This invention relates to a cementing collar for use in a string of well casing and actuating means for opening and closing ports in the collar. In particular, this invention is directed to such a collar for use in multiple stage cementing operations of oil wells with the actuating means adapted to be moved down the well casing after performing the actuating functions, thereby eliminating the need for subsequently drilling or milling through these means.

In the drilling and completion of oil or gas wells, it is often desirable to cement a well pipe or casing into the well bore and this is conventionally accomplished by pumping cement slurry down through the casing and out into the annular space between the well bore and the casing. The cement slurry is introduced into the annulus at or near the bottom of the casing, but if the casing is extremely long or the annulus is small the cement bond and fill at the upper or medium portions of the casing may not be entirely satisfactory. Moreover, occasionallly it is highly desirable to obtain a particularly good cement fill and bond in the annulus at a selected upper or medium portion of the casing as well as near the bottom of the casing. Thus, it has become customary under these conditions and requirements to perform multiple stage cementing where cement slurry is introduced into the annulus between the casing and the well bore in successive stages at more than one location along the length of the casing.

There are a number of device known as “cementers” or “cementing collars” which may be used for introducing the cement slurry into the annulus from within the well casing at a particular intermediate location along a casing. These cementing collars are interposed in the string of well casing and have normally closed ports which may be opened for permitting the discharge of cement slurry into the annulus and then permanently closed. These opening and closing steps are generally accomplished by dropping or pumping a pair of plugs, bombs, go-devils or other devices down the well casing to actuate components of the cementing collar. The first device engages a portion of the cementing collar and opens the ports and the second device engages another portion of the cementing collar and closes the ports. These devices are retained in conventional cementing collars and if it is subsequently desired to gain access to the casing below the cementing collar it is first necessary to drill through these retained devices. Since the particular operation which is to be performed below the cementing collar does not always permit the provision of a drill on the end of the string of pipe being lowered into the casing to perform such operation, this drilling must be conducted as a separate preliminary operation requiring a time-consuming round trip with a drill and string of pipe.

When pumping cement slurry down the casing for these cementing operations it is conventional and practical to drop a plug into the casing below the cement slurry and drop a second plug into the casing on top of the cement slurry; these plugs are commonly referred to as “bottom” and “top” plugs, respectively. When multiple stage cementing is carried on the cementing collar must have a large enough minimum internal diameter to permit the top and bottom plugs used in cementing stages carried on below that collar to pass through the collar without actuating the collar. It is highly desirable that the cementing collar have a minimum internal diameter approximately equal to the internal diameter of the casing both before and after the cementing stage is carried on through that collar so that other tools and devices may be lowered through the collar without the collar presenting any greater obstruction than the casing itself.

Accordingly, it is a principal object of this invention to provide a novel form of cementing collar and means for opening and closing same wherein the collar forms no internal obstruction to the string of casing and the actuating means may be released from the collar after completion of that stage of cementing.

Another object of this invention is to provide novel actuating means for use with a cementing collar wherein the actuating means may be released from the cementing collar by the mere application of fluid pressure for the actuating means to be urged through the cementing collar without requiring drilling.

A further object of this invention is to provide novel actuating means adapted to be carried down through a casing on a conventional top plug and be latched in a cementing collar to provide a seat for engaging subsequently used actuating means.

Still another object is to provide a cementing collar for use in a string of well casing wherein the minimum internal diameter of the collar is equal to or greater than the internal diameter of the casing and novel actuating devices are provided for appropriately latching in the cementing collar to accomplish the opening and closing of the ports, and those actuating devices are released from the cementing collar after the ports have been closed.

Other and more detailed objects and advantages of this invention will appear from the following description in the accompanying drawings.

In the drawings:

FIGURE 1 is a sectional elevation of the cementing collar of this invention connected in a string of casing with the ports of the cementing collar closed and a top cementing plug passing into the cementing collar;

FIGURE 2 is a sectional elevation similar to FIGURE 1 with the opening seat of the actuating means latched in the cementing collar and released from the top plug illustrated in FIGURE 1;

FIGURE 3 is a sectional elevation similar to FIGURE 2 with an actuating device having served to open the ports of the cementing collar;

FIGURE 4 is a sectional elevation similar to FIGURE 3 with the other actuating device positioned in the cementing collar prior to closing of the ports;

FIGURE 5 is a sectional elevation view similar to FIGURE 4 with the ports of the cementing collar closed and all of the actuating means of this invention still supported in the cementing collar;

FIGURE 6 is a sectional elevation view similar to FIGURE 5 showing the actuating means of this invention immediately after release from the cementing collar and in the appropriate position for being urged down through the well casing.

Referring now to the drawings the cementing collar, generally designated 10, of this invention is threaded into a string of casing 11 in a conventional manner through upper and lower threaded connecting subs 12 and 13, respectively. The string of casing with the cementing collar 10 is lowered into the well bore 14 and positioned at the desired location. One or more cementing stages may be conducted below cementing collar 10 in a conventional manner wherein the cement slurry is pumped down through casing 11, past collar 10, and out through a cementing shoe or cementing collar therebelow. In each of...
of special top plug 15, the plug is broadly comprised of a conventional top plug having a plurality of resilient wiper members 33 mounted on a mandrel 34 with an opening seat assembly, generally designated 35, mounted on the top end of the plug body 38 of assembly 34, and provided with a plurality of longitudinal external recesses in which a plurality of latching keys 39 are pivotally mounted at their upper ends by pins 40. Latching keys 39 have a substantial length and are biased outwardly by any convenient means such as coil compression springs 41 mounted in recesses within and behind the keys as shown in FIGURE 2.

The profile of the outer surface of latching keys 39 includes a block portion 42 on the lower end with a tapered surface 43 adjacent and above block portion 42. When the opening seat assembly 35 is positioned within the casing 11 as shown in FIGURE 1, the latching keys 39 are constrained against outward pivoting beyond the position shown due to the internal surface of the casing 11. With keys 39 constrained to this position the block portion 42 does not engage the internal surface of the casing but rather portion 41 will rest in a recess of the casing 11 and engage the casing. Thus, as the opening seat assembly 35 passes through a casing collar between two joints of casing, the latching keys 39 may pivot slightly outwardly but the tapered surface 43 will remain in engagement with the internal surface of the casing collar or casing such that the block portion 42 will not latch within the casing collar as might otherwise be possible.

When the top plug 15 reaches collar 10 and the latch keys 39 are adjacent the opening sleeve 18, the latch keys 39 will expand outwardly due to the compression springs 41. The configuration of the latch keys 39 and the opening sleeve 18 are such that the block portion 42 of the latch keys mates with and engages the annular groove 21 of the opening sleeve 18. The frustoconical surface 22 and enlarged internal cylindrical surface 30 permits the latch keys 39 to expand outwardly and the tapered surface 43 to mate with or at least not interfere with surfaces 22 and 30.

In this manner the opening seat assembly 35 is therefore latched in the position shown in FIGURE 2 against movement in either direction with respect to opening sleeve 18. The fluid pressure in the casing 11 above cementing collar 10 is then increased and will result in a pressure on the end 44 of the mandrel 34 tending to urge the mandrel of the plug 15 downwardly relative to open seat assembly 35 thereby shearing pins 37 to release mandrel 34 from the opening seat assembly. This permits mandrel 34 and wiper members 33 of the plug 15 to proceed downwardly through the casing 11 and thereby complete the top cementing plug function of plug 15.

The shear pins 19 securing the opening sleeve 18 to the housing 16 have a greater strength than the shear pins 37 securing opening seat assembly 35 to mandrel 34 of the plug 15. Therefore, pins 37 will shear, as heretofore described, before pins 19 can shear under the imposed fluid pressure and thus opening sleeve 18 remains in its original position closing ports 17 after release of the opening seat assembly 35 from the plug 15, as shown in FIGURE 2.

When it is desired to conduct the cementing stage through the ports of cementing collar 10, an actuating device such as bomb 45 is dropped into the casing 11 and is adapted to engage the opening seat assembly 35. Although a bomb 45 is illustrated and such device drops by gravity through the fluid within casing 11, it will be readily apparent to those skilled in the art that an-
appropriately modified conventional bottom plug could be substituted for bomb 45, spaced an appropriate distance from plug 15, and pumped down the casing 11 to engage opening seat assembly 35 at the same time that plug 15 reaches the bottom of the casing. The lower end of the sleeve 18 is provided with a reduced diameter portion 46 and a tapered bottom end 47 to fit into the bore 36 of the opening seat assembly. A resilient sealing means 48 on bomb 45 is adapted to engage a tapered shoulder 49 in the upper end of body 38. A sealing means 50 is provided on the outer diameter of body 38 for sealing engagement with cylindrical surface 23 of the opening sleeve 18.

Thus, when bomb 45 engages the opening seat assembly 35 and fluid pressure is applied in the casing 11 thereat, the fluid pressure will tend to force the bomb 45, opening seat assembly 35, and sleeve 18 downwardly due to the interengagement of latch keys 39 with the opening sleeve. When sufficient fluid pressure has been applied, the pins 19 will be sheared and the bomb 45, seat 35, and sleeve 18 will move downwardly relative to housing 16 to thereby uncover ports 17 as shown in FIGURE 3. This downward movement will be terminated by sleeve 18 engaging connecting sub 13. It is to be noted that the fluid pressure required to shear pins 19 is greater than the previously applied fluid pressure employed in shearing pins 37. The cement slurry may then be introduced and displaced upwardly toward the annular space between wellbore 14 and the casing 11.

As is conventional in cementing operations, when the proper quantity of cement slurry has been introduced into casing 11 to accomplish the desired cement fill in the annulus, a top plug is dropped into the casing 11 on top of the cement slurry and pumped down the casing until the downward travel of the plug is arrested. Turning now to FIGURE 4, the top plug, generally designated 51, of this invention serves the normal top plug function but also serves additional functions in cementing collar 10. Top plug 51 is provided with the conventional wiper means 52 adapted to slidably and sealably engage the inside of the casing 11. Wiper means 52 are mounted on the body 53 of the plug. The lower end of body 53 is comprised of a cylindrical portion 54 adapted to loosely fit over the upper end of body 45 and engage the upper end of the body 38 of the opening seat assembly 35.

Thus, it may be seen that the top plug 51 is supported on the opening seat assembly 35 which is latched to the opening sleeve 18 which is in turn supported from further downward movement by the connecting sub 13. The fluid pressure is then increased in the casing 11 above cementing collar 10 and this pressure will bleed past some of the wiper means 52 and be applied to the upper annular end 55 of the closing sleeve 24. The fluid pressure will be prevented from completely bypassing closing sleeve 24 by the lower of wiper means 52 such as the low-est wiper means 52a. When the fluid pressure on end 55 tending to force closing sleeve 24 downwardly reaches a predetermined level the forces will be sufficient to shear pins 25 thereby permitting sleeve 24 to move downwardly within housing 16. Upon sufficient downward movement the reduced diameter portion 29 of sleeve 24 will enter the internal surface 30 of opening sleeve 30 and a seal will be established therebetween by O-rings 31 to thereby close ports 17.

When portions 29 first enters internal surface 30 fluid may become trapped between the closing sleeve 24, opening seat 35, and top plug 51. Ports 36 are provided in body 53 and a releasable plug or check valve 57 is provided in the upper end of body 53 to permit this trapped fluid to pass through the top of plug 51.

As the closing sleeve 24 moves downwardly in response to the pressure on the upper end 55 the sleeve will reach a location shown in FIGURE 5 where the lower locking ring 28 on the exterior of the sleeve expands outwardly into an internal groove 58 in the housing 16. Internal groove 58 has a downward facing shoulder 59 to engage the lock ring 28 and prevent upward movement thereof and thereby prevent upward movement of closing sleeve 24 with respect to housing 16. In this position the ports 17 are irreversibly closed since there can no longer be axial separation of the closing sleeve 24 and the closing sleeve 24. Also, in this position the lower end 60 of closing sleeve 24 has not yet engaged the latch keys 39 nor is the downward travel of closing sleeve 24 terminated. Downward movement of closing sleeve 24 will continue even though wiper means 52 and particularly 52a have been disengaged from the internal surface 32 of the sleeve since the area of upper end 55 is greater than the area of lower end 60 thereby causing a hydraulic unbalancing tendency to force the sleeve 24 downwardly.

Further, downward movement of sleeve 24 from the position shown in FIGURE 5 results in the lower end 60 engaging latch keys 39 to cam the latch keys inwardly thereby releasing the block portions 42 from the annular groove 21 in the opening sleeve 18. With the latch keys 39 thus released from the opening sleeve 18 the opening seat assembly 35, plug 45, and top plug 51 are completely released from the cementing collar 10 and are therefore free to be urged downwardly through the cementing collar and casing 11 by the application of fluid pressure thereabove or lowering tubing into the casing 11. When the closing sleeve 24 has nearly reached the lowermost point in its travel, the uppermost locking ring 27 will also expand into the annular groove 58 to assist in preventing the sleeve from thereafter moving upwardly relative to the housing 16.

Thus, it may be seen that by this invention there is provided a cementing collar that may be opened and closed by actuating devices and that these devices may be urged through the cement collar after completion of the opening and closing procedures without requiring drilling of the actuating devices. Moreover, it may be seen that the collar can have a minimum internal diameter equal to or greater than the internal diameter of the casing both before and after the cementing stage using this collar so that a collar forms no obstruction to the use of various types of tools and devices on the inside of the casing. Furthermore, although a specific type of cementing collar has been employed in this invention, a differential valve cementer, it is to be understood and will readily appear to those skilled in the art that other types and styles of cementing collars and cementers may be used without departing from this invention by making certain minor modifications.

Having fully described my invention it is to be understood that I do not wish to be limited to the details herein set forth nor to the details illustrated in the drawings, but my invention is of the full scope of the appended claims.

1. For use with a ported cementing collar in a well pipe, the collar having an opening sleeve provided with an internal groove, the improvement comprising, in combination: an actuator device having a body member for passing through the well pipe to the cementing collar, latch means mounted in said body member, said latch means movable outwardly relative to said body member for engaging the internal groove in the opening sleeve to latch said body member to said opening sleeve, and said latch means having means for preventing latching engagement with the well pipe. 2. For use with a ported cementing collar in a well pipe, the collar having an opening sleeve provided with an internal groove and having a closing sleeve, the improvement comprising, in combination: an actuator device having a body member for passing through the well pipe to the cementing collar, latch means pivotally mounted in said body member, said latch means movable outwardly
relative to said body member for engaging the internal groove in the opening sleeve to latch said body member to said opening sleeve, and said latch means having a cam surface for being engaged by the closing sleeve to move said body member for disengaging said body member from the opening sleeve.

3. For use with a ported cementing collar in a well pipe, the collar having an opening sleeve provided with an internal groove and having a closing sleeve, the improvement comprising, in combination: an actuator device having a body member for passing through the well pipe to seat a cementing collar, latch means pivotally mounted in said body member, said latch means movable outwardly relative to said body member for engaging the internal groove in the opening sleeve to latch said body member to said opening sleeve, said latch means having means for preventing latching engagement with the well pipe, and said latch means having a cam surface for being engaged by the closing sleeve to move said latch means inwardly for disengaging said body member from the opening sleeve.

4. For use with a ported cementing collar in a well pipe, the collar having an opening sleeve provided with an internal groove and having a closing sleeve, the improvement comprising, in combination: an actuator device having a body member for passing through the well pipe, a plurality of longitudinal recesses in the exterior of said body member, a latch key pivotally mounted in each said recess for engaging bias outwardly each said latch key having an outer profile with a portion for engaging the internal groove in the opening sleeve and a separate portion for preventing latching engagement of the key with the well pipe and each said latch key having a cam surface for being engaged by the closing sleeve to pivot said latch key inwardly for disengaging said body member from the opening sleeve, and said opening sleeve means having means for engaging said opening seat means to move said opening sleeve means to said second position thereof, means for moving said opening sleeve means to said second position for opening said port, an opening seat means for passing through the well pipe to said collar assembly, said opening seat means having means for engaging said opening seat means to move said opening sleeve means to said second position thereof, means for engaging said opening seat means to said second position for opening said port, and means for actuating said opening seat means to move said opening sleeve means to said second position thereof.

5. In a cementing collar device for well pipe and means for actuating that device, comprising: a collar assembly having a body member for passing through the well pipe, a plurality of longitudinal recesses in the exterior of said body member, a latch key pivotally mounted in each said recess for engaging bias outwardly each said latch key having an outer profile with a portion for engaging the internal groove in the opening sleeve and a separate portion for preventing latching engagement of the key with the well pipe and each said latch key having a cam surface for being engaged by the closing sleeve to pivot said latch key inwardly for disengaging said body member from the opening sleeve, and said opening sleeve means having means for engaging said opening seat means to move said opening sleeve means to said second position thereof, means for moving said opening sleeve means to said second position for opening said port, and means for actuating said opening sleeve means to said second position thereof.

6. In a cementing collar device for well pipe and means for actuating that device, comprising: a collar assembly having at least one port, an opening sleeve means first positioned for covering said port and movable to a second position for opening said port, said opening sleeve means having an annular internal groove, a closing sleeve means movable to a position for closing said port after said opening sleeve means has moved to said second position for opening said port, said opening sleeve means having means for engaging said internal groove in said opening sleeve means to latch said opening seat means to said second position thereof, means for moving said opening sleeve means to said second position for opening said port, and means for actuating said opening sleeve means to said second position thereof, means for moving said opening sleeve means to said second position thereof.
assembly, said opening seat means having an annular body with external longitudinal recesses, a latch key pivoted for covering each port and means for engaging said opening seat means and spring biased outwardly, each said latch key having an outer profile with a portion for engaging the internal groove in the opening sleeve and a separate portion for preventing latching engagement of the key with the well pipe, the engagement of said latch keys in said internal groove serving to latch said opening seat means to said opening sleeve means, means for establishing sealing relation between said opening sleeve means and said opening seat means to move said opening sleeve means to said second position thereof upon application of fluid pressure thereabove, means for moving said closing sleeve means from said final position thereof upon application of hydraulic pressure thereabove and said closing sleeve means having means for engaging said latch keys upon movement to said final position for moving said latch means inwardly relative to said body and out of engagement with said internal groove.

10. In a cementing collar device for well pipe and means for actuating that device, comprising: a collar assembly having a tubular housing with means for attachment to the well pipe, at least one port in said housing, an opening sleeve means first positioned in said body, said opening seat means having an annular internal groove, a closing sleeve means first positioned in said housing and then moveable to a second position for closing said port after said opening sleeve means has moved to said second position for opening said port, said opening sleeve means and said closing sleeve means each minimum internal diameters at least as large as the internal diameter of the well pipe, said latch means movably outwardly relative to said body for engaging the said internal groove in said opening sleeve means to latch said opening seat means to said opening sleeve means, plug means for passing through the well pipe to said collar assembly, said opening means having an annular body, latch means mounted in said body, said latch means moveable outwardly relative to said body for engaging the said internal groove in said opening sleeve means to latch said opening seat means to said opening sleeve means, plug means for passing through the well pipe to said collar assembly and engaging said opening seat means to move said opening sleeve means to said second position thereof upon the application of hydraulic pressure, actuating means for passing through the well pipe to said collar assembly, said actuating means having means for engaging said opening seat means and said closing sleeve means having means for engaging said latch means upon movement to said second position for moving said latch means inwardly relative to said body and out of engagement with said internal groove for allowing said opening seat means, plug means and actuating means to pass through the collar assembly.

11. In a cementing collar device for well pipe and means for actuating that device, comprising: a collar assembly having a tubular housing with means for attachment to the well pipe, at least one port in said housing, an opening sleeve means first positioned in said housing for covering said port and moveable to a second position for opening said port, said opening sleeve means having an annular internal groove, a closing sleeve means first positioned in said housing and then moveable to a second position for closing said port after said opening sleeve means has moved to said second position for opening said port, said opening sleeve means and said closing sleeve means each minimum internal diameters at least as large as the internal diameter of the well pipe, means for actuating said opening sleeve means for passing through the well pipe to said collar assembly, said opening seat means having an annular body with external longitudinal recesses, a latch key pivotally mounted in each said recess and spring biased outwardly, each said latch key having an outer profile with a portion for engaging the internal groove in the opening sleeve and a separate portion for preventing latching engagement of the key with the well pipe, plug means for passing through the well pipe to said collar assembly and engaging said opening seat means to break said frangible means and move said opening sleeve means to said second position thereof upon application of hydraulic pressure above said actuating means, and said closing sleeve means having means for engaging said latch means upon movement to said second position for moving said latch means inwardly relative to said body and out of engagement with said internal groove for allowing said opening seat means, plug means and actuating means to pass through the collar assembly.

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