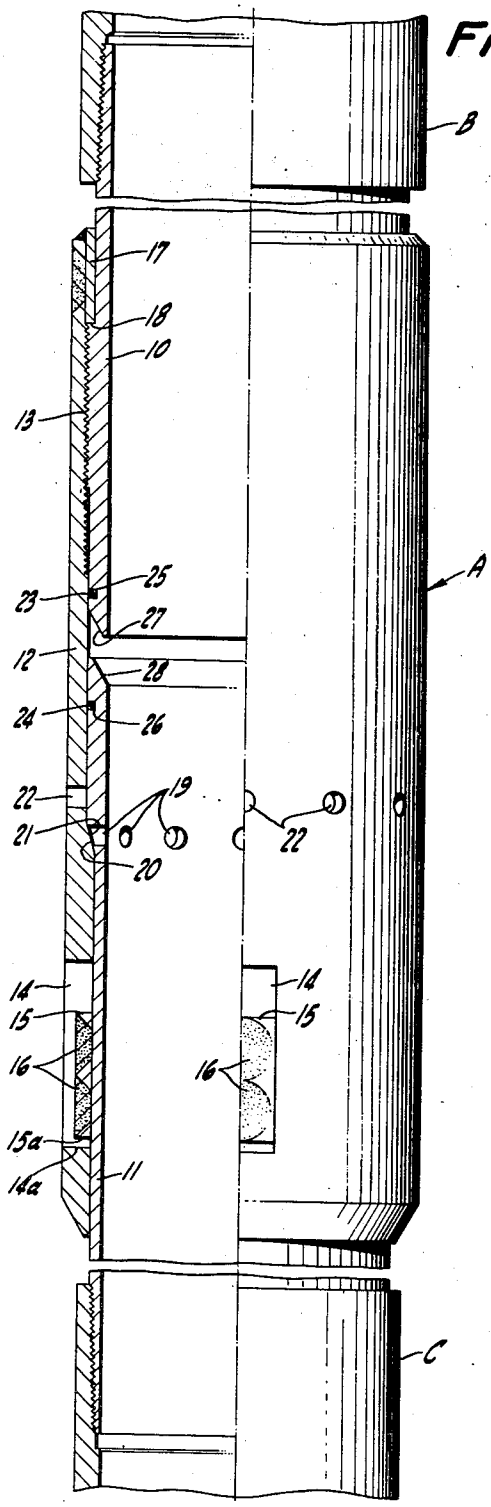


FIG. 2

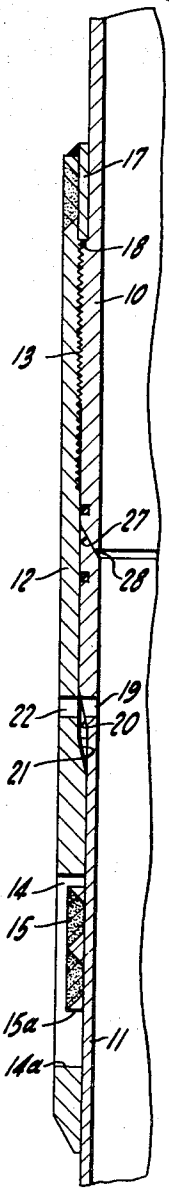
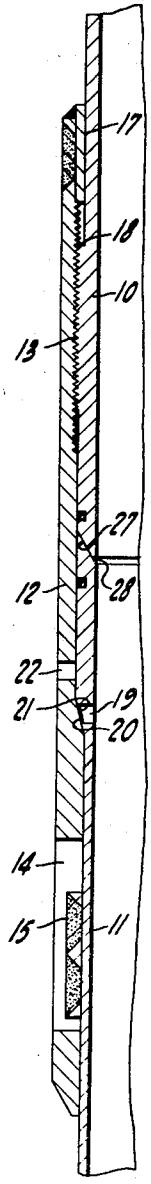


FIG. 3



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COLLAR APPARATUS FOR CEMENTING CASINGS IN WELLS

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7 Claims. (Cl. 251—8)

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The present invention relates to apparatus adapted to be connected in a casing, liner or similar conduit string as a component thereof, and more particularly to such apparatus embodying side ports capable of being opened and closed through manipulation of the conduit string.

It is an object of the present invention to provide side ported apparatus adapted to form part of a casing or similar conduit string, whose side ports are capable of being opened and closed by straight-line longitudinal movement of the casing string, and whose side ports can also be closed by rotation of the casing string, being maintained in such closed position regardless of subsequent movement of the casing string in either longitudinal direction.

This invention has other objects and aspects which will become apparent from a consideration of the embodiment shown in the drawings accompanying and forming part of the present specification. This form will now be described in detail, but it is to be understood that such detailed description is not to be taken in a limited sense, since the scope of the invention is best defined by the claims appended hereto.

Referring to the drawings:

Fig. 1 is a longitudinal view, partly in section and partly in elevation, of an apparatus forming part of a casing string, with its parts in port closing position.

Fig. 2 is a partial longitudinal section of the apparatus, with its parts in port opening position.

Fig. 3 is a view similar to Fig. 2, with the parts in the position to which they have been moved to reclose the ports.

As disclosed in the drawings, a collar apparatus A is connectible to upper and lower casing sections B, C to hold them in longitudinal spaced relation and to form part of a casing string. Although specific reference is made in this specification to a casing and casing string, it is to be understood that the invention is applicable to liners and similar conduit strings as well.

The collar apparatus A includes an upper tubular member 10 adapted to be threaded onto an upper casing section B and an adjacent lower tubular member 11 adapted to be threaded on or within a lower casing section C. The two members are held in assembled relation by an outer sleeve 12, which has a straight threaded connection 13 (preferably righthand) with the upper member 10 and a slidable spline connection with the lower member provided by a pair of opposed longitudinal slots 14 in the sleeve adapted to receive keys 15 suitably secured, as by the use of

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welding material 16, to the lower tubular member. The parts are so arranged as to permit relative longitudinal movement between the lower tubular member 11 and outer sleeve 12, as determined by the greater length of the slots 14 when compared with the length of the keys 15 slidable therein, and as determined by the threaded position of the upper tubular member 10 within the sleeve 12. The downward position of the sleeve along the upper member 10 is limited by engagement of an inner stop ring 17, welded within the upper end of the sleeve 12, with an external shoulder 18 on the upper member.

The lower tubular member 11 is provided with a plurality of circumferentially arranged side ports 19 extending through a downwardly and inwardly tapered external shoulder or abutment portion 20 of the lower member, which provides a tapered shoulder or seat adapted to cooperate with a companion internally tapered shoulder or abutment 21 on the sleeve 12. The latter member has a plurality of circumferentially arranged outer ports 22 disposed above its tapered portion 21 and adapted to be moved into and out of communicating relation with respect to the inner ports 19, thus determining the ability of fluids to pass between the interior and exterior of the collar apparatus through the two sets of ports.

Suitable side seals 23, 24 are provided on the upper and lower members 10, 11 within respective peripheral grooves 25, 26, which are engageable with the interior of the sleeve 12 in order to prevent leakage in an upward direction from the interior of the apparatus between the sleeve 12 and upper member 10, and in a downward direction from the interior of the apparatus between the lower member 11 and sleeve 12. The upper and lower members 10, 11 have cooperable inwardly and downwardly tapered seats 27, 28 adapted to engage or abut.

The collar apparatus A is assembled with the outer sleeve 12 threaded downwardly along the upper member 10 to its fullest extent, governed by engagement of the stop ring 17 with the outer member shoulder 18. The lower tubular member 11 may hang from the outer sleeve with its upper end 28 spaced downwardly from the cooperable end 27 of the upper member 10, by virtue of engagement between its tapered shoulder or seat 20 with the companion tapered shoulder or seat 21 on the outer sleeve. When the tapered shoulders 20, 21 engage, the ports 19 are closed and the keys 15 occupy a lower position within the slots 14. The apparatus A is connected to the upper and lower casing sections B, C and is run in

the well bore, as a part of the casing string, to the desired depth. Since the weight of the casing sections below the apparatus maintains the tapered seats 20, 21 in engagement, fluid cannot pass in either direction between the interior and exterior of the apparatus through the ports 19, 22, in view of the metallic seal furnished by the abutting seating surfaces 20, 21.

In the event that it is desired to cement the casing string in the well bore below the collar, circulating fluid followed by cement slurry may be pumped directly into the casing string for passage through and beyond the apparatus A and for ejection from the casing string at some lower point, as from a casing shoe (not shown), whereupon the cement slurry passes upwardly through the annulus around the lower portion of the casing string to the desired elevation. Following the hardening of the lower charge of cement, the lower portion of the casing string and the lower member 11 attached thereto are prevented from longitudinal and rotary movement, permitting the upper portion of the casing string and the upper tubular member 10 and outer sleeve 12 connected thereto to be moved downwardly, through a simple straight-line longitudinal movement or lowering of the casing string, until the opposed ends 27, 28 of the upper and lower members 10, 11 engage, in which position the port closing surfaces 20, 21 have been separated from one another and the outer ports 22 have been brought into substantial alignment with the inner ports 19, providing a flow path through which fluid may pass from the interior of the apparatus through the open ports to the exterior of the apparatus.

A second charge of cement slurry may now be pumped directly into the casing string for outward passage through the open ports 19 and for upward flowing through the annulus around the apparatus A and upper portion of the casing string. After the desired quantity of cement slurry has been ejected through the open ports, they may be closed through reelevating the casing string, which again engages the sealing surfaces 20, 21 and closes the ports 19. Port closing can also be effected through rotation of the casing string at the top of the well bore. The spline connection provided by the keys 15 and slots 14 prevents rotation of the outer sleeve 12 with respect to the lower member 11, which is held from turning by the lower charge of cement. Accordingly, rotation of the upper portion of the casing string to the right rotates the upper tubular member 10 and causes upward feeding of the outer sleeve 12 (in view of the righthand threaded connection) along the lower member 11 and upper member 10 until the internal tapered seat 21 is again engaging the external tapered seat 20, which provides a metallic seal closing the inner ports 19. Continued rotation of the casing string threads the upper member 10 down within the sleeve 12 until its lower end 27 abuts the upper end 28 of the lower member 11. The fact of port closing and engagement of the members 10, 11 with each other is transmitted to the operator at the top of the well bore through his inability to further rotate the casing string.

The sealing surfaces 20, 21 and abutting ends 27, 28 may be engaged firmly by the threaded action between the sleeve 12 and upper member 10, since a large mechanical advantage results from the use of the threads 13 in effecting upward longitudinal movement of the outer sleeve 12 and downward movement of the upper member 10. Such threading action of the sleeve 12 along the upper body 10 not only provides a firm contact between the tapered surfaces 20, 21 across the inner ports 19, but also provides a firm downward metallic engagement between the ends 27, 28 of the upper and lower members 10, 11. As a result, the rotation of the casing string to close the ports 19 effects a firm and immovable coupling between the upper member 10, sleeve 12 and lower member 11, precluding further relative longitudinal movement from occurring. That is, after the outer sleeve 12 has been threaded upwardly to close the ports 19 and the upper and lower members 10, 11 engage, longitudinal movement of the casing string is incapable of opening the ports 19, since the parts all move in unison.

In the event that the ports 19 are to be opened or closed without cementing the lower portion of the casing string, such action can still occur through setting of the lower end of the casing string on the bottom of the well bore, which will then permit the proper telescoping action of the outer sleeve 12 along the lower member 11 to take place, producing substantial alignment of the inner and outer ports 19, 22. Thereafter, the ports 19 can be closed through rotation of the casing string from the top of the well bore. Ordinarily, there is sufficient friction between the casing string below the apparatus and the wall of the formation to resist rotation of the lower casing string and the lower tubular member 11, permitting the upward threading of the sleeve 12 along the upper member 10, and also along the lower member 11, into port closing position.

It is preferred to employ steeply tapered co-engaging metallic sealing surfaces 20, 21 on the lower member and sleeve since they wedge firmly against one another to close the ports 19 and insure against fluid leakage therethrough. However, such steep taper might produce inward swedging of the lower member 11 if too great a casing load is suspended therefrom, or if too great a torque is imposed on the threaded connection 13. Such swedging possibility is precluded by so proportioning the location of the keys 15 within the slots 14 that the lower ends 15a of the keys are closely adjacent the lower ends 14a of the slots when the tapered surfaces 20, 21 engage. Abnormal loading of such surfaces through the tensile strain on the sleeve 12 and lower member 11 will engage the ends 15a of the keys with the slot ends 14a and relieve the tapered surfaces 20, 21 of part of the load, which part is then transmitted between the lower member 11 and sleeve 12 through the key and slot connection 15, 14, instead of through the tapered co-engaging seats 20, 21.

It is apparent that a well cementing apparatus has been provided in which the ports 19 can be opened or closed simply through straight-line longitudinal movement of the casing string, and that the ports may be closed permanently against reopening through rotation of the casing string, as to the right, which effectively clamps the portions of the collar apparatus A together and prevents their relative longitudinal movement, thus holding the ports in the desired closed position.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. Apparatus of the character described, including a first tubular member having a side port and adapted for connection to a casing section of a casing string positionable in a well bore,

a second tubular member adapted for connection to another casing string section, a sleeve on the exterior of said members for opening and closing said port, means providing a connection between one of said members and said sleeve for effecting relative longitudinal movement of said sleeve along said one of said members upon relative rotation between said members, and means providing a slidable spline connection between said sleeve and the other of said members.

2. Apparatus of the character described, including a first tubular member having a side port and adapted for connection to a casing section of a casing string positionable in a well bore, a second tubular member adapted for connection to another casing string section, a sleeve on the exterior of said members for opening and closing said port, means providing a connection between one of said members and said sleeve for effecting relative longitudinal movement of said sleeve along said one of said members upon relative rotation between said members, means providing a slidable spline connection between said sleeve and the other of said members, abutment means on said sleeve, abutment means on said other of said members, said abutment means engaging each other to place said sleeve in closed position over said port.

3. Apparatus of the character described, including a first tubular member having a side port and adapted for connection to a casing section of a casing string positionable in a well bore, a second tubular member extending from said first member and adapted for connection to another casing string section, a sleeve on the exterior of said members for opening and closing said port, means providing a slidable spline connection between said sleeve and said first member, means providing a connection between said second member and said sleeve for effecting longitudinal movement of said sleeve along said second member in response to rotation of said second member, and cooperable shoulders on said first member and sleeve engageable with each other to place said sleeve in closed position over said port.

4. Apparatus of the character described, including an upper tubular member adapted for connection to a casing section of a casing string positionable in a well bore, a lower tubular member extending from said upper member and adapted for connection to another casing string section, said lower member having a side port, a sleeve on the exterior of said members for opening and closing said port, means providing a slidable spline connection between said sleeve and lower member, means providing a threaded connection between said upper member and sleeve whereby said sleeve is moved longitudinally along said upper member in response to rotation of said upper member, and cooperable shoulders on said lower member and sleeve engageable with each other to place said sleeve in closed position over said port.

5. Apparatus of the character described, including an upper tubular member adapted for

connection to a casing section of a casing string positionable in a well bore, a lower tubular member adapted to abut said upper member and connectible to another casing string section, said lower member having a side port, a sleeve on the exterior of said members for opening and closing said ports, cooperable shoulders on said lower member and sleeve engageable with each other to place said sleeve in closed position over said port, means providing a slidable spline connection between said sleeve and lower member, and means providing a threaded connection between said upper member and sleeve whereby said sleeve is moved upwardly along said upper member in response to rotation of said upper member to engage said shoulders and to abut said upper and lower members with one another.

6. Apparatus of the character described, including a first tubular member adapted for connection to a casing section of a casing string positionable in a well bore, a second tubular member adapted to abut said first member and connectible to another casing string section, said second member having a side port, a sleeve on the exterior of said members for opening and closing said port, cooperable shoulders on said second member and sleeve engageable with each other to place said sleeve in closed position over said port, means providing a slidable spline connection between said sleeve and second member, and means providing a threaded connection between said first member and sleeve whereby said sleeve is moved upwardly along said first member in response to rotation of said first member to engage said shoulders and to abut said first and second members with one another.

7. Apparatus of the character described, including a first tubular member having a side port and adapted for connection to a casing section of a casing string positionable in a well bore, a second tubular member adapted to abut said first member and connectible to another casing string section, a sleeve on the exterior of said members for opening and closing said port, cooperable shoulders on one of said members and sleeve engageable with each other to place said sleeve in closed position over said port, means providing a slidable spline connection between one of said members and said sleeve, and means providing a connection between the other of said members and sleeve whereby said sleeve is moved longitudinally along said other of said members in response to rotation of said other of said members to engage said shoulders and to abut said first and second members with one another.

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