May 1, 1956 J. E. ECKEL 2,743,905

IMPROVED SEALING VALVE ASSEMBLY

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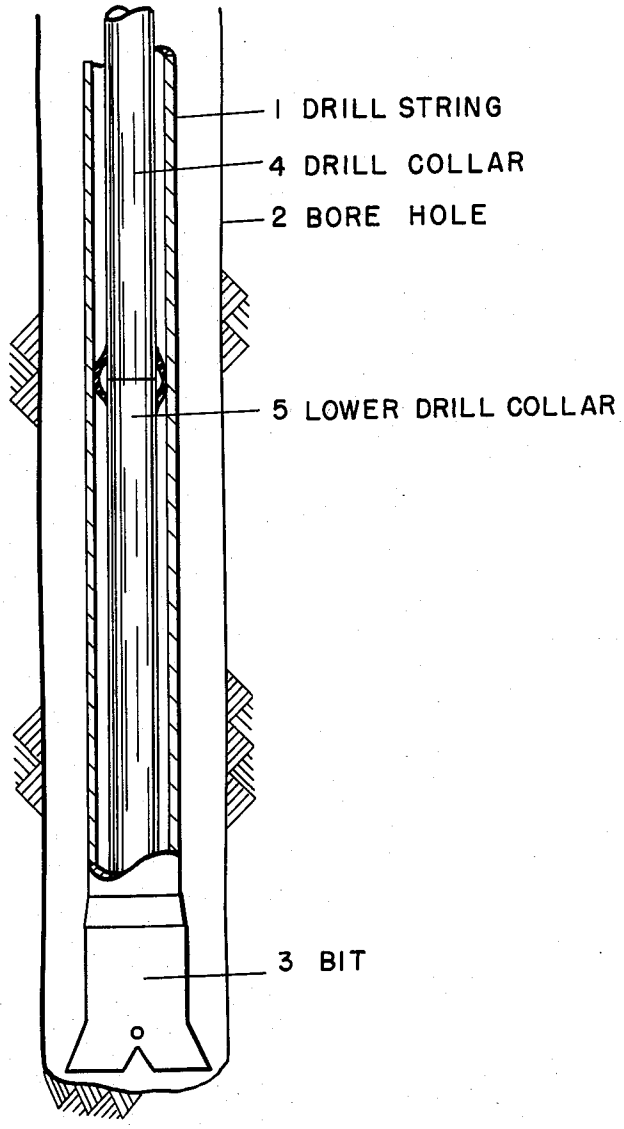


FIG.—1

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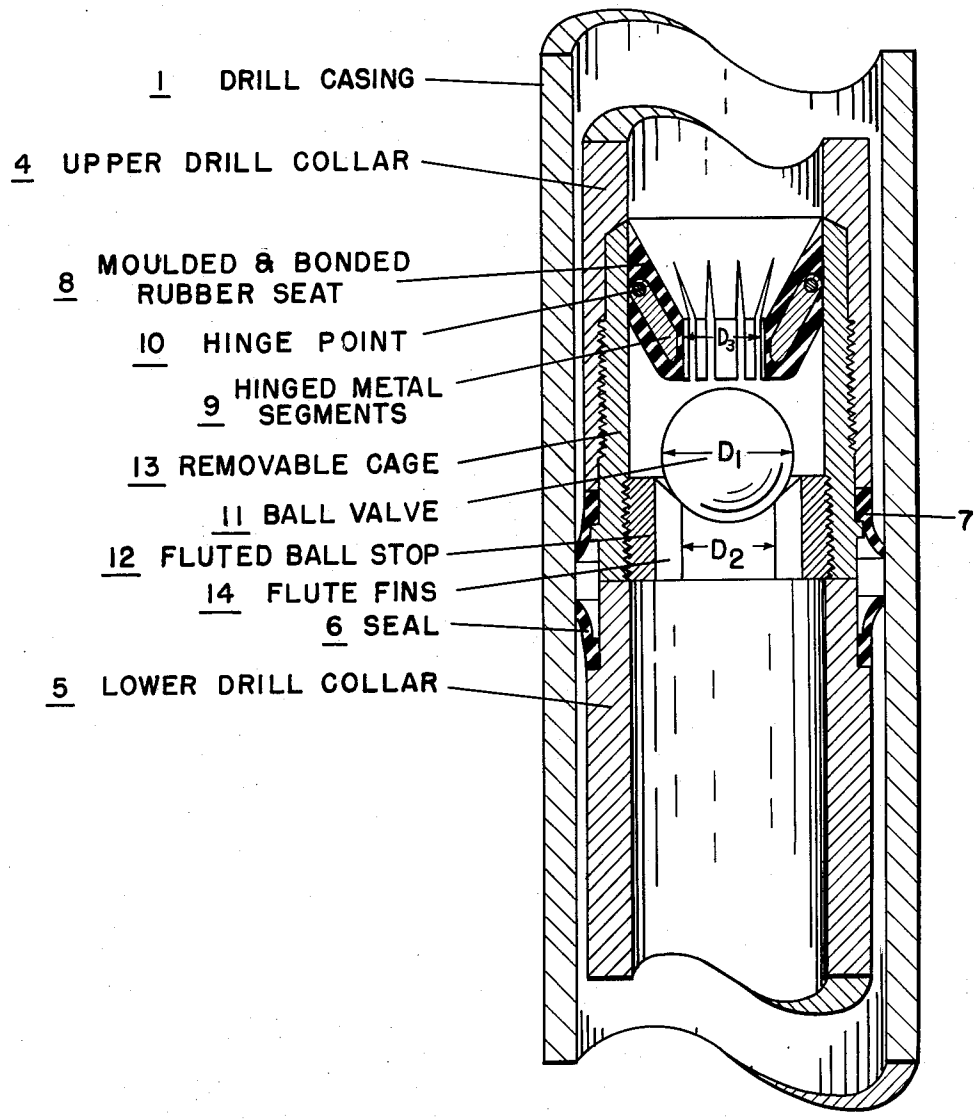


FIG.- 2

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IMPROVED SEALING VALVE ASSEMBLY

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3 Claims. (Cl. 255—28)

The present invention is concerned with an improved sealing valve assembly. The invention is more particularly concerned with the utilization of this assembly in conjunction with floating or removable elements, particularly elements of this character which are used in conjunction with well drilling and production operations. A preferred adaptation of the improved sealing valve assembly of the present invention is in conjunction with removable drill collars wherein the valve assembly comprises an integral part of said drill collars. Other specific adaptations of the present invention are concerned with an improved method for drilling bore holes into the earth substrata wherein the improved valve assembly is utilized for the selective removal of drill collars, for the pulling of tubing or drill pipe and for the setting of casing. The valve assembly of the present invention comprises a rubber valve seat reinforced by hinged metal segments molded into the rubber. In operation, the hinged metal segments open under the pressure of a ball or similar element activated by fluid pressure in one direction. The ball under counterflowing fluid pressure will act as a valve closure.

It is well known in the art to drill bore holes into the earth's substrata utilizing various techniques. For instance, one technique is to utilize a drill stem or pipe string having attached to the lower end thereof a drill bit. The drill stem is rotated thereby rotating the bit. A drilling fluid comprising an aqueous mud or equivalent material is passed down usually within the drill stem and passed upwardly in the bore hole between the outer surface of the drill stem and the inside of the bore hole. In these drilling operations in order to provide sufficient weight on the lower end of the drill stem it is the practice to utilize drill collar sections within the drill stem above the bit. These drill collar sections are relatively heavy pipe sections and provide the necessary weight at the lower end of the drill stem.

As the drilling proceeds it is also desirable to remove one or more of these drill collar sections. Heretofore the procedure was to withdraw the drill stem from the ground, to remove the drill collar, reassemble the string and lower it again into the ground. This comprises a time consuming and very expensive operation. Thus one object of the present invention and apparatus is to provide an efficient means of removing selectively one or more of these drill collars from the pipe string.

Another adaptation of the present invention is to use the valve assembly in conjunction with the setting of casing. In this operation it is initially desirable to allow the full weight of the casing to be supported by the hoist, permitting the weight of the string to sink it into the well. When the weight of the string begins to overload the hoist, it is then desirable to "float" the string of casing into the well by preventing the entry of mud fluid into the interior of the casing, thus taking advantage of its buoyancy. In conventional casing strings it is customary to install a float valve that prevents entry of mud into the casing, such valve having a permanently installed ball check. Since this valve creates undesired buoyancy when

the string is initially started into the well, it is common practice to "fill up" by pumping mud into the interior of the casing to gain weight to sink the string until such depth is reached that the buoyancy is desirable. This filling up operation involves considerable delay. It is within the concept of the present invention to utilize the present valve assembly to eliminate this delay. A float collar embodying the present valve assembly will be installed in the casing string without the valve ball, thus admitting mud into the casing as long as desired to utilize its weight to sink it. Upon reaching the point at which buoyancy is desired to assist the hoist, the valve ball is pumped down the casing and forced through the flexible hinged membrane, thereby preventing mud from entering the casing at the bottom thereof and providing the required buoyancy at greater depths.

Another adaptation of the present invention is in the pulling of the drill string in a drilling well, or tubing in a producing well, from the well bore. In many instances in the removal of the string from the bore hole, it is desirable to seal off the string so as to prevent the flow of fluid into the string as the string is being removed. Heretofore, various means have been used, as for example, so-called "wireline closure valves." These wireline closure valves have been lowered to the bottom of the string and the valve operated by an attached wire. By utilizing the improved closure valve of the present invention as a permanent fixture in the string, it is possible to pump the ball down to the bottom of the string, seal off the string and then to remove the string from the well bore.

The present invention may be more fully understood by reference to the figures illustrating the same. Figure 1 illustrates a drilling string positioned in a bore hole and containing at its lower end drill collar assemblies. Figure 2 illustrates the present invention, showing in detail two drill collar assemblies positioned in the drill string.

Referring specifically to Figure 1, drill string 1 is shown positioned in well bore hole 2. Suitable means are provided to rotate string 1 from the surface. Positioned above drill bit 3 are shown two drill collars 4 and 5.

The details of construction of these drill collars are illustrated in Figure 2. A drill casing or pipe string 1 is shown positioned in a bore hole (not shown). In operation, drill casing 1 is rotated preferably from the surface. The lower end of drill casing 1 contains a suitable rotary or fishtail bit attached thereto (not shown). A suitable drilling fluid is passed downwardly within the drill casing 1 which fluid flows from the lower end of the bit and upwardly to the surface through the annulus between the bore hole and drill casing 1.

An upper drill collar 4 and a lower drill collar 5 are shown positioned within drill casing 1. For purposes of simplicity the details of the top of upper drill collar 4 are not illustrated but are the same as the details of the top of lower drill collar 5 which are shown in detail. The lower sections of collar 5 are not illustrated but are similar to the lower sections of collar 4.

The upper ends of the respective drill collars contain a rubber seal 6 which prevents the flow of fluid between the outer surface of the drill collar and the inner surface of the pipe string. Drill collars 4 and 5 also contain a satisfactory sealing element 7 as shown. Each of the drill collars is fitted at its lower end with a removable tubular cage 13 which is threadedly attached to the drill collar as shown. A molded rubber valve seat 8 of generally frusto-conical shape is bonded to the inner surface of the cage 13. The valve seat is reinforced by circumferentially arranged hinged metal segments 9 that are embedded in the rubber valve seat and pivotally held by pins 10 that fit into suitable lugs or brackets (not shown) fastened to the inner wall of the cage 13. Fastened within

the lower end of cage **13** is a fluted stop whose function will be presently explained.

In operation when it is desired to remove the upper drill collar a ball **11** is inserted in the drill casing at the surface, through a lubricating chamber or by other means, and pumped down the casing by normal directional circulation. The ball moves down through upper drill collar **4** to the rubber seat containing the hinged metal segments **9**. These segments move outwardly until the diameter D_3 of the seat is greater than the diameter D_1 of the ball thereby allowing the sphere to pass below the seat and come to rest on the fluted stop **12** which will not permit its passage because D_2 is less than D_1. The ball does not completely close off circulation because of liquid passage through the inner fluted fins **14** but does restrict circulation enough to cause a rise in the pressure gauge at the surface. This acts as a signal on the surface that the ball is "on bottom."

Normal circulation is then stopped and pressure is applied to the annulus around the drill casing and up through the bit into the lower bore of the drill casing and drill collar segments. Ball **11** is forced upward into contact with the seat of hinged metal segments, causing the rubber portion and metal hinge segments to move inwardly, thereby stopping the upward passage of fluid. Upon closure of the valve seat by the ball, surrounding pressure forces cause reduction of the diameter D_3, preventing upward passage of the ball. The metal segments limit inward and upward travel of the rubber such that inversion of the seat is impossible. Further pressure is applied resulting in the movement upwardly of upper drill collar **4** through the string to the surface. The lower drill collar **5** has a similar construction at the lower end thereof and can similarly be removed by utilizing a second ball. When this invention is applied to drill pipe or tubing to provide a closure means at the bottom of the string, removable cage **13** and the parts attached thereto (parts **8** to **14** except **11**) are installed as a permanent fitting at the lower end of the string before running said drill pipe or tubing into the well. Installation of the ball as a closure means is then carried out as previously described.

The present invention is broadly concerned with an improved valve assembly. It is more specifically concerned with a process and apparatus for the removal of drill collars from a pipe string. In general the drill collars comprise a plurality of regular small segments which can be individually removed as desired, each drill collar segment is of a structure which comprises a hinge flange valve arrangement which permits a sphere to be forced against the upper surface thereof and causes the hinged elements to move outwardly against the inner wall of the drill collar thereby increasing the diameter of the valve element and permitting the ball to pass through.

What is claimed is:

1. An improved valve assembly for bore hole operations comprising a tubular member, an inverted frusto-conical valve seat of flexible resilient material positioned within and fastened to said tubular member, said valve seat having a central opening at its lower end, a plurality of circumferentially arranged rigid ribs embedded in said valve seat material, the upper end of each of said ribs being pivotally fastened to said tubular member, a ball shaped valve element freely movable within said tubular member, said valve element having a diameter greater than the opening of said valve seat whereby said ribs will move outward to enlarge said opening sufficiently to pass said element when a downward force is exerted thereon but will move inwardly to prevent upward return of said element through said opening when an upward force exerted on said element places said element in sealing engagement with said seat, and a stop member positioned within said tubular member below said valve seat and arranged to prevent further downward travel of said valve element after it has passed through said opening.

2. Valve assembly as defined by claim 1 wherein said resilient material comprises molded rubber.

3. A removable drill collar for a string of drilling casing comprising a tubular member adapted to fit slidably within said casing, an inverted frusto-conical valve seat of flexible resilient material positioned within and fastened to said tubular member, said valve seat having a central opening at its lower end, a plurality of circumferentially arranged rigid ribs embedded in said valve seat material, the upper end of each of said ribs being pivotally fastened to said tubular member, a ball shaped valve element freely movable within said tubular member, said valve element having a diameter greater than the opening of said valve seat whereby said ribs will move outward to enlarge said opening sufficiently to pass said element when a downward force is exerted thereon, but will move inwardly to prevent upward return of said element when an upward force exerted on said element places said element in sealing engagement with said valve seat, a stop member positioned within said tubular member below said valve seat and arranged to prevent further downward travel of said valve element after it has passed through said opening, and at least one resilient seal fixed to the exterior of said tubular member in a manner sealing the annulus between said casing and said tubular member, said seal acting in conjunction with said valve element and valve seat to prevent upward movement of fluid past said drill collar within said casing, whereby fluid pressure exerted below said drill collar will raise the drill collar through the casing.

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