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Dalrymple

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(54) **DIESEL FUEL INJECTOR CIRCLIP AND FERRULE RING REMOVING TOOL**

(75) Inventor: **Joshua Kyle Dalrymple**, Columbia, SC (US)

(73) Assignee: **International Engine Intellectual Property Company, LLC**, Lisle, IL (US)

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(51) **Int. Cl.**

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B23P 19/08	(2006.01)
B23P 19/02	(2006.01)
B23P 19/00	(2006.01)
B25B 13/00	(2006.01)

(52) **U.S. Cl.**

USPC **29/235**; 29/280; 29/225; 29/229; 29/426.1; 29/426.5; 29/426.6; 29/253; 29/255; 29/266; 81/90.3; 81/453

(58) **Field of Classification Search**

USPC 29/225, 229, 235, 280, 282, 267, 29/278, 426.1, 426.5, 426.6, 252, 253, 254, 29/255, 263; 254/19, 18; 81/64, 90.3, 92, 81/97, 453

See application file for complete search history.

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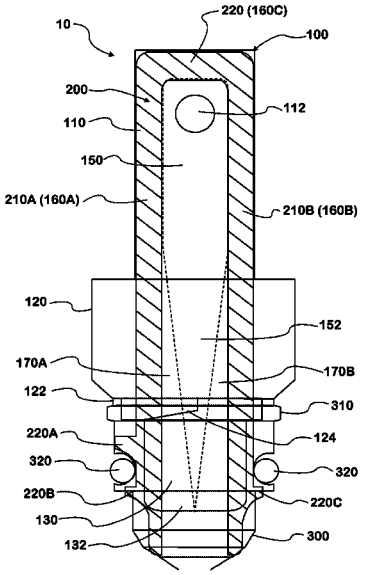
Primary Examiner — Essama Omgba
Assistant Examiner — Darrell C Ford
(74) *Attorney, Agent, or Firm* — Mark C. Bach; Jeffrey P. Calfa

(57) **ABSTRACT**

A removal tool includes a staking unit configured to deform a circlip located at a bore of an apparatus when the removal tool is pushed into the bore, and a spring fork unit configured to push a ferrule ring located at the bore when the removal tool is pushed into the bore.

15 Claims, 2 Drawing Sheets



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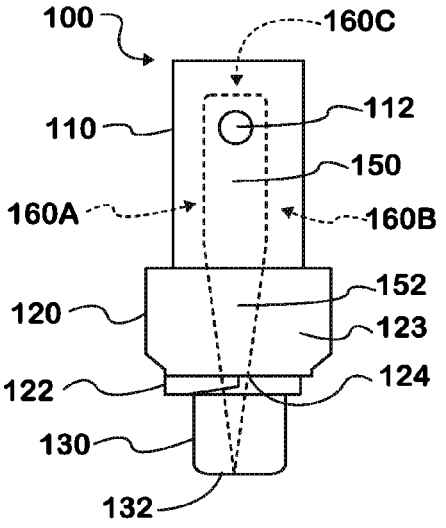

FIG. 1A

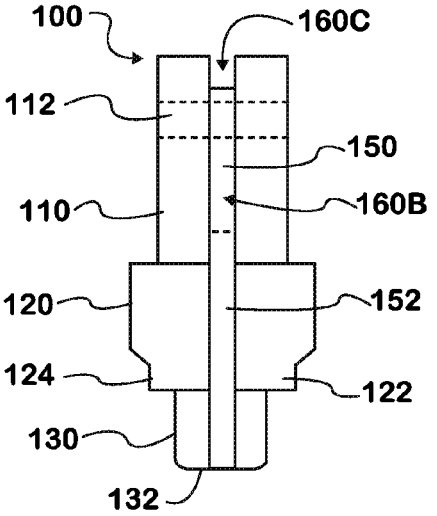

FIG. 1B

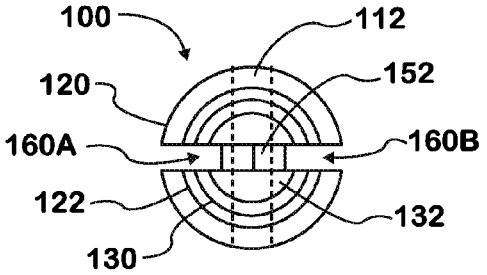

FIG. 1C

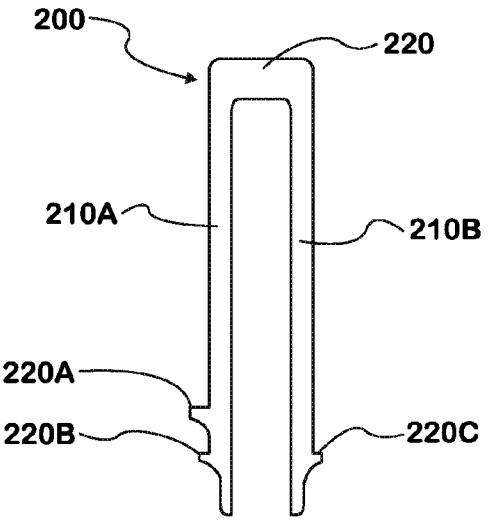

FIG. 2

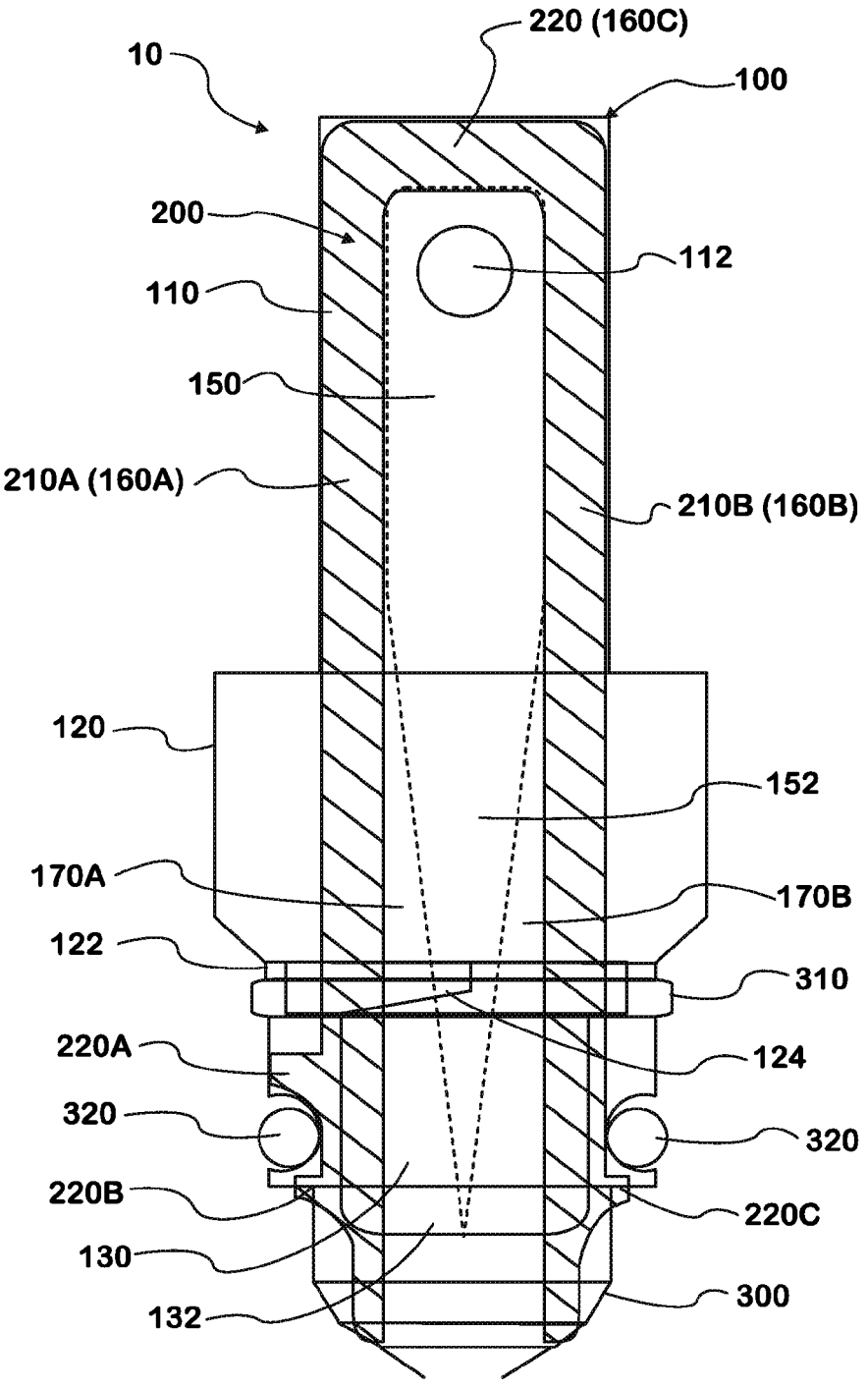
220 (160C)
10
100
200
112
110
150
210A (160A)
210B (160B)
120
152
170A
170B
122
310
220A
124
320
320
220B
220C
130
300
132

FIG. 3

DIESEL FUEL INJECTOR CIRCLIP AND FERRULE RING REMOVING TOOL

CROSS REFERENCE TO PRIOR APPLICATIONS

This application claims the benefit from U.S. Provisional Application No. 61/312,189 filed on Mar. 9, 2010, which is hereby incorporated by reference for all purposes as if fully set forth herein.

FIELD OF THE DISCLOSURE

This disclosure is directed to a removal tool, and particularly to a tool for removing ferrule rings, circlips, and/or the like, from an apparatus, such as, for example, a control valve body of a fuel injector.

BACKGROUND OF THE DISCLOSURE

Fuel injectors, such as, e.g., diesel fuel injectors, typically have retaining components, such as, e.g., a circlip, a ferrule ring, and/or the like, to retain a sealing component, such as, e.g., a D-ring, in a control valve body (CVB). During the recycling/remanufacturing process of fuel injectors, those retaining components may need to be removed. However, different retaining components require different removal processes involving different removal tools, respectively. Accordingly, there is a need for simplifying shortening the retaining component removal process.

SUMMARY OF THE DISCLOSURE

According to an aspect of the disclosure, a removal tool includes a staking unit configured to deform a circlip located at a bore of an apparatus when the removal tool is pushed into the bore, and a spring fork unit configured to push a ferrule ring located at the bore when the removal tool is pushed into the bore.

The spring fork may be further configured to catch and remove the circlip and the ferrule ring from the bore when the removal tool is pulled from the bore. The staking unit may include a slot configured to receive the spring fork unit. The staking unit may include a handle, a neck, and a head.

The neck may include an upper portion that is connected to the handle and a lower portion that is connected to the head, and the lower portion may include a stake for deforming the circlip. The handle, the neck and the head may be substantially concentric. The handle may include a through hole. The handle and the head may have a substantially cylindrical shape.

The head may have a diameter that is smaller than a diameter of the lower portion of the neck or a diameter of the bore of the apparatus. The upper portion of the neck may have a diameter that is larger than a diameter of the handle. The diameter of the lower portion of neck may be smaller than a diameter of the upper portion of the neck.

The slot may include the first side slot extending vertically from the handle to the head via the neck, the second side slot located opposite to the first side slot and extending vertically from the handle to the head via the neck, and a top slot formed at the head and extending between top ends of the first side slot and the second side slot.

The staking unit may include a core portion extending from the handle to the head via the neck and exposed by the first side slot, the second side slot and the top slot. The core portion may include a tapered lower portion.

The spring fork unit may include first and second legs extending substantially in parallel and a link extending between top ends of the first and second legs. The first leg, the second leg and the link may be placeable in the first side slot, the second side slot and the top slot, respectively, when the spring fork unit is engaged to the staking unit.

The spring fork unit may further include the first engagement member extending outwardly from a lower end of the first leg, the first engagement member configured to catch and push the ferrule ring when the removal tool is pushed into the bore, and further configured to catch and pull the circlip when the removal tool is pulled from the bore. The spring fork unit may further include the second engagement member extending outwardly from the lower end of the first leg and configured to catch and pull the ferrule ring when the removal tool is pulled from the bore. The spring fork unit may further include the third engagement member extending outwardly from a lower end of the second leg and configured to catch and pull the ferrule ring when the removal tool is pulled from the bore.

The apparatus may be a control valve body. The apparatus may be a control valve body of a fuel injector.

According to another aspect of the disclosure, a method of removing components from a bore of an apparatus using a removal tool that includes a staking unit configured to deform a circlip located at the bore of the apparatus and a spring fork unit configured to push a ferrule ring located at the bore, the method may include pushing the removal tool into the bore of the apparatus to deform the circlip located at the bore and dislocate the ferrule ring located at the bore, and pulling the removal tool from the bore to remove the deformed circlip and the dislocated ferrule ring from the bore.

Additional features, advantages, and embodiments of the disclosure may be set forth or apparent from consideration of the following detailed description, drawings, and claims. Moreover, it is to be understood that both the foregoing summary of the disclosure and the following detailed description are exemplary and intended to provide further explanation without limiting the scope of the disclosure as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the disclosure, are incorporated in and constitute a part of this specification, illustrate embodiments of the disclosure and together with the detailed description serve to explain the principles of the disclosure. No attempt is made to show structural details of the disclosure in more detail than may be necessary for a fundamental understanding of the disclosure and the various ways in which it may be practiced. In the drawings:

FIG. **1**A shows a front view of a stake unit of a removable tool, constructed according to the principles of the disclosure;

FIG. **1**B shows a side view of the stake unit shown in FIG. **1**A;

FIG. **1**C shows a bottom view of the stake unit shown in FIG. **1**A;

FIG. **2** shows a front view of a spring fork unit of the removable tool, constructed according to the principles of the disclosure; and

FIG. **3** shows the removal tool pushed into a bore of a control valve body.

DETAILED DESCRIPTION OF THE DISCLOSURE

The embodiments of the disclosure and the various features and advantageous details thereof are explained more fully

with reference to the non-limiting embodiments and examples that are described and/or illustrated in the accompanying drawings and detailed in the following description. It should be noted that the features illustrated in the drawings are not necessarily drawn to scale, and features of one embodiment may be employed with other embodiments as the skilled artisan would recognize, even if not explicitly stated herein. Descriptions of well-known components and processing techniques may be omitted so as to not unnecessarily obscure the embodiments of the disclosure. The examples used herein are intended merely to facilitate an understanding of ways in which the disclosure may be practiced and to further enable those of skill in the art to practice the embodiments of the disclosure. Accordingly, the examples and embodiments herein should not be construed as limiting the scope of the disclosure, which is defined solely by the appended claims and applicable law. Moreover, it is noted that like reference numerals represent similar parts throughout the several views of the drawings.

The terms "including", "comprising" and variations thereof, as used in this disclosure, mean "including, but not limited to", unless expressly specified otherwise.

The terms "a", "an", and "the", as used in this disclosure, means "one or more", unless expressly specified otherwise.

When a single device or article is described herein, it will be readily apparent that more than one device or article may be used in place of a single device or article. Similarly, where more than one device or article is described herein, it will be readily apparent that a single device or article may be used in place of the more than one device or article. The functionality or the features of a device may be alternatively embodied by one or more other devices which are not explicitly described as having such functionality or features.

FIG. **1**A shows a front view of an example of a stake unit **100** of a removable tool **10** (shown in FIG. **3**) constructed according to the principles of the disclosure. The stake unit **100** is configured for removing ferrule rings, circlips and/or the like from a bore of an apparatus, such as, e.g., a control valve body (CVB) of a fuel injector or the like. FIG. **1**B shows a side view of the stake unit **100** shown in FIG. **1**A, and FIG. **1**C shows a bottom view of the stake unit **100** shown in FIG. **1**A.

Referring to FIGS. **1**A, **1**B and **1**C concurrently, the stake unit **100** may include a handle **110**, a neck **120**, and a head **130**. The handle **110**, neck **120** and head **130** may be substantially concentric. The handle **110** and the head **130** may have a substantially cylindrical shape. The neck **120** may also have a substantially cylindrical shape except for a lower portion thereof. More specifically, as shown in FIG. **1**A, the neck **130** may be tapered at the lower portion such that a diameter of a bottom end portion **122** of the neck **120** may be smaller than that of an upper portion **123**. Other shapes and configurations are also contemplated for the handle **110**, neck **120** and head **130**.

The neck **120** may include a stake **124** to deform a circlip **310** (shown in FIG. **3**), which may be affixed to a bore, such as, e.g., a control valve body (CVB) bore **300** (shown in FIG. **3**), when the removal tool **10** is pushed into the CVB bore **300**, an example of which is shown in FIG. **3**. The stake **124** may be formed at the bottom end portion **122** of the neck **120**. A diameter of the bottom end portion **122** may be substantially similar to or slightly smaller than the CVB bore **300**, such that the stake **124** may be aligned with the circlip **310** when the removal tool **10** is inserted into the CVB bore **300**. The handle **120** may include a through-hole **112**. A diameter of the handle **110** may be smaller than that of the upper portion **123** of the neck **120**. The head **130** may have a substantially flat bottom surface **132**. A diameter of the head **120** may be smaller than that of the bottom end portion **122** of the neck **120** and the CVB bore **300**.

The stake unit **100** may include a plurality of slots **160**A, **160**B, **160**C (collectively referred to as slot **160**), formed along the sides and top thereof. For example, the slot **160** may include side slots **160**A, **160**B formed on the sides of the stake unit **100** and a top slot **160**C formed at the top of the stake unit **100**. It is noted that the top slot **160**C may be optional. The top slot **160**C may extend horizontally between the upper ends of the side slots **160**A, **160**B. The side slots **160**A, **160**B may extend vertically from an uppermost end of the handle **110** to a lowermost end of the head **130**. The slot **160** may expose a core portion **150** of the stake unit **100**. As seen in FIGS. **1**A and **1**B, the core portion **150** may extend from the slot **160**C in the handle **110** to the lowermost end of the head **130**, including the neck **120**. Where a slot **160**C is not included, the core portion **150** may extend from the uppermost end of the handle **110** to the lowermost end of the neck **120**.

As seen in FIG. **1**C, the stake unit **100** may have a substantially symmetric configuration with respect to the side slots **160**A, **160**B and the core portion **150**. The core portion **150** may have a tapered lower portion **152** such that the side slots **160**A, **160**B become gradually deeper as advancing downwardly. The through-hole **112** may extend through a width of the handle **110**, including the core portion **150**.

FIG. **2** shows a front view of a spring fork unit **200** of the removable tool **10**, constructed according to the principles of the disclosure. The spring fork unit **200** may include a first leg **210**A, a second leg **210**B, and a link **220**. The first leg **210**A, second leg **210**B and link leg **220** may be formed substantially simultaneously as a single, integral structure, or from multiple components assembled into a unitary structure. The first and second legs **210**A, **210**B may extend vertically, substantially in parallel to each other. The link **220** may extend between the top ends of the first and second legs **210**A, **210**B, such that the lower portions of the first and second legs **210**A, **210**B may be bent inwardly towards each other. Other configurations are also contemplated for the spring fork unit **200**.

The spring fork unit **200** may further include one or more engagement members **220**, such as, e.g., an upper engagement member **220**A, and a pair of lower engagement members **220**B, **220**C. The engagement members **220** may extend outwardly from the lower portion of the first and second legs **210**A, **210**B. The upper engagement member **220**A may be configured to engage a ferrule ring **320** (shown in FIG. **3**), or the like, which may be located at the CVB bore **300** when the removal tool **10** is inserted into the CVB bore **300**. When a force is applied to push the removal tool **10** into the CVB bore **300**, the upper engagement member **220**A may engage and dislocate the ferrule ring **320**, pushing the ferrule ring **320** downwardly. The upper engagement member **220**A may be further configured to engage and deform the circlip **310** when the removal tool **10** is pulled from the CVB bore **300**. Thus, when a force is applied to pull the removal tool **10** from the CVB bore **300**, the upper engagement member **220**A may catch the deformed circlip **310** and pull it out from the CVB bore **300**. Although FIG. **2** shows the engagement member **220**A extending from the first leg **210**A, the engagement member **220**A may extend from either or both of the first and second legs **210**A, **210**B.

The lower engagement members **220**B, **220**C may extend outwardly from the first and second legs **210**A, **210**B, respectively. Alternatively, only one of the lower engagement members **220**B, **220**C may be formed at one of the first and second legs **210**A, **210**B. The lower engagement members **220**B, **220**C may be shorter than the upper engagement member

220A to be easily inserted past the ferrule ring **320** and engage the ferrule ring **320** from below. When the removal tool **10** is pulled from the CVB bore **300**, the lower engagement members **220**B may catch the dislocated ferrule ring **320** and move it upwardly to remove the ferrule ring **320** from the CVB bore **300**.

The spring fork unit **200** may be configured to fit within the slot **160** of the stake unit **100**. For example, the spring fork unit **200** may be inserted into the slot **160** of the stake unit **100** downwardly from above, when the longitudinal axis of the stake unit **100** is substantially aligned with the direction of gravity. Upon being completely inserted into the slot **160**, the spring fork unit **200** may substantially occupy the slot **160** of the stake unit **100**. For example, the link **220** may occupy the top slot **160**C, the first side leg **210**A may occupy the side slot **160**A and the second side leg **210**B may occupy the side slot **160**B. As seen in FIG. **1**A, the core portion **150** may include the tapered lower portion **152**. Thus, there may be gaps **170**A, **170**B (shown in FIG. **3**) between the lower portions of the first and second side legs **210**A, **210**B and the tapered lower portion **152**. The gaps **170**A, **170**B may allow the lower portions of the first and second side legs **210**A, **210**B to bend inward toward the tapered lower portion **152**, such that the engagement members **220** may be easily inserted past the circlip **310**, the ferrule ring **320**, and/or the like, and placed at a desired location.

FIG. **3** shows an example of the removal tool **10**, including the stake unit **100** and the spring fork unit **200** pushed into the CVB bore **300** to remove the circlip **310**, the ferrule ring **320**, and/or the like, therefrom. When a force is applied to push the removal tool **10** downwardly into the CVB bore **300**, the stake **124** located at the bottom end portion **122** of the stake unit **100** may permanently deform the circlip **310** such that the circlip **310** may be easily removed from the CVB bore **300**. Also, the upper engagement member **220**A of the spring fork unit **200** may push down the ferrule ring **320** toward the bottom of the CVB bore **300**. Thus, both the circlip **310** and the ferrule ring **320** may be substantially simultaneously dislocated from their respective original locations in the CVB bore **300** by a single downward movement. Alternatively, the circlip **310** and the ferrule ring **320** may be dislocated at different times, depending on the location of the engagement members **220**A, **220**B, **220**C with respect to the positions of the circlip **310** and ferrule ring **330**. The dislocated ferrule ring **320** may be caught from below by the second engagement members **220**B, **220**C. Thus, when a force is applied to pull the removal tool **10** from the CVB bore **300**, the second engagement members **220**B, **220**C may catch and pull the dislocated ferrule ring **320** out from the CVB bore **300**. The upper engagement member **220**A may catch and pull the deformed circlip **310** from below when the removal tool **10** is pulled from the CVB bore **300**. Thus, both the deformed circlip **310** and dislocated ferrule ring **320** may be removed substantially simultaneously from the CVB bore **300** by a single upward movement.

Accordingly, the removal tool **10** may quickly remove components, such as, e.g., the circlip **310**, the ferrule ring **320** and/or the like, from the CVB bore **300** with a minimal effort. Thus, the process for removing the retaining components may be simplified and shortened using a single removal tool.

While the disclosure has been described in terms of exemplary embodiments, those skilled in the art will recognize that the disclosure can be practiced with modifications in the spirit and scope of the appended claims. These examples given above are merely illustrative and are not meant to be an exhaustive list of all possible designs, embodiments, applications or modifications of the disclosure.

What is claimed is:

1. A removal tool comprising:

a staking unit configured to deform a circlip located at a bore of an apparatus when the removal tool is pushed into the bore;

a spring fork unit configured to push a ferrule ring located at the bore when the removal tool is pushed into the bore;

wherein the spring fork unit is further configured to catch and remove the circlip and the ferrule ring from the bore when the removal tool is pulled from the bore;

wherein the staking unit comprises a slot configured to receive the spring fork unit;

wherein the staking unit further comprises:

a handle;

a neck; and

a head,

wherein the neck includes an upper portion that is connected to the handle and a lower portion that is connected to the head,

wherein said lower portion comprises a stake for deforming the circlip; and

wherein the slot comprises:

a first side slot extending vertically from the handle to the head via the neck;

a second side slot located opposite to the first side slot and extending vertically from the handle to the head via the neck; and

a top slot formed at the head and extending between top ends of the first side slot and the second side slot.

2. The removal tool of claim **1**, wherein the handle, the neck and the head are substantially concentric.

3. The removal tool of claim **1**, wherein the handle comprises a through hole.

4. The removal tool of claim **1**, wherein the handle and the head have a substantially cylindrical shape.

5. The removal tool of claim **1**, wherein the head has a diameter that is smaller than a diameter of the lower portion of the neck or a diameter of the bore of the apparatus.

6. The removal tool of claim **5**, wherein the upper portion of the neck has a diameter that is larger than a diameter of the handle.

7. The removal tool of claim **5**, wherein the diameter of the lower portion of neck is smaller than a diameter of the upper portion of the neck.

8. The removal tool of claim **1**, wherein the staking unit comprises a core portion extending from the handle to the head via the neck and exposed by the first side slot, the second side slot and the top slot.

9. The removal tool of claim **8**, wherein the core portion comprises a tapered lower portion.

10. The removal tool of claim **9**, wherein the spring fork unit comprises:

first and second legs extending substantially in parallel; and

a link extending between top ends of the first and second legs,

wherein the first leg, the second leg and the link are placeable in the first side slot, the second side slot and the top slot, respectively, when the spring fork unit is engaged to the staking unit.

11. The removal tool of claim **10**, wherein the spring fork unit further comprises a first engagement member extending outwardly from a lower end of the first leg, the first engagement member configured to catch and push the ferrule ring when the removal tool is pushed into the bore, and further configured to catch and pull the circlip when the removal tool is pulled from the bore.

12. The removal tool of claim **11**, wherein the spring fork unit further comprises a second engagement member extending outwardly from the lower end of the first leg and configured to catch and pull the ferrule ring when the removal tool is pulled from the bore.

13. The removal tool of claim **12**, wherein the spring fork unit further comprises a third engagement member extending outwardly from a lower end of the second leg and configured to catch and pull the ferrule ring when the removal tool is pulled from the bore.

14. The removal tool of claim **1**, wherein the apparatus is a control valve body.

15. The removal tool of claim **1**, wherein the apparatus is a control valve body of a fuel injector.

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