

# 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.

## 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, plunger 28 can be driven by a driver 32, such as a hydraulic system, 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, which is a ball 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.

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, the useful life of the ball can be extended by keeping the protective coating intact until a selected time.

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, when the ball is being launched.

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 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.

Xxx 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, a ball storage cavity 120 in the body with an opening to the main bore 118, a ball chamber 122 for accommodating a ball 123 within the ball storage cavity 120 and a seal 124 for the ball chamber to substantially seal against passage of liquid from the main bore 118 into the ball chamber. 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.

In the illustrated ball launcher, the ball launching mechanism 126 is a plunger 128 that has a recess 130 that defines the ball chamber 122. The plunger 128 has an inner end 128a that is adjacent the opening from cavity 120 into the main bore 118 and an outer end 128b opposite the inner end. Recess 130 is positioned between the ends 128a, 128b.

Plunger 128 normally resides with recess 130 in the ball storage cavity. However, plunger 128 can be driven by a driver 132, such as a hydraulic system, to move the ball chamber defined by recess 130 into the main bore. When recess 130 is moved into main

bore 118, the ball chamber 122 is positioned to release, arrow R, any ball 123 therein into the main bore.

The plunger has a cross-sectional shape at its end 128a that fits closely within the cross sectional open area of ball storage cavity 120. The seal is either formed by the close fit of end 128a within the cavity 120 or the seal 124, as shown, is a separate item such as an o-ring carried on end 128a or installed within cavity 120. In any event, seal 124 is positioned between ball chamber 122 and main bore 118 to seal against infiltration of liquid from the main bore to the ball chamber until the plunger is moved to expose ball chamber 122 to the main bore.

The ball launching apparatus is useful, therefore, for handling (storing and launching) disintegrating balls, which is a ball 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 118 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 120 to chamber 122, 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.

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.

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.