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Franchini

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(54) **DAMPING AND SEALING DEVICE FOR A WELL PIPE HAVING AN INNER FLOW PASSAGE AND METHOD OF USING THEREOF**

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E21B 23/10 (2006.01)

(52) **U.S. Cl.** **166/156**; 166/242.8

(58) **Field of Classification Search** 166/373, 166/156, 242.6, 242.7, 242.8; 285/316, 302
See application file for complete search history.

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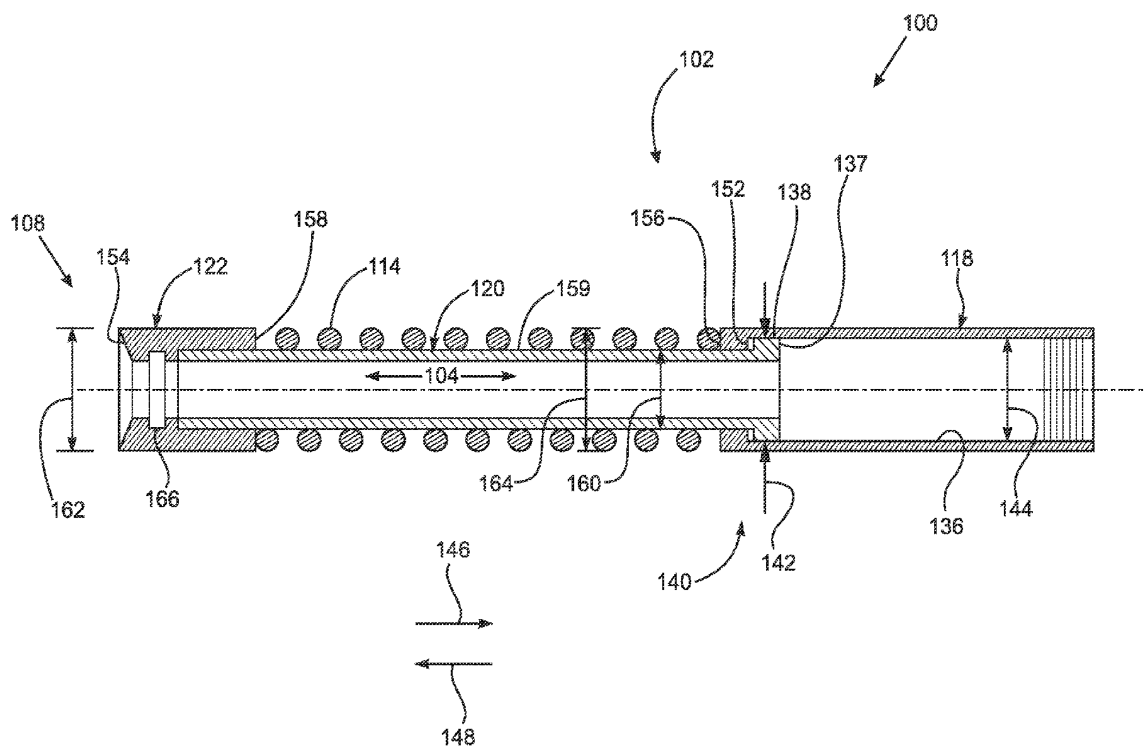
(57) **ABSTRACT**

A damping and sealing device for enabling gas or liquid flow from a well to a production tube in the well, including a body with a flow passage internal to the body and a spring disposed about a portion of the body. The flow passage includes a first opening at a first longitudinal end of the body and a second opening at a second longitudinal end of the body. The first end is arranged to contact a plunger for the well and the body is arranged to sealingly engage the production tube. In one embodiment, the body includes an inner circumferential surface and an outer circumferential surface, the inner circumferential surface forms the internal flow passage, and a portion of the outer circumferential surface is arranged to slide along a portion of the inner circumferential surface in response to the first end contacting a plunger.

8 Claims, 7 Drawing Sheets



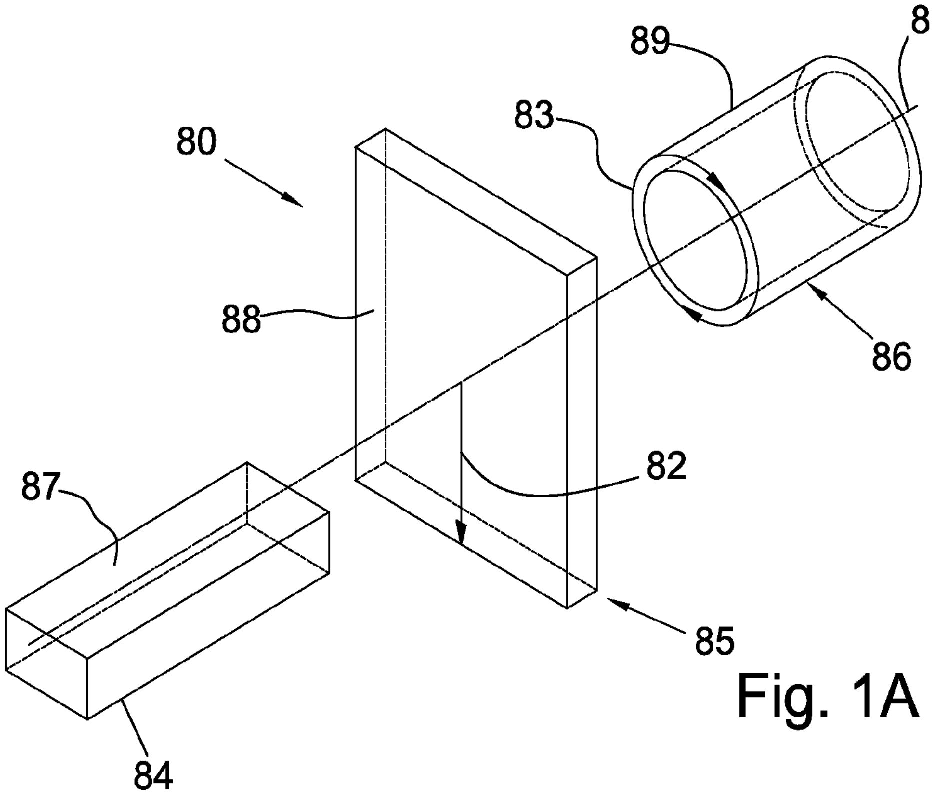


Fig. 1A

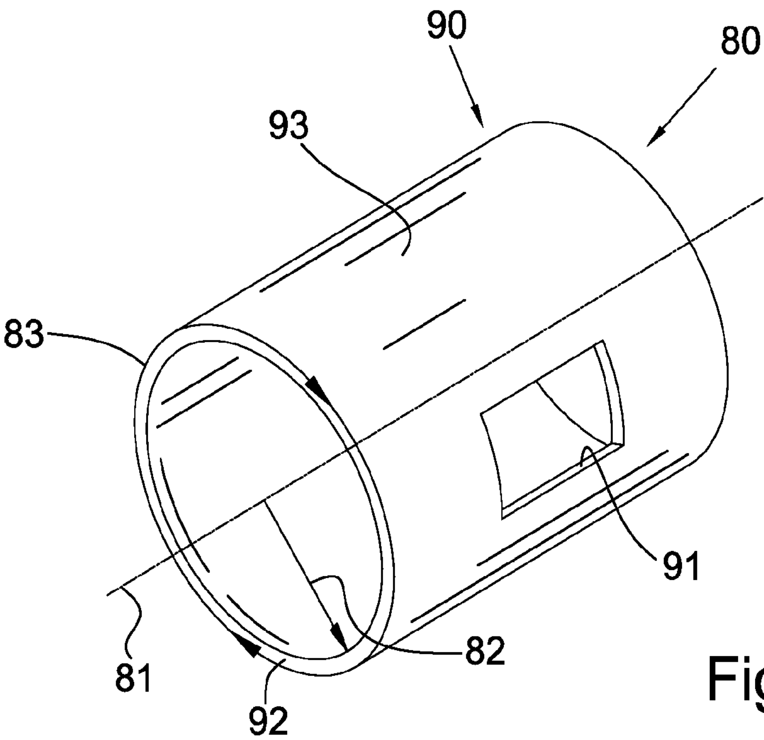
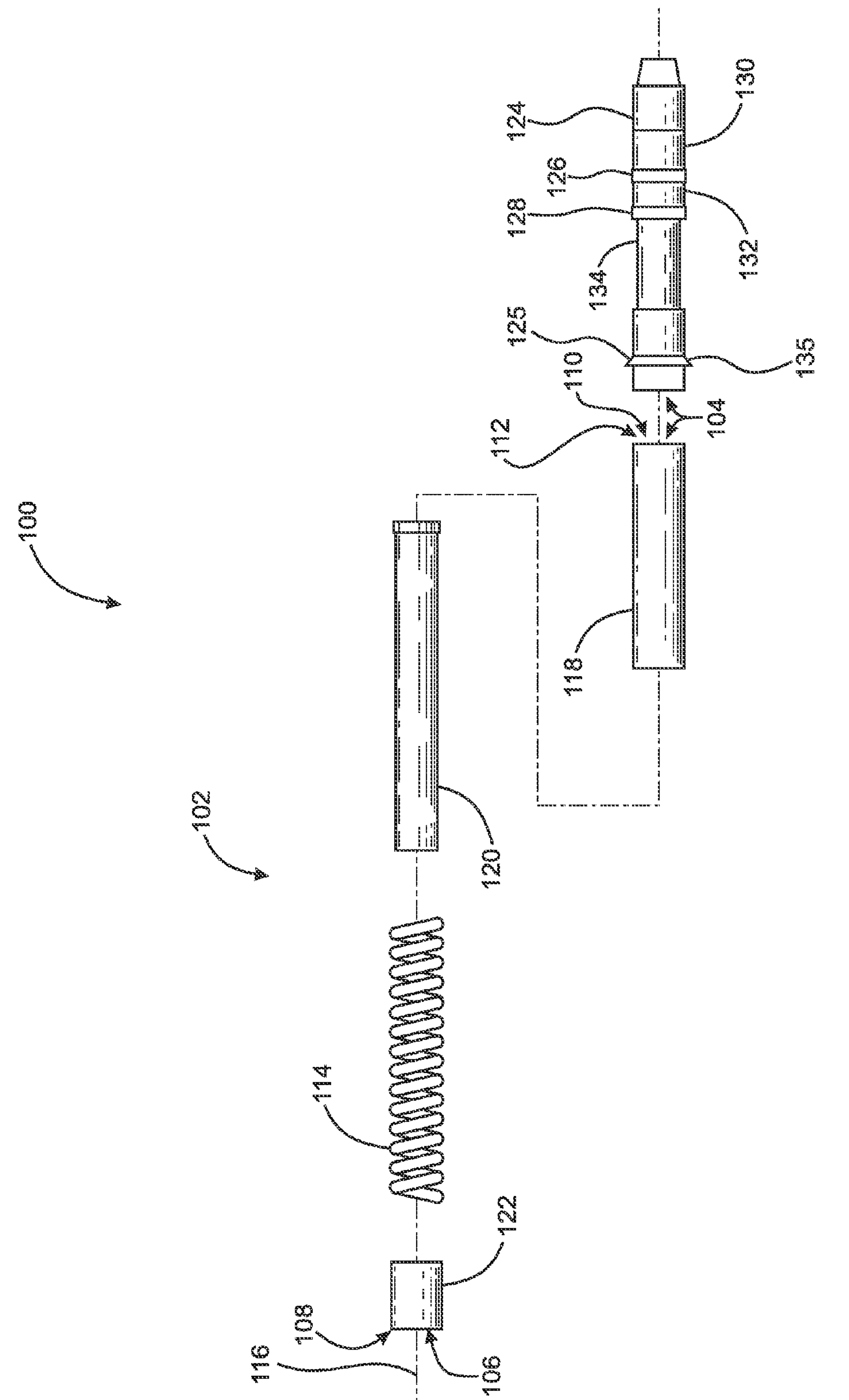


Fig. 1B


100
102
104
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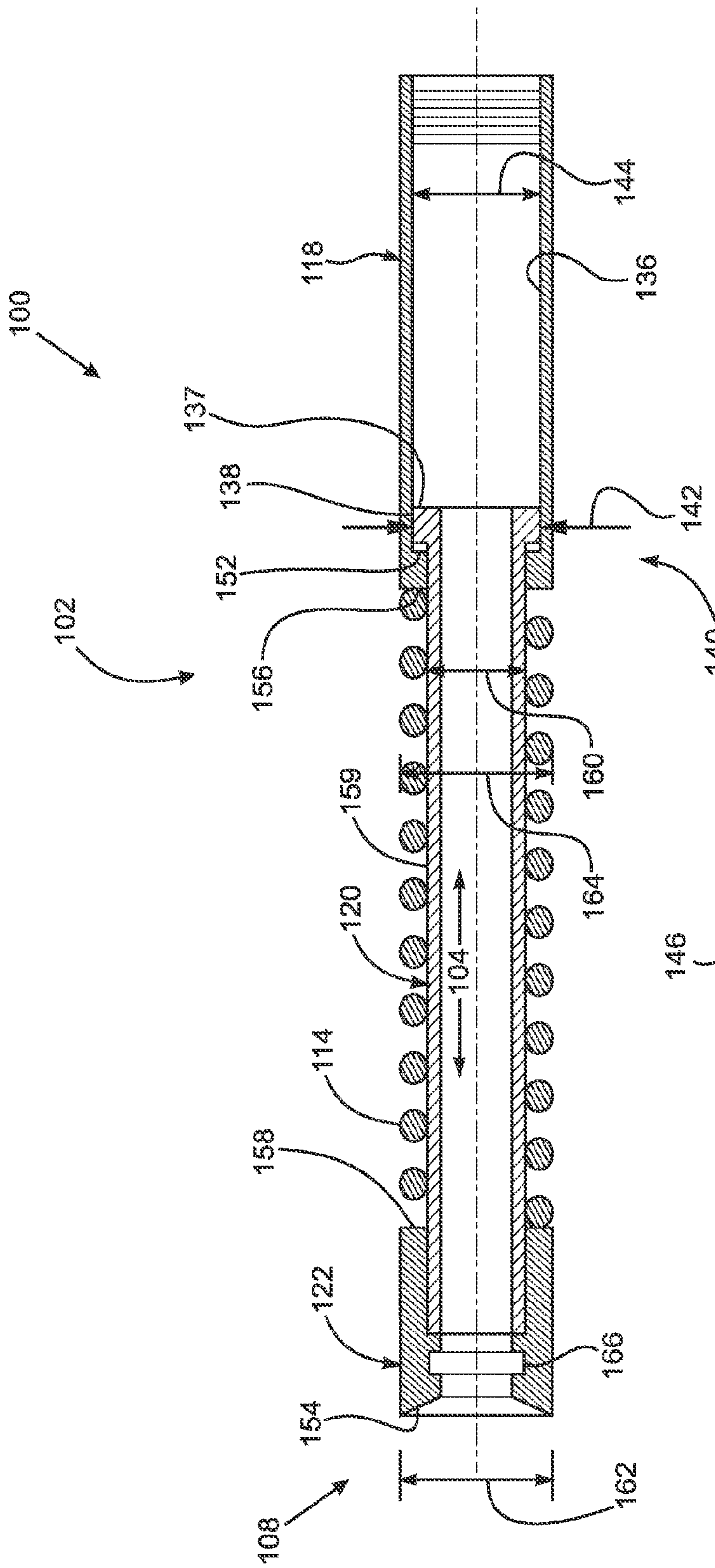
135

Fig. 2


100
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166

Fig. 3

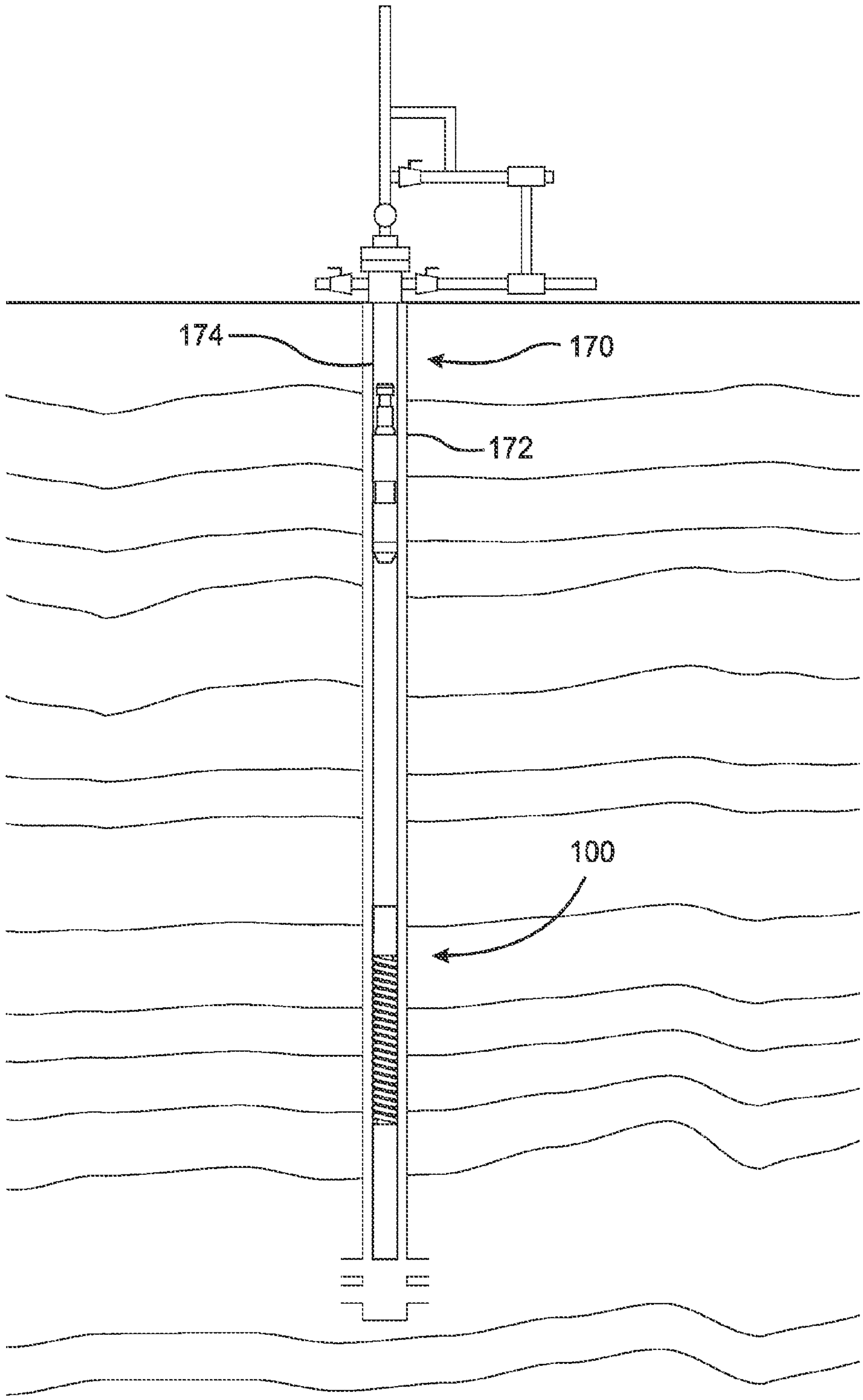

Fig. 3A

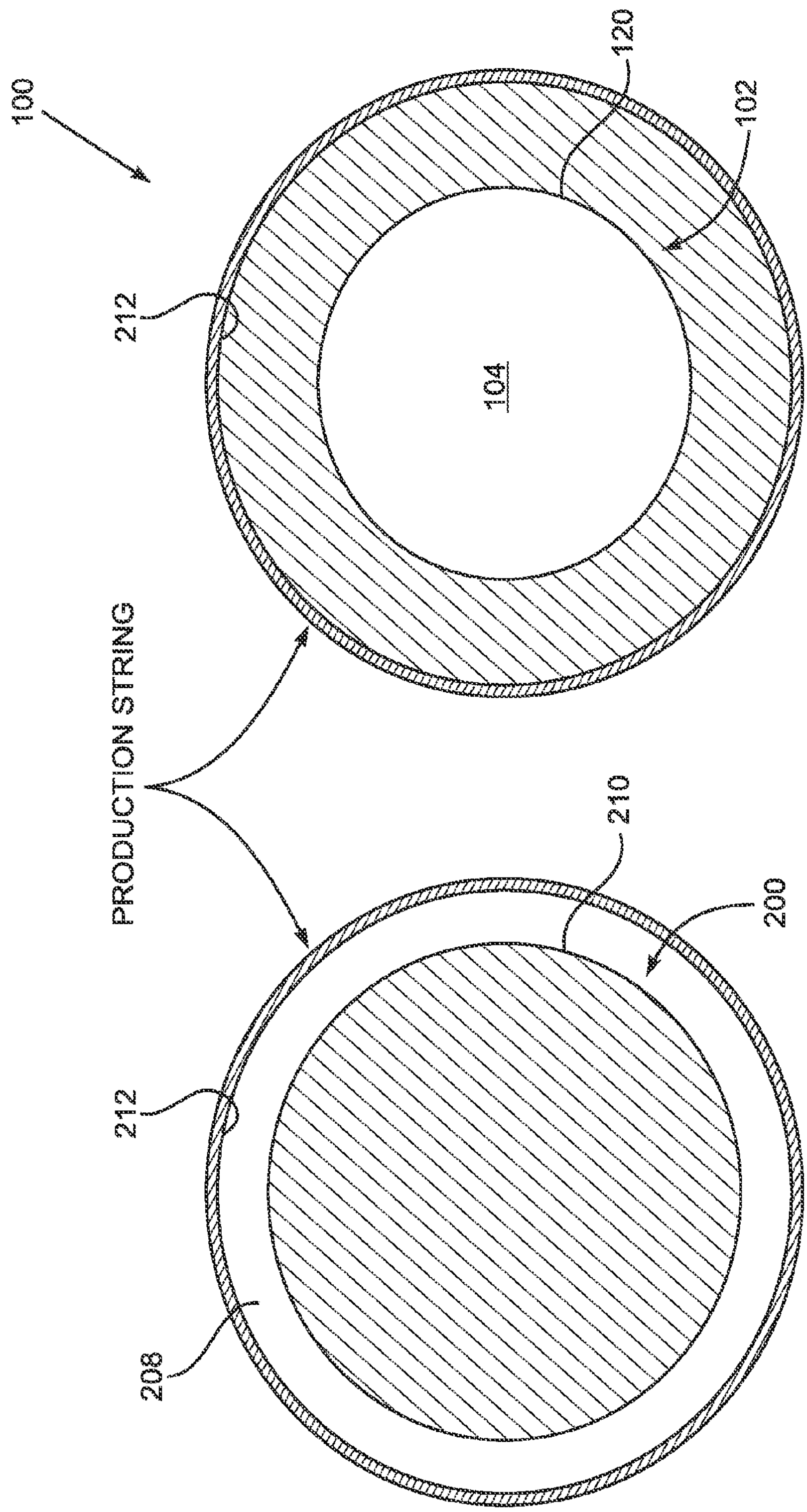

Fig. 4A

PRIOR ART
Fig. 4B

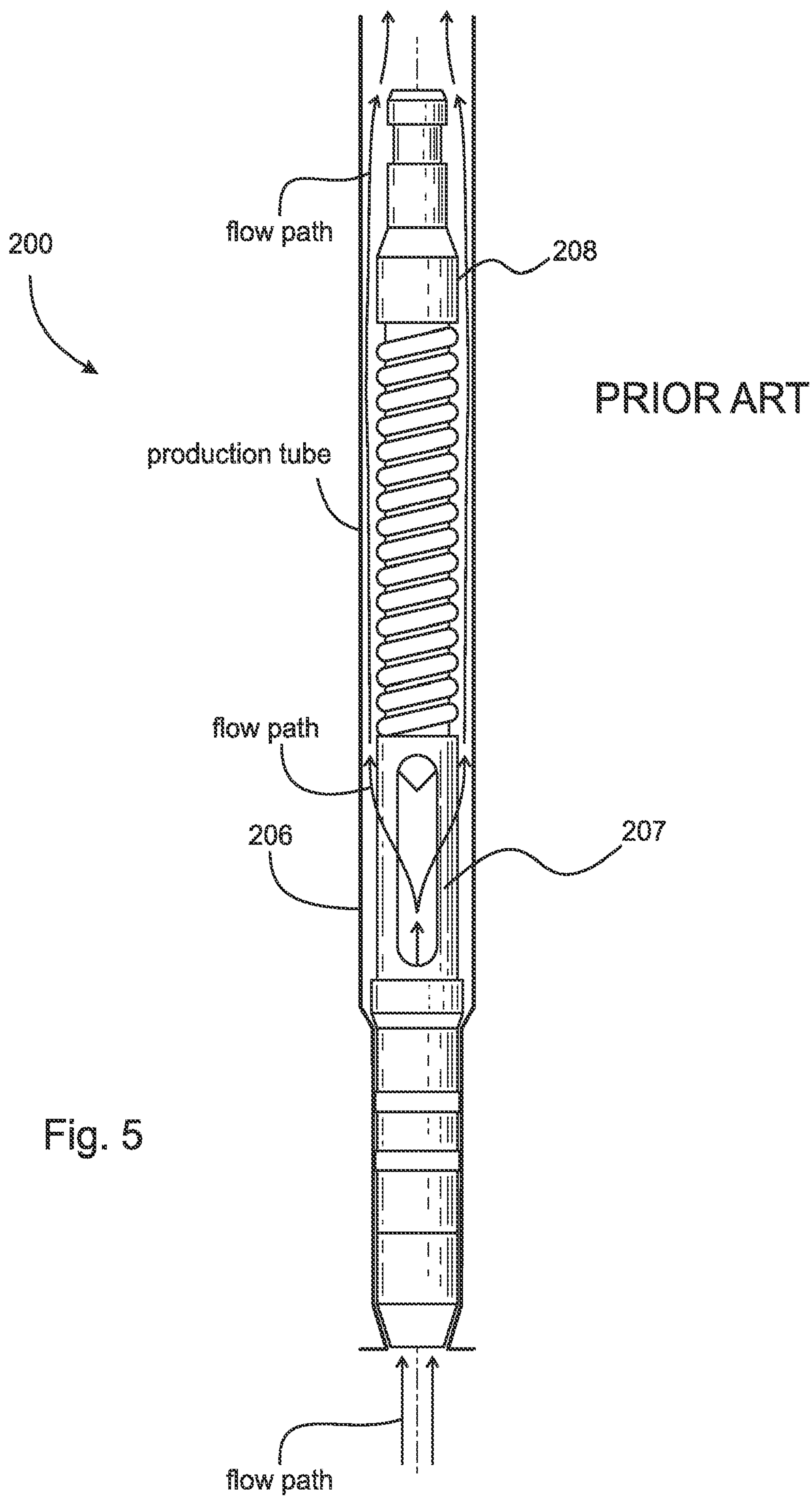
flow path
200
208
PRIOR ART
production tube
flow path
206
207
flow path

Fig. 5

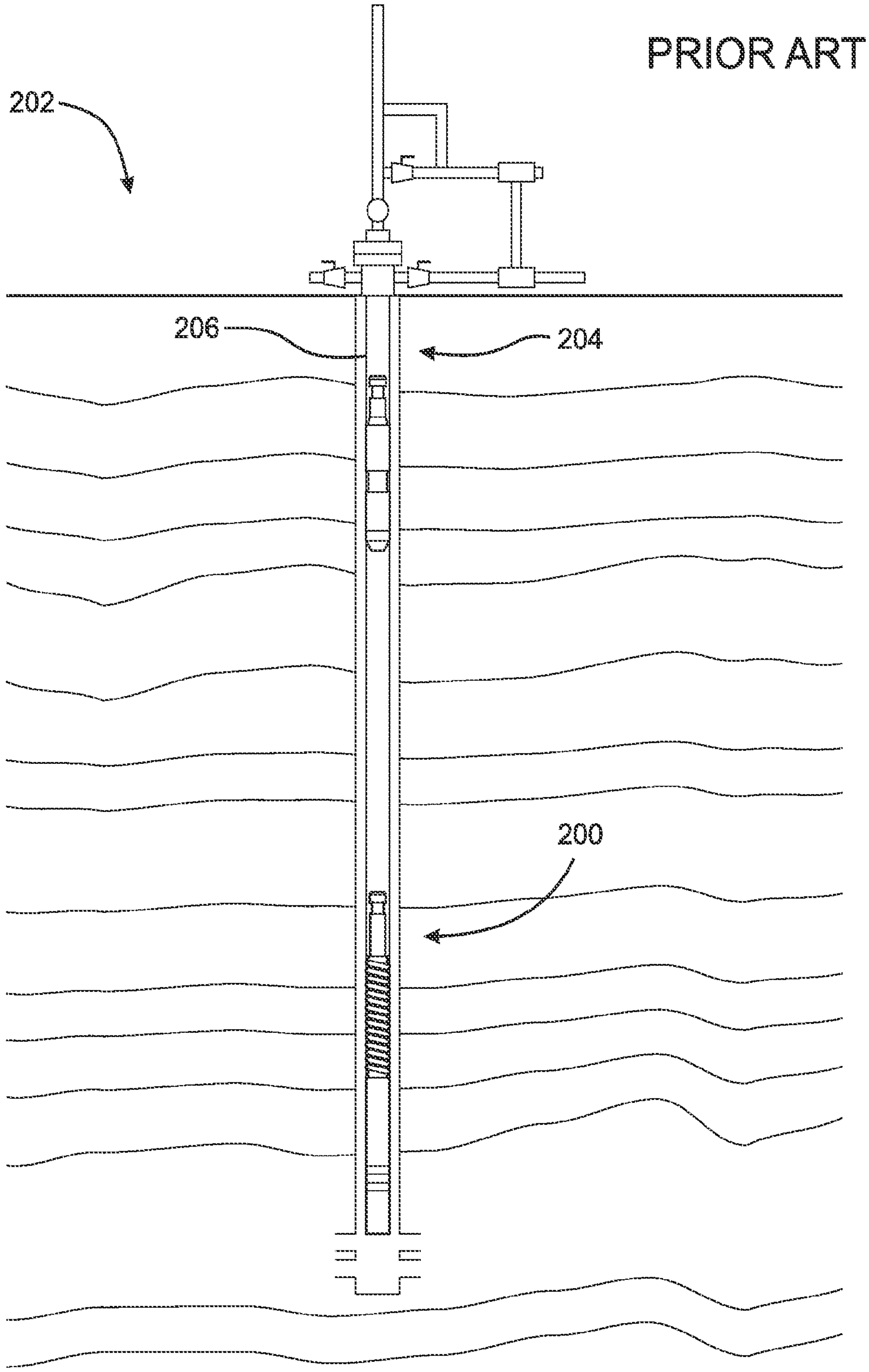

Fig. 6

DAMPING AND SEALING DEVICE FOR A WELL PIPE HAVING AN INNER FLOW PASSAGE AND METHOD OF USING THEREOF

FIELD OF THE INVENTION

The present invention relates generally to a damping and sealing device for a well. More specifically, the present invention relates to a damping and sealing device, for a gas and/or oil well, having an internal flow passage.

BACKGROUND OF THE INVENTION

FIG. **5** is a side view of typical, or conventional, bumper spring **200** in a production tube.

FIG. **6** is a side view of a typical, or conventional, well showing an arrangement and location for bumper spring arrangement **202**. The following should be viewed in light of FIGS. **5** and **6**. Bottom-hole bumper springs, such as spring **200** shown in FIG. **5**, are typically used in wells, such as well **204**, with plunger artificial lift systems. Due to the construction of the bumper springs, the flow path taught for production tubes, such as tube **206**, is restricted to the space through sealing portion **207** and then through the space between an outer circumference of the bumper spring, for example, as defined by the outer circumference of spring **208**, and the production tube. This flow path is shown in FIG. **5**. To more clearly illustrate this flow path, the size of the space noted above has been exaggerated in FIG. **5**.

Operation of a typical bottom-hole bumper spring is predicated upon placing a spring in the space noted above to absorb the impact of a plunger. Typically, the operation of the bumper spring is further based on restricting the size of the portion of the bumper spring impacted by a plunger to fit within the area formed by the outer diameter of the spring. Thus, the area available for flow past the bumper spring also is restricted to the area between the portion of the bumper spring impacted by a plunger and the inner diameter of the production tube.

BRIEF SUMMARY OF THE INVENTION

The present invention broadly comprises a damping and sealing device for enabling gas or liquid flow from a well to a production tube in the well, including a body; a flow passage internal to the body and including a first opening at a first longitudinal end of the body and a second opening at a second longitudinal end of the body; and a spring disposed about at least a portion of the body. The first end is arranged to receive a plunger in the well and the body is arranged to sealingly engage the production tube. In an example embodiment, the body includes first and second segments, the first segment includes an inner circumferential surface forming a portion of the flow passage, and the second segment includes an outer circumferential surface arranged to slide along the inner circumferential surface in response to a plunger contacting the first end. In an example embodiment, the first and second segments are interlocked. In an example embodiment, the body includes first and second segments, the first segment includes an inner circumferential surface forming a portion of the flow passage, and the second segment includes an outer circumferential surface slideable along the inner circumferential surface. In an example embodiment, the body includes an inner circumferential surface and an outer circumferential surface and a portion of the outer circumferential surface is slidingly engaged with a portion of the inner circumferential surface.

The present invention also broadly comprises a damping and sealing device for enabling gas or liquid flow from a well to a production tube in the well, including a body; a flow passage radially within the body; and a spring disposed about a portion of the body and radially aligned with a portion of the flow passage.

The present invention further broadly comprises a damping and sealing device for enabling gas or liquid flow from a well to a production tube in the well, including a body; a flow passage through the body; and a spring surrounding a portion of the body. The portion of the body is disposed between the flow passage and the spring.

The present invention broadly comprises a method for producing a well.

A general object of the present invention is to provide a device providing sufficient shock protection for down-hole components while maximizing flow through the bumper spring to a production tube.

This and other objects, features and advantages of the present invention will become readily apparent to those having ordinary skill in the art from a reading and study of the following detailed description of the invention, in view of the drawing and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The nature and mode of operation of the present invention will now be more fully described in the following detailed description of the invention taken with the accompanying drawing figures, in which:

FIG. **1**A is a perspective view of a cylindrical coordinate system demonstrating spatial terminology used in the present application;

FIG. **1**B is a perspective view of an object in the cylindrical coordinate system of FIG. **1**A demonstrating spatial terminology used in the present application;

FIG. **2** is an exploded side view of a damping and sealing device for enabling gas or liquid flow from a well to a production tube in the well, and ancillary components;

FIG. **3** is a cross section of the device in FIG. **2**;

FIG. **3**A is a side view of a typical, or conventional, well showing an example arrangement and location of the damping and sealing device shown in FIG. **2**.

FIG. **4**A illustrates a cross-sectional flow area for the device shown in FIG. **2**;

FIG. **4**B is a prior art bumper spring, in a production string the same size as the production string shown in FIG. **4**A;

FIG. **5** is a cross-sectional view of a typical bumper spring in a production tube; and,

FIG. **6** is a side view of a typical well showing an arrangement and location for a bumper spring.

DETAILED DESCRIPTION OF THE INVENTION

At the outset, it should be appreciated that like drawing numbers on different drawing views identify identical, or functionally similar, structural elements of the invention. It is to be understood that the invention as claimed is not limited to the disclosed aspects.

Furthermore, it is understood that this invention is not limited to the particular methodology, materials and modifications described and as such may, of course, vary. It is also understood that the terminology used herein is for the purpose of describing particular aspects only, and is not intended to limit the scope of the present invention, which is limited only by the appended claims.

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this invention belongs. Although any methods, devices or materials similar or equivalent to those described herein can be used in the practice or testing of the invention, example methods, devices, and materials are now described.

FIG. **1**A is a perspective view of cylindrical coordinate system **80** demonstrating spatial terminology used in the present application. The present invention is at least partially described within the context of a cylindrical coordinate system. System **80** has a longitudinal axis **81**, used as the reference for the directional and spatial terms that follow. The adjectives "axial," "radial," and "circumferential" are with respect to an orientation parallel to axis **81**, radius **82** (which is orthogonal to axis **81**), and circumference **83**, respectively. The adjectives "axial," "radial" and "circumferential" also are regarding orientation parallel to respective planes. To clarify the disposition of the various planes, objects **84**, **85**, and **86** are used. Surface **87** of object **84** forms an axial plane. That is, axis **81** forms a line along the surface. Surface **88** of object **85** forms a radial plane. That is, radius **82** forms a line along the surface. Surface **89** of object **86** forms a circumferential plane. That is, circumference **83** forms a line along the surface. As a further example, axial movement or disposition is parallel to axis **81**, radial movement or disposition is parallel to radius **82**, and circumferential movement or disposition is parallel to circumference **83**. Rotation is with respect to axis **81**.

The adverbs "axially," "radially," and "circumferentially" are with respect to an orientation parallel to axis **81**, radius **82**, or circumference **83**, respectively. The adverbs "axially," "radially," and "circumferentially" also are regarding orientation parallel to respective planes.

FIG. **1**B is a perspective view of object **90** in cylindrical coordinate system **80** of FIG. **1**A demonstrating spatial terminology used in the present application. Cylindrical object **90** is representative of a cylindrical object in a cylindrical coordinate system and is not intended to limit the present invention in any manner. Object **90** includes axial surface **91**, radial surface **92**, and circumferential surface **93**. Surface **91** is part of an axial plane, surface **92** is part of a radial plane, and surface **93** is part of a circumferential plane.

FIG. **2** is an exploded side view of damping and sealing device **100**, for enabling gas or liquid flow from a well to a production tube in the well, and ancillary components.

FIG. **3** is a cross section of device **100** in FIG. **2**. FIG. **3**A is a side view of a typical, or conventional, well **170** showing an example arrangement and location of damping and sealing device **100** shown in FIG. **2**. The following should be viewed in light of FIGS. **2**, **3**, and **3**A. Device **100**, also referred to as a bottom hole bumper spring or a damping and sealing device, includes body **102** with a flow passage, also referred to as a flow path or channel, **104** internal to the body. Well **170** includes casing **172** and production tube **174**. Plunger **176** is shown in the production tube. As further described infra, device **100** is arranged to enable fluid flow through production tube **174**, or string, in a well. A typical well arrangement with a flow path restricted to the space through a sealing portion, the space between an outer circumference of the bumper spring and the production tube, and the area between the portion of the bumper spring impacted by a plunger and the inner diameter of the production tube is shown supra in FIG. **5**.

By internal to the body, we mean that the body defines or encloses the passage. That is, the passage is surrounded by, or formed by, the body, as further described infra. Alternately stated, production from the well does not flow between the outer circumference of device **100** and the production tube, for example, as for the typical bumper springs described supra, but rather the production from the well flows inside device **100**. The flow passage includes opening **106** at longitudinal end **108** of the body and opening **110** at longitudinal end **112** of the body. Spring **114** is disposed about a portion of the body. Longitudinal and special references infra are defined with respect to longitudinal axis **116**. Flow through the flow passage can be, but is not limited to, gas, liquid, or any mixture of gas and liquid known in the art.

In an example embodiment, body **102** includes slide segment **118**; spring segment **120**; and plunger segment **122**. The body is connected to ancillary pieces as known in the art to sealingly engage with the production string so that flow from the well is directed through channel **104**. In an example embodiment, the following ancillary parts are connected to device **100**: lower end **124**, seals **126** and **128**; spacer segments **130** and **132**; and coupling **134**. Ancillary parts can be joined by any means known in the art, for example, by mating threaded connections. It should be understood that other numbers, shapes, and configurations of ancillary parts can be used with device **100**.

Alternately stated, passage **104** is an internal flow passage and the spring is disposed about portion **120** of the body radially aligned with the internal flow passage. That is, a portion of the body separates the flow passage and the spring. Specifically, portion **120** of the body is disposed between the flow passage and the spring. The description below is directed to an example embodiment as shown in FIGS. **2** and **3**; however, it should be understood that device **100** is not limited to the example embodiment shown in FIGS. **2** and **3**.

End **108** is arranged to contact plunger **176** for the well and body **102** is arranged to be sealingly engaged with the production string by any means known in the art. By sealingly engage, we mean that a substantially gas or liquid-tight seal is created between the device **100** and the ancillary parts noted supra and the production string. In an example embodiment, seals **126** and **128** are arranged to form a seal with the production tube. Thus, for example, due to the seal, the flow path from the production string through device **100** is formed by passage **104**. That is, the seal described supra and infra forces flow through passage **104**. As further described infra, the plunger segment and the spring provide a shock absorbing function with respect to functioning of a plunger. Flared segment (no go) **135** prevents device **100** from falling through the seating nipple. In an example embodiment, end **124** is tapered to facilitate insertion into the seating nipple.

In an example embodiment, segments **118** and **120** are slidingly engaged. For example, body **102**, specifically, slide segment **118**, includes inner circumferential surface **136** and the spring segment includes flange **137** with an outer circumferential surface, for example, surface **138** at interlocking portion **140** of segment **120**. The inner circumferential surface forms a part of the internal flow passage, for example, the surface forms walls defining part of the passage. Portion **140** of the spring segment is for sliding along surface **136** in response to end **108** being contacted by a plunger, as described infra.

In an example embodiment, portion **140** forms an axially displaceable, or slideable, interlocking connection between segments **118** and **120**. For example, outside diameter **142** of flange **137** is slightly less than inside diameter **144** of segment **118**, enabling axial movement between flange **137** and segment **118**. Movement of segment **120** in direction **146** is due to contact of a plunger with segment **122** and subsequent displacement of segment **122** in direction **146** and is limited by the compression of spring **114**. For example, a maximum displacement of segment **120** in direction **146** occurs when the spring is fully compressed. Displacement of segment **120** in direction **148** is limited by contact of flange **137** with segment **118**, for example, shoulder **152**. That is, the flange and shoulder are at least partially axially aligned and movement of segment **120** in direction **148** eventually brings the flange and shoulder into contact, axially locking segments **118** and **120** in direction **148**. Alternately stated, the spring segment is for sliding longitudinally within the slide segment in response to force applied to and removed from the plunger segment by a plunger. Segment **122** includes surface **154** configured to receive a plunger. In an example embodiment, the surface is beveled.

In an example embodiment, segment **118** includes shoulder **156** and segment **122** includes shoulder **158**. Spring **114** is disposed between the shoulders. Specifically, the spring is axially restrained, or held, between the shoulders. In an example embodiment, spring **114** is partially compressed between shoulders **156** and **158** in a "neutral" position, that is, when segment **122** is not in contact with a plunger. In an example embodiment, segment **118** is held stationary due to flange **135** and the contact of seals **126** and **128** with the production tube. That is, the contact of flange **135** and seals **126** and **128** with the production tube prevents segment **118** from axially displacing further down the well, for example, in direction **146**. Therefore, as a plunger contacts the plunger segment, the plunger segment is pushed in direction **146**, compressing spring **114** in axial direction **146**. The spring resists compression and thus absorbs the shock associated with the contact of the plunger with the plunger segment. Advantageously, due to the internal flow channel, the spring can be placed about outer surface **159** of the spring segment, increasing the size, strength, durability, and cushioning capacity of the spring. Increasing the cushioning capacity advantageously reduces the shock and wear on device **100** due to contact with a plunger.

Alternately stated, when a plunger contacts end **108**, spring **114** absorbs the impact, and passage **104** advantageously remains open and unobstructed by the spring. For example, diameter **160** of the spring segment is not diminished or obstructed by the movement of segment **120**, since spring **114** is disposed radially outside of the passage. As the energy from the plunger impact is dissipated by the spring, the spring recoils and displaces segment **122** back in direction **148**.

The configuration of passage **104** advantageously reduces problems due to scale build-up and debris deposits, since the inner circumferential surface of passage **104** is relatively smooth and free of restrictions, discontinuities, and uneven surfaces at which scale build-up and debris deposits occur. Advantageously, these discontinuities are much less than the discontinuities in the flow path of a conventional bumper spring, for example, associated with a spring in the flow path.

The sliding action of flange **137** along surface **136** acts to scrape surface **136**, further preventing build-up of deposits on passage **104**. Further, debris, such as dislodged scale, pieces of a plunger, or sand, in the flow path, for example, passage **104**, tends to fall down through the passage and out of device **100**, rather than accumulating in passage **104**, since passage **104** is substantially straight and planar and in alignment with gravitational flow through the passage.

In an example embodiment, the configuration of segment **122** enables an increase in the area of surface **154**, which contacts a plunger. For example, diameter **162** of segment **122** can be nearly the same as the inner diameter of the production tube, since, unlike in a typical arrangement, it is not necessary to provide a flow path between segment **122** and the production tube. The increase in area for surface **154** increases the durability of the body, in particular, end **108** and segment **122**.

Since the flow path for device **100** is through passage **104**, internal to the device, and is not external to the device, for example, between an outer surface and spring for the device and the production string, outer diameter **164** of the spring can be advantageously increased. That is, the outer diameter of the spring does not need to be reduced to leave space between the spring and the production tube for an external flow path as is necessary for a flow path external to a typical bumper spring outer surface. For example, diameter **164** can be nearly equal to the inner diameter of the production string. Increasing the size of the spring advantageously increases the shock-absorbing capacity of device **100**. The durability and service life of device **100** also is advantageously increased by the optimized cushioning. For example, increasing spring diameter improves cushioning, reducing shock and wear on down-hole parts.

Further, the lack of restrictions in flow path **104** minimizes pressure differential between the production tube and a space formed by an outer casing for the well and the production tube (from which gas or fluid is to be withdrawn), which in turn minimizes the build-up of scale. The lack of restrictions also increase flow from the space to the production tube.

In an example embodiment (not shown), device **100** includes a check valve, or standing valve, at least partly disposed in the internal flow passage. Any check valve configuration known in the art can be used.

In one embodiment, segment **122** includes receiving feature **166** arranged to engage a retrieval element, or tool, (not shown). In an example embodiment, feature **166** is a groove. In an example embodiment, the retrieval tool includes at least one downward protruding element. In an example embodiment, surface **154** includes a beveled lip and as the element is pushed in direction **146** and contacts the beveled lip, the element is radially compressed by contact with the lip. As the element slides down passage **104**, the element reaches groove **166** and expands to "snap" into groove, locking the element in the groove. The retrieval tool can then be displaced in direction **148**, drawing the element and device **100** in the same direction.

FIG. **4**A illustrates a cross-sectional flow area for device **100** shown in FIG. **2**. FIG. **4**B is a prior art bumper spring, in a production string the same size as the production string shown in FIG. **4**A. The following should be viewed in light of FIGS. **2** through **6**. In the discussion that follows, bumper spring **200** is used as an example; however, it should be understood that FIG. **4**B and the discussion regarding bumper spring **200** are applicable to conventional bumper springs in general. Disposing passage **104**, which forms a portion of the flow path through device **100**, within body **102** advantageously minimizes the flow restriction problems associated with a conventional bumper spring. For example, conventional bumper spring **200** has flow path **208** between outer circumference **210** of the bumper spring and inner circumference **212** of the production string.

It should be understood that conventional bumper spring **200** and bumper spring **100** are substantially proportionally accurate with respect to the production string; therefore, the relative proportion of passage **104** with respect to flow area **208** is substantially accurate. Advantageously, passage **104** has a greater cross-sectional area than flow path **208**. For example, in one embodiment, the cross-sectional area of passage **104** is greater than the cross-sectional area of **208** by 30% or more.

According to aspects illustrated herein, there is provided a method for producing a well. The method includes: sealing a damping and sealing device with a seating arrangement for a production tube in the well; and flowing gas or liquid from an annulus for the well through a first opening, proximate one longitudinal end of the device, to an internal channel in the device and through the internal channel and a second opening, proximate the other longitudinal end of the device, to the production tube. In an example embodiment, the method includes disposing a spring about an outer circumference of the device; impacting the other longitudinal end with a plunger; and cushioning, using the spring, force associated with impacting the other longitudinal end with the plunger.

It should be understood that a present invention device is not limited to the configuration shown in the figures. For example, different numbers and configurations of components can be used to obtain the claimed invention.

Thus, it is seen that the objects of the present invention are efficiently obtained, although modifications and changes to the invention should be readily apparent to those having ordinary skill in the art, which modifications are intended to be within the spirit and scope of the invention as claimed. It also is understood that the foregoing description is illustrative of the present invention and should not be considered as limiting. Therefore, other embodiments of the present invention are possible without departing from the spirit and scope of the present invention.

What I claim is:

1. A damping and sealing device for enabling gas or liquid flow from a well to a production tube in the well, comprising:
- a body including:
  - a plunger segment including a first longitudinal end of the body and arranged to receive a plunger in the well;
  - a slide segment including a second longitudinal end of the body, opposite the first longitudinal end; and,
  - a portion with a first end connected to the plunger segment and a second end disposed within the slide segment;
- a flow passage internal to the body and including a first opening at the first longitudinal end of the body and the second opening at a second longitudinal end of the body;
- a spring disposed about the portion and directly engaged with the plunger segment and the slide segment; and,
- an outer circumference formed by the plunger segment, the slide segment, the portion, and the spring, wherein:
  - the body is arranged to be installed with the production tube; and,
  - the body is arranged to sealingly engage the production tube.

2. The device of claim **1** wherein the slide segment includes an inner circumferential surface forming a portion of the flow passage, and wherein the portion includes an outer circumferential surface arranged to slide along the inner circumferential surface in response to the plunger contacting the plunger segment.

3. The device of claim **1** wherein the slide segment includes an inner circumferential surface forming a portion of the flow passage, and wherein the portion includes an outer circumferential surface slideable along the inner circumferential surface.

4. The device of claim **3** wherein the slide segment and the portion are interlocked.

5. The device of claim **1** wherein the slide segment includes an inner circumferential surface and the portion includes an outer circumferential surface and wherein a portion of the outer circumferential surface is slidingly engaged with a portion of the inner circumferential surface.

6. A damping and sealing device for enabling gas or liquid flow from a well to a production tube in the well, comprising:
- a body including:
  - a plunger segment including a first longitudinal end of the body and arranged to receive a plunger in the well;
  - a slide segment including a second longitudinal end of the body, opposite the first longitudinal end; and,
  - a portion including:
    - a first end connected to the plunger segment and having a first outside diameter; and,
    - a second end including a flange having a second outside diameter greater than the first outside diameter;
- a flow passage radially within the body and extending between the first and second longitudinal ends; and,
- a spring disposed about the portion, directly engaged with the plunger segment and the slide segment, and radially aligned with a portion of the flow passage, wherein:
  - the flange is disposed within a portion of the flow passage formed by the slide segment; and,
  - the flange is axially displaceable within the slide.

7. A damping and sealing device for enabling gas or liquid flow from a well to a production tube in the well, comprising:
- a body including:
  - a plunger segment including a first longitudinal end of the body and arranged to receive a plunger in the well;
  - a slide segment including a second longitudinal end of the body, opposite the first longitudinal end; and,
  - a portion including:
    - a first end connected to the plunger segment and having a first outside diameter; and,
  - a second end including a flange disposed within the slide segment and having a second outside diameter greater than the first outside diameter;
- a flow passage through the body from the first longitudinal end to the second longitudinal end;
- a spring surrounding the portion of the body, directly engaged with the plunger segment and the slide segment, and axially disposed between the plunger segment and the slide segment; and,
- an outer circumference formed by the plunger segment, the slide segment, the portion, and the spring, wherein:
  - the portion of the body is disposed between the flow passage and the spring;
  - the spring is arranged to compress and absorb force associated with impacting the first longitudinal end; and,
  - the flange is axially displaceable within the slide.

8. A method for producing a well, using a damping and sealing device including: a body with a plunger segment with a first longitudinal end of the body, a slide segment with a second longitudinal end of the body, opposite the first longitudinal end, and a portion with a first end connected to the plunger segment and having a first outside diameter and with a second end including a flange disposed within the slide segment and having a second outside diameter greater than the first outside diameter; a flow passage radially within the body; and a spring disposed about the portion, directly engaged with the plunger segment and the slide segment, and radially aligned with a portion of the flow passage, the method comprising:
- sealing the slide segment with a seating arrangement for a production tube in the well;
- impacting the plunger segment with a plunger;
- cushioning, using the spring, force associated with impacting the other longitudinal end with the plunger;

axially displacing the plunger segment and the portion toward the slide segment;

axially displacing the flange within the slide segment; and,

flowing gas or liquid from a space between a casing for the well and the production tube through a first opening, at the second longitudinal end of the device, to the flow passage and through the flow passage and a second opening, at the first longitudinal end of the device, to the production tube.

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