

LAUNCHING APPARATUS FOR DOWNHOLE ACTUATOR BALLS

BACKGROUND

A downhole actuator ball is conveyed downhole to actuate a wellbore tool, as by landing in the tool and creating a seal therewith. While commonly called a ball, some devices are indeed in the form of an actual spherical ball but some are alternately shaped as darts, are oblong, have tails, etc.

In some operations, a large number of balls are launched. Ball launching apparatus, also called dropping heads, are known for storing the balls and dropping in a controlled sequence. Most ball launching apparatus expose the balls to liquid to assist with conveying a released ball into the wellbore.

In some operations, it is desirable to use a dissolvable ball that can be conveyed downhole to actuate a wellbore tool, but which will dissolve over time when in contact with liquid.

A ball dropping head is needed for handling dissolvable balls.

SUMMARY

In accordance with a broad aspect of the present invention, there is provided a method for launching an actuator ball into a wellbore, the method comprising: storing the actuator ball in a chamber in a ball dropping apparatus, the chamber being substantially free of liquid, and releasing the ball from the chamber.

In accordance with another broad aspect of the present invention, there is provided a ball launching apparatus for launching a ball into a wellhead, the ball launching apparatus comprising: a body, a mounting surface for mounting the body on a wellhead, a main bore opening onto the mounting surface and extending into the body, a ball storage cavity in the body opening into the main bore, a ball chamber within the ball storage cavity, the ball chamber sized to accommodate the ball, and a seal for the ball chamber to

substantially seal against passage of liquid from the main bore into the ball chamber.

In accordance with another broad aspect of the present invention, there is provided a method for launching an actuator ball into a wellbore, the actuator ball having a protective coating on its outer surface, the method comprising: releasing the actuator ball from a ball storage chamber to pass along a ball launching path toward the well, and moving the actuator ball past a protective coating opener that protrudes into the ball launching path to open the protective coating.

In accordance with another broad aspect of the present invention, there is provided a ball launching apparatus for launching a ball into a wellhead, the ball launching apparatus comprising: a body, a mounting surface for mounting the body on a wellhead, a main bore extending from an opening on the mounting surface into the body and, a ball storage chamber in the body opening into the main bore, a ball launching path defined through the ball storage chamber and the main bore leading from the ball storage chamber to the opening, and a protrusion in the ball launching path configured to open a coating on the ball as the ball passes the protrusion.

It is to be understood that other aspects of the present invention will become readily apparent to those skilled in the art from the following detailed description, wherein various embodiments of the invention are shown and described by way of illustration. As will be realized, the invention is capable for other and different embodiments and its several details are capable of modification in various other respects, all without departing from the spirit and scope of the present invention. Accordingly the drawings and detailed description are to be regarded as illustrative in nature and not as restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

Several aspects of the present invention are illustrated by way of example, and not by way of limitation, in detail in the drawings.

The drawings include:

Figures 1 and 2 are schematic sectional views through one embodiment of a ball

launching apparatus where Figure 1 shows a ball in a stored position and Figure 2 shows a ball being launched.

Figures 3 and 4 are schematic sectional views through another embodiment of a ball launching apparatus where Figure 3 shows the ball launching apparatus in a ball-storing position and Figure 4 shows a ball being launched.

Figure 5 is a section through a ball launcher with an ball coating opener.

Figure 6 is a section through a ball launcher with a ball coating opener.

DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS

The description that follows and the embodiments described therein are provided by way of illustration of an example, or examples, of particular embodiments of the principles of various aspects of the present invention. These examples are provided for the purposes of explanation, and not of limitation, of those principles and of the invention in its various aspects. In the description, similar parts are marked throughout the specification and the drawings with the same respective reference numerals. The drawings are not necessarily to scale and in some instances proportions may have been exaggerated in order more clearly to depict certain features.

A ball launching apparatus is mounted on a wellhead and has a main bore that opens into the passage of the wellhead that leads to the well. One or more balls may be stored in the ball launching apparatus and released through the main bore to enter the wellhead and, thereby, the well.

The ball launching apparatus may take many forms but in one embodiment, the ball launching apparatus has a ball storage chamber that stores a ball in a substantially dry condition such that a ball stored in the ball storage chamber is substantially not exposed to liquid until the time it is to be released into the main bore for entry into the wellhead.

In the illustrated embodiment, the ball launching apparatus 10 includes: a body 12, a mounting surface 14 for mounting the body on a wellhead 16, a main bore 18 opening onto the mounting surface 14 and extending into the body, a ball storage cavity 20 in the

body with an opening to the main bore 18, a ball chamber 22 for accommodating a ball 23 within the ball storage cavity 20 and a seal 24 for the ball chamber to substantially seal against passage of liquid from the main bore 18 into the ball chamber. The illustrated apparatus also includes a ball launching mechanism 26 for moving a ball from the ball storage cavity into the main bore for launching from the main bore into the wellhead.

In the illustrated ball launcher, the ball launching mechanism 26 is a plunger 28 that has a recess 30 that defines the ball chamber 22. The plunger 28 has an inner end 28a that is adjacent the opening from cavity 20 into the main bore 18 and an outer end 28b opposite the inner end. Recess 30 is positioned between the ends 28a, 28b.

Plunger 28 normally resides with recess 30 in the ball storage cavity. However, a driver 32, such as a hydraulic system, can drive plunger 28 to move the ball chamber defined by recess 30 into the main bore. When recess 30 is moved into main bore 18, the ball chamber 22 is positioned to release, arrow R, any ball 23 therein into the main bore.

The plunger has a cross-sectional shape at its end 28a that fits closely within the cross sectional open area of ball storage cavity 20. The seal is either formed by the close fit of end 28a within the cavity 20 or the seal 24, as shown, is a separate item such as an o-ring carried on end 28a or installed within cavity 20. In any event, seal 24 is positioned between ball chamber 22 and main bore 18 to seal against infiltration of liquid from the main bore to the ball chamber until the plunger is moved to expose ball chamber 22 to the main bore.

The ball launching apparatus is useful, therefore, for handling (storing and launching) disintegrating balls. A disintegrating ball is one formed at least in part of a material that breaks down in ball launching liquids. Launching liquids, arrow L, are normally passed through the main bore 18 to assist with the movement of a ball from the ball launching apparatus to the wellhead. If launching liquids were able to migrate into cavity 20 to chamber 22, the ball may begin to disintegrate prematurely and may therefore not be capable of properly actuating a tool downhole. The current ball launcher avoids this problem.

The ball launching apparatus generally is intended to store a plurality of balls and, therefore, has a plurality of ball storage cavities or a plurality of ball chambers in the ball storage cavity. Each ball storage cavity may have its own seal, such that the launching of one ball does not place the remaining balls in contact with liquid. The seal for each ball storage cavity may remain in tact until the ball from that ball storage cavity is launched. The ball storage cavity is sized to accommodate only one ball.

While a particular embodiment of a ball launcher has been shown, it is to be understood that other forms are possible, such a ball launcher where the ball launching mechanism does not actually form the ball chamber but the ball chamber is an empty space in the ball storage cavity and the seal positioned between this space and the opening where the ball storage cavity opens to the main bore. The seal could be a valve such as a flapper valve or a ball valve. There may or may not be a ball launching mechanism, depending on whether the ball can reliably exit on its own from the ball storage cavity.

In another embodiment, the ball launching apparatus is particularly configured to handle a dissolvable ball with a protective coating. In particular, in some applications, the ball to be employed is dissolvable, having a main body that includes dissolvable material but in which the main body is coated with a protective coating. The protective coating is intended to protect the ball's dissolvable components against exposure to the liquid that causes them to dissolve. Only when the protective coating is opened will the dissolvable material be exposed to liquid and begin to dissolve. As such, keeping the protective coating intact until a selected time can extend the useful life of the ball.

In one embodiment, therefore, the ball launching apparatus may act to open the protective coating when the ball is launched. In such an apparatus, the ball has its protective coating maintained intact until the ball is launched. Thus, the ball with its coating can withstand the presence of a liquid that would otherwise cause dissolution thereof even if the liquid normally is in, or leaks into, the ball storage chamber.

The ball's protective coating may be opened as the ball is launched, at any point in or between the ball storage chamber and the opening to the wellhead. The apparatus includes a protrusion in the ball-launching path, which is the path along which the ball

moves during the launching process, which the ball must pass during the launching. The protrusion may be positioned to act in the ball storage chamber or in the main bore and is configured to open the protective coating on the ball during the launching process.

The protrusion can take many forms such as including one or more sharpened surfaces such as an edge or tip. The protrusion may be fixed and the ball must push past it. Alternately the protrusion may be moveable such that it moves to contact the ball and/or moves out of the way after contacting the ball. The protrusion can be one structure or a plurality of structures.

The protrusion may act to open the protective coating in various ways as by cracking, cutting, scraping, etc. the coating. The action of the protrusion may be selected to open the protective coating but not destroy the ability of the ball to land on and seal against a seat or sealing surface if, in fact, the ball is intended to act in that way to fulfill its actuation purpose.

In the illustrated embodiment, the ball launching apparatus 110 includes: a body 112, a mounting surface 114 for mounting the body on a wellhead 116, a main bore 118 extending from an opening 118a on the mounting surface 114 into the body and one or more ball storage areas 119 in the body which each define a ball storage cavity, the ball storage area has an opening 119a to the main bore 118. The illustrated apparatus also includes a ball launching mechanism 126 for moving a ball from the ball storage cavity into the main bore for launching from the main bore into the wellhead.

The illustrated ball launching apparatus 110 moves a ball along a ball-launching path P during the launching process. The illustrated path P is the longest one of the apparatus, extending from the opening 118a to the area 119 furthest from the opening. It is to be understood that all areas 119 have a path through their individual openings 119a to the main bore. For example, arrows R show another launching path from another area 119 toward opening 118a.

In the illustrated ball launcher, the ball launching mechanism 126 includes a plunger 128. The plunger 128 has an inner end 128a that is adjacent opening 119a from ball storage

area 119 into the main bore 118 and an outer end 128b opposite the inner end. The space between ends 128a and opening 119a and defines the ball storage cavity.

Plunger 128 normally resides in a retracted position. However, a driver 132, such as a hydraulic system, can drive plunger 128 to move plunger toward opening 119a and thereby toward main bore. When plunger 128 is moved toward main bore 118, any ball 123 stored between plunger 128 and opening 119a is released, arrow R, into the main bore.

The ball launching apparatus further includes a protrusion, shown as options 140a, 140b, 140c, in the ball-launching path from cavity 120 to opening 118a, which is the path along which the ball moves during the launching process. While only one protrusion is required, three protrusions 140a, 140b, 140c are shown to illustrate options with respect to possible positions and forms.

For example a protrusion can be positioned to act in area 119 in the ball storage chamber such as on a portion of the driver that will contact the ball, as shown by option 140a, at or adjacent opening 119a between the ball storage chamber and the main bore, as shown by option 140b, or in the main bore at any of various locations, as shown by protrusion 140c.

The one or more protrusions are configured to open the ball's protective coating during the launching process.

Some enlarged embodiments of protrusions for opening a ball coating are shown to illustrate that the protrusion can take any of many forms. In one embodiment as shown in Figure 5, for example, protrusion 140d takes the form of a pin with a sharpened tip 140d'. Protrusion 140d is positioned in the ball storage area 119d to strike against the ball during the launching process. In particular, protrusion 140d is installed in the ball storage area normally out of the way of the ball storage cavity 120d and, thereby, out of the way of the ball when the ball is stored in the ball launcher. As such, when ball 123d is stored in ball storage cavity, the ball is not in contact with the protrusion. However, during the launching process, the launching mechanism moves, arrow A, the ball in the cavity forcefully against the protrusion. As such, the pointed tip 140d' of protrusion 140d is

driven against and punctures the coating of the ball before or while it is launched into main bore 118d.

It is noted that ball storage area 119d has seals 124d that protect ball storage cavity from infiltration of liquid from main bore 119d, when chamber 120d is retracted away from opening 119a. As such, any ball 123d that is being stored in chamber 120d is protected from contact with liquid, such as that liquid in bore 118d, until the ball launching mechanism 126d is moved as shown to align chamber 120d with opening 119a.

Another protrusion 140e is shown in Figure 6. Protrusion 140e is positioned in main bore 118e. Protrusion 140e protrudes into the inner diameter of main bore in a position past which all balls must move during their launch. For example, protrusion 140e may be positioned adjacent end 118a. Protrusion 140e includes a sharpened edge 140e' that can open, as by cutting or scraping, the coating from ball 123e while it is being launched through main bore 118e. Protrusion 140e extends a distance into main bore such that all balls, even of the smallest diameter to be handled by the launcher must be push past and be scraped. In other words the clearance distance c between protrusion edge 140e' and another edge 140e' or the sidewall of the main bore is no greater than the diameter D of the smallest ball to be launched. If desired, protrusion 140e may have a retraction mechanism 142 to permit protrusion 140e to retract, arrow B, to increase the clearance distance if sufficient force is applied against protrusion 140e. This ability to retract prevents a ball from being caught in the main bore.

The ball launching apparatus of Figures 4 to 6 are useful, therefore, for handling (storing and launching) coated disintegrating balls, which is a ball formed at least in part of a disintegrating material that breaks down in ball launching liquids but which has a coating to prevent contact between the disintegrating material and the liquid until the coating is opened. The current ball launcher opens the coating as the ball is launched.

The previous description of the disclosed embodiments is provided to enable any person skilled in the art to make or use the present invention. Various modifications to those embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments. Thus, the present

invention is not intended to be limited to the embodiments shown herein, but is to be accorded the full scope consistent with the claims, wherein reference to an element in the singular, such as by use of the article "a" or "an" is not intended to mean "one and only one" unless specifically so stated, but rather "one or more". All structural and functional equivalents to the elements of the various embodiments described throughout the disclosure that are known or later come to be known to those of ordinary skill in the art are intended to be encompassed by the elements of the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. No claim element is to be construed under the provisions of 35 USC 112, sixth paragraph, unless the element is expressly recited using the phrase "means for" or "step for".

Claims:

1. A method for launching an actuator ball into a wellbore, the method comprising: storing the actuator ball in a chamber in a ball dropping apparatus, the chamber being substantially free of liquid, and releasing the ball from the chamber.
2. A ball launching apparatus for launching a ball into a wellhead, the ball launching apparatus comprising: a body, a mounting surface for mounting the body on a wellhead, a main bore opening onto the mounting surface and extending into the body, a ball storage cavity in the body opening into the main bore, a ball chamber within the ball storage cavity, the ball chamber sized to accommodate the ball, and a seal for the ball chamber to substantially seal against passage of liquid from the main bore into the ball chamber.
3. A method for launching an actuator ball into a wellbore, the actuator ball having a protective coating on its outer surface, the method comprising: releasing the actuator ball from a ball storage chamber to pass along a ball launching path toward the well, and moving the actuator ball past a protective coating opener that protrudes into the ball launching path to open the protective coating.
4. A ball launching apparatus for launching a ball into a wellhead, the ball launching apparatus comprising: a body, a mounting surface for mounting the body on a wellhead, a main bore extending from an opening on the mounting surface into the body and, a ball storage chamber in the body opening into the main bore, a ball launching path defined through the ball storage chamber and the main bore leading from the ball storage chamber to the opening, and a protrusion in the ball launching path configured to open a coating on the ball as the ball passes the protrusion.