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(54) **LIQUID FILTER, ASSEMBLY, SYSTEM, AND METHODS**

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Publication Classification

(51) **Int. Cl.**

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B23P 11/00	(2006.01)
B23P 19/00	(2006.01)

(52) **U.S. Cl.** **210/234**; 210/232; 210/236; 29/428; 29/426.1

(57) **ABSTRACT**

A filter cartridge **38** includes a first endcap **41** defining a first open aperture and having at least first and second protrusions extending from a wall along the aperture and into the first open aperture. The first protrusion is spaced from the second protrusion in both a vertical direction and a circumferential direction. The filter cartridge also includes filter media **44** and a second endcap **42**. The filter cartridge is mountable in a filter bowl **36** having an inner liner assembly, and the bowl and the inner liner assembly is connectable to a filter head to form a filter system. The filter system can have any one or combination of the following features: a filter lock-out mechanism to ensure that the filter head and the filter bowl are not connectable unless there is a proper filter cartridge installed therein; an automatic drain mechanism to drain the filter bowl of liquid before the filter cartridge is removed from the bowl; and a cartridge retention mechanism, to ensure that the filter cartridge remains with the filter bowl after the filter bowl has been removed from the filter head. Adaptor rings can be utilized in order to test other types of filter elements in the system, when those other types of filter elements do not have the protrusion arrangement. Assemblies, methods of servicing, methods of installing, methods of use, and methods of retaining can be practiced.

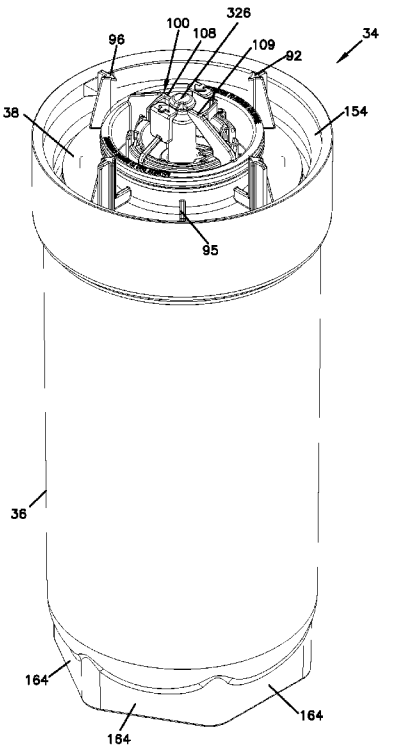


FIG. 1

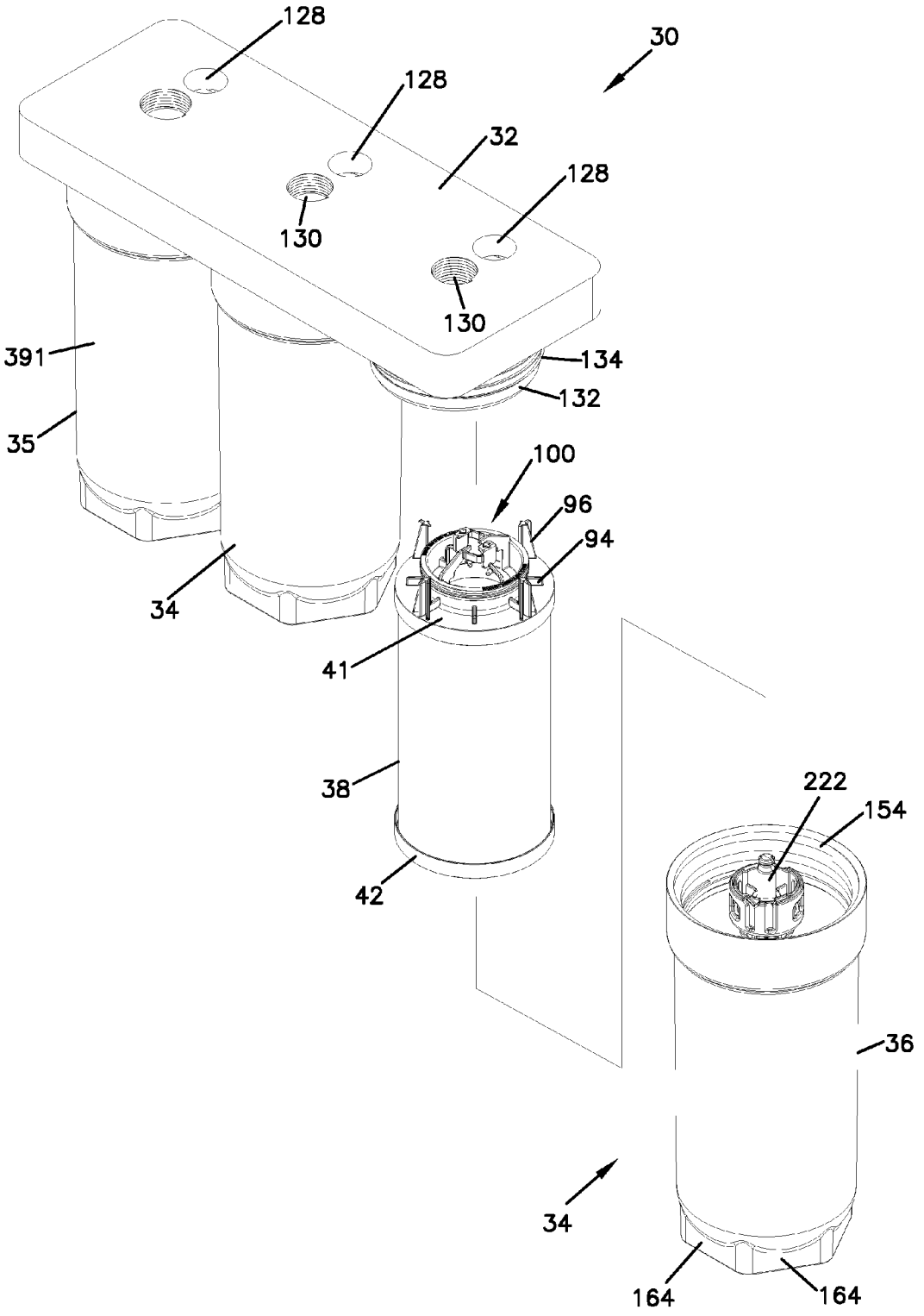

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FIG.2

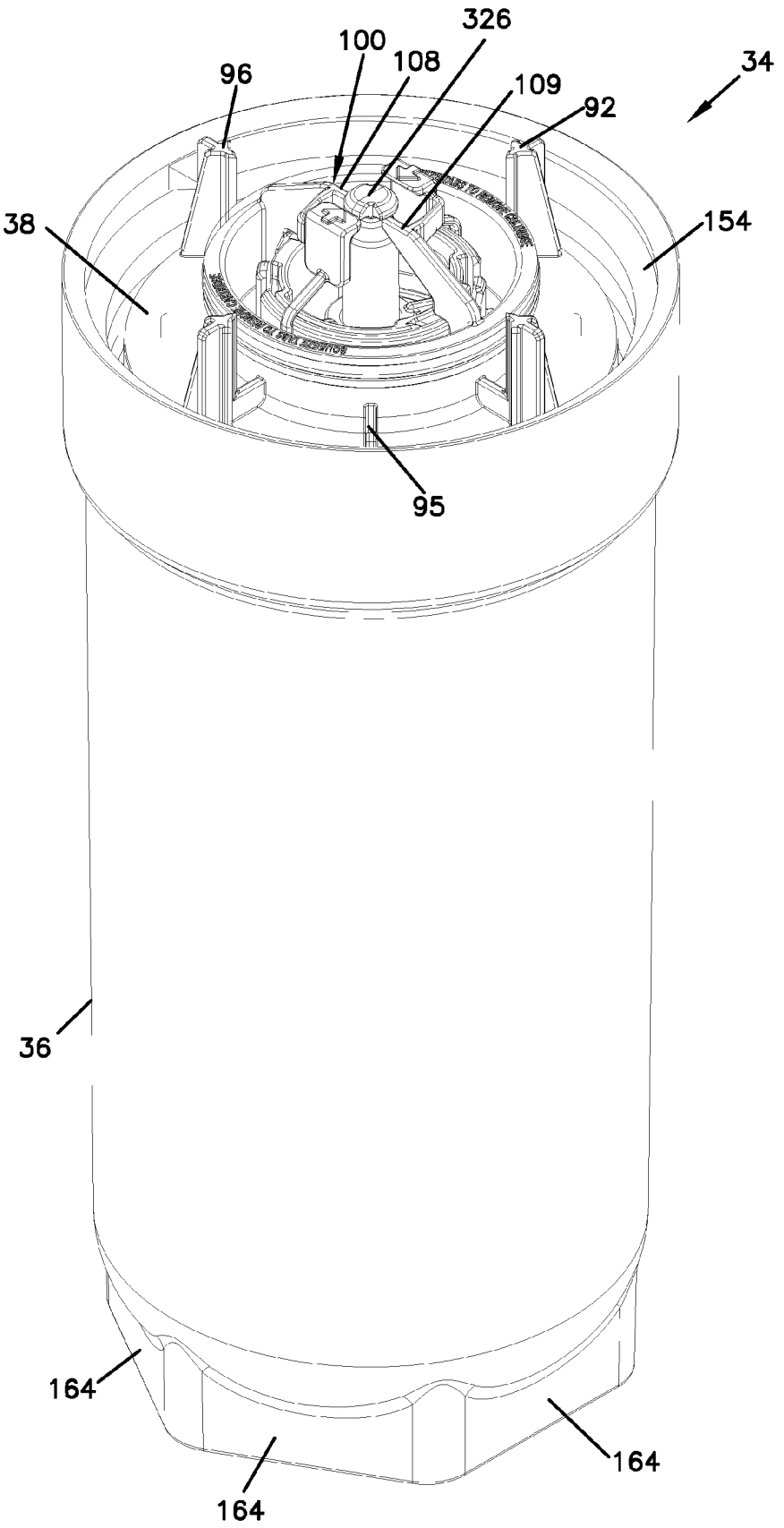


FIG.3

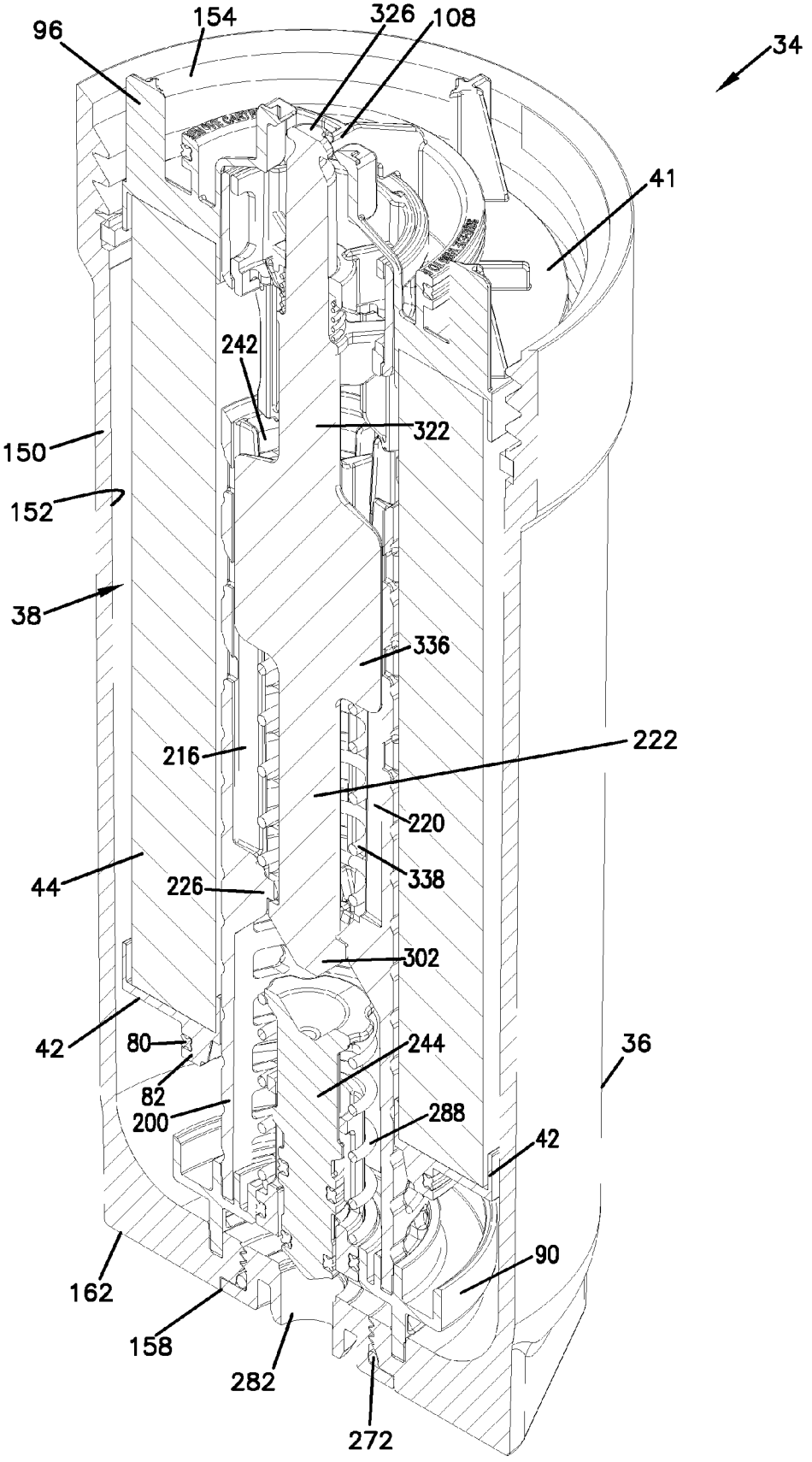
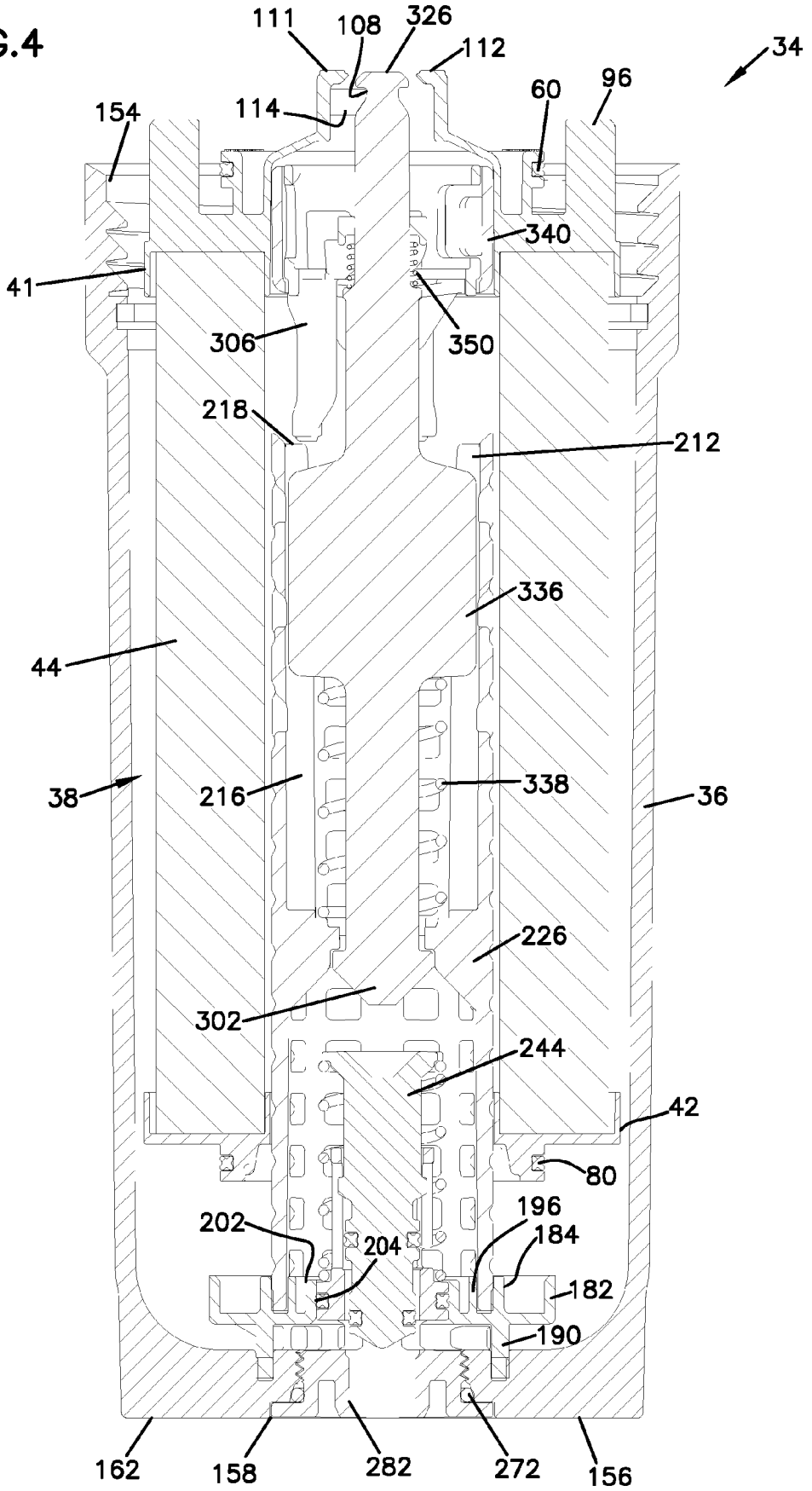

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FIG.4


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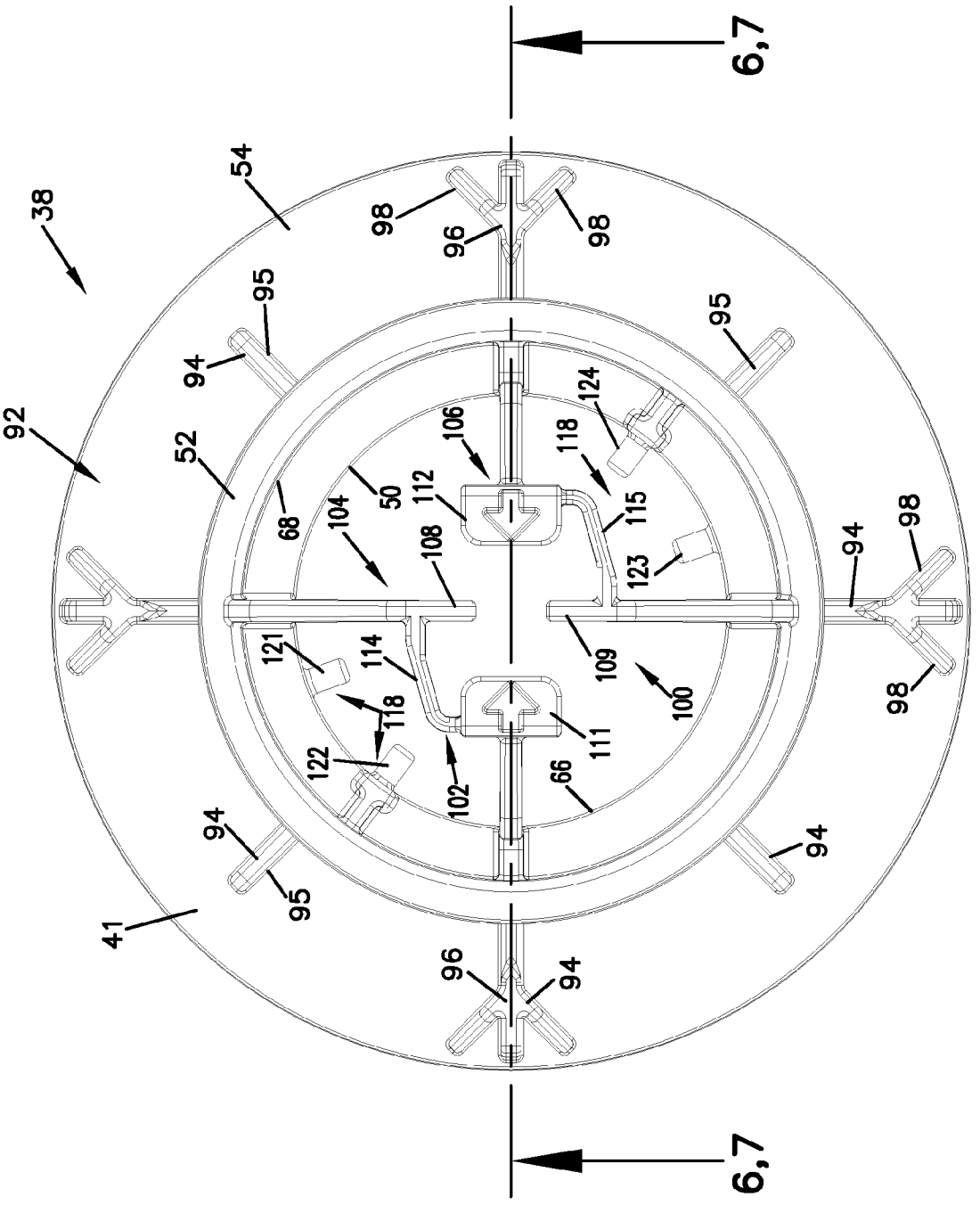

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FIG.5

FIG.6

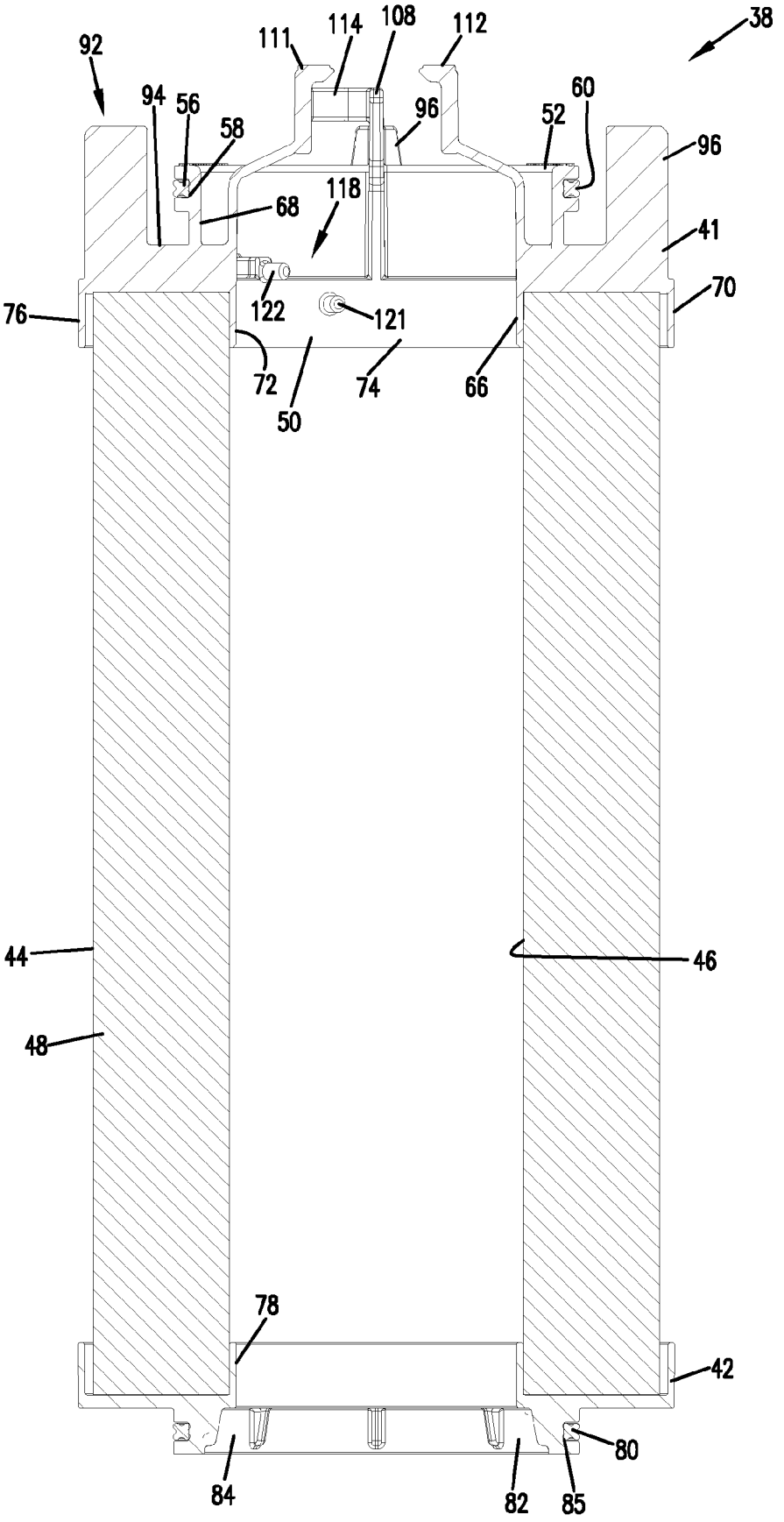

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FIG.7

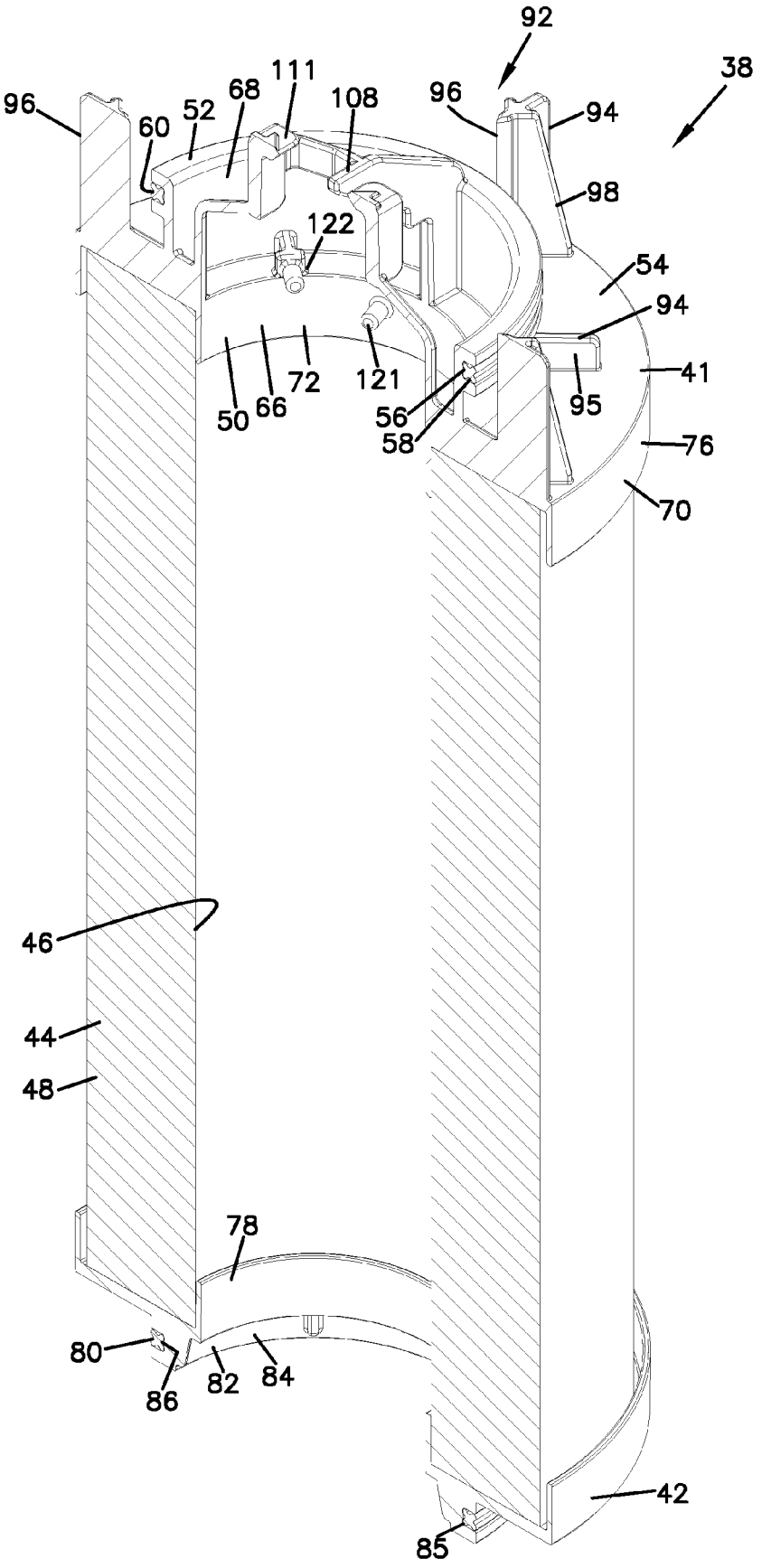

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FIG.8

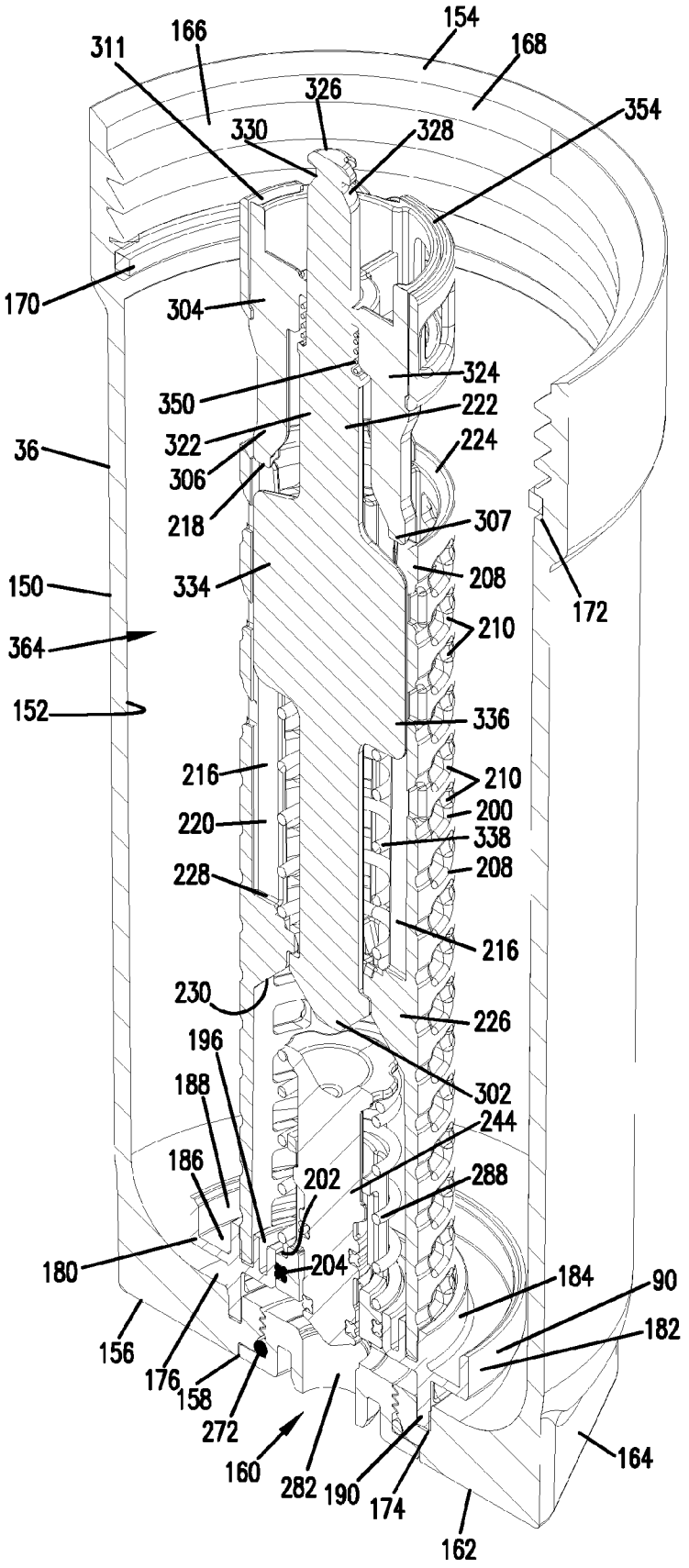

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FIG.9

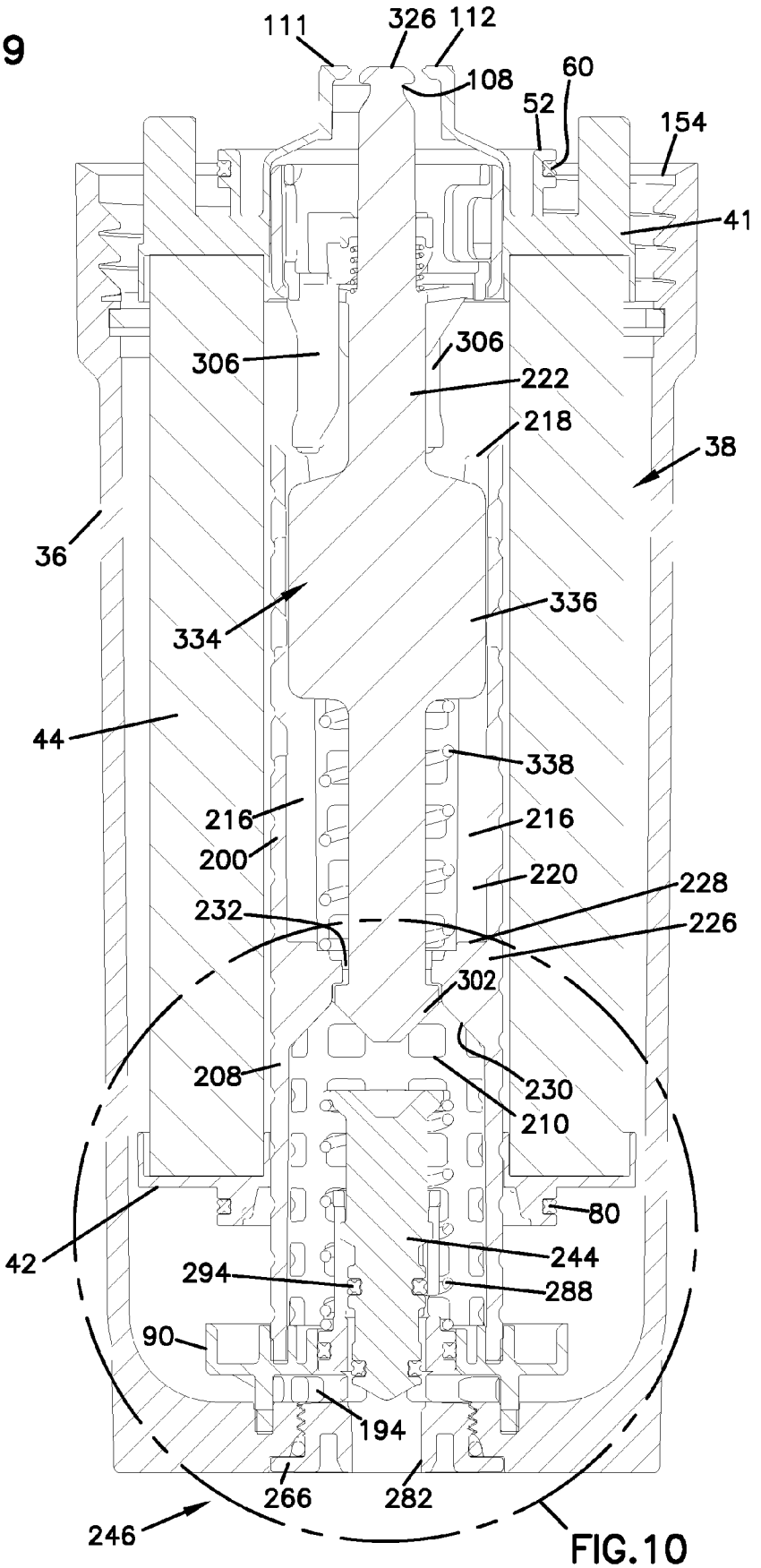

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FIG.10

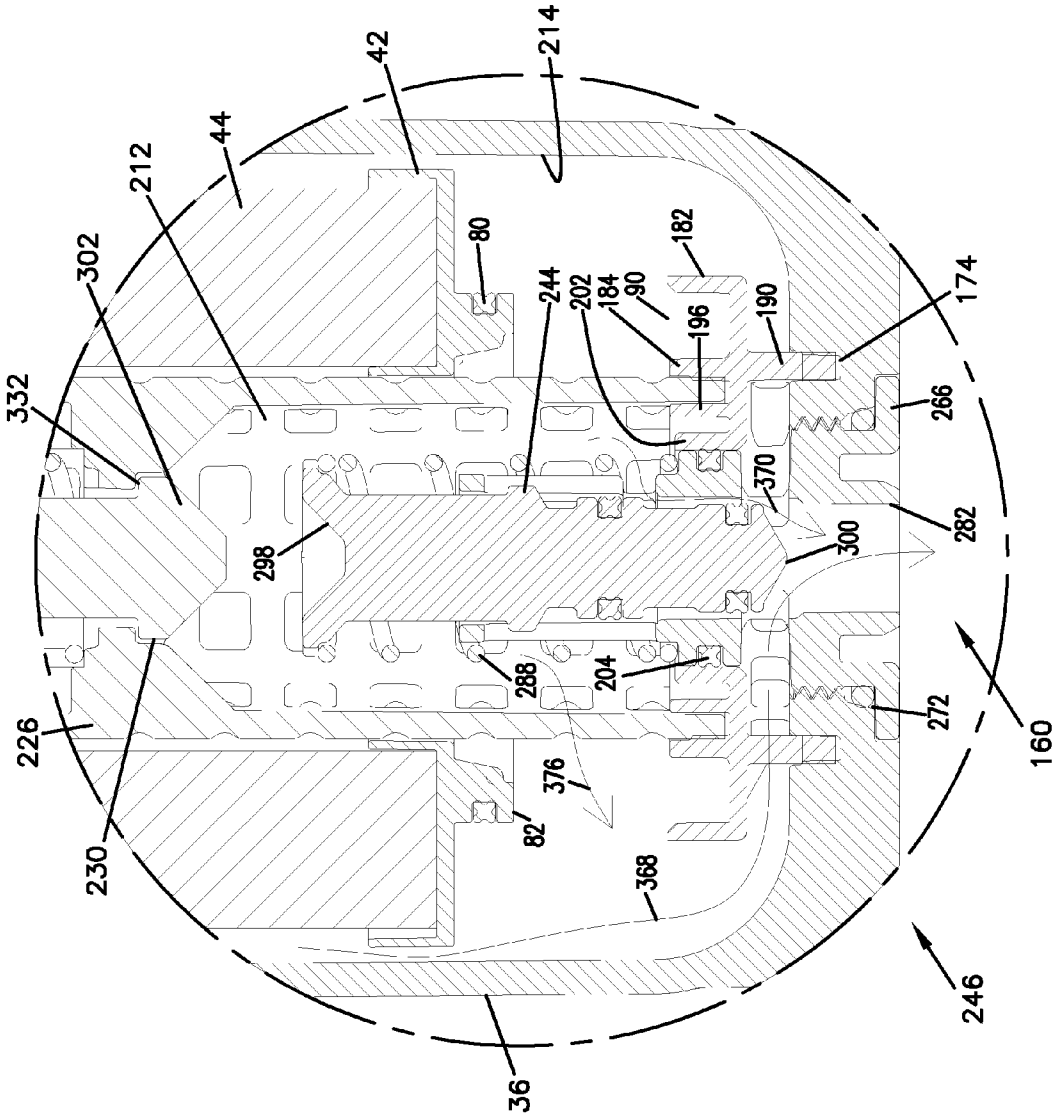

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FIG. 10

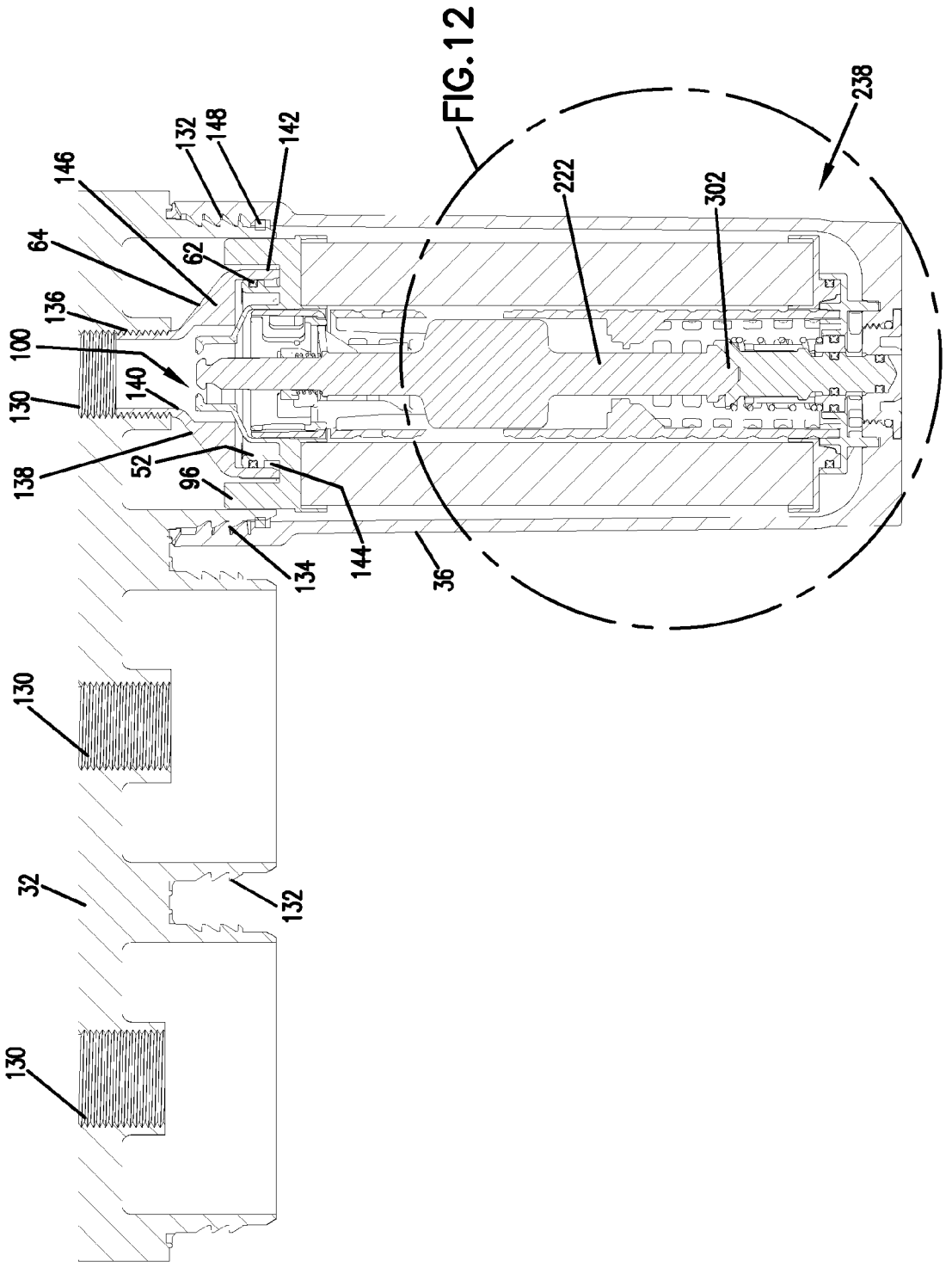

FIG. 12
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FIG. 11

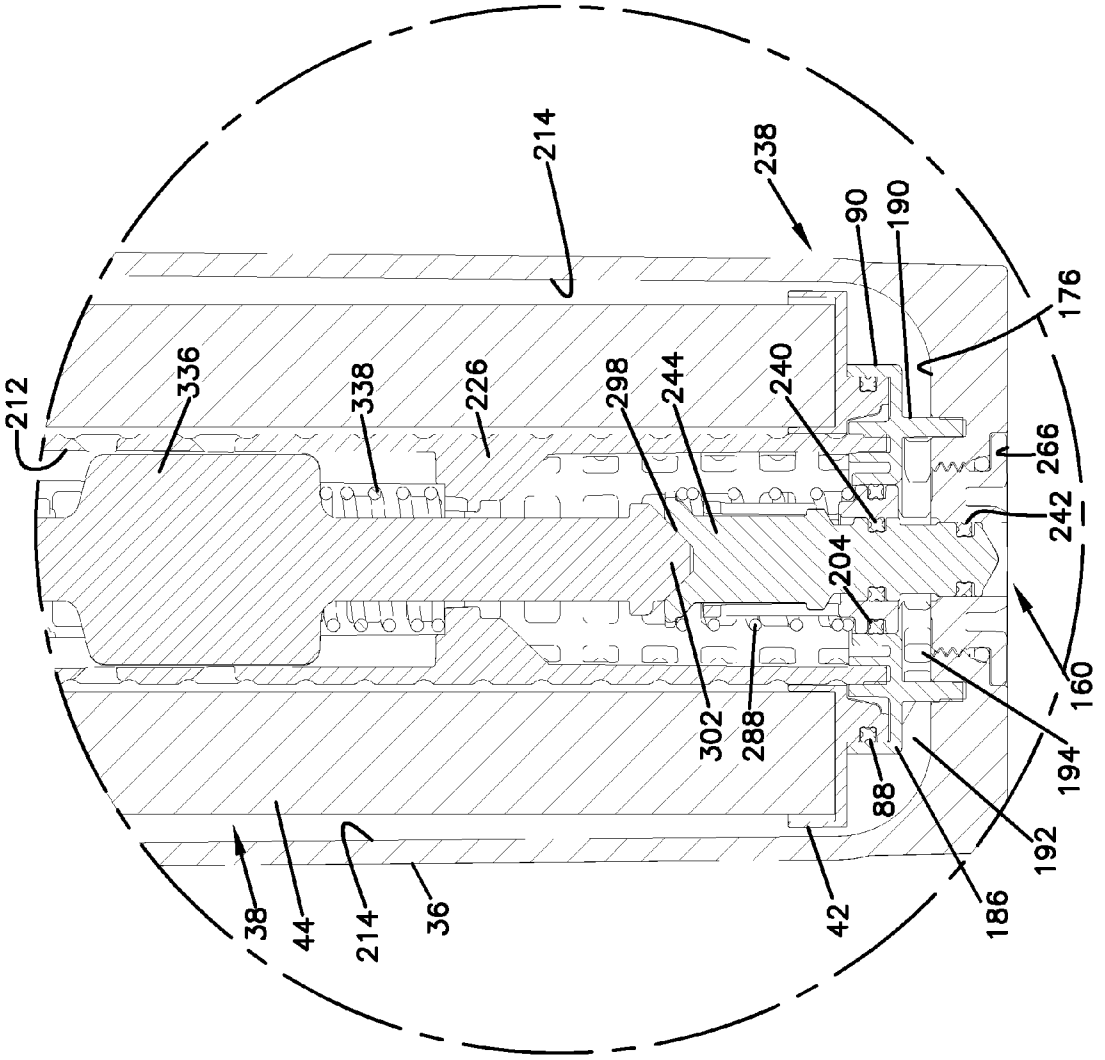

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FIG.12

FIG.13

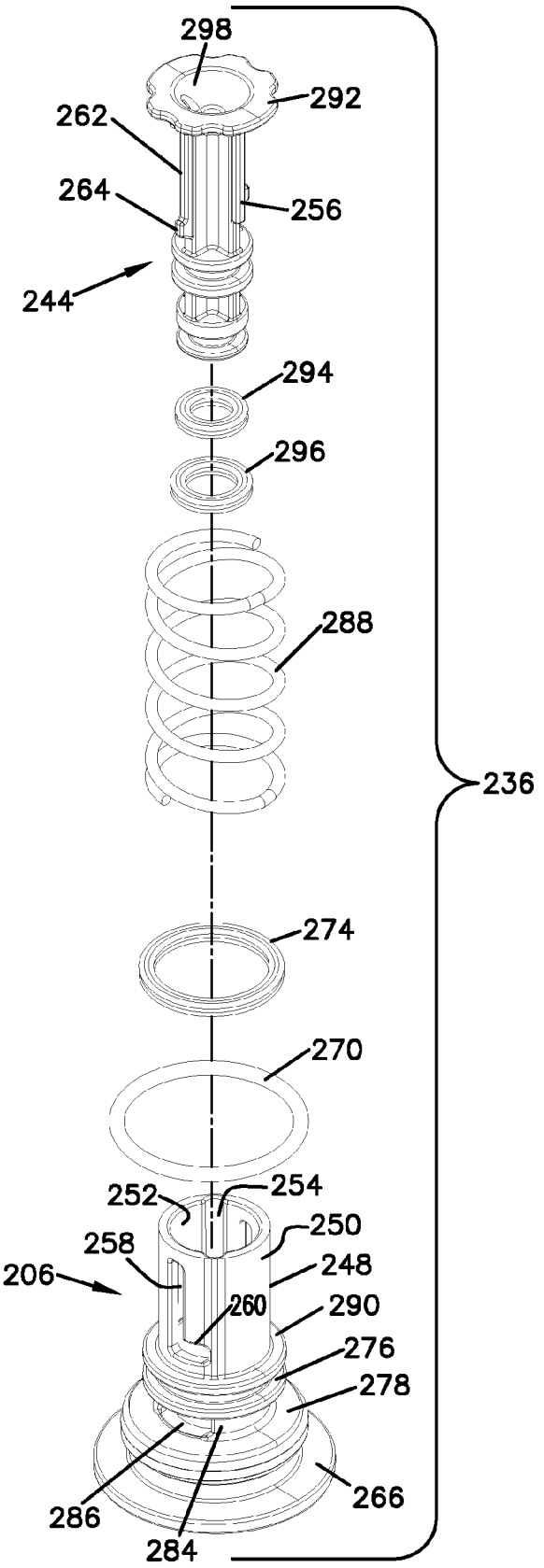

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FIG. 14

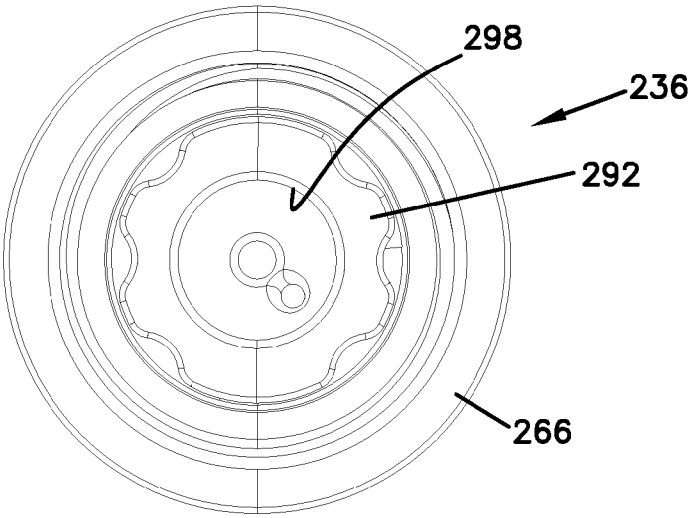

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FIG. 15

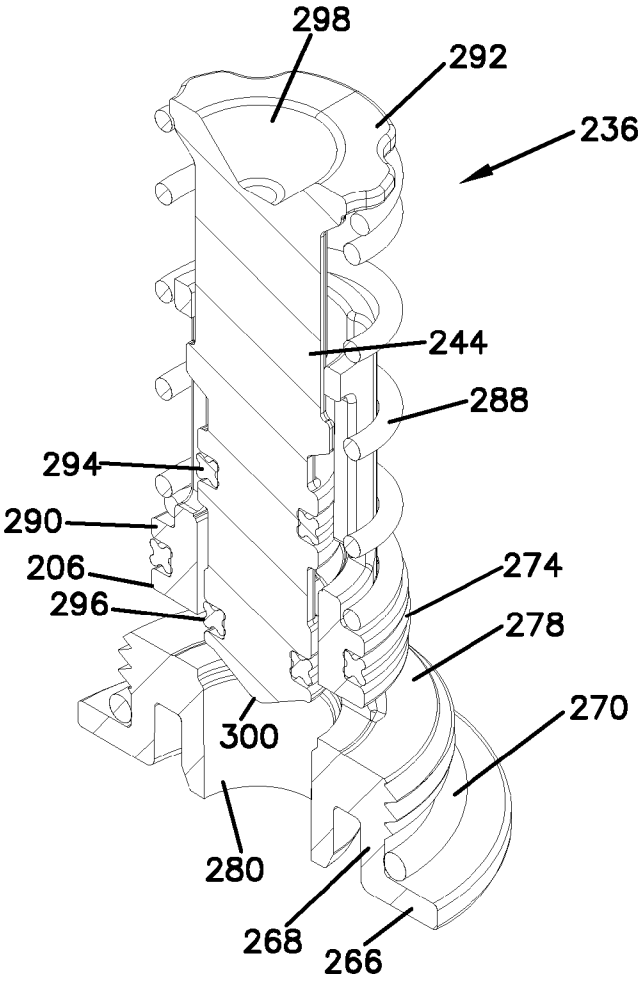

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FIG.16

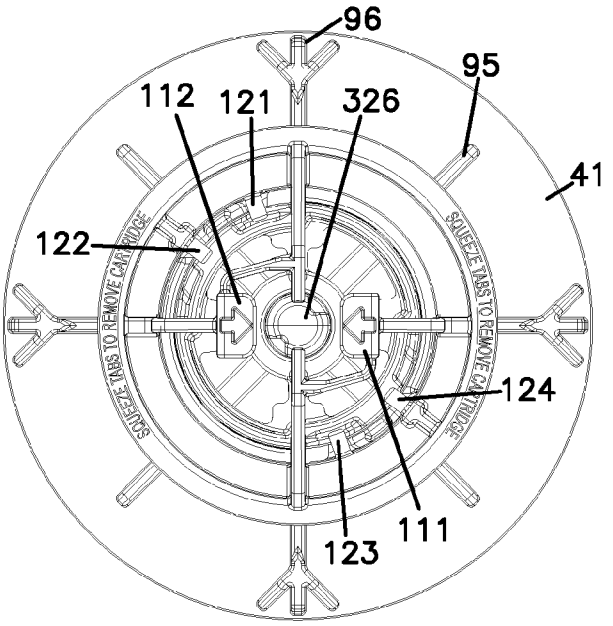

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FIG.17

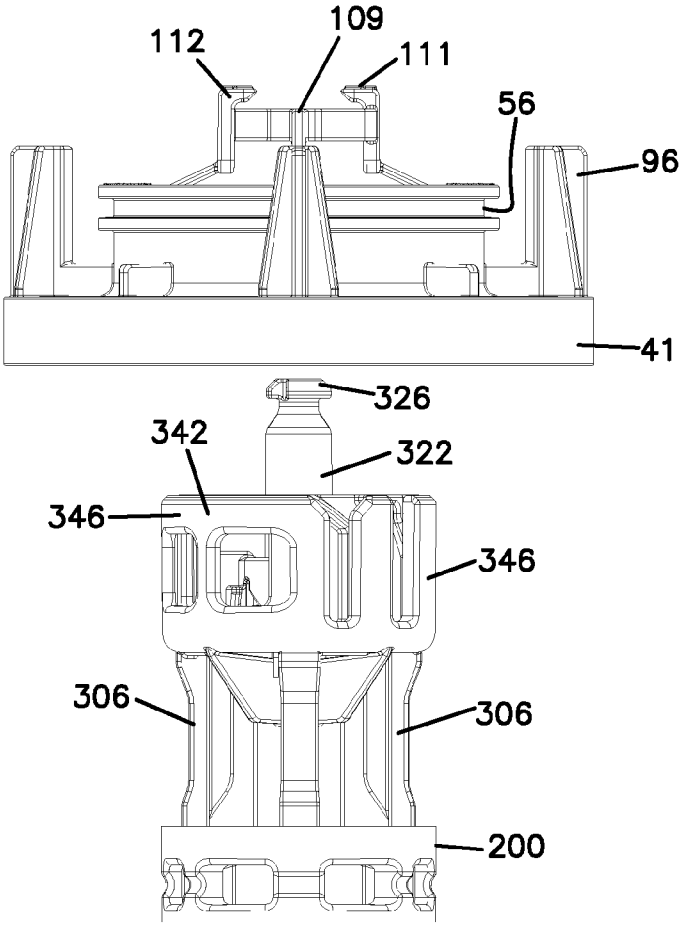

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FIG.18

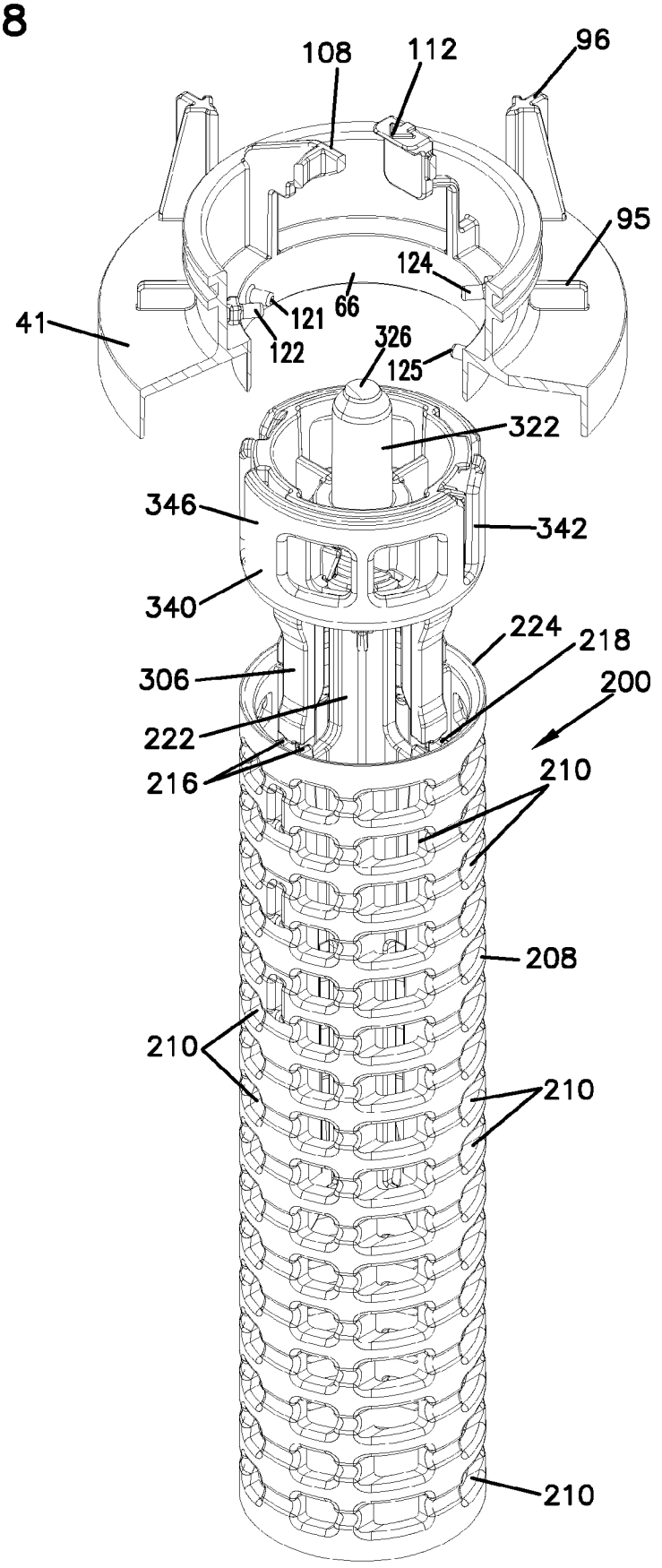

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FIG.19

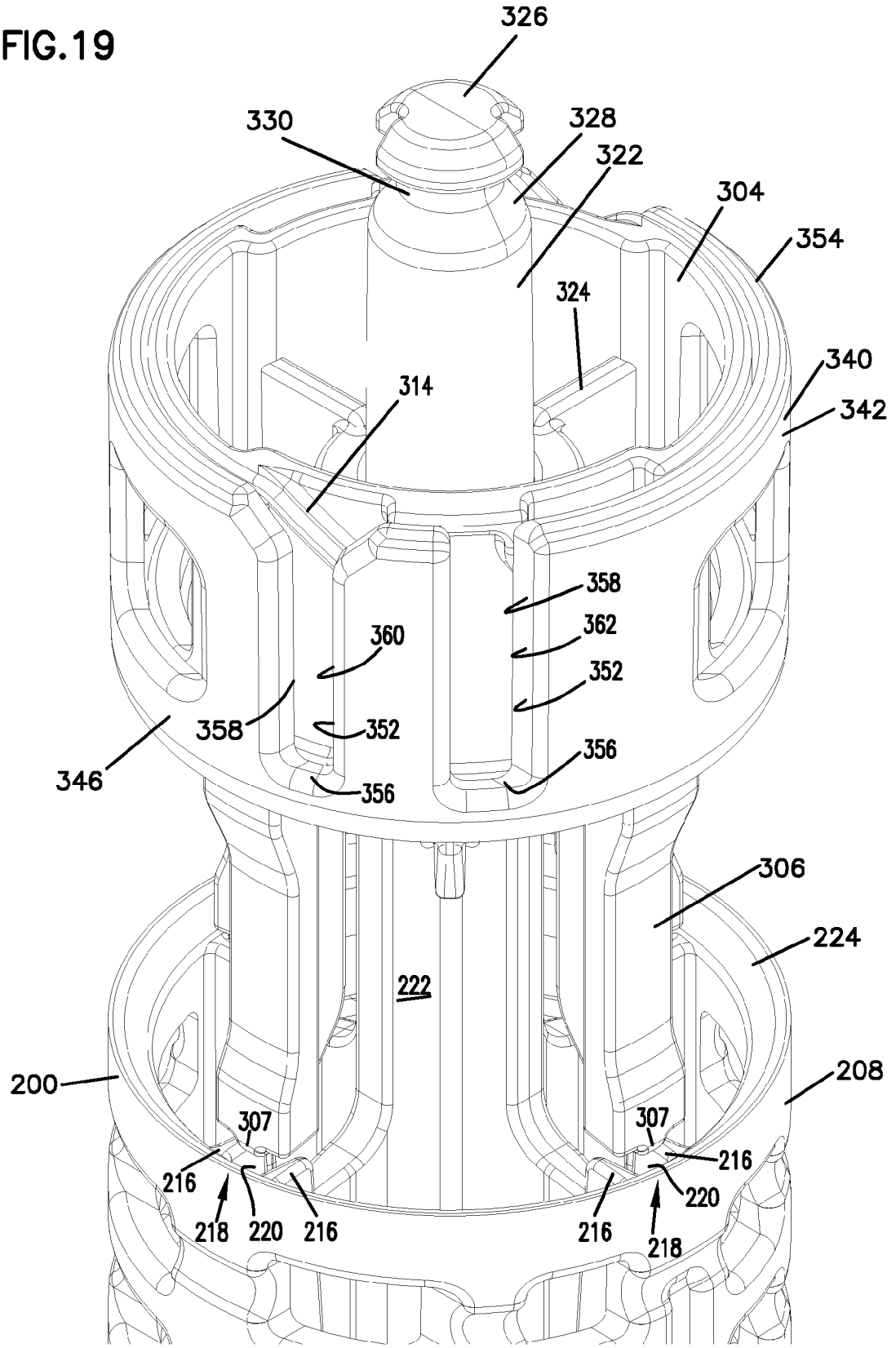

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FIG.20

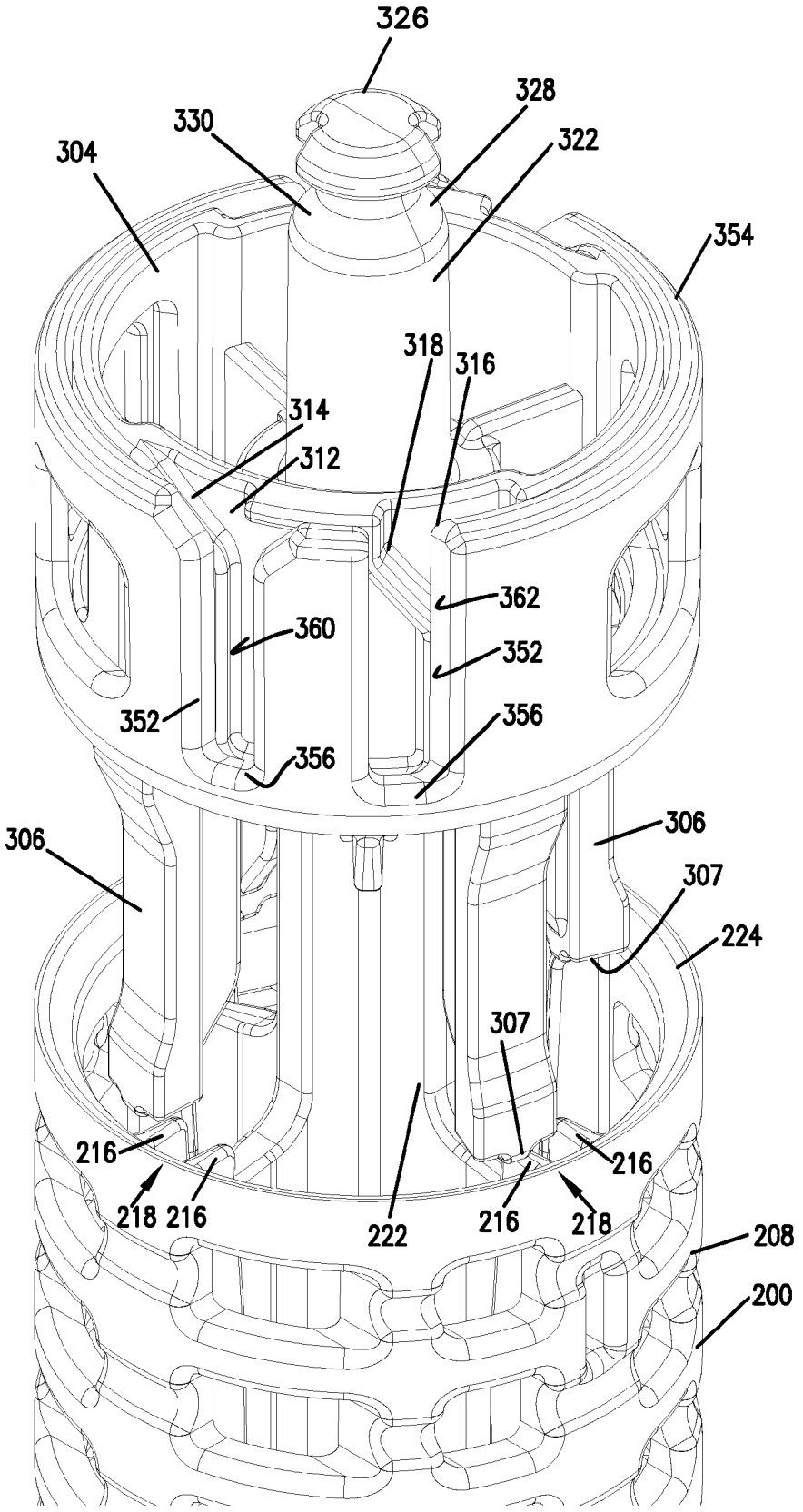

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FIG.21

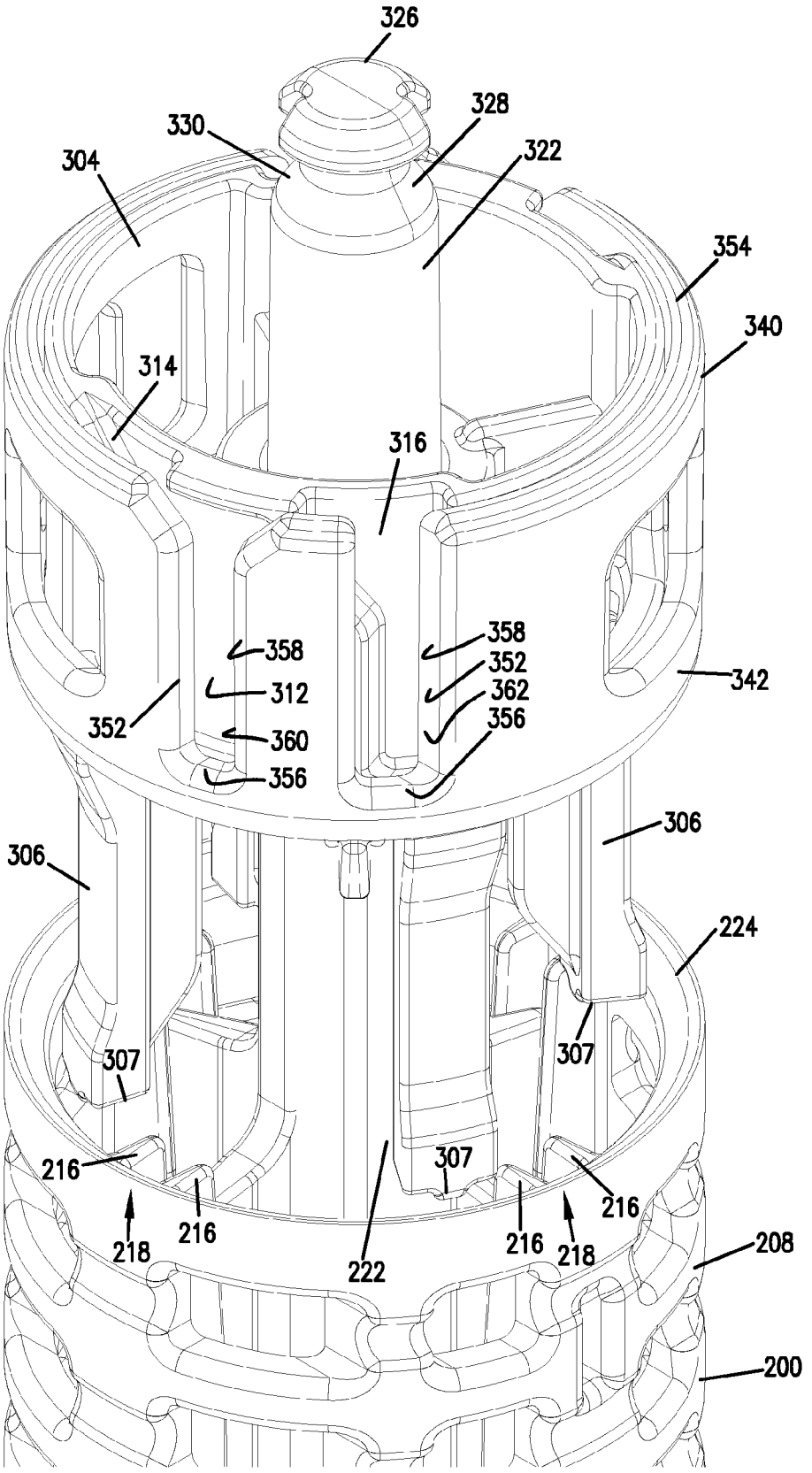

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FIG.22

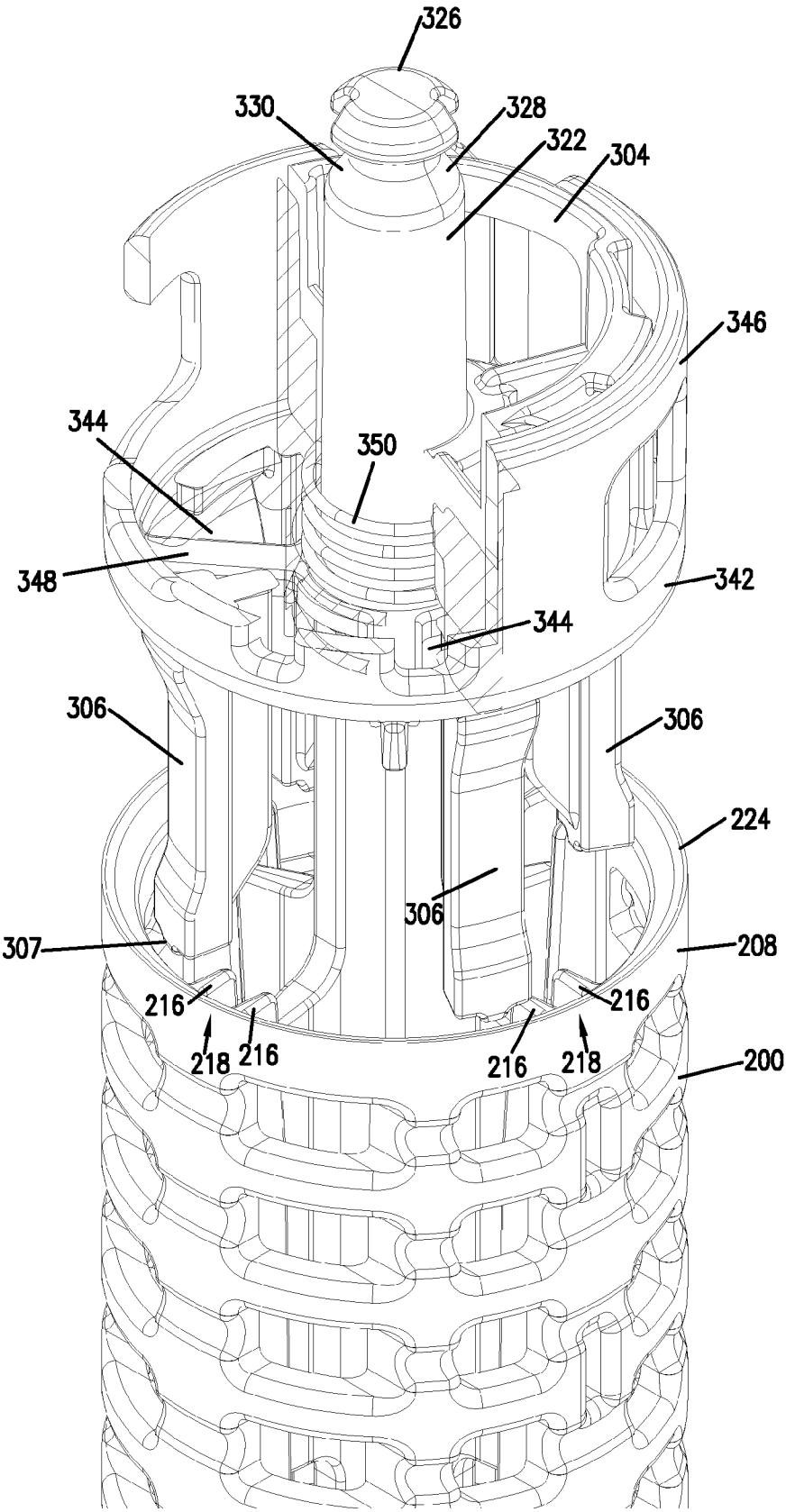

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FIG.23

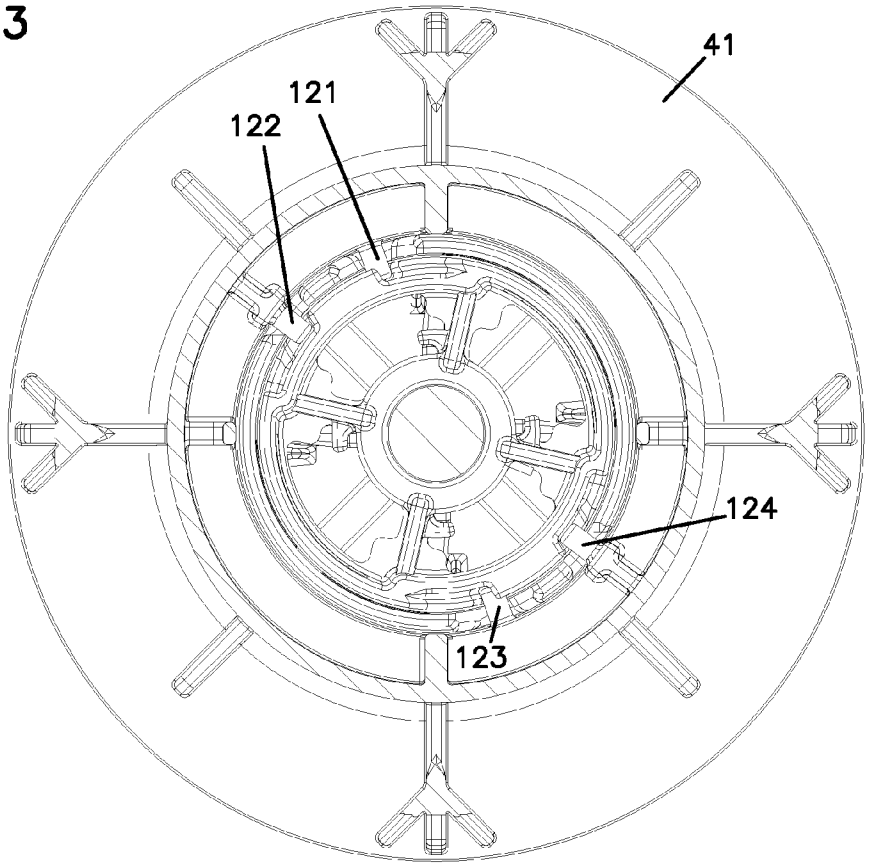

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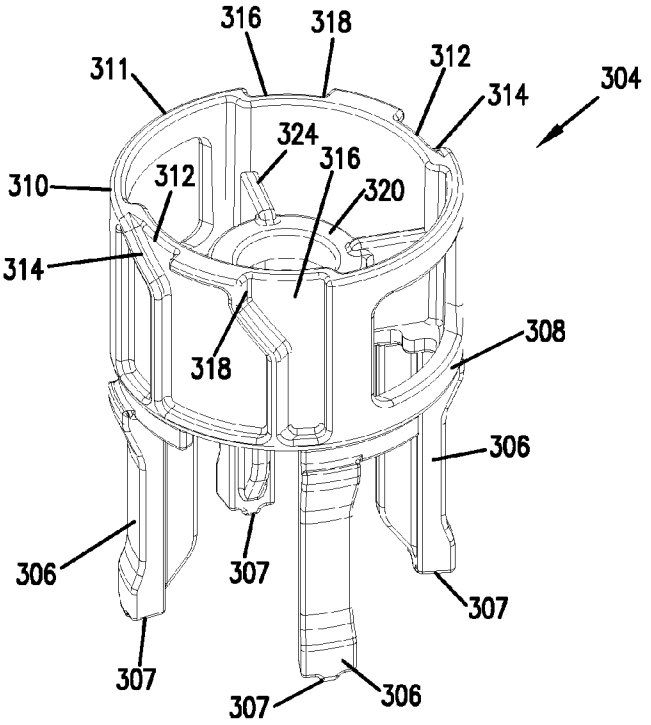

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FIG.25

FIG.27

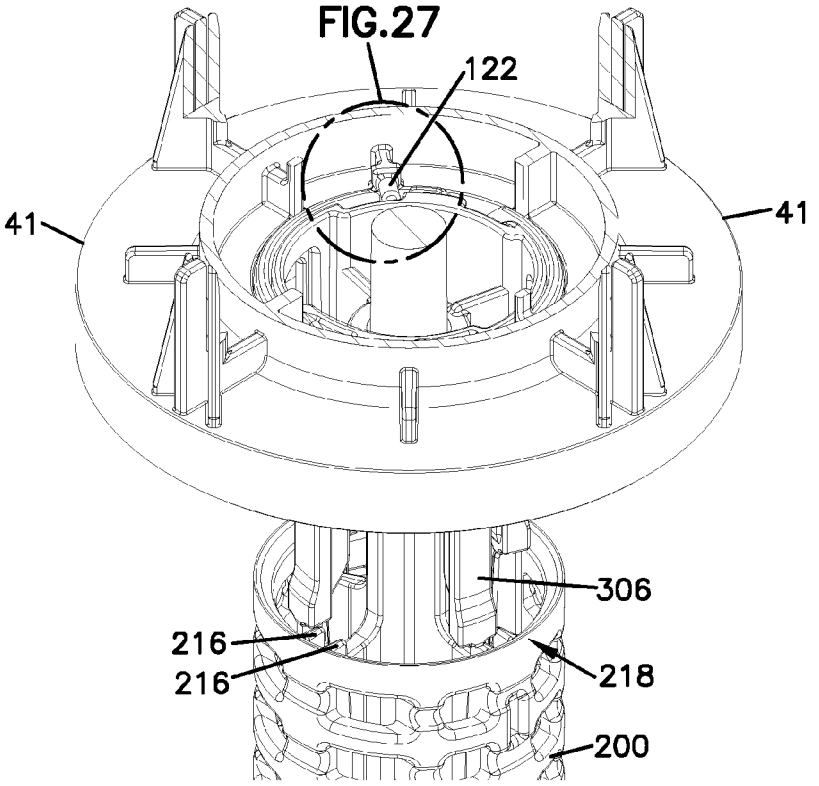


FIG.26

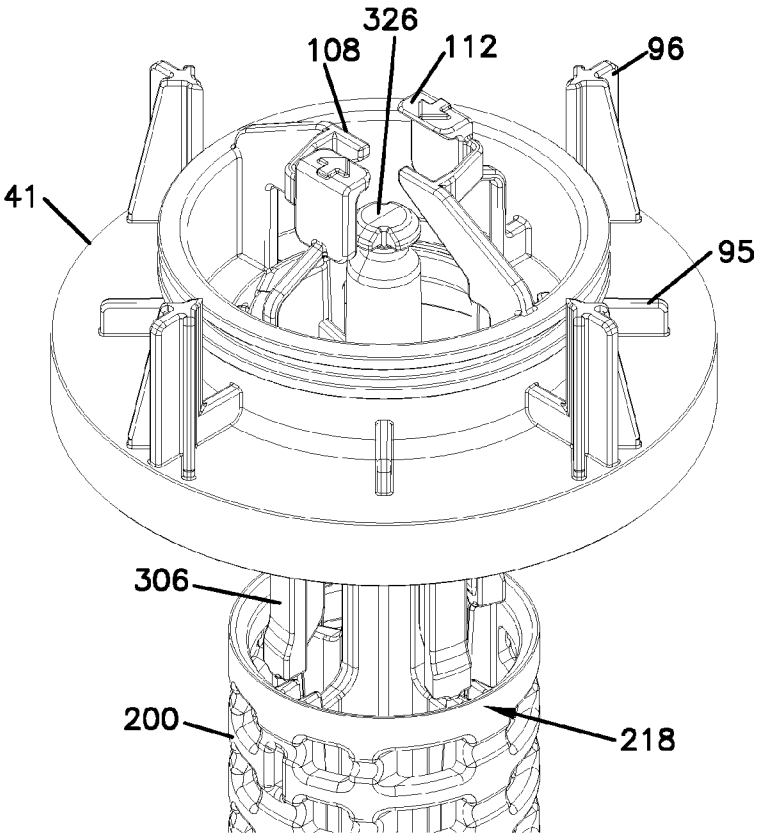


FIG.27

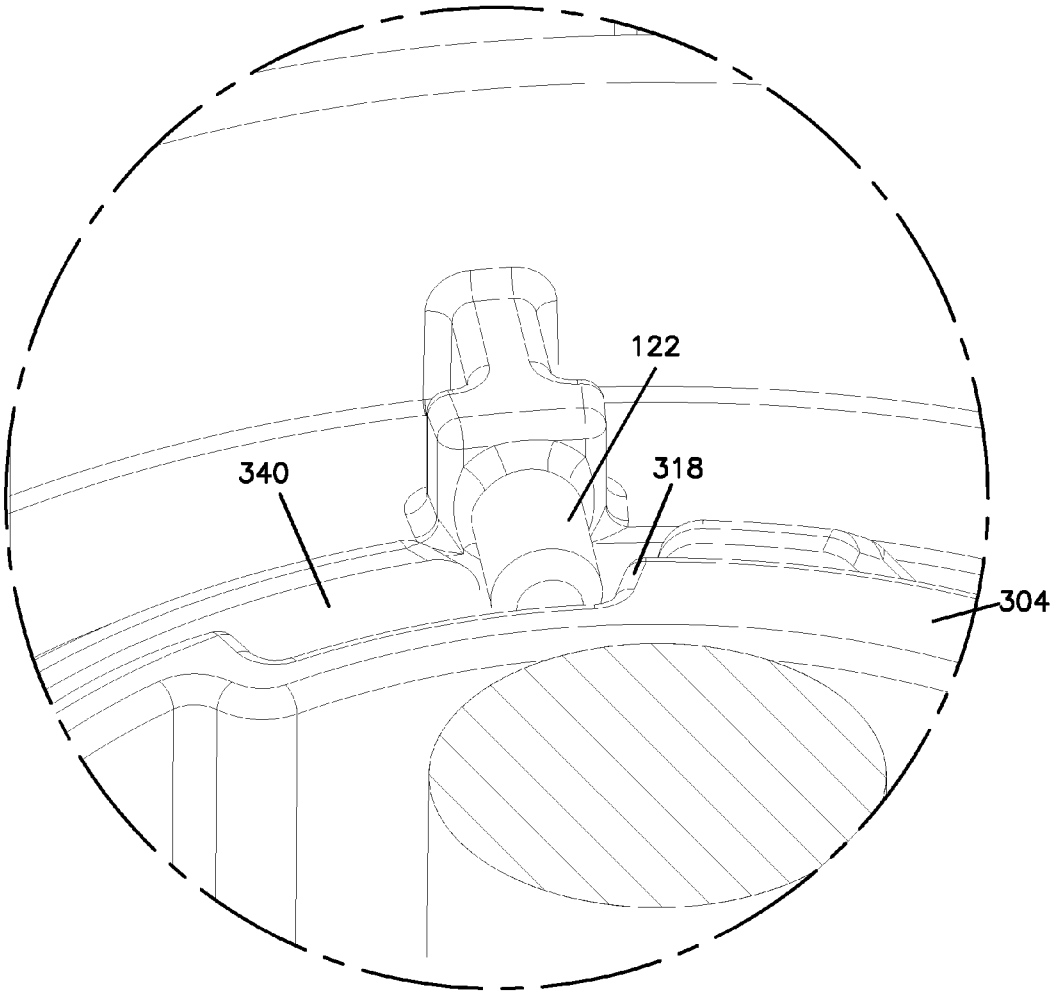


FIG.28

FIG.30

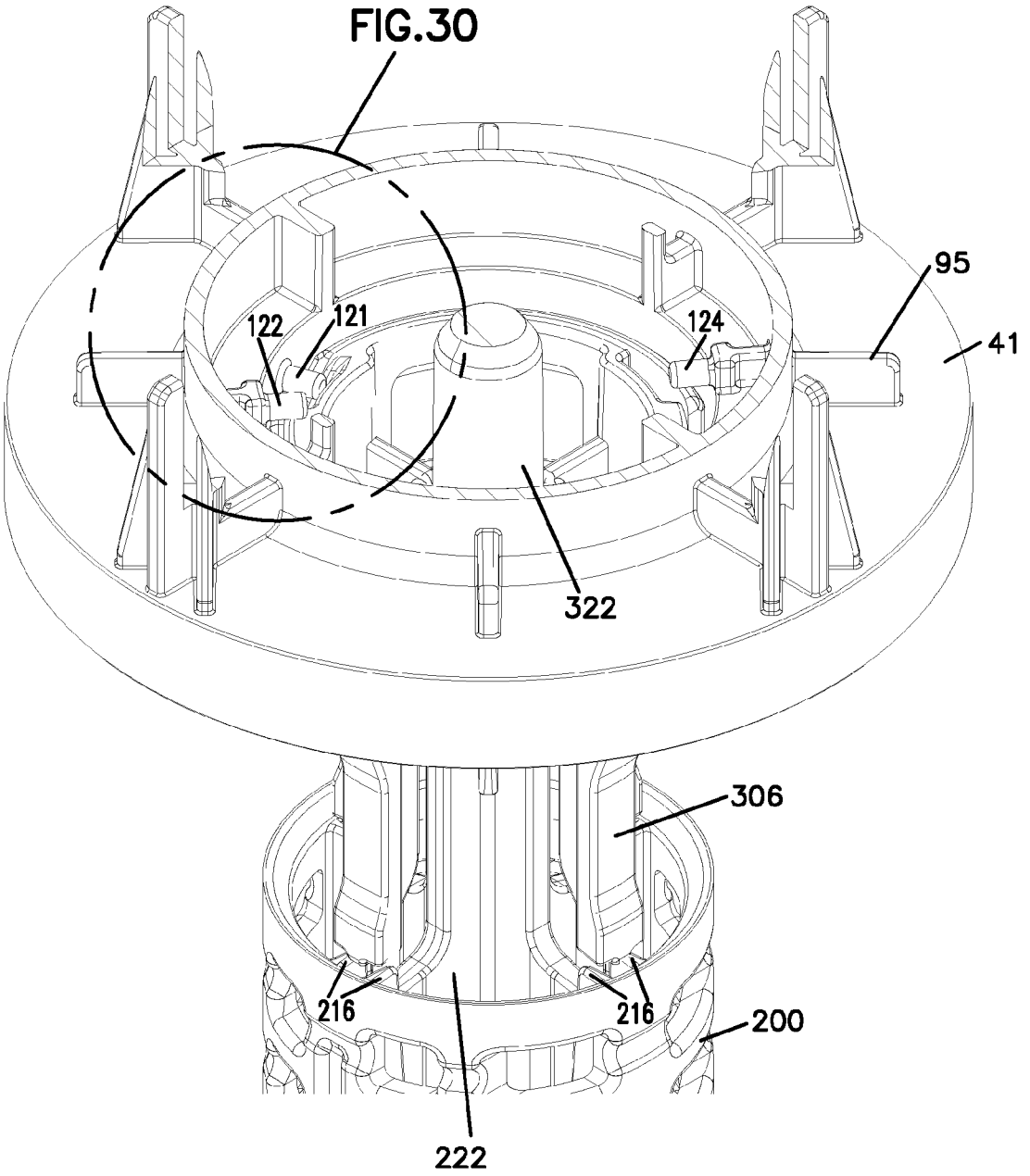


FIG.29

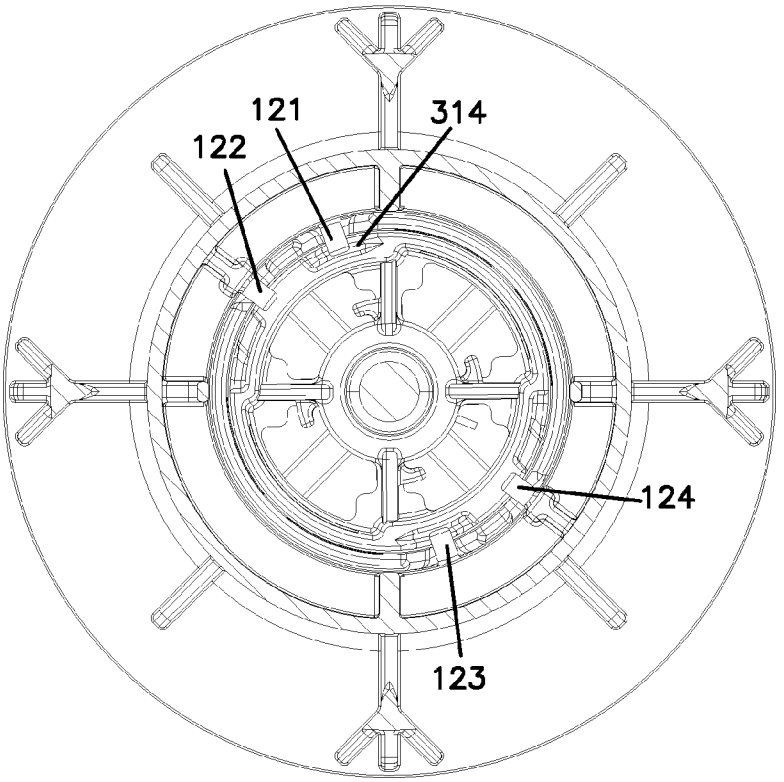


FIG.30

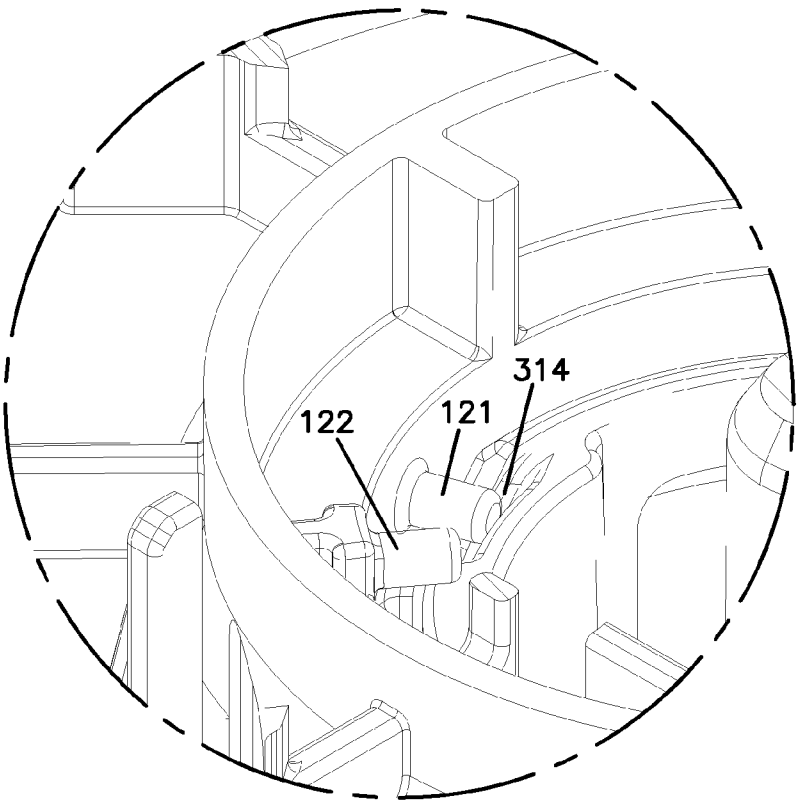


FIG.31

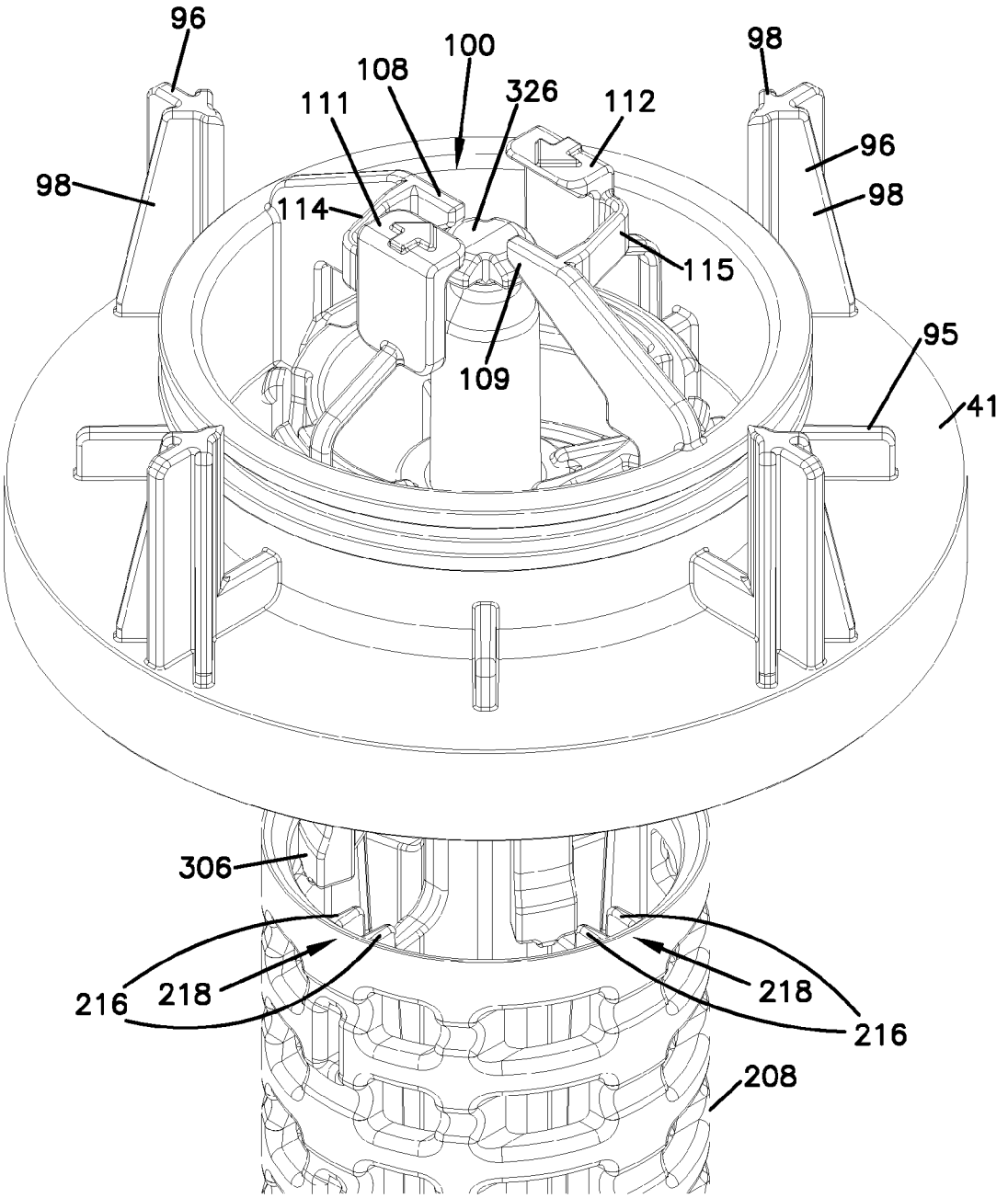

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FIG.32

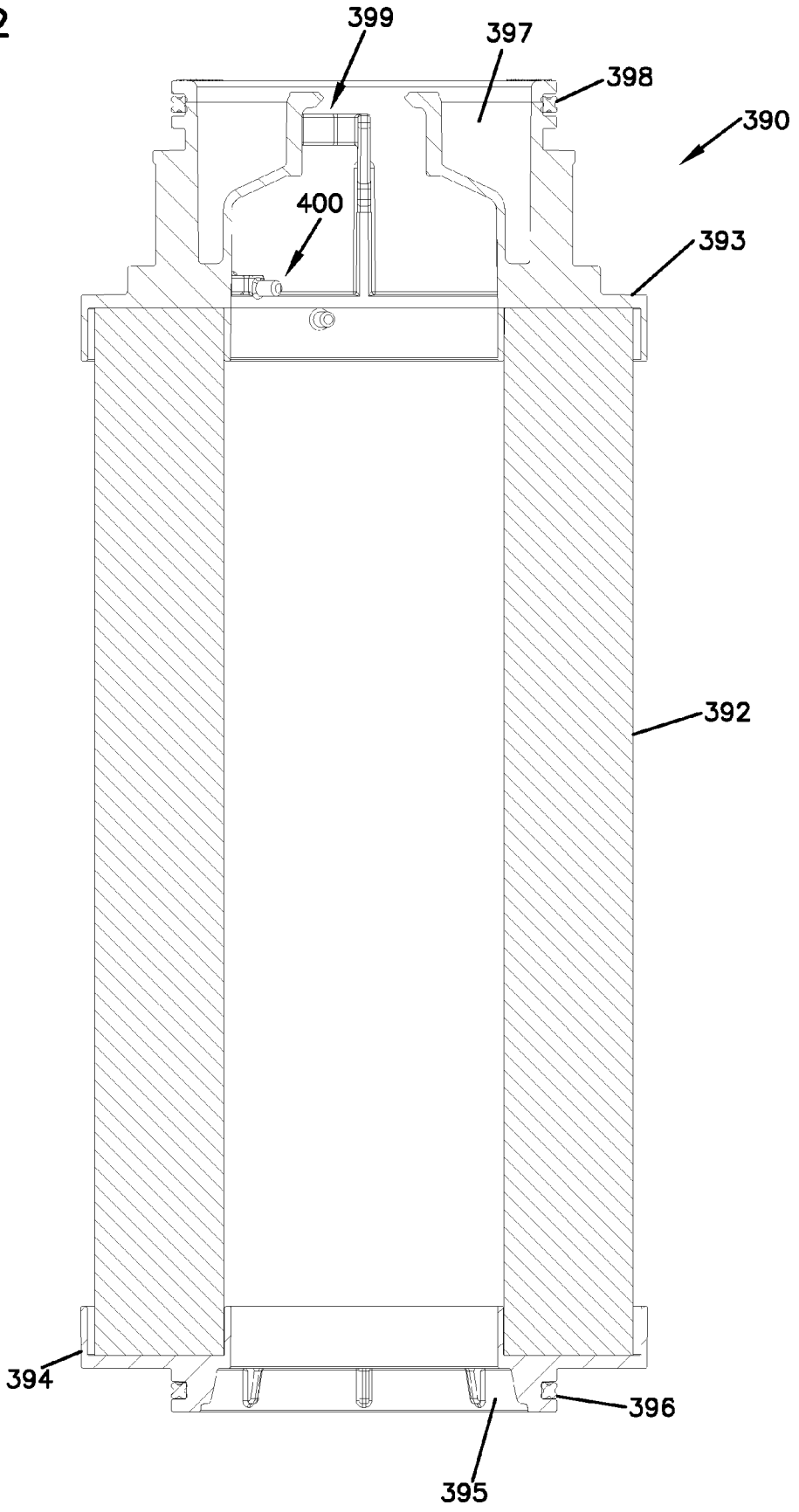


FIG.33

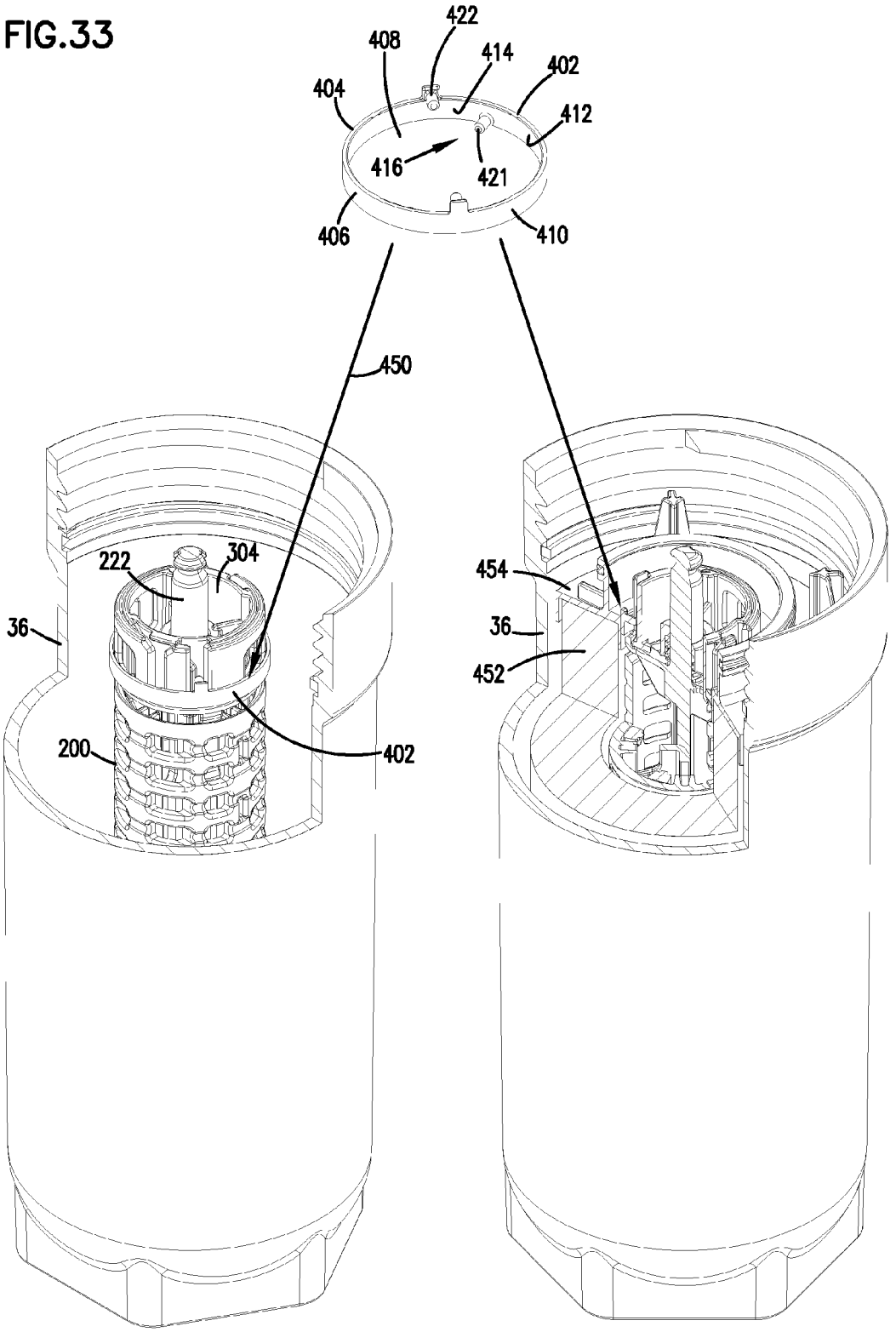

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FIG.37

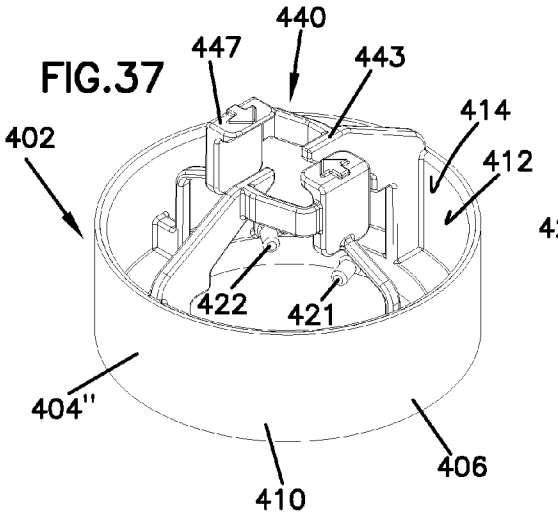


FIG.38

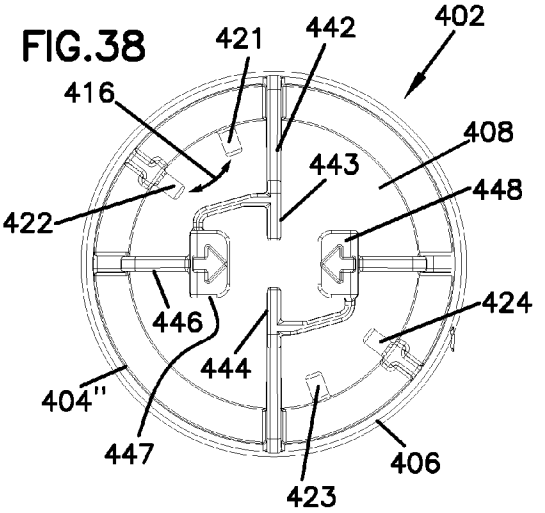


FIG.35

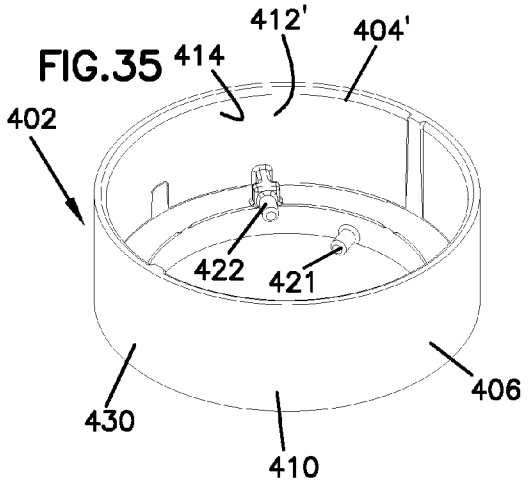


FIG.36

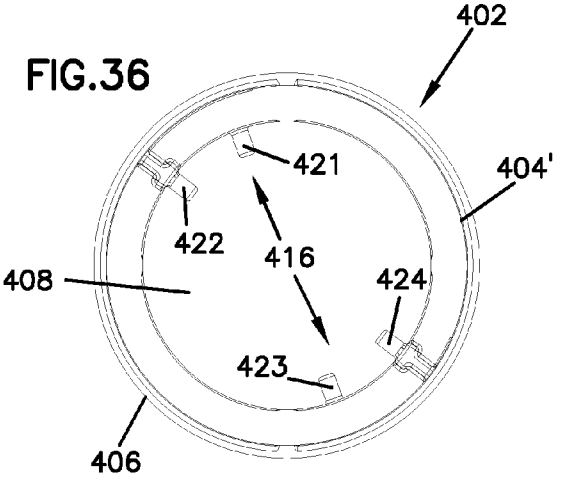


FIG.34

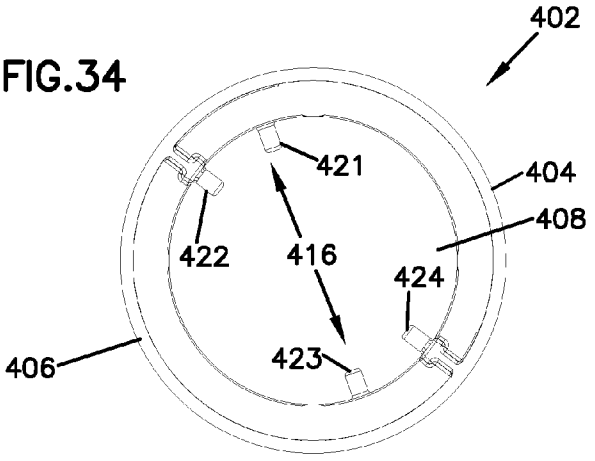
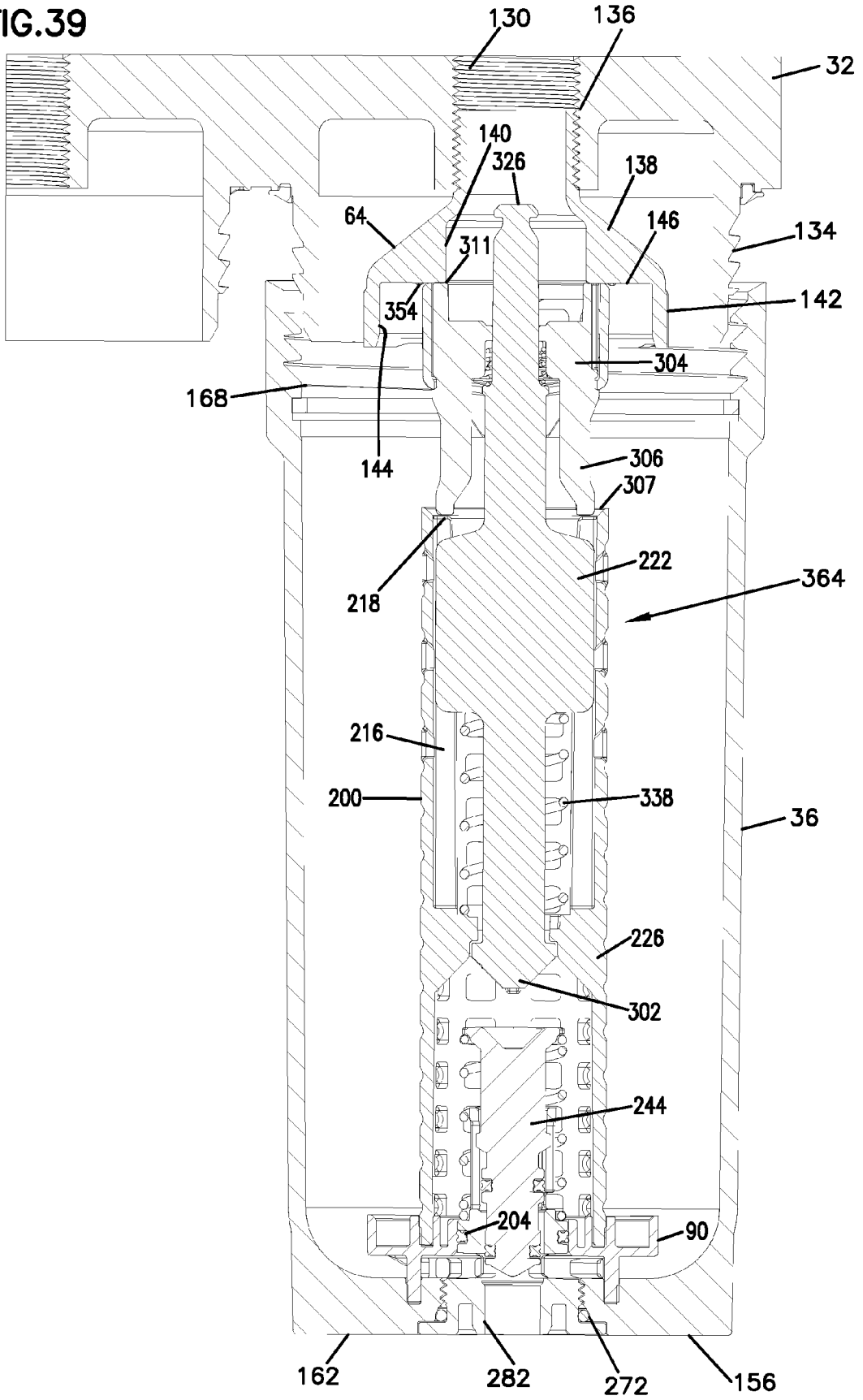


FIG.39


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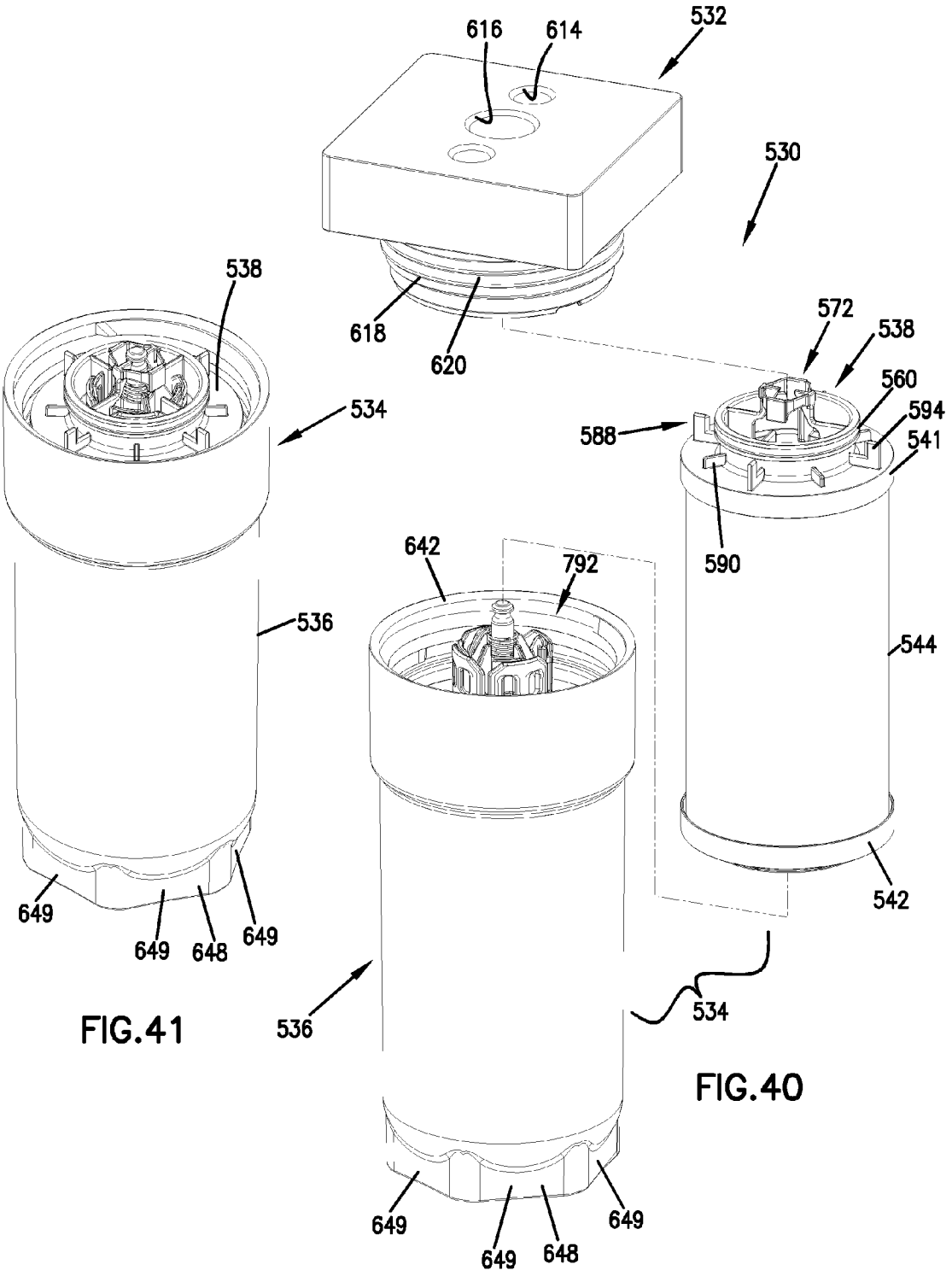

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FIG.41

FIG.40

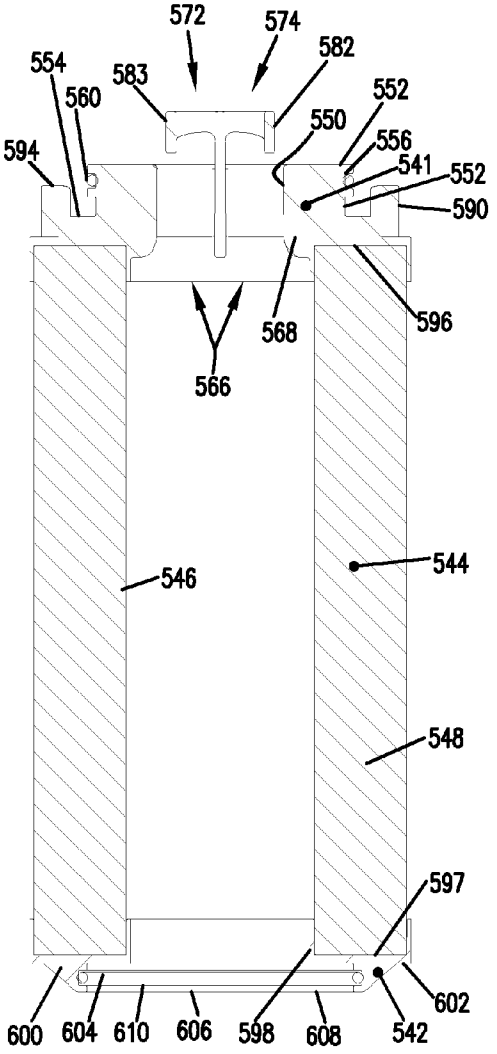

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FIG.43

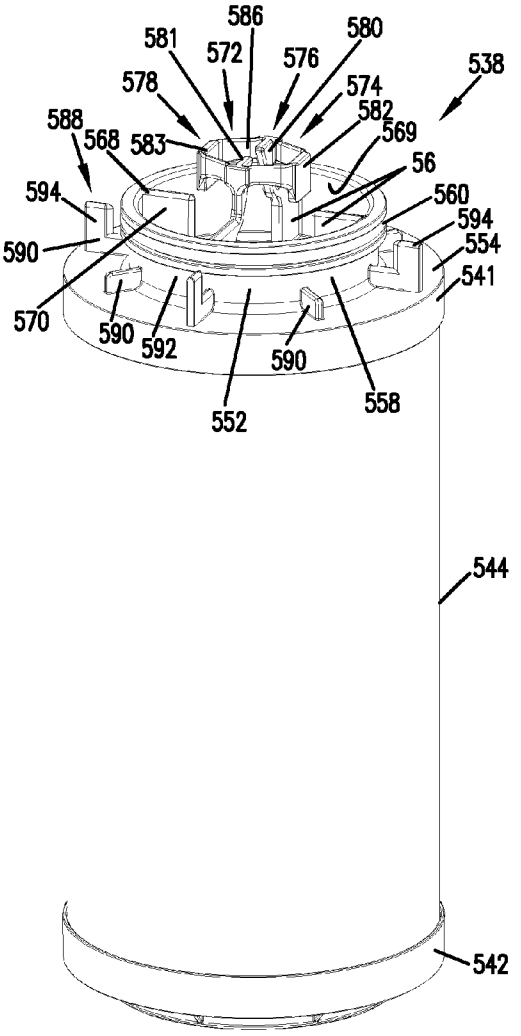

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FIG.42

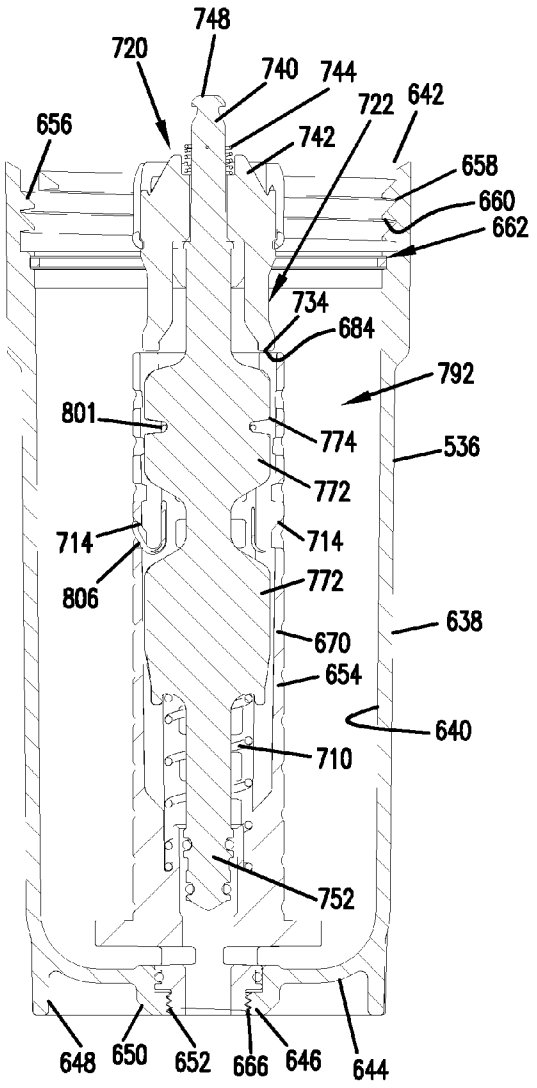

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FIG.45

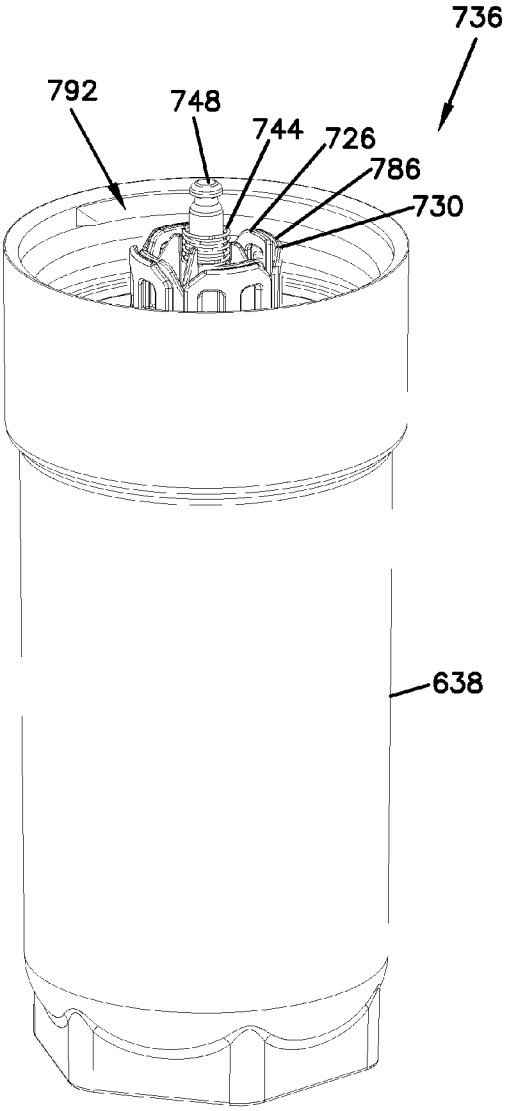

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FIG.44

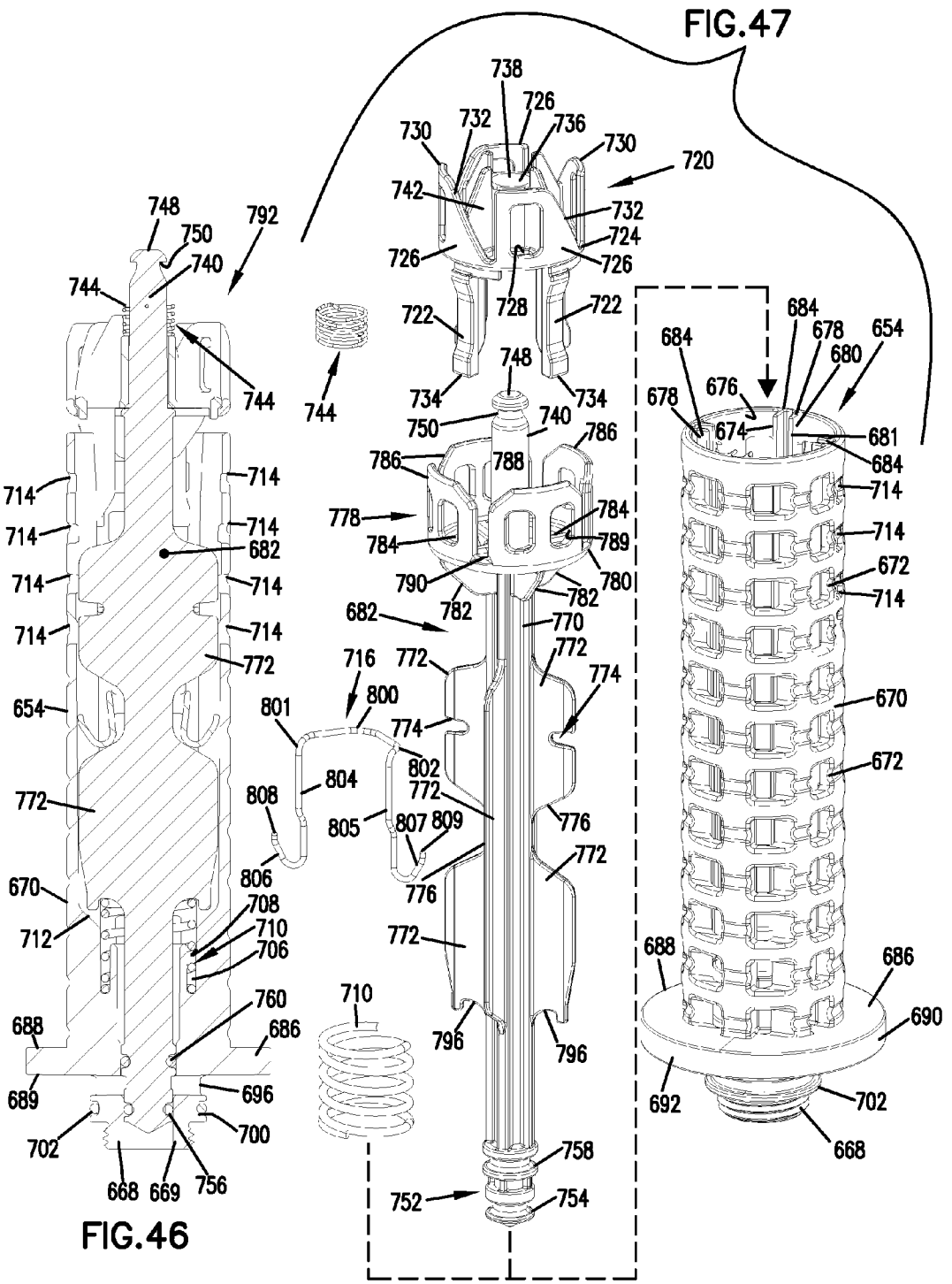

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FIG.46

FIG.47

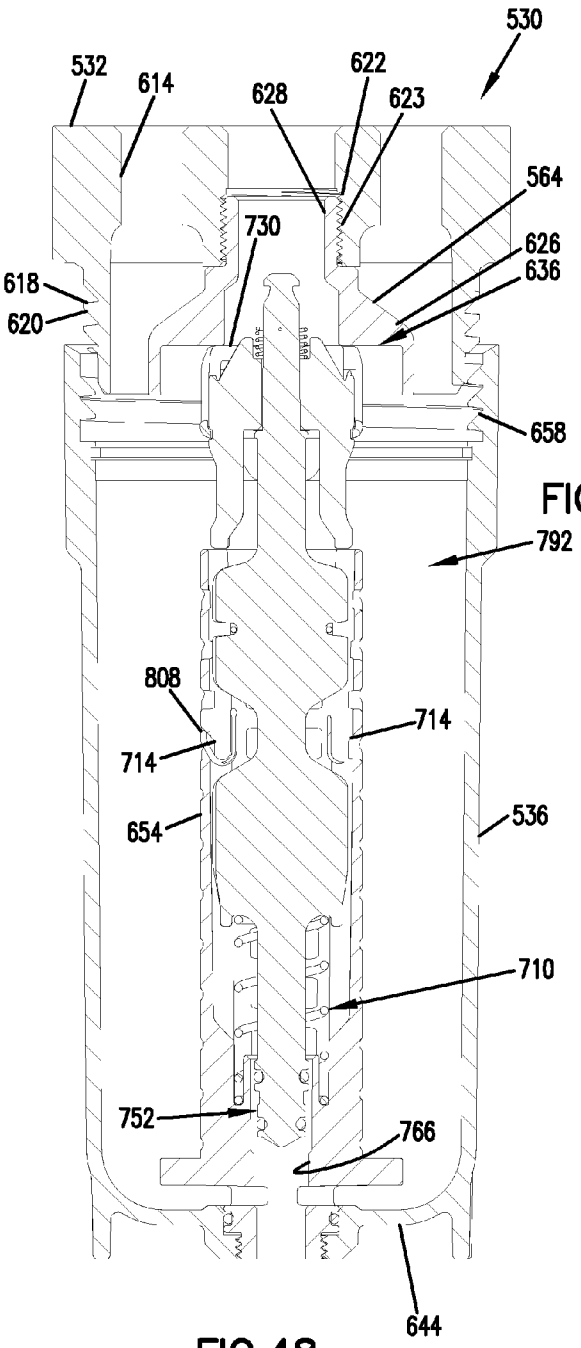

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FIG.48

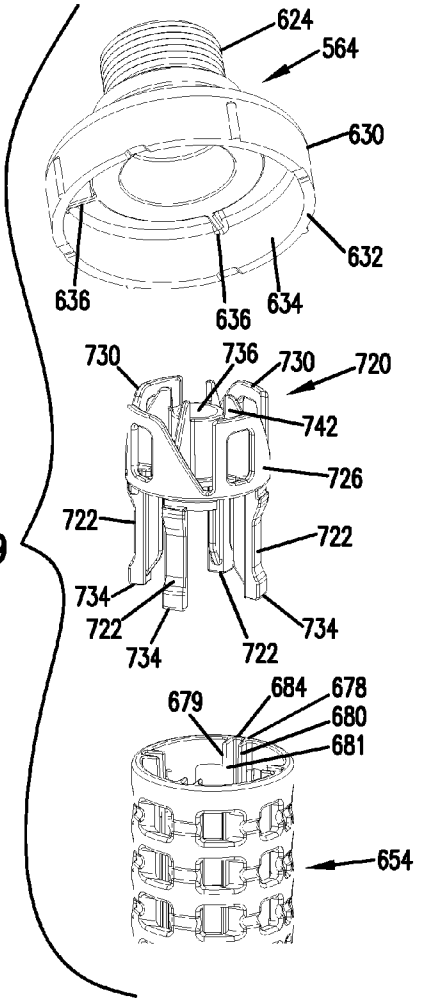

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FIG.49

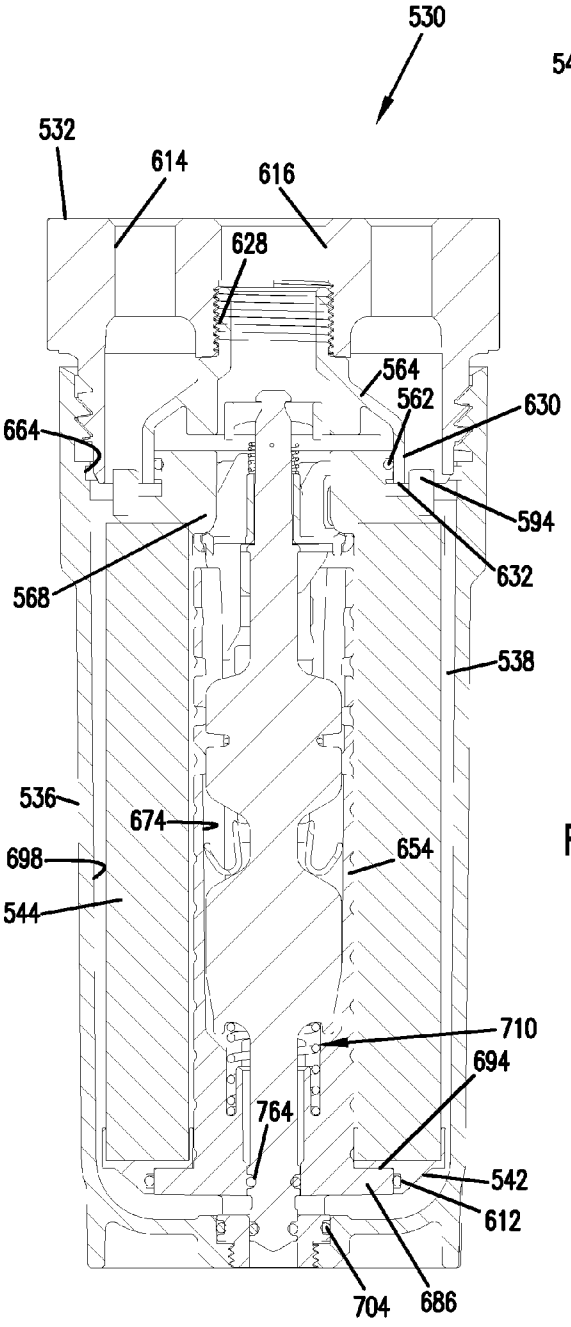


FIG.50

FIG.51

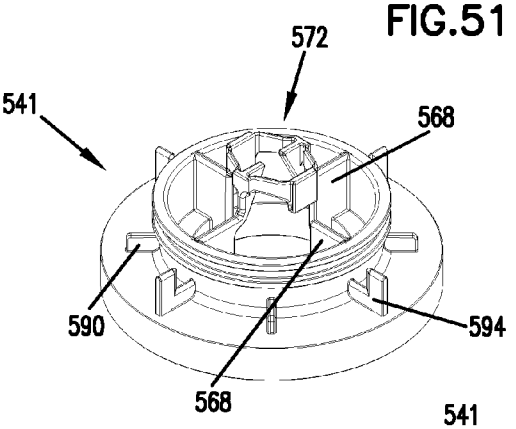
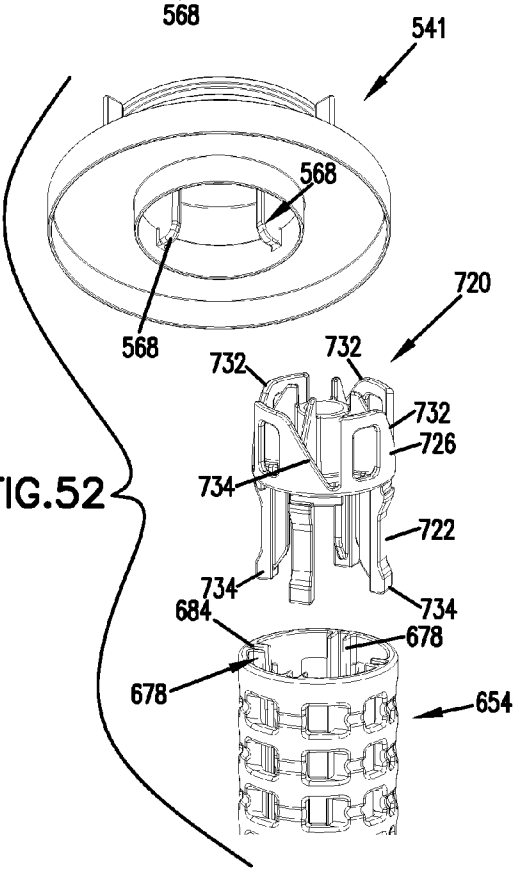


FIG.52



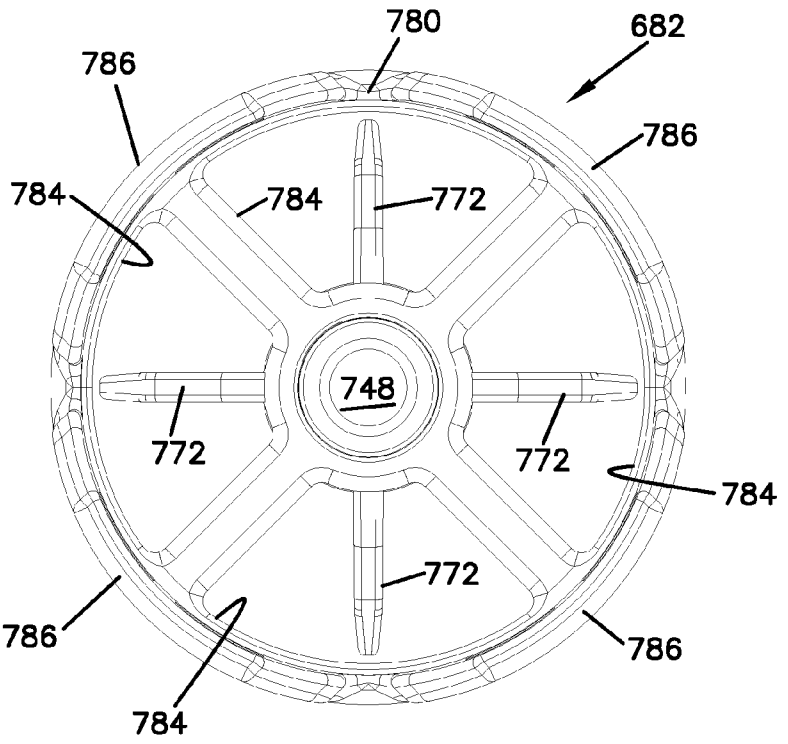

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FIG.58

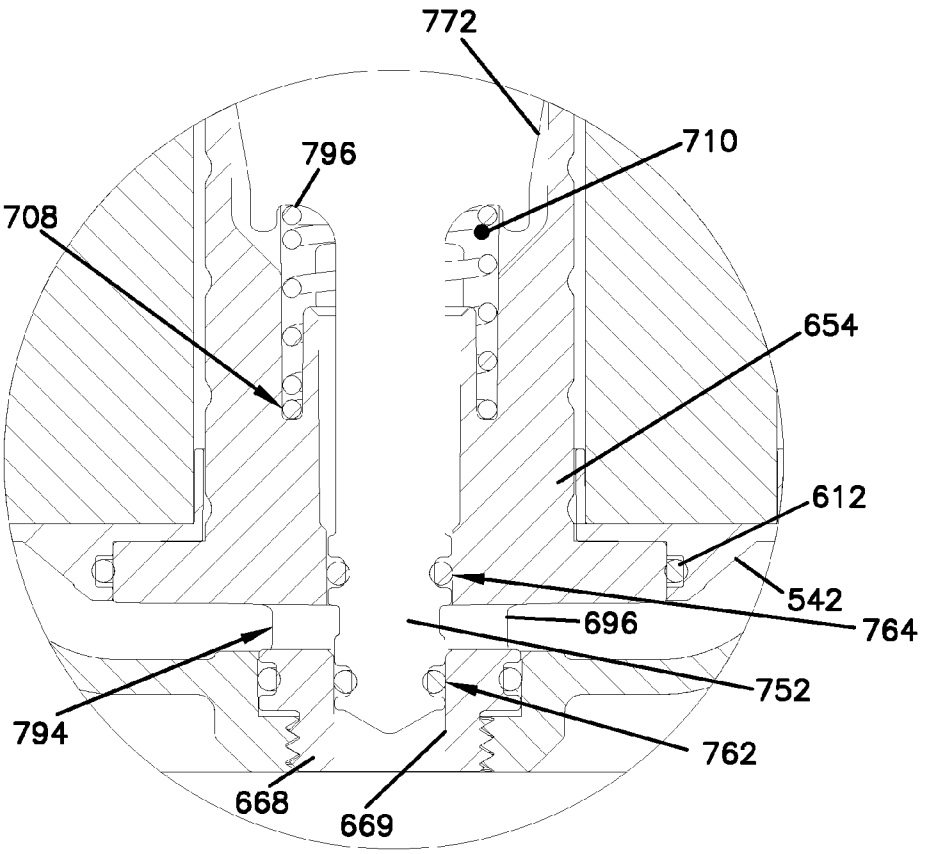

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FIG.53

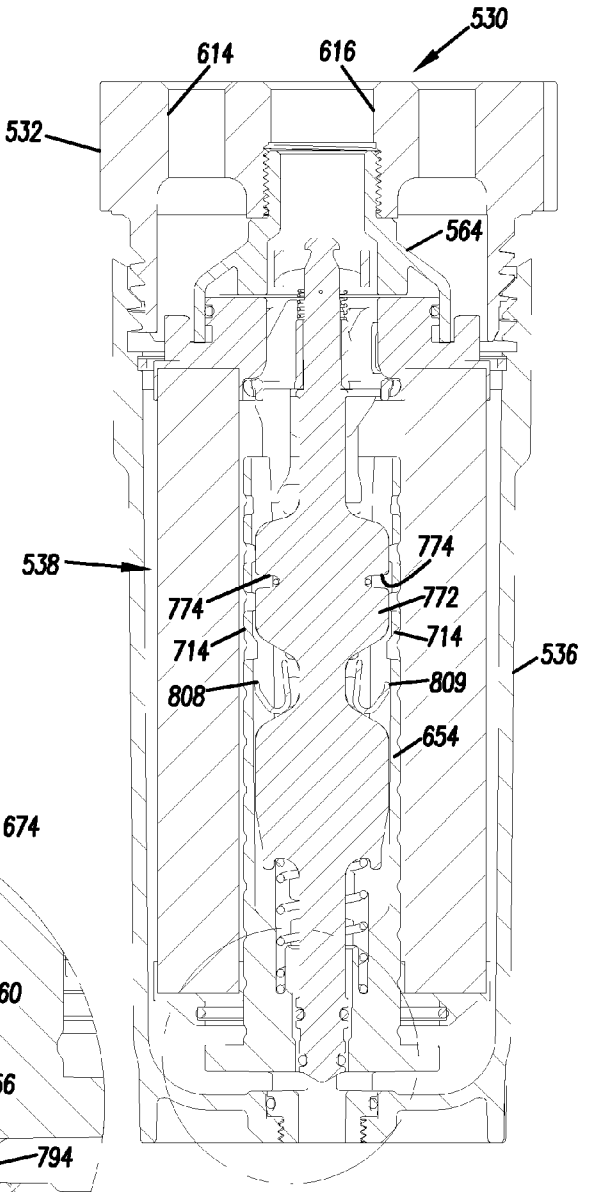

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FIG.54

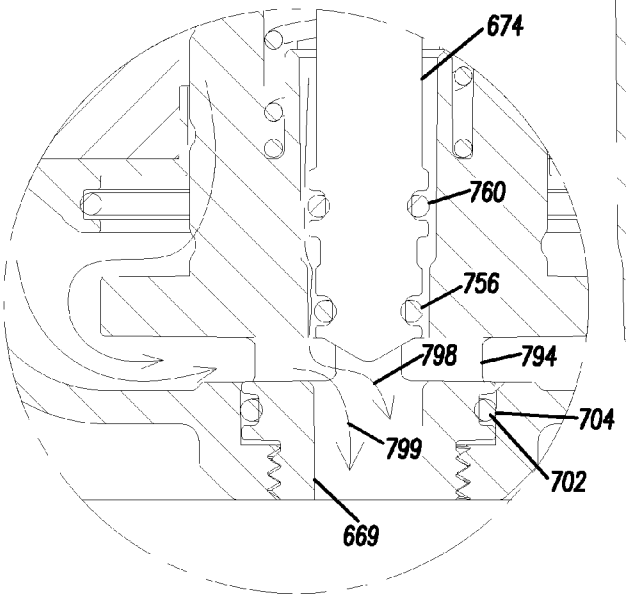

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FIG.55

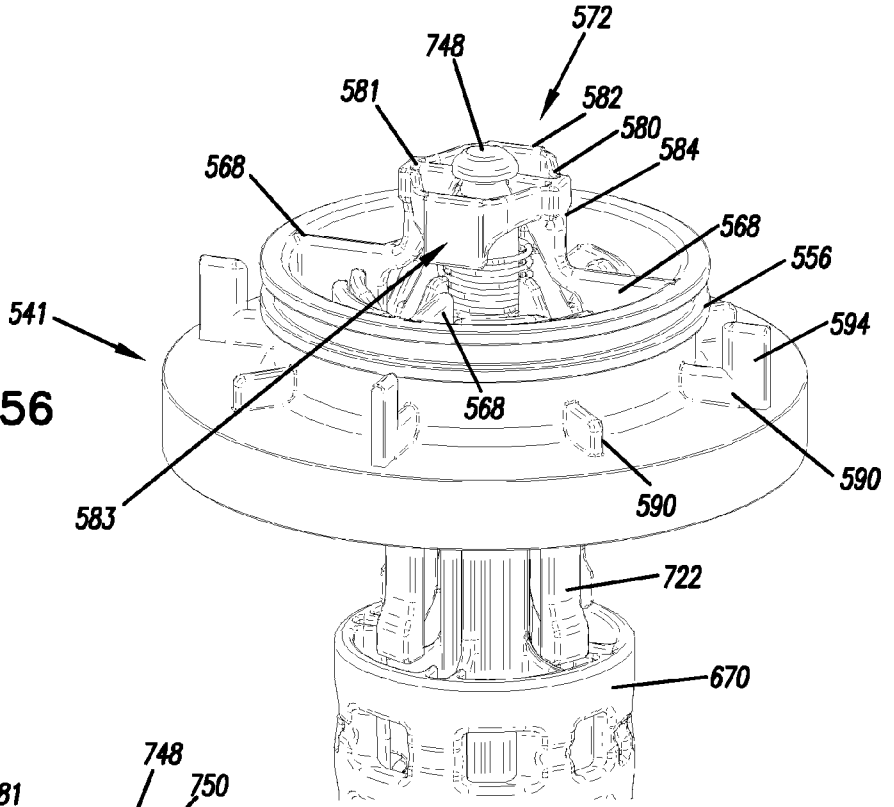

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FIG.56

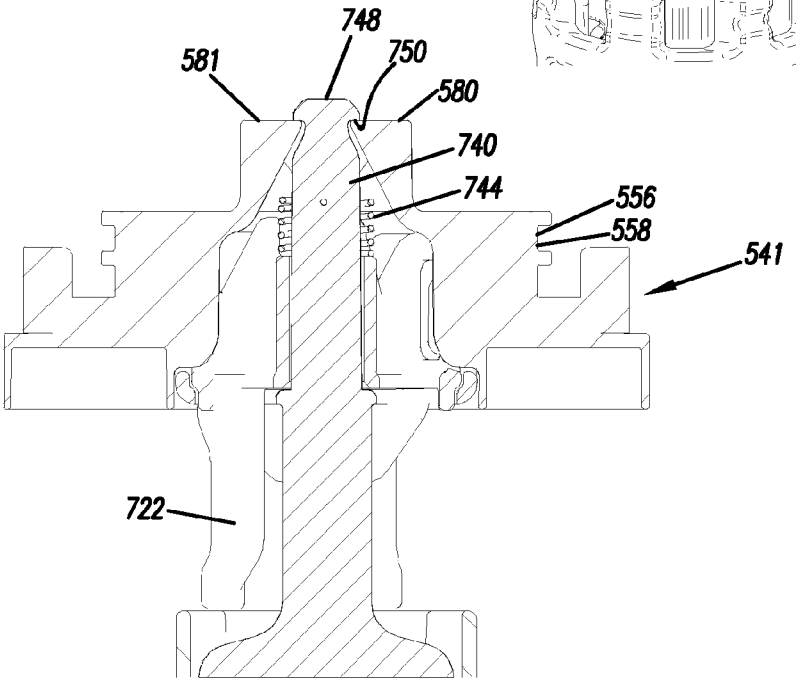

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FIG.57

LIQUID FILTER, ASSEMBLY, SYSTEM, AND METHODS

[0001] This application is being filed on 25 Apr. 2008, as a PCT International Patent application in the name of Donaldson Company, Inc., a U.S. national corporation, applicant for the designation of all countries except the US, and Bradley S. Honermann, Kathryn A. Legault, John R. Hacker and Mark S. Emery, citizens of the U.S., applicants for the designation of the US only, and claims priority to U.S. Provisional Patent Application Ser. No. 60/926,547 filed Apr. 27, 2007 and U.S. Provisional Patent Application Ser. No. 60/955,954 filed Aug. 15, 2007. These applications are incorporated herein by reference.

TECHNICAL FIELD

[0002] This disclosure relates to filtration assemblies and methods. In particular, this disclosure relates to filter assemblies and methods for use in liquid filtration, such as lube filters, hydraulic filters, and fuel filters.

BACKGROUND

[0003] Filters are commonly used in connection with lubrication systems and fuel systems for internal combustion engines, and hydraulic systems for heavy-duty equipment. Filters are also used in many other types of liquid systems. In these types of systems, the filter is changed periodically. In the art, there are at least two standard types of filters used. One type is a spin-on canister filter, while the other is a bowl-cartridge filter.

[0004] Bowl-cartridge filters typically include a reusable bowl holding a replaceable filter element (filter cartridge). Bowl-cartridge filters are sometimes preferred instead of spin-on canister filters due to disposal or other issues. Bowl-cartridge filters are mounted onto a filter head, and liquid to be cleaned passes through the filter head, into the bowl, through the replaceable filter cartridge, out of the bowl, and back into the filter head. After a period of use, the bowl-cartridge filter is removed from the filter head, and the replaceable filter cartridge is removed from the reusable bowl. The old filter cartridge is discarded and replaced with a new filter cartridge. The new filter cartridge is operably-mounted into the reusable bowl to provide a refurbished bowl-cartridge filter. This refurbished bowl-cartridge filter, containing the new filter cartridge, is then mounted onto the filter head.

[0005] Some problems with existing arrangements include the mess that is caused when servicing the bowl-cartridge filter. That is, when the bowl is removed from the filter head, it typically has oil, hydraulic fluid, or whatever fluid is being filtered within it. While removing the bowl from the filter head, the fact that the bowl has this liquid in it can lead to spills, drips, and inconvenience regarding disposal of this liquid. Improvements in filter design are desired to deal with these issues.

[0006] Other problems include the possibility of forgetting to replace the filter cartridge after removing the old filter cartridge. That is, after removing the old filter cartridge for servicing, it can be possible to replace the bowl back onto the filter head without operably inserting a new filter cartridge. This can lead to disastrous consequences for the equipment that needs the filtration. Furthermore, when there are multiple filter assemblies within close proximity of each other on one system, sometimes on a common filter head, the person servicing the filters can sometimes get mixed-up regarding which filter assembly goes on where—putting the wrong filter assembly onto the wrong mount on the filter head can lead to catastrophic results. Improvements to address these issues are desirable.

SUMMARY

[0007] To address these and other problems, in one aspect, a filter cartridge is provided. The filter cartridge includes a first endcap defining a first open aperture; a tubular construction of filter media; and a second endcap. The first endcap holds a first endcap seal member. The first endcap defines an aperture wall lining the first open aperture. At least first and second protrusions extend from the aperture wall and into the first open aperture. The first protrusion is spaced from the second protrusion in a vertical direction along the aperture wall. The first protrusion is also circumferentially spaced from the second protrusion along the aperture wall.

[0008] In another aspect, a filter assembly is provided including a bowl including a surrounding wall defining an interior volume; a filter cartridge removably oriented within the interior volume of the bowl; a porous inner filter support oriented within an open filter interior of the filter cartridge; and a basket. The filter support includes at least one projection extending radially inwardly therefrom. The basket includes at least one cantilevered leg extending axially in a direction toward the end of the bowl. The basket also includes a grooved wall extending axially in a direction toward the open mouth of the bowl. The basket is rotationally movable from a first locked position in which the leg axially abuts the at least one projection on the filter support and an unlocked position in which the leg is free of axial abutment with the projection and permits the basket to move in a direction toward the end of the bowl. The grooved wall is constructed and arranged to engage a portion of the filter cartridge and rotate the basket from the first locked position to the unlocked position.

[0009] In another aspect, a filter system is provided including a filter assembly, as characterized above, and further including a filter head selectively connectable to the bowl with the bowl and the filter head having mating structure permitting the bowl to be selectively removably attached to the filter head at the mouth.

[0010] In another aspect, a method of installing a filter cartridge into a filter bowl includes orienting a filter cartridge having a tubular construction of filter media into a filter bowl, the filter bowl having an inner filter support and a core piece within the inner filter support, the core piece holding a basket. While orienting, the method includes pushing the filter cartridge against the basket piece to disengage the core piece and the inner filter support. The method further includes after the step of disengaging, axially moving both the filter cartridge and the core piece relative to the inner filter support.

[0011] In another aspect, a filter assembly is provided including a bowl including a surrounding wall, an open mouth, an end opposite of the mouth, and a drainage aperture at the end opposite of the mouth that is in fluid communication with the interior volume. A filter cartridge is removably oriented within the interior volume of the bowl and includes a tubular construction of filter media defining an open filter interior. A porous inner filter support is oriented within the open filter interior. A drain valve assembly including a plug is moveably oriented between a sealed position and a drainage position. The sealed position includes the plug blocking fluid

flow between the interior volume of the bowl and the drainage aperture. The drainage position includes the plug being oriented relative to the bowl to permit the flow from the interior volume of the bowl through the drainage aperture.

[0012] In another aspect, a method for draining liquid from a filter assembly includes at least partially unscrewing a bowl containing a filter cartridge from a filter head and permitting a spring to axially move a plug from a sealed position to a drainage position, the bowl having an interior volume and a fluid outlet port. The sealed position includes a plug blocking fluid flow between the interior volume of the bowl and the fluid outlet port and by blocking fluid flow between an upstream side of the filter cartridge and a downstream of the filter cartridge. The drainage position includes the plug being oriented to permit fluid flow between the interior volume of the bowl and the fluid outlet port of the bowl.

[0013] In another aspect, a filter assembly is provided including a bowl, a filter cartridge removably oriented within the bowl, a porous inner filter support oriented within the open filter interior of the filter cartridge, and a core piece operably oriented within an interior of the porous inner filter support. The core piece includes a post. The filter cartridge further includes a retention mechanism removably connected to the post.

[0014] In another aspect, a method for servicing a filter system includes removing a filter assembly, including a bowl containing a filter cartridge from a filter head. Next, the method includes during the step of removing, retaining the filter cartridge to the bowl by gripping with a pair of opposing fingers radially extending toward each other on the filter cartridge with a button on a core piece attached to the bowl.

[0015] In another aspect, an adaptor ring for use with a filter bowl is provided. The adaptor ring includes a circular band defining an open aperture. The band has an outer radial surface and an inside radial surface. The inside radial surface defines an aperture wall. At least first and second protrusions extend from the aperture wall and into the open aperture. The first protrusion is spaced from the second protrusion in a vertical direction along the aperture wall. The first protrusion is circumferentially spaced from the second protrusion along the aperture wall.

[0016] In another aspect, a method of using an adaptor ring to unlock a core piece and the filter support is provided. The method includes orienting an adaptor ring having at least first and second protrusions into a filter bowl. A filter bowl has an inner filter support mounted therein. The filter bowl further has a core piece within an inner filter support. The core piece holds a basket. The method also includes while orienting, pushing the first protrusion against the basket and then the second protrusion against the basket to disengage the core piece and the inner filter support. This allows for conducting a step, after disengaging, of axially moving the core piece relative to the inner filter support.

[0017] In another aspect, a filter assembly is provided including a bowl having an open mouth and a drainage aperture; a filter cartridge removably oriented within the interior volume of the bowl; a porous inner filter support oriented within the open filter interior of the filter cartridge; and a core piece operably oriented within the interior of the porous inner filter support. The core piece includes a plug movably oriented between a sealed position and a drainage position within the drainage aperture of the bowl. The sealed position includes the plug blocking fluid flow between the interior volume of the bowl and the drainage aperture, and the drainage position includes the plug being oriented relative to the bowl to permit flow from the interior volume of the bowl through the drainage aperture.

[0018] In another aspect, a method for draining liquid from a filter assembly includes at least partially unscrewing a bowl containing a filter cartridge from a filter head and permitting a spring to axially move a core piece having a plug from a sealed position to a drainage position. The sealed position includes the plug blocking fluid flow between the interior volume of the bowl and the fluid outlet port by blocking flow through a section of an inner filter support; and the drainage position including the plug being oriented relative to the inner filter support to permit flow through the section of the inner filter support permitting fluid flow between the interior volume of the bowl and fluid outlet port of the bowl.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. **1** is a perspective view of a filter system including a plurality of filter assemblies, one of which shows the filter cartridge removed from a filter bowl, constructed according to principles of this disclosure;

[0020] FIG. **2** is a perspective view of a filter assembly including a filter cartridge and filter bowl, constructed according to principles of this disclosure;

[0021] FIG. **3** is a perspective, cross-sectional view of the filter assembly depicted in FIG. **2**;

[0022] FIG. **4** is a cross-sectional view of the filter assembly depicted in FIG. **2**;

[0023] FIG. **5** is a top plan view of a filter cartridge utilized in the filter assembly of FIG. **2**;

[0024] FIG. **6** is a cross-sectional view of the filter cartridge depicted in FIG. **5**, the cross-section being taken along the line **6-6** of FIG. **5**;

[0025] FIG. **7** is a perspective, cross-sectional view of the filter cartridge of FIGS. **5** and **6**, the cross-section being taken along the line **7-7** of FIG. **5**;

[0026] FIG. **8** is a perspective, cross-sectional view of only the filter bowl and inner assembly, with the filter cartridge being removed therefrom;

[0027] FIG. **9** is a cross-sectional view of the filter assembly similar to FIG. **4** and highlighting a drain valve feature;

[0028] FIG. **10** is an enlarged cross-sectional view of the region of the drain valve feature of FIG. **9**;

[0029] FIG. **11** is a cross-sectional view of a filter system, similar to FIG. **1**, but depicting only a single filter assembly connected to a filter head;

[0030] FIG. **12** is an enlarged, cross-sectional view of the drain valve feature depicted in FIG. **11**;

[0031] FIG. **13** is an exploded, perspective view of a drain valve assembly utilized in the filter assembly of FIGS. **1-12**;

[0032] FIG. **14** is a top plan view of the drain valve assembly of FIG. **13**, when assembled together;

[0033] FIG. **15** is a perspective, cross-sectional view of the assembled drain valve assembly of FIGS. **13** and **14**;

[0034] FIG. **16** is a top plan view of an endcap of the filter cartridge as it is ready to engage a core piece and filter support, remaining portions of the filter cartridge being omitted for purposes of explanation;

[0035] FIG. **17** is a side elevational view of the view of FIG. **16**, showing the endcap, core piece, and a portion of the filter support;

[0036] FIG. **18** is a perspective view of FIG. **17** and showing the full extension of the filter support, while having a portion of the endcap broken away;

[0037] FIG. **19** is a perspective view showing the basket within a basket holder of the core piece and in a first locked position relative to the filter support;

[0038] FIG. **20** is a perspective view analogous to FIG. **19**, but showing the basket in a second locked position relative to the filter support;

[0039] FIG. **21** is a perspective view analogous to FIGS. **19** and **20** but showing the basket in an unlocked position relative to the filter support;

[0040] FIG. **22** is a the same perspective view as FIG. **21**, but showing a portion of the basket and basket holder broken away in order to show other parts;

[0041] FIG. **23** is a partial cross-section, top plan view showing the endcap engaged against the basket and basket holder as the basket is rotated from its first locked position to its second locked position;

[0042] FIG. **24** is a perspective view of the basket;

[0043] FIG. **25** is a perspective view of the arrangement of FIG. **23**;

[0044] FIG. **26** is a perspective view of the arrangement of FIG. **25**, but not having structure cut off in cross-section as shown in FIG. **25**;

[0045] FIG. **27** is an enlarged, perspective, partially cross-sectional view of the arrangement of FIG. **25** at the portion shown in FIG. **25**;

[0046] FIG. **28** is a perspective, partially cross-sectional view of the cartridge end cap in engagement with the basket and basket holder, analogous to the view of FIG. **25**, but showing the basket in the first locked position;

[0047] FIG. **29** is a top plan view of the arrangement of FIG. **28**;

[0048] FIG. **30** is an enlarged, perspective view of the portion shown in FIG. **28**;

[0049] FIG. **31** is a perspective view of the cartridge endcap engaged with the basket, when the basket is in the unlocked position;

[0050] FIG. **32** is a cross-sectional view of a bypass filter cartridge utilized with the system of FIG. **1**;

[0051] FIG. **33** is a perspective view illustrating a first embodiment of an adapter arrangement and how it would be utilized in the filter assembly;

[0052] FIG. **34** is a top plan view of the adapter of FIG. **33**;

[0053] FIG. **35** is a perspective view of a second embodiment of an adapter arrangement;

[0054] FIG. **36** is a top plan view of the adapter arrangement of FIG. **35**;

[0055] FIG. **37** is a perspective view of a third embodiment of an adapter arrangement;

[0056] FIG. **38** is a top plan view of the adapter arrangement of FIG. **37**;

[0057] FIG. **39** is a cross-sectional view of the filter bowl not being able to mate with the filter head because of the lock-out arrangement;

[0058] FIG. **40** is an exploded, perspective view of another filter system including a filter assembly and a filter head, constructed according to principles of this disclosure;

[0059] FIG. **41** is a perspective view of the filter assembly, including a filter bowl and a filter cartridge illustrated in FIG. **40**;

[0060] FIG. **42** is a perspective view of the filter cartridge illustrated in FIG. **40**;

[0061] FIG. **43** is a schematic, cross-sectional view of the filter cartridge depicted in FIG. **42**;

[0062] FIG. **44** is a perspective view of the filter bowl depicted in FIGS. **40** and **41**;

[0063] FIG. **45** is a schematic, cross-sectional view of the filter bowl depicted in FIG. **44** and showing an inner liner assembly;

[0064] FIG. **46** is a schematic, cross-sectional view of one embodiment of an inner liner assembly depicted in FIG. **45**;

[0065] FIG. **47** is an exploded, perspective view of the components of FIG. **46**;

[0066] FIG. **48** is a schematic, cross-sectional view of the filter bowl, inner liner assembly, and filter head of certain preferred embodiments constructed according to principles of this disclosure;

[0067] FIG. **49** is an exploded, perspective view of an adaptor, basket, and portion of an inner filter support tube that can be seen in the cross-sectional view of FIG. **48**;

[0068] FIG. **50** is a schematic, cross-sectional view of a filter system including a filter head, a filter bowl, and filter cartridge operably assembled together, constructed according to principles of this disclosure;

[0069] FIG. **51** is a top-perspective view of an endcap that is utilized on one embodiment of a filter cartridge, constructed according to principles of this disclosure;

[0070] FIG. **52** is an exploded, perspective view of the endcap of FIG. **51** and the basket and inner filter support shown in FIG. **49**;

[0071] FIG. **53** is an enlarged, cross-sectional view of a portion of a drain valve in a closed position and as illustrated in FIG. **50**;

[0072] FIG. **54** is a schematic, cross-sectional view of the filter system shown in FIG. **50**, but in FIG. **54** showing the filter head partially removed from the filter bowl and showing the drain valve mechanism in an open position;

[0073] FIG. **55** is an enlarged portion of the cross-section depicted in FIG. **54**;

[0074] FIG. **56** is a partial, schematic perspective view of an endcap engaging a plug in a center piece, which would occur when the filter cartridge was removed from the filter bowl, the filter media not being depicted for purposes of clarity, constructed according to principles of this disclosure;

[0075] FIG. **57** is a schematic, cross-sectional view of the assembly of FIG. **56**; and

[0076] FIG. **58** is a schematic top plan view of the core piece of FIG. **47**.

DETAILED DESCRIPTION

I. The Embodiments of FIGS. **1-39**

A. Overview

[0077] An example embodiment of a filtration system including a filter assembly and a filter head is depicted in FIGS. **1-39**. It should be realized that many examples are envisioned and not illustrated in the drawings. FIG. **1** shows a filter system **30**, including a filter head **32** and a filter assembly **34**. In the embodiment of FIG. **1**, there is one common filter head **32** accommodating at least first and second filter assemblies **34**. Also attached to the filter head **32** is a bypass filter assembly **35**. The filter assemblies **34** are full-flow filters, while the filter assembly **35** is a bypass filter assembly.

[0078] In FIG. **1**, one of the filter assemblies **34** is shown in an exploded, perspective view as including filter bowl **36** and a removable and replaceable filter cartridge **38**.

[0079] Each of the filter assemblies **34**, **35** is selectively connectable and mountable on the filter head **32**. The filter

head **32** is connected with other equipment, including a lubrication system of an engine, a fuel system for an engine, a hydraulic system for heavy-duty equipment, and generators for industrial use.

[0080] In the embodiment illustrated, the filter assembly **34** includes features including a lock-out mechanism, an auto-drain valve mechanism, and a cartridge retention mechanism. Each of these features can be implemented independently of the other features. The particular embodiment illustrated in the drawings shows all three features integrated into the same filter assembly. One skilled in the art will appreciate that each feature can be implemented independently of the others.

[0081] In general, the lock-out mechanism ensures that the filter system **30** is not accidentally operated with equipment without the filter cartridge **38** installed therein (see FIG. **39**, for example). Furthermore, in the particular system **30**, the lock-out mechanism helps to ensure that the filter cartridge that goes within the bypass filter assembly **35** is not mistakenly used with the filter cartridge of the full-flow filter assemblies **34**. The equipment upon which the filter system **30** is mounted is protected by ensuring that the filter head **32** and the filter bowl **36** cannot be operably connected unless there is a filter cartridge **38** operably oriented within the filter bowl **36** (FIG. **39**). It also protects the equipment by ensuring that the correct filter cartridge **38** is mounted within the filter bowl **36**, rather than, for example, the bypass filter cartridge utilized in the bypass filter assembly **35**. Details on an example lock-out mechanism are described in Section K of this disclosure.

[0082] An auto-drain valve mechanism can be included in the filter system **30** and will allow for draining of the filtered liquid from the filter bowl **36** during servicing of the filter system **30**. The auto-drain valve mechanism allows for draining of the filter bowl **36** before the filter cartridge **38** is removed from the bowl **36**. An example embodiment is described in Section L of this disclosure.

[0083] The filter system **30**, in this embodiment, also includes a cartridge retention mechanism. This feature allows for attachment of the filter cartridge **38** to the filter bowl **36** after the filter assembly **34** has been completely removed from the filter head **32**. Section M describes an example embodiment of a cartridge retention mechanism.

[0084] For purposes of organization, it should be understood that the following description will be of various pieces of the particular, illustrated embodiment. After each of the pieces in this embodiment is described, the way in which the pieces interact to provide the above and other functions are described. Methods of operation, assembly, filtering, and servicing are also described. The following are example embodiments only. A variety of implementations can be made without departing from the scope of the disclosure. Not all of the reference numerals are shown on each FIG., for purposes of clarity.

B. Filter Cartridge **38**, FIGS. 6 and 7

[0085] Reference is made to FIGS. **6** and **7**, which illustrate one embodiment of filter cartridge **38** usable in this arrangement. In the embodiment shown, the filter cartridge **38** includes first and second opposite endcaps **41**, **42** and a tubular construction of filter media **44** extending between the first and second endcaps **41**, **42**. In the embodiment shown, the media **44** is cylindrical in construction and defines an open filter interior **46**. A variety of different types of media **44** can be used and will depend upon the particular fluid that is being filtered. In the embodiment shown, the media **44** is pleated media **48**. The pleated media **48** can include cellulose, synthetic, and blends of synthetic and cellulose, for example.

[0086] In general, fluid to be filtered flows through the media **44**, which functions to remove particulate or other debris from the fluid before flowing into the open filter **46**. In some systems, it will be possible to operate the filter system **30** in a reverse-flow manner, in which the liquid to be filtered flows from the open filter interior **46**, through the media **44**, and to a region outside of the media **44**.

[0087] The first endcap **41**, depicted, defines a first open aperture **50**, which is in fluid communication with the open filter interior **46**. The first endcap **41** further includes an axially-extending neck **52** protruding from an outward axial surface **54**. The neck **52** defines a groove **56** along an outer radial surface **58** of the neck **52**. Seated within the groove **56** along the radial surface **58** is a first seal member **60**. The first seal member **60** forms a releasable seal **62** (FIG. **11**) with an adaptor **64** when the filter cartridge **38** is operably assembled in the filter system **30** with the filter head **32** operably engaged with the filter bowl **36**.

[0088] The first endcap **41** defines an aperture wall **66** lining the first open aperture **50**. The first open aperture **50** in the embodiment shown, is circular and defines an inner diameter. The neck **52** defines an inner radial surface **68** that is on an opposite side as the outer radial surface **58**. In the embodiment shown, the first endcap **41** further defines a filter media holding section **70**. The filter media holding section **70** is the portion of the first endcap **41** that is secured to the filter media **44** and contains the media **44** on radial sides thereof. In the embodiment shown, the filter media section **70** includes an inner media wall **72** defining an inner radial surface **74**, which forms part of the aperture wall **66**. The inner wall surface **74** of the inner media wall **72** is spaced radially inwardly relative to the neck inner radial surface **68**. The filter media holding section **70** further includes an outer media wall **76** that circumscribes remaining portions of the first endcap **41**. The first endcap **41** further includes other features, in the embodiment shown, and those features will be further described below after the second endcap **42** is described.

[0089] Second endcap **42** is at an end of the filter cartridge **38** opposite from the first endcap **41**. The second endcap **42** is secured to a second end of the filter media **44**. It defines a second open aperture **78** in communication with the open filter interior **46**. The second endcap **42** holds a second endcap seal member **80**.

[0090] In the embodiment shown, the second endcap **42** defines a second axially extending neck **82**. The neck **82** defines inner and outer radial surfaces **84**, **85**. The second endcap seal member **80** is held by the second axially extending neck **82** on one of the radial surfaces, and in the embodiment shown, is held by the outer radial surface **85**. In the embodiment shown, the neck **82** includes a groove **86** in the radial surface **85**, which holds the second seal member **80**. The second seal member **80** forms a releasable seal **88** (FIG. **12**) with a disk **90**. The disk **90** is secured to the bowl **36**, and is further described below.

[0091] The filter cartridge **38** further includes, in the embodiment shown, a centering arrangement **92** (FIG. **5**) to assist with positioning and centering the filter cartridge **38** relative to the filter head **32**. In the embodiment shown, the centering arrangement **92** includes a plurality of stand-offs or projections **94** extending axially from the outward axial surface **54** of the first endcap **41**. In the embodiment shown, the projections **94** include both first projections **95** and second

projections **96**. The second projections **96** are taller than the first projections **95**. The second projections **96**, in cross section, have an L-shaped cross section and in preferred embodiments have ribs or flanges **98** to add strength. The second projections **96** assist in holding the filter cartridge **38** in place relative to the adaptor **64** (FIG. **11**). As can be seen in FIG. **11**, the adaptor **64** is contained between the second projections **96** and the first neck **52**.

[0092] In the illustrated embodiment, the filter cartridge **58** further includes a retention mechanism **100**. In the embodiment shown, the retention mechanism **100** is spaced both axially and radially from the neck **52**. The retention mechanism **100** cooperates with other structure to retain the cartridge **38** with the filter bowl **36** during servicing. Details on this operation are discussed later below in Section M of this disclosure.

[0093] In the embodiment shown, the retention mechanism **100** is radially centered within the first open aperture **50**. While a variety of implementations are contemplated, in the embodiment shown, the retention mechanism **100** includes a flexible semi-tubular arrangement **102** (FIG. **5**) secured to a portion of the endcap **41**, for example, the neck **52**. By the term "semi-tubular", it is meant that when viewing in top plan, such as FIG. **5**, overall it may be generally tubular in shape, but not necessarily have a closed perimeter, and the perimeter can form an irregular, non-circular shape, or it may also form a circle, in some embodiments shown.

[0094] Still in reference to FIG. **5**, the semi-tubular arrangement **102** has a gripper arrangement **104** and a release arrangement **106**. In general, the gripper arrangement **104** is useful in providing a releasable connection with other structure in the filter bowl **36** to allow for the cartridge **38** to remain retained in the filter bowl **36** when servicing system **30**. The release arrangement **106** is useful in providing a convenient, quick, and easy to use mechanism to release the filter cartridge **38** from the filter bowl **36**, during servicing, and allow the cartridge **38** to be removed from the bowl **36**.

[0095] As embodied herein, the gripper arrangement **104** includes a pair of opposing fingers **108**, **109** radially extending into the end cap aperture **50**. As will be explained below, in Section M of this disclosure, the fingers **108**, **109** engage structure (a button **326**, which is part of a core piece **222**) in the filter bowl **36**.

[0096] As embodied herein, the release arrangement **106** includes a pair of opposing tabs **111**, **112**. In the embodiment shown, each tab **111**, **112** is located about 90 degrees relative to the fingers **108**, **109**. Tab **111** is connected to finger **108** by way of rib **114**, while tab **112** is connected to finger **109** by way of rib **115**.

[0097] The tabs **111**, **112** are depressible or compressible in a direction toward each other, and because of the connection of the tabs **111**, **112** to the fingers **108**, **109** by way of the ribs **114**, **115**, upon squeezing the tabs **111**, **112** toward each other, the ribs **114**, **115** move the fingers **108**, **109** away from each other. Moving the fingers **108**, **109** away from each other will release the filter cartridge **38** from the corresponding structure in the filter bowl **36**.

[0098] The filter cartridge **38** further includes a protrusion arrangement **118** (FIG. **5**) extending into the first open aperture **50**. The protrusion arrangement **118** cooperates, in one embodiment with the lock-out arrangement described in Section K below. In the embodiment shown, the protrusion arrangement **118** includes at least first and second protrusions **121**, **122** extending from the aperture wall **66** and into the first open aperture **50**. By reviewing FIGS. **6** and **7**, it can be seen how in the preferred embodiment, the first protrusion **121** is spaced from the second protrusion **122** in a vertical direction along the aperture wall **66**. That is, in the embodiment shown, the first protrusion **121** is vertically lower than the second protrusion **122**. By reviewing FIGS. **6** and **7**, it can further be appreciated that the first protrusion **121** is circumferentially-spaced from the second protrusion **122** along the aperture wall **66**. In preferred embodiments, the vertical distance between first and second protrusions is between 2-30% of the distance of the inner diameter of the first open aperture **50**.

[0099] In preferred embodiments, the first protrusion **121** extends into the first open aperture **50** no greater than 40% of the inner diameter of the first open aperture **50**. Similarly, the second protrusion **122** extends into the first open aperture **50** no greater than 40% of the inner diameter of the first open aperture **50**. In the preferred embodiment illustrated, the first and second protrusions **121**, **122** extend a same amount into the first open aperture **50**. In other embodiments, one of the first and second protrusions **121**, **122** can be longer than the other.

[0100] Attention is directed to FIG. **5**. In FIG. **5**, there is a top plan view of the filter cartridge **38**. In the embodiment shown, the protrusion arrangement **118** further includes at least a third protrusion **123** extending from the aperture wall **66** and into the first open aperture **50**. The third protrusion **123** is circumferentially-spaced from the first protrusion **121** and the second protrusion **122**. The third protrusion **123** is vertically spaced from only one of either the first protrusion **121** or the second protrusion **122**; in other words, the third protrusion **123** is evenly spaced at the same vertical distance along the aperture wall **66** with only one of either the first protrusion **121** or the second protrusion **122**.

[0101] In FIG. **5**, it can be seen that the protrusion arrangement **118**, in the embodiment shown, further includes at least a fourth protrusion **124**. The fourth protrusion **124** is shown extending from the aperture wall **66** and into the first open aperture **50**. The fourth protrusion **124** is circumferentially-spaced from the first protrusion **121**, the second protrusion **122**, and the third protrusion **123**. The fourth protrusion **124** is vertically-spaced from only two of the first protrusion **121**, the second protrusion **122**, or the third protrusion **123**. In other words, the fourth protrusion **124** is vertically even with only two of the first protrusion **121**, the second protrusion **122**, and the third protrusion **123**.

[0102] In the particular embodiment illustrated, the third protrusion **123** is vertically-spaced from the second protrusion **122** and the fourth protrusion **124**, while it is vertically even with the first protrusion **121**. Also, in the specific illustrated embodiment, the fourth protrusion **124** is vertically even with the second protrusion **122**, while being vertically spaced from the first protrusion **121** and the third protrusion **123**.

[0103] While the embodiment of FIG. **5** identifies the first protrusion at **121**, it could also be located at the physical location of the third protrusion **123**. Likewise, while the second protrusion is shown in FIG. **5** at reference numeral **122**, it could also be at the location shown at fourth protrusion **124**. In other words, in one contemplated embodiment, the protrusion arrangement **118** can include only a protrusion located at **121** and a protrusion located at **122**. Another variation includes the protrusion arrangement **118** as including a protrusion only at **121** and only at **124**. Another variation of the protrusion arrangement **118** includes a protrusion only at **123**

and **122**. Another variation includes the protrusion arrangement **118** as including a protrusion only at **123** and only at **124**. The particular embodiment illustrated has the protrusion arrangement **118** as including four protrusions at **121**, **122**, **123**, and **124**. Additional protrusions can be utilized to help cooperate with the other features of the assembly **34**, but in the embodiment of FIG. **5**, there are only four protrusions depicted.

[0104] In the embodiment shown, for the protrusion arrangement **118**, two of the first protrusion **121**, second protrusion **122**, third protrusion **123**, and fourth protrusion **124** are circumferentially-spaced within 45 degrees of each other (for example, 10-20 degrees), and a remaining two of the first protrusion **121**, second protrusion **122**, third protrusion **123**, and fourth protrusion **124** are located within 45 degrees of each other (for example, 10-20 degrees). In the embodiment illustrated in FIG. **5**, the first protrusion **121** and second protrusion **122** are circumferentially-spaced within 45 degrees of each other, while the third protrusion **123** and fourth protrusion **124** are circumferentially-spaced within 45 degrees of each other. In general, in preferred embodiments, the first protrusion **121** and the second protrusion **122** are circumferentially-spaced within 50 degrees of each other.

[0105] In some arrangements, one of the protrusions will be located greater than 45 degrees relative to the other protrusion. For example, consider an embodiment in which the protrusion arrangement **118** includes a first protrusion at **121**, and the second protrusion is located where the fourth protrusion **124** is located—in such an embodiment, the protrusions are located greater than 45 degrees relative to each other. In such a case, it could be said that the first protrusion **121** and the second protrusion located at reference numeral **124** are circumferentially-spaced greater than 45 degrees of each other. An analogous embodiment would include a first protrusion at reference numeral **123** and a second protrusion at reference numeral **122**.

C. The Filter Head **32** and Adaptor **64**

[0106] In FIGS. **1**, **11**, and **39**, a schematic depiction of filter head **32** is shown. The filter head **32** in the embodiment shown has an inlet conduit **128** (FIG. **1**) and an outlet conduit **130**. As mentioned above, in the particular example shown in FIG. **1**, the filter head **32** shows connections with three filter assemblies, two of which are full-flow filter assemblies **34**, and one of which is a bypass filter assembly **35**. Of course, this is just an example, and other arrangements can include only a single filter assembly **34** connected to a filter head **32**. The filter head **32** is connected to other equipment, such that liquid to be filtered flows into the filter head **32** through the inlet conduit **128** and then exits the filter head **32** by flowing through the outlet conduit **130**. In some example arrangements, the filter head **32** is constructed of a cast metal part.

[0107] The filter head **32** includes mating structure **132** for selective engagement with the filter bowl **36**. In the embodiment shown, the mating structure **118** includes threads **134**. The threads **134** are illustrated as being along an outer radial surface of the filter head **32**. Of course, the threads **134** can also be located on an inner radial surface of the filter head **32**. In addition, other ways of connecting the bowl **36** to the filter head **32** are contemplated, as conventionally known in the art.

[0108] In FIG. **11**, it can be seen that the adaptor **64** is connected to the outlet conduit **130**, in this example, by way of threads **136**. In this manner, the adaptor **64** can be selectively secured to the filter head **32** through engagement through the threads **136**. Other ways can also be used to attach the adaptor **64** to the filter head **32**, including, for example, press-fit, adhesive, welding, or making the adaptor **64** integral to the head **32**.

[0109] In the embodiment shown, the adaptor **64** includes a funnel **138** circumscribing a central, open aperture **140**. Extending from the funnel **138** is a cylindrical wall **142**. The wall **142** becomes positioned between the first neck **52** and the second projection **96** of the first endcap **91**. The wall **142** defines an inner radial surface **144**, which provides a surface against which seal **62** (FIG. **11**) is formed between the filter cartridge **38** and the adaptor **64**.

[0110] Extending from an inner wall of the funnel surface **138** is a plurality of ribs **146**. The ribs **146**, in this embodiment, cooperate with the lock-out mechanism (Section K, below) in that they interfere with a portion of the filter bowl **36** when the cartridge **38** is not operably oriented within the filter bowl **36**, and the engagement between the ribs **146** and the structure within the filter bowl **36** prevents the filter head **32** from threadably engaging the filter bowl **36**. See FIG. **39** for an example of when the ribs **146** engage end rims **311**, **354** of an inner assembly **364**, as described more fully below in Section K of this disclosure.

[0111] From reviewing FIG. **11**, it can also be seen how the filter head **32** forms a seal **148** with the bowl **36**, when the seal **136** is operably-mounted on the filter head **132**.

D. Filter Bowl **36**

[0112] Attention is directed to FIG. **8**, in which a perspective, cross-sectional view of the filter bowl **36** is illustrated. In the embodiment shown, the filter bowl **36** includes a surrounding wall **150** defining an open interior volume **152** for receiving and holding filter cartridge **38** therein.

[0113] The bowl **36** has, at one end, an open mouth **154** for allowing the filter cartridge **38** to be selectively inserted and removed from the bowl **36**. At an end opposite of the open mouth **154** is a closed end **156** defining an opening **158**. In preferred embodiments, the opening **158** cooperates to form part of a drainage aperture arrangement **160**.

[0114] The closed end **156** in the embodiment shown generally has a flat base **162** to allow the bowl **36** to be stood on a horizontal surface, such as a shop bench, without tipping. In this embodiment, the end **156** further includes flat side surfaces **164** (FIG. **1**) to be used in conjunction with a tool, such as a wrench.

[0115] Adjacent to the mouth **154** is mating structure **156**, illustrated herein as threads **168**. The threads **168** are selectively engageable with the threads **134** of the filter head **132** to allow for attachment and removal of the bowl **36** with the filter head **32**. Of course, the threads **168** could also be on an exterior wall with threads **134** on the head **132** on an interior wall. Also viewable in FIG. **8** is a seal member **170** held on an inner radial surface of the surrounding wall **150** within a groove **172**. The seal member **170** forms seal **148** (FIG. **11**) with the filter head **32**.

[0116] The closed end **156** of the bowl **36**, in the embodiment shown, includes a disk-holding groove **174**. The disk-holding groove **174** is defined by a floor **176** on an inner surface of the wall **150** at the closed end **156**. The disk-holding groove **174** supports the disk **90** extending axially from the floor **176** of the inside surface of the wall **150** of the bowl **36**.

[0117] In the embodiment shown in FIG. **8**, the disk **90** includes a cartridge-receiving tray **180** constructed and

arranged to receive at least a portion of the filter cartridge **38**. In preferred embodiments, the cartridge receiving tray **180** receives the second axially-extending neck **82** of the filter cartridge **38** and forms seal **88** (FIG. **12**) therewith. In FIG. **8**, the cartridge receiving tray **180** includes an outer ring **182**, an inner ring **184**, and a base **186** therebetween. In the embodiment shown in FIG. **12**, the seal **88** is formed between and against neck **82** and an inner radial surface **188** of the outer ring **182**.

[0118] Extending axially below the cartridge-receiving tray **180** is a base ring **190**, which is held by and fixed within the disk-holding groove **174**. As can be seen in FIGS. **8** and **12**, the base ring **190** holds a remaining portion of the disk **90** from the floor **176** to allow for a flow of liquid in the volume **192** (FIG. **12**) between the base **186** and the floor **176**. The base ring **190** includes through-holes **194** (FIG. **12**) to allow for the flow of fluid to flow from volume **192** through the base ring **190**, and in a direction toward the drainage aperture arrangement **160**.

[0119] In the embodiment shown in FIG. **8**, the disk **90** further includes a second inner ring **196**. The second inner ring **196** is spaced radially inwardly of the inner ring **184**. The space located between the inner ring **184** and the second inner ring **196** accommodates a porous inner filter support **200**, described further below. In the embodiment shown, the disk **90** further includes a third inner ring **202** located radially inwardly of the second inner ring **196**. The third inner ring **202** has an inner radial surface that provides a seal surface for forming a seal **204** between a drain valve housing **206** (FIGS. **13** and **15**) and the disk **90**.

E. Porous Inner Filter Support **200**

[0120] One embodiment of a porous inner filter support **200** is illustrated in various FIGS. including, for example, FIGS. **3**, **4**, **8**, **9**, **11**, and **18**. Portions of the filter support **200** can be seen in several of the other figures. The porous inner filter support **200** is oriented within the open filter interior **46** (FIG. **6**) of the filter cartridge **38**. Further, in the embodiment shown, the porous inner filter support **200** is oriented within the open interior volume **152** of the bowl **36**. In the specific embodiment illustrated, the inner filter support **200** is secured to the filter bowl **36** by being secured to the disk **90** between inner ring **184** and second inner ring **196**. In other embodiments, the support **200** can be secured directly to the bowl **36** at, for example, the floor **176** of the bowl **36**. Filter support **200** can be permanently secured to the disk **90** through a variety of techniques including adhesive, press-fit, staking, welding; or, the support **200** and the bowl **36** can be the same integral piece. In another embodiment, the disk **90** and the filter support **200** can be the same integral piece.

[0121] In the embodiment illustrated, the inner filter support **200** includes a porous wall **208**. The porous wall **208** defines a plurality of flow passages **210** (FIGS. **8**, **9** and **18**) therethrough. In use, the filter support **200** functions to help support the filter media **44** by lining the open filter interior **46** of the media **44**, and the flow passages **210** allow for the filtered liquid to flow into a filtered liquid volume **212** (FIGS. **3** and **4**) with in the porous wall **208**.

[0122] In preferred embodiments, the porous wall **208** of the filter support **200** includes a plurality of guide rails **216** projecting radially inwardly in a direction toward an inside volume of the filter support **200**. In the cross section of FIGS. **8** and **9**, a cross-section of the guide rails **216** is depicted, so that only half of the guide rail **216** is viewable. In FIGS. **19-22**, the upper ends of the guide rails **216** can be seen. In FIGS. **19-22**, the upper ends of the guide rails **216** function as projections **218** extending from a remaining portion of the porous wall **208**; the projections **218** cooperate with the lock-out mechanism, explained below. Between the guide rails **216**, a slide channel **220** (FIG. **8**) is formed, which helps to slidably hold a portion (e.g., fins **336**) of a core piece **222**, described further below. As can be seen in FIG. **8**, the guide rails **216** extend at least a partial length along the wall **208** of the filter support **200**. In FIG. **8**, the guide rails **216** are shown extending from a free end **224** of the filter support **200** about half way down the full length of the filter support **200**.

[0123] In the embodiment shown, the porous inner filter support **200** further includes an inwardly extending shoulder or support **226**. The inwardly extending support **226** extends radially inwardly from the wall **208** and includes an upper surface **228** and a lower surface **230**. The support **226** defines a throat or opening **232**, as it extends circumferentially along and within the wall **208** of the filter support **200**. The opening **232** within the inwardly extending support **226** allows for a portion of the core piece **222** to slide therewithin and also cooperates with a portion (e.g., the head **302**) of the core piece **222** to help hold the core piece **222** in place. It also helps to cooperate with the auto-drain mechanism, which is described in Section L below.

F. Drain Valve Assembly

[0124] The filter system **30** depicted also has a drain-valve assembly **236** (FIG. **13**) to allow liquid in the complete assembly to automatically be drained during the servicing of the system **30**. The drain-valve assembly **236** can be implemented independently of other features in the example embodiment. For example, the drain valve assembly **236** can be implemented independently of the lock-out mechanism and cartridge retention mechanism **100**.

[0125] Attention is directed to FIGS. **12** and **13**. In FIGS. **12** and **13**, the filter cartridge **38** is operably positioned in the filter bowl **36**, and the bowl **36** is fully-threaded on the filter head **32**. In this condition, the drain-valve assembly **236** is in a sealed position **238**. In the sealed position **238**, there is in place a first plug seal **240** and a second plug seal **242**.

[0126] The drain-valve assembly **236** includes a plug **244**. The plug **244** is movably oriented between the sealed position **238** (FIGS. **11** and **12**) and a drainage position **246** (FIGS. **9** and **10**, for example). The sealed position **238** includes the plug **244** blocking fluid flow between the interior volume **152** of the bowl **36** and the drainage aperture arrangement **160**. The drainage position **246** includes the plug **244** being oriented relative to the bowl **36** to permit flow from the interior volume **152** of the bowl **36** through the drainage aperture arrangement **160**.

[0127] FIGS. **13-15** show one example embodiment of drain valve assembly **236**. FIG. **13** shows an exploded, perspective view of the drain-valve assembly **236**, while FIG. **14** is a top plan view of the assembly **236** after it has been assembled. FIG. **15** is a cross-sectional perspective view of the drain valve assembly **236**, after it has been assembled.

[0128] While a variety of embodiments can be used, in the embodiment pictured in FIGS. **13-15**, the drain valve assembly **236** includes a valve housing **248**. The valve housing **248** includes a generally tubular wall **250** defining an opening **252**. The opening **252** receives the plug **244**, such that the plug **244** is axially moveable therewithin. The wall **250** defines a pair of grooves **254** extending longitudinally, and constructed

and arranged to receive corresponding ribs **256** on the plug **244**. The wall **250** further includes an elongated slot **258** including a transverse portion **260**. The elongated slot **258** receives ribs **262** emanating from the plug **244**. The ribs **262** have hooks or extensions **264** that help to keep the plug **244** from popping out of the valve housing **248** through opening **252**.

[0129] Still in reference to FIGS. **13-15**, the valve housing **248** depicted further includes a base **266**. The base **266** is held within the opening **158** (FIG. **8**) of the bowl **36**, and when properly oriented therein forms a part of the flat base **162** of the bowl **36**. Extending vertically from the base **266** is a wall **268** (FIG. **15**). The wall **268**, in the embodiment shown, is threaded such that it can be removably mounted within the opening **158** of the bowl **36**. Along the wall **268** is a valve seal member **270**. The seal member **270** forms a second valve seal **272** (FIG. **8**) with the bowl **36**. The second valve seal **272** prevents fluid from flowing from the bowl **36** through the opening **158**.

[0130] The first valve seal **204** was described above. The first valve seal **204** is formed by seal member **274** which is held within a groove **276** of the valve housing **248**. The seal member **274** forms first valve seal **204** (FIG. **8**) with the disk **90** connected to the bowl **36** to prevent unfiltered fluid from bypassing the filter media **44** and flowing into the open filter **46**.

[0131] Still in reference to FIG. **15**, in the valve housing **248** depicted, extending from the wall **268** is an upper base **278**. The upper base **278**, in the embodiment shown, is generally parallel to the base **266**, but is radially spaced and vertically spaced therefrom. Extending downwardly from the upper base **278** is an inner wall **280**. The inner wall **280** forms the drain port **282** (FIG. **8**) of the drainage aperture arrangement **160**.

[0132] Extending upwardly from the upper base **278** is a slotted wall **284** (FIG. **13**). The slotted wall **284** has apertures **286** to allow liquid to flow through the wall **284**.

[0133] Still in reference to FIGS. **13-15**, a spring **288** is operably oriented around the valve housing wall **250** and pushes against a portion of the plug **244**. Specifically, the spring **288** is located between an outwardly extending rib **290** extending outwardly from the wall **250** of the valve housing **248**. The spring **288** engages rib **290** and against flange **292** of the plug **244**. The spring **288** biases the plug **244** to be in the position in FIG. **15**, which corresponds to drainage position **246**. The plug **244** is moveable within the opening **252** of the valve housing **248** in a direction toward the sealed position **238** by compression of the spring **288**.

[0134] The drain valve assembly **236** further includes a first plug seal member **294** secured to the plug **244** to form first plug seal **240** (FIG. **12**). The first plug seal **240** prevents unfiltered fluid from bypassing the filter media **44** and then flowing into the open filter interior **246**, when the plug **244** is in the sealed position **238** (FIG. **12**). The drain valve assembly **236** further includes a second plug seal member **296** secured to the plug **244** to form the second plug seal **242** (FIG. **12**) with the inner wall **280** of the valve housing **248**. The second plug seal **242** prevents liquid from flowing from the bowl **36** through the drain port **282** of the drainage aperture arrangement **160**.

[0135] Still in reference to FIGS. **13-15**, in the embodiment shown, the plug **244** includes a receiver **298**, which is circumscribed by the flange **292**. The receiver **298** is at an end of the plug **244** that is opposite from a sealing end **300** (FIG. **15**) of the plug **244**. The receiver **298** is generally bowl-shaped and is constructed and arranged to engage and receive a portion (head **302**) of the core piece **222**, described further below.

[0136] Details of the core piece **222** are described further below. One portion of the core piece **222** includes a core piece head **302** (FIGS. **8**, **11**, and **12**). The head **302** engages the plug **244** when the drain valve assembly **236** is in its sealed position **238**. When the head **302** moves away from the plug **244**, this allows the plug **244** to move axially within the interior of the filter support **200**, with the spring **288**, to allow the plug **244** to move to the drainage position **246**.

[0137] Further details on operation of the auto drain valve assembly **236** are described further below in Section L.

G. Basket **304**

[0138] Attention is directed to FIG. **24**. A basket **304** is illustrated in perspective view. The basket **304** can be seen in various other views, and the FIG. **24** perspective view is an example implementation. The basket **304** is part of the lock-out mechanism, and its function will be more fully-described below in Section K.

[0139] In the embodiment illustrated, the basket **304** includes at least one cantilevered leg **306** extending from a basket base **308**. The leg **306** extends axially in a direction toward the closed end **156** of the bowl **36**. In preferred embodiments, the basket **34** includes a plurality of legs **306**, and in the example embodiment shown, there are four legs **306**, evenly and circumferentially spaced relative to each other.

[0140] The embodiment of the basket **304** depicted further includes a grooved wall **310**. The groove wall **310** forms, generally, a cylinder and extends axially in a direction toward the open mouth **154** of the bowl **36**. In general, the grooved wall **310** is constructed and arranged to engage a portion of the filter cartridge **38** such that the engagement with the filter cartridge **38** will rotate the basket **304** from a first locked position to an unlocked position. The first locked position is a position in which the at least one leg **306** axially abuts the projection **218** on the filter support **200** (FIG. **19**). The unlocked position is a position in which the at least one leg **306** is free of the axial abutment with the projection **218** and permits the basket **304** to move in a direction toward the end **156** of the bowl **36** (FIG. **21**).

[0141] In preferred embodiments, the basket **304** is rotationally moveable from the first locked position (FIG. **19**) to a second locked position (FIG. **20**). In the second locked position (FIG. **20**), the at least one leg **306** is partially free of the abutment against the at least one projection **218** on the filter support **200**, but there is still axial interference therebetween.

[0142] The grooved wall **310** has at least a first groove **312** with a first slide surface **314**, and a second groove **316** with a second slide surface **318**. In the preferred embodiment, the grooved wall **310** includes a pair of first grooves **312**, each having a first slide surface **314**, and a pair of second grooves **316**, each having a second slide surface **318**. As can be seen in FIG. **24**, the pair of first grooves **312** are located about 180 degrees relative to each other while the pair of second grooves **316** are located about 180 degrees relative to each other.

[0143] The first slide surface **314** of the first groove **312** is constructed and arranged to engage the filter cartridge **38** and rotate the basket **304** from the first locked position to the second locked position. This rotation of the basket **304** also exposes the second slide surface **318** of the second groove **316**

to engagement with the filter cartridge **38**. An example can be seen by comparing FIGS. **19** and **20**. In FIG. **19**, the basket **304** is in the first locked position. The first slide surface **314** is exposed to engagement with the filter cartridge **38**. In particular, and as explained further below in Section K, the first slide surface **314** engages the first protrusion **121** of the filter cartridge **38**. The third protrusion **123** will engage the other first slide surface **314**, in preferred embodiments. The first protrusion **121** engages the first slide surface **314**, which rotates the basket **304** clockwise when viewed from above. The basket **304** is rotated to the second locked position, depicted in FIG. **20**. The second locked position then exposes the second slide surface **318**. The second slide surface **318**, in preferred embodiments, has the second protrusion **122** engage against it, which causes the basket **304** to further rotate clockwise, when viewed above, to the unlocked position as shown in FIG. **21**. In preferred embodiments, the fourth protrusion **124** will engage the other second slide surface **318**.

[0144] In FIG. **24**, in the embodiment shown, the basket **304** further includes a hollow column circumscribed by the grooved wall **310**. In use, as explained further below, the column **320** receives a post **322**, which is part of the core piece **222**, explained in Section H below. The basket **304** further includes webs or flanges **324** extending between the column **320** and the grooved wall **310**.

[0145] Further operation of the basket **304** is described below in connection with the lock-out mechanism, Section K.

H. Core Piece **222** and Spring

[0146] Several FIGS. show an embodiment of the core piece **222**. The core piece **222** is operably-oriented within the interior of the wall **208** of the filter support **200**, and within the filtered liquid volume **212**.

[0147] As mentioned above, in the embodiment shown, the core piece **222** includes post **322**. At one free end of the post **322**, a button **326** is defined. Adjacent to the button **326** is a reduced dimension **328** in the form of a neck **330**. The post **322** is received by the column **320** of the basket **304**. The retention mechanism **100** engages the post **322** at the button **326**. Specifically, the gripper arrangement **104** holds the post **322** at the button **326** by having fingers **108**, **109** engage the neck **330** of the post **322**. Further operational details of the retention arrangement **100** are discussed below in Section M.

[0148] As mentioned previously, the post **322** further includes, at an end opposite of the button **326**, the head **302**. In the embodiment shown, the head **302** is mushroom-shaped and constructed and arranged to engage the inwardly extending shoulder or support **226** of the filter support **200**.

[0149] The head **302** of the core piece **222** is movably oriented between an engaged position and a released position. The engaged position includes the head **302** being oriented against the receiver **298** of the plug **244** to push the plug **244** into the sealed position **238**. The released position includes the head **302** being spaced away from the receiver **298** of the plug **244** to allow the plug **244** to move to the drainage position **246**. When the head **302** is in the released position, a radial flange **332** (FIG. **10**) on the head **302** is engaged against lower surface **230** of the inwardly extending support **226**. When the head **302** is in its engaged position (FIG. **12**), the head **302** is engaged against the plug **244** and received within the receiver **298**.

[0150] In the embodiment shown, the core piece **222** further includes a fin arrangement **334**. The fin arrangement **334** includes a plurality of fins **336** projecting radially from a center longitudinal axis of the post **322**. In preferred embodiments, the fins **336** slide within respective channels **220** defined by guide rails **216**. The fins **336**, in cooperation with the channels **220** within the guide rails **216**, ensure that the core piece **222** will maintain operable orientation and sliding orientation within the porous inner filter support **200**. A core piece spring **338** is operably oriented between the fin arrangement **334** and the upper surface **228** of the support **226** (FIG. **10**). The spring **338** will exert a pushing force on the core piece **222** in a direction axially upwardly relative to the porous inner filter support **200** and in a direction toward the open mouth **154** of the bowl **36**.

[0151] In reference now to FIGS. **17-22**, the core piece **222** further includes a basket holder **340**. The basket holder **340** supports the basket **304** and allows the basket **304** to move between its first locked position (FIG. **19**), to its second locked position (FIG. **20**), and to its unlocked position (FIG. **21**). In the embodiment shown, the basket holder **340** includes an apertured frame **342**. The apertured frame **342** defines leg-receiving apertures **344** (FIG. **22**), such that the legs **306** of the basket **306** can penetrate the basket holder **340** by having legs **306** pass through the leg-receiving apertures **344**. The basket holder frame **342** includes a slotted wall **346** circumscribing the post **322** and also includes spokes **348** (FIG. **22**) joining the slotted wall **346** to the post **322**. Adjacent spokes **348** define the leg-receiving apertures **344**.

[0152] In reference to FIG. **22**, the assembly includes a spring **350** oriented around the post **322** and operably oriented between the webs or flanges **324** of the basket **304** to bias the basket **304** rotationally within the basket holder **340** and into the locked position (FIG. **19**).

[0153] The slotted wall **346** includes a plurality of slots **352**. The slots **352** are open at one end and closed at an opposite end; that is, the slots **352** are open at the end rim **354** of the slotted wall **346** and have closed ends **356** adjacent to a bottom portion of the slotted wall **346**. The slots **352** function as a slide channel **358** for cooperating structure on the filter cartridge **38**.

[0154] In particular, the first slot **360** forms slide channel **358** for the first protrusion **121** or the third protrusion **123**, after the first protrusion **121** or third protrusion **123** engages the first slide surface **314** of the basket **304**, rotating the basket **304** from the first locked position. This rotation of the basket **304** then aligns the first slot **360** with the first groove **312** of the basket **304**.

[0155] The second slot **362** will be put in alignment with the second groove **316**, to allow either the second protrusion **122** or the fourth protrusion **124** slide therewithin slide channel **358** after the basket **304** has been rotated from the second locked position to the unlocked position (FIG. **21**).

I. Bypass Filter Cartridge FIG. 32

[0156] FIG. **32** shows a cross-sectional view of one embodiment of a bypass filter cartridge **390**. The bypass filter cartridge **390** is usable with a bowl **391** (FIG. **1**) in the system **30**. The bypass filter cartridge **390** includes a region of filter media **392** attached between a first endcap **393** and a second endcap **394**. The second endcap **394** has an axially extending neck **395** holding a seal member **396**.

[0157] The first endcap **393** is preferably constructed and arranged in a manner that will prevent it from operably fitting within the bowl **36** for the full flow filter assembly **34**. Switching the bypass filter cartridge **390** and the full-flow filter cartridge **38** could have catastrophic results. Therefore, struc-

ture is built in to prevent this mix-up. One structure is the lock-out mechanism, described herein and further below. Another such mechanism is the structure of the first endcap **393**. The first endcap **393** includes an upstanding projection **397** that holds seal member **398**.

[0158] The height of the projection **397** is such that it will not be allowed to operably-engage the filter head **32** in the location of the full-flow filter assemblies **34**.

[0159] In the bypass filter cartridge **390**, it can optionally include a cartridge retention mechanism **399**, analogous to the retention mechanism **100** described above. Further, it may also include a protrusion arrangement **400** analogous to the protrusion arrangement **118**, described above.

J. Adaptor Arrangements, FIGS. 33-38

[0160] Attention is directed to FIGS. **33-38**, which illustrate various embodiments of an adaptor arrangement **402**. FIG. **33** illustrates one method for using, including installing an adaptor arrangement **402**.

[0161] A first embodiment of an adaptor arrangement **402** is shown in FIGS. **33** and **34** as adaptor ring **404**. A second embodiment is shown in FIGS. **35** and **36** as **404'**, and a third embodiment is shown in FIGS. **37** and **38** as **404"**. Each of the adaptor rings **404**, **404'**, and **404"** have common features, and will utilize common reference numerals. Differences will be indicated by different reference numerals.

[0162] The adaptor ring **404**, **404'**, **404"** includes a circular band **406** defining an open aperture **408**. In the embodiment shown, the band **406** is generally circular, defining a generally circular open aperture **408**. The band **406** has an outer radial surface **410** and an opposite inside radial surface **412**. The inside radial surface **412** defines an aperture wall **414**, because it lines the open aperture **408**.

[0163] A protrusion arrangement **416** extends from the band **406**. Preferably, the protrusion arrangement **416** includes at least first and second protrusions **421**, **422** extending from the aperture wall **414** and into the open aperture **408**. The first protrusion **421** is spaced from the second protrusion **422** in a vertical direction along the aperture wall **414**. The first protrusion **421** is also circumferentially spaced from the second protrusion **422** along the aperture wall **414**.

[0164] Preferably, the first protrusion **421** extends into the open aperture **408** no greater than 40% than the inner diameter of the open aperture **408**. Similarly, it is preferred that the second protrusion **422** extends into the open aperture **408** no greater than 40% of the inner diameter of the open aperture **408**. Preferably, the vertical distance between the first protrusion **421** and the second protrusion **422** is 2-30% of the inner diameter of the open aperture **408**.

[0165] The first protrusion **421** and the second protrusion **422** are circumferentially spaced within 50 degrees of each other. It is also possible to arrange the first protrusion **421** and the second protrusion **422** such that they are located greater than 45 degrees relative to each other.

[0166] In the embodiment shown, the protrusion arrangement **416** further includes a third protrusion **423** extending from the aperture wall **414** and into the open aperture **408**. The third protrusion **423** is circumferentially spaced from the first protrusion **421** and the second protrusion **422**. The third protrusion **423** is also vertically spaced from only one of either the first protrusion **421** or the second protrusion **422**.

[0167] In the illustrated embodiments, there is also at least a fourth protrusion **424** extending from the aperture wall **414** and into the open aperture **408**. The fourth protrusion **424** is circumferentially spaced from the first protrusion **421**, the second protrusion **422**, and the third protrusion **423**. The fourth protrusion **424** is also vertically spaced from only two of the first protrusion **421**, the second protrusion **422**, or the third protrusion **423**; that is, the fourth protrusion **424** is vertically even with only two of the first protrusion **421**, second protrusion **422**, and third protrusion **423**.

[0168] In the embodiments shown, two of the first protrusion **421**, second protrusion **422**, third protrusion **423**, and fourth protrusion **424** are circumferentially-spaced within 15 degrees of each other, while a remaining two are circumferentially-spaced within 15 degrees of each other.

[0169] The embodiment of adaptor ring **404'** illustrated in FIGS. **35** and **36** differs from the embodiment of adaptor ring **402** in FIGS. **33** and **34**, in that the band **406** has a longer vertical wall **430**. This longer vertical wall **430** can be useful in certain arrangements.

[0170] The embodiment of the adaptor ring **404"** of FIGS. **37** and **38** further includes cartridge retention mechanism **440**. The retention mechanism **440** is analogous to the retention mechanism **100** and includes a gripper arrangement **442** including fingers **443**, **444**. Further, the retention mechanism **440** includes a release arrangement **446**, including opposing tabs **447**, **448**.

[0171] FIG. **33** demonstrates a technique for using the adaptor arrangements **402** in order to unlock the core piece **222** and the inner filter support **200**. Adaptor arrangements **402** are useful in that it is sometimes helpful to be able to use a filter cartridge that does not have the protrusion arrangement **118** on the endcap **41**. For example, in the laboratory and out in the field, it may be desirable to test filter cartridges that have different filtration performance but do not have the protrusion arrangement **118**. In such situations, the adaptor arrangements **402** are useful.

[0172] In FIG. **33**, the arrow **450** shows where the adaptor ring **404** is mounted relative to the filter support **200**. The adaptor ring **404** is generally mounted over the filter support **200**, to engage the basket **304**. The filter cartridge **452** may then be mounted thereon. The adaptor ring **404** is generally located between the filter cartridge **452** and the filter support **200**. In the embodiment shown, the adaptor ring **404** is then located within the aperture of the first endcap **454** of the cartridge **452**.

[0173] In use, the adaptor ring **404** is oriented into the filter bowl **36**, and the first protrusion **421** is pushed against the basket **304** to then allow the second protrusion **422** to engage the basket **304**. Engagement of the second protrusion **422** against basket **304** then rotates the basket **304** relative to the projections **218** (FIG. **19**) on the filter support **200**. This frees the legs **306** of the basket **304** relative to the projections **218**. When the legs **306** are free of interference with the projections **218**, the core piece **222** may move axially relative to the inner filter support **200**.

K. Methods of Operation of the Lock-Out Mechanism

[0174] As mentioned above, it may be desirable to have in the filter system **30** a mechanism that ensures that the filter system **30** cannot be operated unless the filter cartridge **38** has been operably assembled within the filter bowl **36**. In addition, in the particular system **30** depicted, there is more than one type of filter assembly and it would be disastrous if a user were to mix up filter cartridges. A lock-out mechanism will achieve both objectives.

[0175] Reference is first made to FIG. **39** which depicts filter bowl **36**, inner filter support **200**, core piece **222**, and filter head **32**. In FIG. **39**, the filter cartridge **38** is not within the filter bowl **36**. During servicing, for example, the bowl **36** would not have the filter cartridge **38** installed therewithin. FIG. **8** also depicts the bowl **36** without the filter cartridge **38** installed within.

[0176] In FIGS. **8**, **18**, **19**, and **39**, the basket **304** is fitted around the post **322**, and the basket **304** is oriented in its locked position by the bias of spring **350**. In particular, the spring **350** is oriented such that it biases the basket **304** into the locked position by rotational force exerted between the flanges **324** and the resistance to that force because of engagement between the legs **306** and the leg-receiving apertures **344** (FIG. **22**). In FIG. **19**, when the basket **304** is in its locked position, each of the legs **306** has its free end **307** in engagement with the projections **218** formed by the ends of the guide rails **216**.

[0177] In this position, without filter cartridge **38** installed in the filter bowl **36**, the upper rim **311** of the basket **304** and the upper rim **354** of the basket holder **340** will contact or engage against ribs **146** of the adaptor **64**. See FIG. **39**. Because the legs **306** are resting on top of the projections **218** (in this embodiment, shown as an end of the guide rails **216**), the core piece **222** and the basket **304** cannot move axially downwardly in a direction toward the closed end **156** of the bowl **36**. The entire inner assembly **364** is in an extended and rigidly fixed position. As can be seen in FIG. **39**, in this rigidly fixed position, the filter head **32** cannot operably connect with the bowl **36** by connection between the threads **134** on the filter head **32** and the threads **168** on the bowl **36**.

[0178] During servicing, when a new filter cartridge **38** has been provided, the filter cartridge **38** is oriented in the bowl **36** by placing it through the open mouth **154**. When the filter cartridge **38** is properly and operably positioned in the filter bowl **36**, the first protrusion **121** comes in contact or engages the ramped first slide surface **314** of the basket **304**. See FIGS. **19**, **28**, **29**, and **30**. In embodiments that have more than two protrusions, one possibility is that both the first protrusion **121** and the third protrusion **123** will engage a corresponding first slide surface **314** on the basket **304**. As the first protrusion **121** engages this first slide surface **314**, it causes the basket **304** to rotate against the spring **350**. In preferred embodiments, the rotation will be less than 45 degrees, for example, 5-20 degrees. This rotates the basket **304** from the first locked position (FIGS. **19** and **30**) to the second unlocked position (FIG. **20**). The first groove **312** in the basket **304** become aligned with the first slot **360** of the basket holder **340**, which will eventually allow the first protrusion **121** to slide down.

[0179] When the basket **304** is rotated to the second locked position (FIG. **20**), this exposes the second slide surface **318**. The second protrusion **122** is oriented such that it will contact or engage the second slide surface **318**. The contact with the second slide surface **318** can be made through a protrusion located in the location of the fourth protrusion **124**, as well. In embodiments that have protrusions at both locations of the second protrusion **122** and fourth protrusion **124**, then both the second protrusion **122** and the fourth protrusion **124** will contact the corresponding second slide surface **318**. The initial contact between the second protrusion **122** and the second slide surface **318** causes the basket **304** to rotate against the spring **350** from its second locked position to its unlocked position (FIG. **21**). FIGS. **23**, **25**, and **27** illustrate engagement of the second protrusion **122** against the second slide surface **318**. The rotation of the basket **304** from the second locked position (FIG. **20**) to the unlocked position (FIG. **21**) is preferably less than 45 degrees, for example, 5-20 degrees. Rotation to the unlocked position aligns second groove **316** and second slot **362**, which will eventually allow axial sliding of the second protrusion **122** therein downwardly.

[0180] As the basket **304** moves to the unlocked position, the legs **306** also rotate, moving away from engagement against the projections **218** created by the end of the guide rails **216**. When the legs **306** are completely clear of the projections **218**, any additional movement of the filter cartridge **38** in a downwardly axial direction toward the closed end **156** will cause the basket **304** and the core piece **222** to also move in that direction against the core piece spring **338**. The core piece spring **338** normally biases the basket **304** and the core piece **222** in the extended position of FIGS. **8** and **39**.

[0181] When the filter assembly **34** is mounted onto the filter head **32**, the adaptor **64** will exert force on the first end cap **41** of the filter cartridge **38**, moving the filter cartridge **38** downwardly relative to the bowl **36** and the inner filter support. Moving the filter cartridge **38** downwardly toward the closed end **156** of the bowl **36** also moves downwardly the core piece **222**. The filter head **32** will then be able to matably engage the threads **168** on the bowl **36** for secure attachment, as shown in FIG. **11**.

[0182] It should be appreciated that the lock-out mechanism as characterized above can be utilized in a method of installing a filter cartridge into a filter bowl such as a filter cartridge **38** into filter bowl **36**. In such a method, filter cartridge **36** is oriented into filter bowl **36**. The filter cartridge **36** will have a tubular construction of filter media, such as media **44**. The filter bowl **36** will have a porous inner filter support **200** mounted therein and a core piece **222** within the inner filter support **200**. The core piece **200** will be holding a basket **304**. The method further includes while orienting, pushing the filter cartridge **38** against the basket **304** to disengage the core piece **222** and the inner filter support **200**. For example, this can be implemented by pushing a protrusion arrangement **118** against the basket **304**. In particular, first protrusion **121** can be pushed against the first slide surface **304** to rotate the basket **304** from the first locked position to the second locked position. Then, the second protrusion **122** will be oriented to be in a position to engage the second slide surface **318** and cause further rotation of the basket **304** from the second locked position to the unlocked position. The unlocked position will cause the legs **306** to move from engagement against projections **218** to a position in which they are free of interference with the projections **218**. This disengages the interference between the core piece **222** and the filter support **200**. Next, after disengaging, the method includes axially moving both the filter cartridge **38** and the core piece **222** relative to the inner filter support **200**.

[0183] This method of installing can be incorporated into a method for servicing, in which, first, the bowl **36** is removed from the filter head **32**. Next, the bowl filter cartridge **38** is removed from the bowl **36**. This method can employ the method of using the retention mechanism **100**, which is described further below (Section M). During services, the bowl can be drained, which is also described in Section L.

[0184] Next, a new filter cartridge **38** is provided. The method of installing the filter cartridge, as described above, is then utilized. In preferred such methods, after the cartridge **38** unlocks the engagement between the basket **304** and inner

filter support **200**, and the cartridge **38** with the basket **304** and core piece **222** is allowed to move axially downwardly.

L. Drain Valve Mechanism

[0185] The filter system **30** depicted also has a drain valve mechanism to allow liquid in the complete assembly to automatically be drained during the servicing of the system **30**. The drain valve mechanism can be implemented independently of other features in the example embodiment.

[0186] When the filter cartridge **38** is operably positioned in the filter bowl **36** with the bowl **36** being fully-threaded on the filter head **32** as shown in FIG. **11**, the plug **244** is in the closed and sealed position. In this position, the first plug seal **240** and the second plug seal **242** are in place (FIG. **12**).

[0187] The first plug seal **240** seals off liquid located on the clean side in the filtered liquid volume **212** (FIG. **12**), from allowing unfiltered liquid in the unfiltered liquid volume **214** from flowing through holes **194** (FIG. **12**). The second plug seal **242** seals off liquid from the unfiltered liquid volume **214** from the drain port **282** that is directed to the outside environment. Also, the seal **204** (FIG. **10**) prevents liquid from the unfiltered liquid volume **214** to be able to reach the filtered liquid volume **212**.

[0188] With the filter cartridge **38** operably positioned in the bowl **36** and the head **32** fully engaged and connected to the bowl **36**, the adaptor **64** presses against the first endcap **41**, which pushes the cartridge **38** and the core piece **222** holding the basket **304** and legs **306** downward axially relative to the porous inner filter support **200**. As the core piece **222** moves in a direction toward the closed end **156** of the bowl **36**, the head **302** of the core piece **222** is moved away from the inwardly extending support **226** and engages the receiver **298** of the plug **244**. This axial force presses the plug **244** against the valve spring **288** to move the plug into the sealed position of FIG. **12**.

[0189] When it is time to service the filter cartridge **38**, because of wear or because of occlusion, the filter assembly **34** will be rotated about its central axis relative to the filter head **32**. As this occurs, the filter assembly **34** moves downwardly along the central axis due to the unthreading action between the bowl **36** and the filter head **32**. While this downward action is occurring, the core spring **338** pushes against fins **336** on the core piece **222**. This moves the cartridge **38** holding the core piece **222** axially upwardly relative to the bowl **36**. The axial motion upwardly of the core piece **222** stops when the head **302** is stopped by engagement with the lower surface **230** of the inwardly extending support **226**. When the head **302** is not acting against the plug **244**, it allows the plug **244** to move with the valve spring **288** away from drain port **282** to the position of FIG. **10**. This allows liquid to drain from both the unfiltered liquid volume **214**, shown by drain path arrow **368**, as well as drain from the filtered liquid volume **212** shown by drain path arrow **370** through the drain port **282** into the outside environment where it can be captured by some kind of container for proper disposal. This drainage can occur while the assembly **34** remains attached to the filter bowl **36**.

[0190] It should be appreciated that with the described drainage system, a method for draining liquid from the filter assembly **34** can be employed. One such method would include at least partially unscrewing the bowl **36** containing the filter cartridge **38** from the filter head **32** to permit the spring **338** to move the plug **244** from the sealed position to a drainage position. The bowl **36** has an interior volume **152** and drainage aperture arrangement **160**. The sealed position includes the plug **244** blocking fluid flow between the interior volume **152** of the bowl **36** and the fluid outlet port **282** in the drainage arrangement **160** and by blocking fluid flow between an upstream side of the filter cartridge **38** and a downstream side of the filter cartridge **38**. The upstream side of the filter cartridge **38** corresponds to the unfiltered liquid volume **214**. The downstream side of the filter cartridge **38** corresponds to the filtered liquid volume **212**. The drainage position includes the plug **244** being oriented to permit fluid flow between the interior volume **152** of the bowl **36** and fluid outlet port **282** of the bowl **36**. The fluid outlet port **282** of the bowl is part of the drainage aperture arrangement **160**, in which in the embodiment shown, holds the valve housing **248** having drain port **282** therein. The step of partially unscrewing the bowl **36** includes permitting core piece spring **338** to move the core piece **222** having head **302** axially out of engagement with the plug **244**, permitting valve spring **248** to move the plug **244** from the sealed position to the drainage position.

[0191] When the assembly **34** is mounted onto the filter head **32**, engagement between a portion of the filter head (such as adaptor **64**) and the cartridge (such as end cap **41**), pushes the filter cartridge **38** and structure connected to it, axially downwardly against the core piece spring **338** in a direction toward the closed end **156** of the bowl **36**. The structure connected to the cartridge **38** will include the core piece **222**, having head **302**. The core piece **222** moves axially relative to the filter support **200**, and the fins **336** will slide within channels **220** between the guide rails **216**. As the core piece **222** moves in a direction toward the closed end **156**, the head **302** moves toward the valve assembly **236**. Eventually, the head **302** engages the receiver **298** of the plug **244** and pushes the plug **244** against spring **288** to move the plug **244** into the sealed position **238**, in which first plug seal **240** is formed and second plug seal **242** is formed.

M. Cartridge Retention Mechanism **100**

[0192] In the preferred embodiment, illustrated, the filter system **30** includes cartridge retention mechanism **100** to releasably hold the filter cartridge **38** within the filter bowl **36** during servicing. The cartridge retention mechanism **100** can be implemented independently of the other features in the filtration system, including independent of the lock-out mechanism and the drain valve mechanism.

[0193] FIGS. **2**, **3**, **4**, **9**, and **11** each shows the retention mechanism **100** engaged with the gripper arrangement **104** connected to the core piece **222**, specifically, the neck **330** of the button **326**. Specifically, the fingers **108**, **109** are gripping the neck **330**, which causes the filter cartridge **38** to remain in the bowl **36**, rather than stay connected to the adaptor **64** in the filter head **32**.

[0194] When the filter assembly **34** is removed from the head **32**, the filter cartridge **38** remains captured in the bowl **36** by engagement between the fingers **108**, **109** of the gripper arrangement **104** and the button **326** of the post **322**. In order to release the filter cartridge **38** from the bowl **36**, the release arrangement **106** is actuated. Specifically, the tabs **111**, **112** are squeezed together in a direction toward each other and toward the post **322**, by using, for example, the thumb and forefinger of the person providing the servicing. This causes the fingers **108**, **109** to move away from the neck **330** of the post **322**, allowing the fingers **108**, **109** to clear the button **326**. The thumb and forefinger of the service person is on the tabs

111, **112**, and the service person can now pull the filter cartridge **38** clear of the button **326** and remove the filter cartridge **38** from the bowl **36**.

[0195] The retention mechanism **100** can be made from a material flexible enough to provide deflection of the fingers **108**, **109** away from each other when the tabs **111**, **112** are squeezed. This material may be plastic, although it may be other materials as well.

[0196] The retention system **100** can be used in a method for servicing the filter system **30** including removing the filter assembly **34**, including bowl **36** containing filter cartridge **38**, from filter head **32**. Next, during the step of removing, the method includes retaining the filter cartridge **38** to the bowl **36** by gripping the button **326** with opposing fingers **108**, **109**, radially extending toward each other. After the step of retaining, opposing tabs **111**, **112** may be gripped and squeezed toward each other to release the fingers **108**, **109** from the button **326** and thereby release the filter cartridge **38** from the bowl **36**. The method further includes the step of, while still gripping the opposing tabs **111**, **112**, pulling the filter cartridge **38** from the bowl **36**. The step of gripping includes using opposing fingers **108**, **109** that are integral with the filter cartridge **38**. The step of gripping may also include using opposing fingers **443**, **444** that are part of an adaptor **404"** between the filter cartridge **38** and the core piece **222**.

II. The Embodiment of FIGS. **40-57**

A. Overview

[0197] FIGS. **40-57** illustrate an example embodiment of a filtration system including a filter assembly and filter head. The particular embodiment illustrated depicts one example, but it should be realized, that many examples are envisioned and not illustrated in the drawings. FIG. **50** shows a filter system **530** including a filter head **532** and a filter assembly **534**. In FIG. **40**, it can be seen that the filter assembly **534** includes a filter bowl **536** and a removable and replaceable filter cartridge **538**. FIG. **40** shows this embodiment of the filter system **530** in an exploded, perspective view. In FIG. **41**, a perspective view of the filter assembly **534** including filter bowl **536** and filter cartridge **538** is illustrated.

[0198] In the embodiment illustrated in FIGS. **40-57**, the filter assembly **534** has features including a lock-out mechanism, an auto-drain valve mechanism, and a cartridge retention mechanism. Each of these features can be implemented independently of the other features. The particular embodiment illustrated in the drawings shows all three features integrated into the same filter assembly **534**. One skilled in the art will appreciate that each feature can be implemented independently of the others.

[0199] In general, the lock-out mechanism ensures that the filter system **530** is not accidentally operated with equipment without the filter cartridge **538** installed therein. Thus, it is a mechanism to protect the equipment being filtered by ensuring that the filter head **532** and filter bowl **536** cannot be operably connected unless there is a filter cartridge **538** operably oriented within the filter bowl **536**. Details on an example lock-out mechanism are described in Section H of this disclosure.

[0200] An auto-drain valve mechanism can be included in the filter system **530** and will allow for draining of the filtered liquid from the filter bowl **536** during a servicing of the filter system **530**. The auto-drain valve mechanism allows for draining of the filter bowl **536** before the filter cartridge **538** is removed from the bowl **536**. An example embodiment is described in Section I of this disclosure.

[0201] The filter system **530**, in this embodiment, also includes a cartridge retention mechanism. This feature allows for attachment of the filter cartridge to the filter bowl **536** after the filter head **532** has been completely removed from the filter assembly **534**. Section J describes an example embodiment of a cartridge retention mechanism.

[0202] For purposes of organization, it should be understood that the following description will be of various pieces of the particular, illustrated embodiment. After each of the pieces in this embodiment is described, the way in which the pieces interact to provide the above and other functions is described. Methods of operation, assembly, filtering, and servicing are then described. The following are example embodiments only. A variety of implementations can be made without departing from the scope of this disclosure.

B. The Filter Cartridge **538**

[0203] Reference is made to FIGS. **40**, **42**, **50**, **51**, and **52**, which illustrate one embodiment of filter cartridge **538** usable in this arrangement. In the embodiment shown, the filter cartridge **538** includes first and second opposite endcaps **541**, **542** and a tubular construction of filter media extending between the first and second endcaps **541**, **542**. In the embodiment shown, the media **544** is cylindrical in construction and defines an open filter interior **546**. A variety of different types of media can be used and may depend upon the particular liquid that is being filtered. In the embodiment shown, the media **544** is pleated media **548**. The pleated media **548** can include cellulose, synthetic, blends of synthetic and cellulose, for example. In general, liquid to be filtered flows through the media **544**, which functions to remove particulate or other debris from the liquid before flowing into the open interior **546**. In some systems, it will be possible to operate the filter system **530** in a reverse-flow manner, in which the liquid to be filtered flows from the open filter interior **546**, through the media **544**, and to a region outside of the media **544**.

[0204] The first endcap **541** defines a first open aperture **550**, which is in fluid communication with the open filter interior **546**. The first endcap **541** further includes a first neck **552** protruding from an outward axial surface **554**. The first neck **552** defines a groove **556** along a radial surface **558** of the neck **552**. Seated within the groove **556** along the radial surface **558** is a first seal member **560**. The first seal member **560** forms a releasable seal **562** (FIG. **50**) with an adaptor **564** (FIGS. **49** and **50**) when the filter cartridge **538** is operably assembled in the filter system **530** with the filter head **532** operably engaged with the filter bowl **536**.

[0205] The first endcap **541** further includes a rib arrangement **566** (FIG. **43**) extending into the first open aperture **550**. In the embodiment shown, the rib arrangement **566** extends from the first neck **552** into the first open aperture **550**. As described below, the rib arrangement **566** (which, the example embodiment shown, contains at least one rib **568**) cooperates, in one embodiment, with the lock-out arrangement. Another function of the rib arrangement **566** is to cooperate with the cartridge retention mechanism. In the embodiment shown, the rib arrangement **566** includes a plurality of ribs **568** extending radially from an inner wall **569** (FIG. **42**) of the neck **552**. In the embodiment shown, each of the ribs **568** is illustrated as a relatively thin projection **570** (FIG. **42**) extending radially into the first open aperture **550** from the inner wall **569** of the neck **552**.

[0206] In this embodiment of the filter cartridge **538**, the cartridge **538** further includes a retention mechanism **572** that is spaced both axially and radially from the first neck **552**. The retention mechanism **572** cooperates with other structure to retain the cartridge **538** with the filter bowl **536** during servicing. The details on this operation is discussed later below in Section J of this disclosure.

[0207] In the embodiment shown, the retention mechanism **572** is radially centered within the first open aperture **550**. While a variety of implementations are contemplated, in the embodiment shown, the retention mechanism **572** includes a flexible semi-tubular arrangement **574** (FIG. **42**) connected to the rib arrangement **576**. By "semi-tubular", it is meant that it may be tubular in shape, having a closed perimeter, and the perimeter can form a circle or not form a circle (i.e., the perimeter may be irregular or any other non-circular shape). The flexible semi-tubular **574** has a gripper arrangement **576** and a release arrangement **578**. In general, the gripper arrangement **576** is useful in providing a releasable connection with other structure in the filter bowl **536** to allow for the cartridge **538** to remain retained in the filter bowl **536** when servicing the system **530**. The release arrangement **578** is useful in providing a convenient, quick, and easy to use mechanism to release the filter cartridge **538** from the filter bowl **536**, during servicing, and allow the cartridge **538** to be removed from the bowl **536**.

[0208] As embodied herein, the gripper arrangement **576** includes a pair of opposing fingers **580**, **581** radially extending into the flexible semi-tubular **574**. As will be explained below, in conjunction with FIGS. **56** and **57** and in Section J of this disclosure, the fingers **580**, **581** engage structure in the filter bowl **536**.

[0209] As embodied herein, the release arrangement **578** includes a pair of opposing tabs **582**, **583**, with each tab being located about 590 degrees relative to the fingers **580**, **581**. The tabs **582**, **583** are connected to the fingers **580**, **581** to form a flexible ring defining a receiving aperture **586**. The receiving aperture **586** receives structure in the filter bowl **536** for retaining the cartridge **538** to the bowl **536**.

[0210] The tabs **582**, **583** are depressible or compressible in a direction toward each other, and because of the connection of the tabs **582**, **583** to the fingers **580**, **581** by way of the flexible ring **584**, upon squeezing the tabs **582**, **583** toward each other, the ring **584** moves the fingers **580**, **581** away from each other. Moving the fingers **580**, **581** away from each other will release the filter cartridge **538** from the corresponding structure in the filter bowl **536**.

[0211] The filter cartridge **538** further includes, in the embodiment shown, a centering arrangement **588** to assist with positioning and centering the filter cartridge **538** relative to the filter head **532**. In the embodiment shown, the centering arrangement **588** includes a plurality of projections **590** (FIG. **42**) extending radially from an exterior wall **592** of the first neck **552** and axially from the outward axial surface **554** of the first endcap **541**. In the embodiment shown, selected ones of the projections **590** are L-shaped members **594**, which assist in holding the filter cartridge in place relative to the adaptor **564** (FIG. **11**). As can be seen in FIG. **50**, the adaptor **564** is contained between the L-shaped member **594** and the first neck **552**.

[0212] As mentioned above, the filter media **544** extends between and is secured to the first endcap **541** and second endcap **542**. As shown in FIG. **43**, the filter media **544** has a first end **596** that is secured to the first endcap **541** through a conventional techniques. The media **544** has a second end **597** that is secured to the second endcap **542**.

[0213] In FIG. **43**, the second endcap **542** defines a second open aperture **598** in communication with the open filter interior **546**. In the embodiment shown, the second endcap **542** includes a second neck **600** extending from an outward axial surface **602** of the second endcap **542**.

[0214] A second seal member **604** is oriented on a radial surface **606** of the second neck **600**. In the embodiment shown, the second seal member **604** is oriented on an inner radial surface **608** of the second neck **600**. As can be seen in FIG. **43**, the second seal member **604** is oriented within a groove **610** defined in the inner radial surface **608** of the second neck **600**. When the filter cartridge **538** is operably assembled in use with the filter bowl **536**, the second seal member **604** forms a seal **612** (FIG. **50**) with structure in the filter bowl **536**.

C. The Filter Head **532** and Adaptor **564**

[0215] In FIGS. **40**, **48**, **50**, and **54**, a schematic depiction of filter head **532** is shown. The filter head **532**, in the embodiment shown, has a conduit **614**, typically functioning as an inlet conduit, and a conduit **616**, typically functioning as an outlet conduit. The filter head is connected to other equipment such that liquid to be filtered flows into the filter head **532** through the inlet conduit **614** and then exits the filter head **532** by flowing through the outlet conduit **616**. In many typical arrangements, the filter head **532** is constructed of a cast metal part.

[0216] The filter head **532** includes mating structure **618** for selective engagement with the filter bowl **536**. In the embodiment shown, the mating structure **618** are threads **620**. The threads **620** are illustrated as being along an outer radial surface of the filter head **532**. Of course, the threads can also be located on an inner radial surface of the filter head **532**.

[0217] Lining the outlet conduit **616**, the filter head **532** includes mating structure **622** for engagement with the adaptor **564**. In the embodiment shown, the mating structure **622** are threads **623** that connect to external threads **624** on the adaptor **564**. In this manner, the adaptor **564** can be selectively secured to the filter head **532** through engagement between the threads **623** and **624**. Other ways can be used to attach the adaptor **564** to the head **532** by, for example, press fit, adhesive, or welding, or making the adaptor **564** integral to the head **532**.

[0218] One embodiment of adaptor **564** is illustrated in perspective view in FIG. **49** and in cross-sectional view in FIGS. **48**, **50**, and **54**. In the embodiment shown, the adaptor **564** includes a funnel **626** circumscribing a central, open aperture **628**. Extending from the funnel **626** is a cylindrical wall **630**. The wall **130** has an end rim **632**, which becomes positioned between the first neck **552** and the L-shaped member **594** of the first endcap **541**. The wall **630** defines an inner radial surface **634**, which provides a surface against which seal **562** (FIG. **50**) is formed between the filter cartridge **538** and the adaptor **564**.

[0219] Extending from an inner wall of the funnel surface **626** is a plurality of ribs **636**. The ribs **636**, in this embodiment, are part of the lock-out mechanism in that they interfere with a portion of the filter bowl **536**, when the cartridge **538** is not operably oriented within the filter bowl **36**, and the engagement between the ribs **636** and the structure in the filter

bowl **536** prevents the filter head **532** from threadably engaging the filter bowl **536**. This is described more fully below in Section H of this disclosure.

[0220] The adaptor **564** cooperates with the filter cartridge **538** to help center the cartridge **538** and filter bowl **536** relative to the filter head **532**. As can be seen in FIG. **50**, the wall **630** of the adaptor **564** becomes located between the first neck **552** and the L-shaped member **594** of the first endcap **541**.

D. The Filter Bowl **36**

[0221] In reference now to FIGS. **44**, **45**, **48**, **50**, and **54**, one embodiment of the filter bowl **536** is illustrated. In the embodiment shown, the filter bowl **536** includes a surrounding wall **638** defining an open interior volume **640** for receiving and holding filter cartridge **538** therein. The bowl **536** has, at one end, an open mouth **642** for allowing the filter cartridge **538** to be selectively inserted and removed from the bowl **536**. At an end opposite of the open mouth **642** is a closed end **644** defining an opening, which functions as a drainage aperture **646**. Circumscribing the closed end **644** is a surrounding rim **648** to allow the bowl **536** to be stood on a horizontal surface, such as a shop bench, without tipping. In this embodiment, the rim **648** also has flat surfaces **649** (FIGS. **40** and **41**) to be used in conjunction with a removal tool such as a wrench. In the embodiment shown, centered within the surrounding rim **648** is a tube **650**, which axially extends from the closed end **644** and defines the drainage aperture **646**. In the embodiment shown, the drainage aperture **646** has connection structure, such as threads **652** to allow it to be operably connected to a porous inner filter support **654** (FIG. **47**), which is described further below. The drainage aperture **646** is in fluid communication with the open interior volume **640** of the filter bowl **536**.

[0222] Adjacent to the open mouth **642** is mating structure **656**, illustrated herein as threads **658**. The threads **658** are along the inner wall **660** of the surrounding wall **638**. The threads **658** are selectively engageable with the threads **620** on the filter head **532**. Of course, the threads **658** can also be on the exterior wall, when threads **620** on the head **532** are on an interior wall and a seal groove for holding a seal member **662** is on the exterior wall.

[0223] In the embodiment shown, along the inner wall **660** is seal member **662** for forming a releasable seal **664** (FIG. **50**) between the filter bowl **536** and the filter head **532**.

E. Filter Support **654**

[0224] Reference is now made to FIGS. **45**, **46**, **47**, **48**, **49**, **52**, and **54**. One embodiment of the porous inner filter support **654** is illustrated. The porous inner filter support **654** is oriented within the open filter interior **640** of the filter bowl **536**. In particular, in the specific embodiment illustrated, the inner filter support **654** is releasably secured to the filter bowl **536** through a threaded connection **666** between the threads **652** in the aperture **646** of the bowl **536** and a hollow stem **668** that is part of the inner filter support **654**. The filter support **654** can also be permanently attached to the bowl **536** by adhesive, press fit, staking, welding, or the support **654** and bowl **536** can be the same integral piece.

[0225] In the particular embodiment shown, the inner filter support **654** includes a outer porous wall **670**. The outer porous wall **670** defines a plurality of flow passages **672** (FIG. **47**) therethrough. In use, the porous inner filter support **154** functions to help support the filter media **654** by lining the open filter interior **546** of the media **544**, and the flow passages **672** allow for filtered liquid to flow into a filtered liquid volume **674** (FIG. **50**) within the outer porous wall **670**.

[0226] Attention is directed to FIG. **47**, The outer porous wall **670** defines an interior wall surface **676**. Extending from the interior wall surface **676** are a plurality of guide rails **678** projecting radially inwardly in a direction toward the filtered liquid volume **674**. The guide rails **678**, in the embodiment shown, include two parallel rails **679**, **680** with a slide track **681** therebetween. The slide track **681** engages portions of a core piece **682**, which is described below in Section G of this disclosure.

[0227] Each of the guide rails **678** has an engagement end **684**. The engagement ends **184** are part of the lock-out mechanism, described in Section H of this disclosure.

[0228] At the end of the outer porous wall **670** is a base **686**. In general, the base **686** is oriented normal to or perpendicular relative to the porous wall **170**. The base **686** includes a first axial surface **688** and an opposite, second axial surface **689**. (FIG. **46**) Between the first axial surface **688** and second axial surface **689** is an outer radial surface **690**. The radial surface **690** forms an outer periphery sealing surface **692** to form seal **612** (FIG. **50**) with the second seal member **604** held by the second endcap **542** on the filter cartridge **538**. The first axial surface **688** forms a stop or engagement surface **694** (FIG. **50**) for engagement against the second endcap **542** of the filter cartridge **538**.

[0229] Adjacent to the base **686** is a porous neck **696**. When the porous inner filter support **654** is operably oriented within the filter bowl **536**, and when the filter cartridge **538** is also operably oriented in the filter bowl **536** (as shown in FIG. **50**), the porous neck **696** is in selective fluid communication with the filtered liquid volume **674** (FIG. **50**) and an unfiltered liquid volume **698** (FIG. **50**) by way of a port **794** (FIG. **53**). The unfiltered liquid volume **698** is the volume within the filter bowl **536** that is upstream of the filter media **544**. The porous neck **696** is selectively in communication with the filtered liquid volume **674**, when the drain valve mechanism is in an open position. The drain valve mechanism is described in Section I of this disclosure.

[0230] The hollow stem **668**, mentioned above, is in fluid communication with the porous neck **696**. The stem **668** is removably oriented within the drainage aperture **646** of the bowl **536**. The stem **668** defines an outer radial groove **700** holding a seal member **702** therein. The seal member **702** forms a seal **704** with an inner surface of the tube **650** of the filter bowl **536**. The stem **668** is hollow and defines drainage aperture **669**, which is located with aperture **646** of the bowl **536**.

[0231] The inner filter support **654** further includes an inner wall **706** within the outer wall **670** (FIG. **46**). The inner wall **706** is solid and extends a relatively short distance from the base **686**, specifically, less than 25% of the outer wall **670**. The inner wall **706** is circumscribed by the outer wall **670**. The inner wall **706** and outer wall **670** define a spring-holding seat **708** therebetween. The spring-holding seat **708** holds a lower spring **710**. The lower spring **710** is part of the lock-out mechanism, described in Section H of this disclosure.

[0232] Still in reference to FIG. **46**, along the interior wall surface **676** of the outer porous wall **670** is an inner sloped shoulder **712**. The shoulder **712** can help to limit downward motion of the core piece **682** because it will interfere with the

core piece **682** and prevent further downward travel of the core piece **682** within the filter support **654**.

[0233] The outer porous wall **670** further defines a plurality of receiving slots **714** therethrough. The receiving slots **714** are oriented to receive a portion of a locking spring **716** during servicing of the filter system **530**. This is described further below in Section I.

F. Basket **720**

[0234] Attention is directed to FIGS. **46**, **47**, **48**, and **49**. A basket **720** is illustrated. The basket **720** is part of the lock-out mechanism, and its function will be more fully-described below in Section H. A variety of implementations are contemplated. In the particular embodiment illustrated, the basket **720** includes a plurality of legs **722** cantilevered from a base **724**. In the embodiment shown, there are four legs **722** evenly and radially-spaced relative to each other. The legs **722** extend axially from the base **724** in a direction toward the closed end **644** of the bowl **536**, when the basket **720** is operably assembled in use.

[0235] The basket **720** further includes a plurality of petals **726** extending axially from the base **724**. In the embodiment shown, there are four petals **726** extending axially from the base **724** in a direction toward the open mouth **642** of the bowl **536**, when the basket **720** is operably assembled in use. Thus, the petals **726** extend axially in a direction opposite from the legs **722**. The petals **726** are evenly spaced relative to each other. Each of the petals **726**, in the embodiment shown, defines an open flow aperture **728**, an upper end tip **730**, and an angled ramp surface **732**. The ramp surface **732** slants downwardly from the end tip **730** down to the base **724**.

[0236] When the basket **720** is operably assembled with the core piece **682** and installed within the filter bowl **536**, the basket **720** is rotationally moveable from a locked position in which a free end **734** of each of the legs **720** axially engages or abuts the engagement end **684** of the guide rails **678** on the filter support **654**. The basket **720** is moveable rotationally from the locked position to an unlocked position, the unlocked position being when the legs **722** are free of axial abutment between the free ends **734** and the engagement ends **684** of the guide rails **678** to permit the basket **720** to move axially in a direction toward the closed end **644** of the bowl **536**. This is further described in conjunction with the lock-out mechanism, described in Section H below.

[0237] The ramp surface **732** on the petals **726** are constructed and arranged to move or rotate the basket **720** from its locked position to its unlocked position by engagement with a portion of the filter cartridge **538**. In particular, there will be engagement between the ribs **568** on the first endcap **541** and the ramped surface **732** of each of the petals **726**. This is described further below in the lock-out mechanism section, Section H.

[0238] The basket **220** further includes a center tube **736** extending from the base **724**. The center tube **736** defines a post-receiving aperture **738** sized to receive a post **740** of the core piece **682**. The post **740** and core piece **682** are described below in Section G.

[0239] Extending between each petal **726** and the center tube **736** is a web **742**. In the embodiment shown, there are four webs **742**. The webs **742** help to support the center tube **736** and connect it with the rest of the basket **720**. Each of the webs **742** also helps to hold an upper spring **744**, such that the basket **720** is biased relative to the core piece **682** to keep the basket **720** in the locked position. The function of the upper spring **744** as part of the lock-out mechanism is described in Section H.

G. Core Piece **682** and Locking Spring **716**

[0240] In reference now to FIG. **47**, one embodiment of core piece **682** is illustrated in perspective view. A cross-sectional view of the core piece is illustrated in FIGS. **45**, **46**, **48**, **50**, and **54**. In general, the core piece **682** is operably oriented within the filtered liquid volume **674**, and within the interior of the inner filter support **654**.

[0241] As can be seen in FIG. **47**, in the embodiment shown, the core piece **682** includes a post **740**, a center member **770**, and a plug **752**. In the embodiment shown, the core piece **682** extends a length that, in certain preferred embodiments, will be longer than the length of the media **544**.

[0242] In the embodiment shown, at one free end of the post **740**, a button **748** is defined. Adjacent to the button **748** is a reduced dimension region in the form of a neck **750**. The post **740** is received within the post receiving aperture **738** of the basket **720**, and the retention mechanism **572** (FIG. **56**) engages the post **740** at the button **748**. Specifically, the gripper arrangement **576** holds the post **740** at the button **748** by having fingers **580**, **581** engage the neck **750** of the post **740**. See FIG. **57**. Further operational details of the retention arrangement are discussed below in Section J.

[0243] In the embodiment shown, the core piece **682** further includes plug **752** moveably oriented between a sealed position (FIGS. **50** and **53**) and a drainage position (FIGS. **54** and **55**) within the drainage aperture **669** of the porous inner filter support **654**. In addition, the plug **752** has a third position, which is a position when it is locked in place during servicing awaiting the insertion of filter cartridge **538**. This third locked position is illustrated in FIG. **48**.

[0244] When the plug **752** is in the sealed position, the plug **752** blocks fluid flow between the interior volume **640** of the bowl **536** and the drainage aperture **669**. When the plug **752** is in the drainage position, the plug **752** is oriented relative to the bowl **536** to permit flow from the interior volume **640** of the bowl **536** through the drainage aperture **669**.

[0245] The plug **752**, in the embodiment shown, includes a first groove **754** (FIG. **47**) holding a first seal member **756** (FIG. **46**) spaced from but adjacent to the first groove **754** is a second groove **758** (FIG. **47**). Oriented in the second groove **758** is a second seal member **760** (FIG. **46**). The first seal member **756** forms a first seal **762** (FIG. **53**) between the plug **752** and the inner wall of the stem **668** within the drainage aperture **669**. Thus, in this embodiment, the first seal **762** is between a portion of the porous inner filter support **654** and the core piece **682**. The first seal **762** blocks unfiltered liquid from the unfiltered liquid volume, which is in the open interior volume **640** but upstream of and outside of the filter media **544**, from flowing through the porous neck **696** and into the drain aperture **669**.

[0246] Still in reference to FIG. **53**, the second seal member **760** forms a second seal **764** between the plug member **752** of the core piece **682** and an inner flow conduit **766** (FIG. **48**) of the filter support **654**. As such, the second seal **764** seals against unfiltered liquid from the unfiltered liquid volume **698** (FIG. **50**) from reaching the filtered liquid volume **674** (FIG. **50**). The second seal **764** also prevents liquid from the filtered liquid volume **674** from flowing downwardly into the unfiltered liquid volume **698**.

[0247] The plug **752** is discussed more fully below in Section I, in connection with its contribution to the drain valve mechanism.

[0248] In reference again to FIG. **47**, in the example embodiment shown, the core piece **682** includes center member **770**. In this specific embodiment, the center member **770** extends between the post **740** and the plug **752**. The core piece **682**, in this embodiment, includes a plurality of guide fins **772** radially extending from the center member **770**. The guide fins **772** help to hold the core piece **682** centered within the inner filter support **654**. The guide fins **772** are also a component, in this embodiment, of the drain valve mechanism, discussed in Section I below.

[0249] In the embodiment shown in FIG. **47**, at least two of the guide fins **772** define slots **774**. In the embodiment shown, the slots **774** are, in general, U-shaped openings that extend from an outer edge of the guide fins **772** partially inwardly toward the center member **770**. The guide fins **774** receive a portion of the locking spring **716**, when the core piece **682** is operably assembled in use with the parts shown in this example embodiment.

[0250] In the embodiment shown, between adjacent ones of the fins **272** is a receiving gap **276**. As will be explained below, the receiving gap **276** helps to orient and hold other portions of the locking spring **216**.

[0251] Still in reference to FIG. **47** and in reference to FIG. **58**, in the embodiment shown, the core piece **682** further includes a basket holder **778**. In this embodiment, the basket holder **778** supports the basket **720** and allows the basket **720** to move between its locked position and its unlocked position. In the embodiment shown, the basket holder **778** includes an apertured frame **780** extending radially from the center member **770**. The apertured frame **780** is supported by a plurality of gussets **782**. In the embodiment shown, there are four gussets **782** supporting the apertured frame **780**. The apertured frame **780** defines leg-receiving apertures **784** (FIG. **58**), such that the legs **722** of the basket **720** can penetrate the basket holder **778**, by having the legs **722** pass through the apertures **784**. The apertures **784** generally have a center axis that is parallel to the center member **770**.

[0252] Extending axially from the apertured frame **780** in a direction toward the open mouth **642**, when the core piece **682** is assembled in use, is a plurality of flanges **786**. In the embodiment shown, there are four flanges **786** evenly spaced apart and circumscribing or surrounding the post **740**. Each of the flanges **786** defines a pair of openings **788**, **789** therethrough. A groove **790** separates each flange **786** from an adjacent flange **786**.

[0253] The locking spring **716** includes a horizontal member **800**, a pair of shoulders **801**, **802** at the end of the horizontal member **800**, and a pair of hooked arms **804**, **805** extending from respective shoulders **801**, **802**. The hooked arms **804**, **805** terminate with hooks **806**, **807**. The shoulders **801**, **802** are generally positioned within the fin slots **774**, and the horizontal member **800** extends across the core piece **682**. The locking spring **716** functions to limit the vertical motion of the core piece **682**.

H. Operation of The Lock-Out Mechanism

[0254] As mentioned above, it may be desirable to have in the filter system **530** a mechanism that will ensure that the filter system **530** cannot be operated unless the filter cartridge **538** has been operably assembled within the filter bowl **536**. A lock-out mechanism will achieve this objective.

[0255] Reference is first made to FIGS. **44** and **45**, which show this embodiment of filter bowl **536** and the filter support **554** and core piece **682** operably assembled therein. In FIG. **45**, the filter cartridge **538** is not within the filter bowl **536**. FIG. **45** would be, for example, the state of the filter bowl **536** during servicing, after the old filter cartridge **538** has been removed.

[0256] In FIG. **45**, the basket **720** is snap-fitted to the post **740**, and the basket **720** is oriented in its locked position by the bias of the upper spring **744**. In particular, the upper spring **744** is oriented such that it biases the basket **720** into the locked position by rotational force exerted between the webs **742** and the resistance to that force because of engagement between the legs **722** and the leg receiving apertures **784**.

[0257] When the basket **720** is in its locked position, each of the legs **722** has its free end **734** in engagement with the engagement end **684** of the guide rails **678**. In this position, without filter cartridge **538** installed in the filter bowl **536**, the tips **730** of the petals **726** will contact or engage against the ribs **636** of the adaptor **564**. See FIG. **48**. Because the legs **722** are resting on top of the guide rails **678**, the core piece **682** and the basket **220** cannot move axially downwardly in a direction toward the closed end **644** of the bowl **536**. Instead, the entire inner liner assembly **792** is in an extended and rigidly fixed position. As can be seen in FIG. **48**, in this rigidly fixed position, the filter head **532** cannot matably connect with the bowl **536** by connection between the threads **658** on the bowl **536** and the threads **620** on the filter head **532**.

[0258] During servicing, when a new filter cartridge **538** has been provided, the filter cartridge **538** is oriented in the filter bowl **536** by placing it through the open mouth **642**.

[0259] Attention is directed to FIGS. **50** and **52**. When the filter cartridge **538** is properly positioned in the filter bowl **536**, the ribs **568** on the first endcap **541** come in contact or engage the ramped surfaces **732** of the basket **720**. As the filter cartridge **538** moves axially downwardly toward the closed end **644** of the filter bowl **638**, the ribs **568** on the endcap **541** engage against the ramped surfaces **732** of the petals **726** of the basket **720**. This engagement between the ribs **568** and ramped surfaces **732** cause the basket **720** to rotate from its locked position to its unlocked position against the spring **744**. The rotation is 20-40 degrees, for example, about 25-28 degrees. As the basket **720** rotates from its locked position to its unlocked position, the legs **722** also rotate moving away from the engagement against the engagement end **684** of the guide rails **678**. At some point, prior to the basket **720** rotating its full motion (for example, between 525 and 528 degrees), the legs **722** completely clear the guide rails **678**. At this point, any additional movement of the filter cartridge **538** in a downwardly axial direction toward the closed end **644** will cause the basket **720** and core piece **682** to also move in that direction against the lower spring **710**. The lower spring **710** biases the basket **720** and the core piece **682** in the extended position of FIG. **45**.

[0260] Once the filter cartridge **538** has been moved downwardly enough to unlock the core piece **682** and move the basket **720** from its locked position to its unlocked position, the filter head **532** will be able to matably engage the threads on the bowl **536** for secure attachment, as shown in FIG. **50**.

I. Drain Valve Mechanism

[0261] The filter system **530** depicted also has a drain valve mechanism to allow liquid in the complete assembly to automatically be drained during the servicing of the system **530**.

The drain valve mechanism can be implemented independently of other features in the example embodiment. For example, the drain valve mechanism can be implemented independent of the lock-out mechanism and of the cartridge retention mechanism.

[0262] Attention is directed to FIGS. **50** and **53-55**. In FIG. **50**, when the filter cartridge **538** is operably positioned in the filter bowl **536** and with the bowl **536** being fully threaded on the filter head **532** as shown in FIG. **50**, the plug **752** is in the closed and sealed position. In this position, there is in place the first seal **762** and second seal **764**.

[0263] The second seal **764** seals off liquid located on the clean side, in the filtered liquid volume **674** (FIG. **50**), from port **794** that is fluidly connected to the unfiltered liquid volume **698** (FIG. **50**). First seal **762** seals off liquid from port **794** from the drainage aperture **669** that is directed to the outside environment.

[0264] The lower spring **710** is located in the spring-holding seat **708** and a lower edge **796** of the guide fins **772**. With the filter cartridge **538** operably positioned in the bowl **536** and the filter head **532** fully engaged and connected to the bowl **536**, the lower spring **710** is a compressed state and is producing a force acting along the central axis of the filter cartridge **538**, thereby holding the core piece **682** and basket **720** against the ribs **68** that are integral in the first endcap **541**. Further, projections **590**, **594** integral to the outward axial surface **554** of the first endcap **541** are held against the lower edge or rim **632** (FIG. **49**) of the adaptor **564**. Because the first endcap **541** is part of the filter cartridge **538**, the entire assembly including the cartridge and the inner liner assembly **792** is held up against the adaptor **564**.

[0265] When it is time to service the filter cartridge **538**, because the media **544** becomes clogged or restricted, or if it just time to replace the cartridge **538** because of wear, the filter assembly **534** will be rotated about its central axis relative to the filter head **532**. As this occurs, the filter assembly **534** moves downwardly along the central axis due to unthreading action between the bowl **536** and the filter head **532**. While this downward action is occurring, the lower spring **710** continues to hold the filter cartridge **538** against the adaptor **564**. The result of this is that the filter cartridge **538** remains fixed in position relative to the adaptor **564** and filter head **532** as the filter bowl **536** moves axially downwardly. This action creates relative motion between the plug **252** and the sealing surfaces forming the first and second seals **762**, **764**. After two full turns of the filter bowl **536**, the drainage aperture **669** is fully open to the fluid in both the unfiltered liquid volume **698** and the filtered liquid volume **674**, allowing the liquid to flow along flow paths **798**, **799** (FIG. **55**) into the outside environment, where it can be captured by some kind of container for proper disposal.

[0266] At this point, the core piece **682** can no longer move relative to the inner filter support **654**. Locking spring **716** is attached to the core piece **682** by way of slots **774** in the guide fins **772** (See FIG. **47**).

[0267] With the filter cartridge **538** fully installed in the bowl **536**, the hooks **806**, **807**, in particular, ends **808**, **809** of the hooks **806**, **807**, of the locking spring **716** are spring-loaded against the slide tracks **681** in the guide rails **678** within the wall **670** of the filter support **654**.

[0268] As the core piece **682** moves upwardly in a direction toward the open mouth **642** of the bowl **536**, relative to the filter support **654**, the locking spring **716**, being attached to the core piece **682** through the slots **774**, moves with the core piece **682** until the two ends **808**, **809** of the locking spring **716** move radially outwardly and into receiving slots **714** in the wall **670** of the filter support **654**. See FIG. **48**. The ends **808**, **809** of the locking spring **716** lock into a position relative to the filter support **654** preventing the core piece **682** from moving any further. This prevents the core piece **682** from falling out of the filter bowl **536** after the filter cartridge **538** has been removed.

[0269] As can be seen in FIG. **48**, the plug **752** is in a third position, axially above the drainage position, the position of FIG. **48** of the plug **752** is the position when the core piece **682** is locked in place during servicing awaiting the insertion of filter cartridge **538**.

J. Cartridge Retention Mechanism **572**

[0270] The preferred embodiment illustrated of the filter system **530** includes a cartridge retention mechanism **572**, to releasably hold the filter cartridge **538** within the filter bowl **536** during servicing. The cartridge retention mechanism **572** can be implemented independently of other features in the filtration system, including independent of the lock-out mechanism and of the drain valve mechanism.

[0271] Attention is directed to FIGS. **56** and **57**. These FIGS are schematic and the filter media **544** is not illustrated for purposes of clarity. Rather, only the first endcap **541** is shown, along with a portion of the inner liner assembly **792**.

[0272] When the core piece **682** is in the position shown in FIG. **48**, locked in its upward vertical direction, the post **740** is positioned relative to the first endcap **541** such that fingers **580**, **581** on the endcap **541** are located underneath button **748**. Specifically, the fingers **580**, **581** are gripping the neck **750**. Any further downward motion in the axial direction of the bowl **536** including the inner liner assembly **792** causes the neck **750** to come into contact with the fingers **580**, **581**, applying an axial downward force on the entire filter cartridge **538**. The net result is that the cartridge **538** remains inside the bowl **536** during the last full turn of the bowl **536** as it is removed from the filter head **532**.

[0273] With the filter assembly **534** now completely separated from the filter head **532**, the filter cartridge **538** remains captured in the filter bowl **536** by the engagement between the fingers **580**, **581** of the gripper arrangement **576** and the button **748** of the post **740**. In order to release the filter cartridge **538** from the bowl **536**, the release arrangement **578** is depressed. Specifically, the tabs **582**, **583** are pressed radially inwardly toward each other and toward the post **740** by the thumb and forefinger of the person providing the servicing. This causes the fingers **580**, **581** to move away from the neck **750** of the post **740**, allowing the fingers **580**, **581** to clear the button **748**.

[0274] The thumb and forefinger of the service person is on the tabs **582**, **583**, and the service person can now pull the filter cartridge **538** clear of the button **748** and remove the cartridge **538** from the bowl **536**.

[0275] It should be understood that in order for the tabs **582**, **583** to deflect inwardly and cause the fingers **580**, **581** to deflect outwardly, the retention mechanism **572** is made from a material flexible enough to provide that function with an amount of force that can be generated by the squeezing action of a thumb and forefinger. This material may typically be plastic, although it can be other materials as well.

K. Methods

[0276] A method for draining liquid from the filter system **530** should now be apparent from the foregoing. One method

can include at least partially unscrewing the filter bowl **536** containing the filter cartridge **538** from the filter head **532** and permitting lower spring **710** to axially move core piece **682** having plug **752** from the sealed position shown in FIGS. **50** and **53** to a drainage position, shown in FIGS. **54** and **55**. The sealed position includes the plug **752** blocking fluid flow between the unfiltered liquid volume **698** and the fluid outlet port, shown as drainage aperture **669**, by blocking flow through a section, such as stem **668**, of the inner filter support **654**. The drainage position includes the plug **752** being oriented relative to the inner filter support **654** to permit flow through the drain aperture **669** of the stem **668**, and permitting flow from the unfiltered liquid volume **698** and the drainage aperture **669**.

[0277] A method of installing the filter cartridge **538** in the filter bowl **536** should also now be apparent. One method includes orienting the filter cartridge **538** into the filter bowl **536**. The method further includes while orienting the filter cartridge **538**, pushing the filter cartridge **538** against the core piece **682** to disengage the core piece **682** and the inner filter support **654**. This is done, specifically, by engaging the ribs **568** of the first endcap **541** against the ramped surfaces **732** of the basket **720**, causing rotation of the basket **720** against the spring **744**, which causes the legs **722** to move out of axial abutment between the ends **734** and the engagement **684** of the guide rails **678**. The legs **722** are then allowed to move axially downwardly within the outer wall **670** of the filter support **654**. Next, after disengaging, the method includes axially moving both the filter cartridge **538** and the core piece **682** relative to the inner filter support **654**. Specifically, the filter cartridge **538** pushes the basket **720** and the core piece **682** axially downwardly relative to the filter support **654**. This then permits mating engagement between the filter head **532** and the filter bowl **536**.

[0278] To service the filter system **530**, the filter bowl **536** is unscrewed from the filter head **532**. As this is done, the core piece **682** moves axially relative to the filter support **654**, until the locking spring **716** becomes locked in place relative to the inner filter support **654**. Specifically, the ends **808**, **809** of the hooks **806**, **807** travel along the slide tracks **681** of the guide rails **678** until they snap through the slots **714**. When the locking spring **716** has its ends **808**, **809** snap into the slots **714**, the core piece **682** is axially locked relative to the porous inner filter support **654**.

[0279] As the core piece **682** moves axially upwardly relative to the filter support **654**, the button **748** on the post **740** became gripped by the gripper arrangement **576** of the first endcap **541** of the filter cartridge **538**. The filter assembly **534** is removed from the filter head **532**, and the filter cartridge **538** stays with the filter bowl **536**. The user then grips the release arrangement **578**, by placing his forefinger and thumb on the tabs **582**, **583**. The person squeezes the tabs **582**, **583** in a direction toward the post **740**. This causes the deflection of the fingers **580**, **581**, such that they move radially away from the neck **750** of the button **748**.

[0280] With the cartridge **538** now disengaged from the core piece **682**, the user removes the cartridge **538** from the bowl **536** by maintaining the grip on the tabs **582**, **583**, to axially pull the cartridge **538** from the bowl **536**. The old filter cartridge is then disposed.

[0281] A new filter cartridge is then installed. A method of installing the filter cartridge has been described above and is then followed.

[0282] A method of filtering includes directing liquid to be filtered into the filter head **532** through the inlet conduit **614**. The liquid then flows into the unfiltered liquid volume **698**. The liquid is prevented from bypassing the filter media **544** by the seal **612** between the second endcap **542** and the base **686** of the porous inner filter support **654**; and seal **62** between the first endcap **541** and the adaptor **564**. Further, the seal **764** helps to seal against the liquid from bypassing the media **544**. The liquid then flows through the filter media **544**, through the flow passages **672** in the porous inner filter support **654**, and then into the filtered liquid filter volume **674**. The filtered liquid then flows through the first open aperture **550** (FIG. **43**), through the open aperture **628** of the adaptor **564** and then through the outlet conduit **616** of the filter head **532**.

1-57. (canceled)

58. A filter cartridge for use in a filter bowl; the filter cartridge comprising:

(a) a first end cap defining a first open aperture;
  (i) the first end cap holding a first end cap seal member;
  (ii) the first end cap defining an aperture wall lining the first open aperture;
  (iii) at least first and second protrusions extending from the aperture wall and into the first open aperture; the at least first and second protrusions engaging a lock-out mechanism in a filter bowl, when the filter cartridge is operably installed in the filter bowl;
    (A) the first protrusion being spaced from the second protrusion in a vertical direction along the aperture wall;
    (B) the first protrusion being circumferentially spaced from the second protrusion along the aperture wall;
  (iv) the first end cap defines an axially extending neck defining an outer radial surface;
    (A) the first end cap seal member is held by the axially extending neck on the outer radial surface;

(b) a tubular construction of filter media defining an open filter interior and having first and second opposite ends; the first end being secured to the first end cap;
  (i) the first open aperture being in communication with the open filter interior; and

(c) a second end cap secured to the second end of the filter media; the second end cap defining a second open aperture in communication with the open filter interior;
  (i) the second end cap holding a second end cap seal member.

59. A filter cartridge according to claim **58** wherein:

(a) the first open aperture of the first end cap defines an inner diameter;

(b) the first protrusion extends into the first open aperture no greater than 40% of the inner diameter of the first open aperture; and

(c) the second protrusion extends in the first open aperture no greater than 40% of the inner diameter of the first open aperture.

60. A filter cartridge according to claim **58** wherein:

(a) the first protrusion and second protrusion are located circumferentially spaced within 50° of each other.

61. A filter cartridge according to claim **58** wherein:

(a) the first protrusion and the second protrusion are located greater than 45° of each other.

62. A filter cartridge according to claim **58** wherein:

(a) the first open aperture of the first end cap defines an inner diameter;

(b) the vertical distance between the first and second protrusions is 2-30% of the inner diameter.

63. A filter cartridge according to claim **58** further comprising:

(a) at least a third protrusion extending from the aperture wall and into the first open aperture;

(i) the third protrusion being circumferentially spaced from the first protrusion and the second protrusion;

(ii) the third protrusion being vertically spaced from only one of either the first protrusion or the second protrusion.

64. A filter cartridge according to claim **63** further comprising:

(a) at least a fourth protrusion extending from the aperture wall and into the first open aperture;

(i) the fourth protrusion being circumferentially spaced from the first, second, and third protrusions; and

(ii) the fourth protrusion being vertically spaced from only two of the first protrusion, the second protrusion, or the third protrusion.

65. A filter cartridge according to claim **64** wherein:

(a) two of the first, second, third, and fourth protrusions are circumferentially spaced within 45° of each other; and a remaining two of the first, second, third, and fourth protrusions are circumferentially spaced within 45° of each other.

66. A filter cartridge according to claim **58** wherein:

(a) the neck defines an inner radial surface forming a portion of the aperture wall; and

(i) only one of the first and second protrusions extends from the inner radial surface of the neck.

67. A filter cartridge according to claim **66** wherein:

(a) the first end cap defines a filter media holding section having an inner media wall; the inner media wall defining an inner radial surface which forms part of the aperture wall;

(i) the inner radial surface of the inner media wall being spaced radially inwardly relative to the neck inner radial surface;

(ii) only one of the first and second protrusions extends from the inner radial surface of the inner media wall.

68. A filter cartridge according to claim **58** wherein:

(a) the second end cap defines a second axially extending neck defining a radial surface;

(i) the second end cap seal member is held by the second axially extending neck on the radial surface.

69. A filter cartridge according to claim **58** wherein:

(a) the first end cap further includes an axially projecting centering arrangement projecting from an outward axial surface thereof adjacent to an outer rim of the first end cap.

70. A filter cartridge according to claim **58** further including:

(a) a retention mechanism centered within the first open aperture and extending from the first end cap; the retention mechanism having a gripper arrangement and a release arrangement.

71. A filter cartridge according to claim **70** wherein:

(a) the gripper arrangement includes a pair of opposing fingers radially extending toward each other; and

(b) the release arrangement includes a pair of opposing tabs, each tab being located about 90° relative to the fingers.

72. A filter cartridge according to claim **58** wherein:

(a) the filter media is pleated media.

73. A filter assembly for attachment to a filter head; the filter assembly comprising:

(a) a bowl including a surrounding wall defining an interior volume, an open mouth, and an end opposite of the mouth;

(i) the bowl end defining a drainage aperture in fluid communication with the interior volume;

(b) a filter cartridge removably oriented within the interior volume of the bowl; the filter cartridge including a tubular construction of filter media defining an open filter interior;

(c) a porous inner filter support oriented within the open filter interior; the filter support including at least one projection extending radially inwardly therefrom; and

(d) a lockout mechanism having a first locked position and an unlocked position; the first locked position preventing a filter head from operably connecting to the bowl; the unlocked position permitting attachment of a filter head to the bowl; the lockout mechanism including a basket having a grooved wall extending axially in a direction toward the open mouth of the bowl and including at least one cantilevered leg extending axially in a direction toward the end of the bowl; the basket defining a central longitudinal axis;

(i) the basket being rotationally movable about the central longitudinal axis from the first locked position in which the leg axially abuts the at least one projection on the filter support and the unlocked position in which the leg is free of axial abutment with the projection and permits the basket to move in a direction toward the end of the bowl; and

(ii) the grooved wall being constructed and arranged to rotate the basket from the first locked position to the unlocked position by engagement with a protrusion arrangement that is part of optionally either the filter cartridge or an adapter ring.

74. A filter assembly according to claim **73** wherein:

(a) the basket is rotationally movable from the first locked position, in which the leg axially abuts the at least one projection on the filter support, to a second locked position in which the leg is partially free of abutment against the at least one projection on the filter support;

(b) the grooved wall has at least a first groove with a first slide surface and a second groove with a second slide surface;

(i) the grooved wall being constructed and arranged to engage a portion of the filter cartridge at the first slide surface of the first groove and rotate the basket from the first locked position to the second locked position exposing the second slide surface of the second groove; and

(ii) the second slide surface of the second groove is constructed and arranged to engage the filter cartridge and rotate the basket from the second locked position to the unlocked position.

75. A filter assembly according to claim **74** further comprising:

(a) a core piece operably oriented within an interior of the porous inner filter support; the core piece including a post and a basket-holder;

(i) the basket including a plurality of cantilevered legs;
(ii) the basket holder having a slotted wall circumscribing the post and spokes joining the slotted wall to the post; adjacent spokes defining leg-receiving apertures;
(iii) the legs of the basket extending into the leg-receiving apertures;
(b) the basket having a hollow column circumscribed by the grooved wall; the post extending through the hollow column.

76. A filter assembly according to claim **75** wherein:
(a) the basket further includes flanges extending between the column and the grooved wall;
(b) the at least one projection on the filter support comprises a plurality of guide rails constructed and arranged to slidably hold the core piece; and
(c) the assembly further includes a spring operably oriented between the flanges to bias the basket rotationally within the basket holder into the locked position.

77. A filter assembly according to claim **73** wherein:
(a) the filter cartridge includes a first end cap defining a first open aperture;
(i) the first end cap defining an aperture wall lining the first open aperture;
(ii) at least first and second protrusions being the protrusion arrangement extending from the aperture wall and into the first open aperture;
(A) the first protrusion being spaced from the second protrusion in a vertical direction along the aperture wall;
(B) the first protrusion being circumferentially spaced from the second protrusion along the aperture wall;
(1) the first protrusion being constructed and arranged to engage the first slide surface of the first groove; and
(2) the second protrusion being constructed and arranged to engage the second slide surface of the second groove.

78. A filter assembly according to claim **73** wherein:
(a) the filter cartridge includes a first end cap defining a first open aperture;
(b) the basket is rotationally movable from the first locked position, in which the leg axially abuts the at least one projection on the filter support, to a second locked position in which the leg is partially free of abutment against the at least one projection on the filter support;
(c) the grooved wall has at least a first groove with a first slide surface and a second groove with a second slide surface; and
the filter assembly further includes,
(d) the adapter ring operably mounted around the basket; the adapter ring defining an adapter aperture and having an aperture wall;
(i) at least first and second protrusions being the protrusion arrangement extending from the aperture wall and into the adapter aperture;
(A) the first protrusion being spaced from the second protrusion in a vertical direction along the aperture wall;
(B) the first protrusion being circumferentially spaced from the second protrusion along the aperture wall;
(1) the first protrusion being constructed and arranged to engage the first slide surface of the first groove; and
(2) the second protrusion being constructed and arranged to engage the second slide surface of the second groove.

79. A filter assembly according to claim **73** further comprising:
(a) a core piece operably oriented within an interior of the porous inner filter support; the core piece including a post;
(b) wherein the filter cartridge includes a retention mechanism removably connected to the post.

80. A filter assembly according to claim **73** further comprising:
(a) a drain valve assembly including a plug moveably oriented between a sealed position and a drainage position;
(i) the sealed position including the plug blocking fluid flow between the interior volume of the bowl and the drainage aperture; and
(ii) the drainage position including the plug being oriented relative to the bowl to permit flow from the interior volume of the bowl through the drainage aperture.

81. A filter assembly according to claim **80** further comprising:
(a) a core piece operably oriented within an interior of the porous inner filter support; the core piece including a post having a head movably oriented between an engaged position and a released position;
(i) the engaged position including the head being oriented against the plug to push the plug into the sealed position; and
(ii) the released position including the head being spaced away from the plug to allow the plug to move to the drainage position.

82. A filter assembly according to claim **81** wherein:
(a) the core piece further includes a fin arrangement; the head of the post includes a radial flange;
(b) the porous inner filter support further includes an inwardly extending support and a plurality of guide rails;
(i) the radial flange of the head is movably engaged against a lower surface of the support, when the head is in the released position;
(ii) the fin arrangement is slidably positioned within the plurality of guide rails; and
(c) the filter assembly further includes a core piece spring operably oriented between the fin arrangement and an upper surface of the support.

83. A filter assembly according to claim **81** wherein:
(a) the drain valve assembly includes:
(i) a valve housing having a tubular wall; the plug being oriented within the tubular wall and being axially movable therewithin;
(ii) a spring around the valve housing tubular wall and pushing against a portion of the plug;
(iii) a first plug seal member secured to the plug and forming a first plug seal with the valve housing; the first plug seal preventing unfiltered fluid from bypassing the filter media and flowing into the open filter interior, when the plug is in the sealed position;
(iv) a second plug seal member secured to the plug and forming a second plug seal with the valve housing; the second plug seal preventing fluid from flowing from the bowl through the drainage aperture;
(v) a first valve seal member secured to the valve housing and forming a first valve seal with a disk connected to

the bowl; the first valve seal preventing unfiltered fluid from bypassing the filter media and flowing into the open filter interior; and

(vi) a second valve seal member secured to the valve housing and forming a second valve seal with the bowl; the second valve seal preventing fluid from flowing from the bowl through the drainage aperture.

84. A filter assembly according to claim **83** wherein:

(a) the valve housing tubular wall defines an open slot arrangement allowing fluid flow therethrough.

85. A filter system comprising:

(a) a filter assembly including,

(i) a bowl including a surrounding wall defining an interior volume, an open mouth, and an end opposite of the mouth; the bowl end defining a drainage aperture in fluid communication with the interior volume;

(ii) a filter cartridge removably oriented within the interior volume of the bowl; the filter cartridge including a tubular construction of filter media defining an open filter interior;

(iii) a porous inner filter support oriented within the open filter interior; the filter support including at least one projection extending radially inwardly therefrom; and

(iv) a lockout mechanism having a first locked position and an unlocked position; the first locked position preventing a filter head from operably connecting to the bowl; the unlocked position permitting attachment of a filter head to the bowl; the lockout mechanism including a basket having a grooved wall extending axially in a direction toward the open mouth of the bowl and including at least one cantilevered leg extending axially in a direction toward the end of the bowl; the basket defining a central longitudinal axis;

(A) the basket being rotationally movable about the central longitudinal axis from the first locked position in which the leg axially abuts the at least one projection on the filter support and the unlocked position in which the leg is free of axial abutment with the projection and permits the basket to move in a direction toward the end of the bowl; and

(B) the grooved wall being constructed and arranged to rotate the basket from the first locked position to the unlocked position by engagement with a protrusion arrangement that is part of optionally either the filter cartridge or an adapter ring; and

(b) a filter head selectively connectable to the bowl;

(i) the bowl and the filter head having mating structure permitting the bowl to be selectively removably attached to the filter head at the mouth.

86. A method of installing a filter cartridge into a filter bowl; the method comprising:

(a) orienting a filter cartridge having a tubular construction of filter media into a filter bowl having an open mouth;

(i) the filter bowl having an inner filter support mounted therein;

(ii) the filter bowl further having a core piece within the inner filter support; the core piece holding a basket having a grooved wall extending axially in a direction toward the open mouth of the bowl; the basket defining a central longitudinal axis; the basket being rotationally movable about the central longitudinal axis;

(iii) the core piece and the inner filter support engaging against each other as part of a lock-out mechanism;

(b) while orienting, pushing the filter cartridge against the basket to rotate the basket and disengage the core piece and the inner filter support; and

(c) after disengaging, axially moving both the filter cartridge and the core piece relative to the inner filter support.

87. A method according to claim **86** wherein:

(a) the basket includes at least one cantilevered leg extending axially in a direction toward the end of the bowl;

(b) the inner filter support includes at least one inwardly radially extending projection; and

(c) the step of pushing includes:

(i) engaging a first protrusion extending from the filter cartridge against the grooved wall of the basket to partially rotate the basket and then,

(ii) engaging a second protrusion extending from the filter cartridge against the grooved wall of the basket to further rotate the basket and move the cantilevered leg from engagement against the inwardly radially extending projection on the inner filter support.

88. A filter assembly comprising:

(a) a bowl including a surrounding wall defining an interior volume, an open mouth, and an end opposite of the mouth;

(i) the bowl end defining a drainage aperture in fluid communication with the interior volume;

(b) a filter cartridge removably oriented within the interior volume of the bowl; the filter cartridge including a tubular construction of filter media defining an open filter interior;

(c) a porous inner filter support oriented within the open filter interior; and

(d) a drain valve assembly including a plug moveably oriented between a sealed position and a drainage position;

(i) the sealed position including the plug blocking fluid flow between the interior volume of the bowl and the drainage aperture; and

(ii) the drainage position including the plug being oriented relative to the bowl to permit flow from the interior volume of the bowl through the drainage aperture;

(iii) the drain valve assembly including:

(A) a valve housing having a tubular wall; the plug being oriented within the tubular wall and being axially movable therewithin;

(B) a spring around the valve housing tubular wall and pushing against a portion of the plug;

(C) a first plug seal member secured to the plug and forming a first plug seal with the valve housing; the first plug seal preventing unfiltered fluid from bypassing the filter media and flowing into the open filter interior, when the plug is in the sealed position;

(D) a second plug seal member secured to the plug and forming a second plug seal with the valve housing; the second plug seal preventing fluid from flowing from the bowl through the drainage aperture;

(E) a first valve seal member secured to the valve housing and forming a first valve seal with a disk connected to the bowl; the first valve seal preventing unfiltered fluid from bypassing the filter media and flowing into the open filter interior; and

(F) a second valve seal member secured to the valve housing and forming a second valve seal with the bowl; the second valve seal preventing fluid from flowing from the bowl through the drainage aperture.

89. A filter assembly according to claim **88** further comprising:

(a) a core piece operably oriented within an interior of the porous inner filter support; the core piece including a post having a head movably oriented between an engaged position and a released position;

(i) the engaged position including the head being oriented against the plug to push the plug into the sealed position; and

(ii) the released position including the head being spaced away from the plug to allow the plug to move to the drainage position.

90. A filter assembly according to claim **89** wherein:

(a) the core piece further includes a fin arrangement; the head of the post includes a radial flange;

(b) the porous inner filter support further includes an inwardly extending support and a plurality of guide rails;

(i) the radial flange of the head is movably engaged against a lower surface of the support, when the head is in the released position;

(ii) the fin arrangement is slidably positioned within the plurality of guide rails; and

(c) the filter assembly further includes a core piece spring operably oriented between the fin arrangement and an upper surface of the support.

91. A filter assembly according to claim **89** wherein:

(a) the valve housing tubular wall defines an open slot arrangement allowing fluid flow therethrough.

92. A filter assembly according to claim **88** further comprising:

(a) a filter head selectively connectable to the bowl;

(i) the bowl and the filter head having mating structure permitting the bowl to be selectively removably attached to the filter head at the mouth.

93. A method for draining liquid from a filter assembly; the method comprising:

(a) at least partially unscrewing a bowl containing a filter cartridge from a filter head and permitting a spring mounted around a valve housing tubular wall to axially move a plug oriented within the valve housing tubular wall from a sealed position to a drainage position; the bowl having an interior volume and a fluid outlet port;

(i) the sealed position including:

(A) a first plug seal member secured to the plug and forming a first plug seal with the valve housing tubular wall; the first plug seal blocking fluid flow between the interior volume of the bowl and the fluid outlet port and by blocking fluid flow between an upstream side of the filter cartridge and a downstream side of the filter cartridge; and

(B) a second plug seal member secured to the plug and forming a second plug seal with the valve housing tubular wall; the second plug seal blocking fluid flow between the interior volume of the bowl and the fluid outlet port of the bowl;

(ii) the drainage position including the plug being oriented within the valve housing to permit fluid flow between the interior volume of the bowl and the fluid outlet port of the bowl.

94. A method according to claim **93** wherein:

(a) the step of partially unscrewing a bowl includes permitting a core piece spring to move a core piece having a head axially out of engagement with the plug, permitting a valve spring to move the plug from the sealed position to the drainage position.

95. A filter assembly comprising:

(a) a bowl including a surrounding wall defining an interior volume, an open mouth, and an end opposite of the mouth;

(b) a filter cartridge removably oriented within the interior volume of the bowl; the filter cartridge including a tubular construction of filter media defining an open filter interior;

(c) a porous inner filter support oriented within the open filter interior;

(d) a core piece operably oriented within an interior of the porous inner filter support; the core piece including a post; and

(e) a retention mechanism constructed and arranged to removably connect the filter cartridge to the post.

96. A filter assembly according to claim **95** wherein:

(a) the post defines a button at a free end thereof; and

(b) the retention mechanism includes a gripper arrangement and a release arrangement;

(i) the gripper arrangement holding the post at the button; and

(ii) the release arrangement being constructed and arranged such that upon squeezing the release arrangement, the gripper arrangement is disengaged from the post.

97. A filter assembly according to claim **96** wherein:

(a) the retention mechanism is part of an adapter ring located between the filter cartridge and the core piece.

98. A filter assembly according to claim **96** wherein:

(a) the retention mechanism is integral with an end cap of the filter cartridge.

99. A filter assembly according to claim **95** wherein:

(a) the core piece further includes a fin arrangement radially extending from the post; the post having a head at an end opposite of the button;

(b) the porous inner filter support further includes an inwardly extending support and a plurality of guide rails;

(i) head is movably engaged away from and against a lower surface of the support;

(ii) the fin arrangement is slidably positioned within the plurality of guide rails; and

(c) the filter assembly further includes a core piece spring operably oriented between the fin arrangement and an upper surface of the support to move the core axially within the porous inner filter support.

100. A method for servicing a filter system; the method comprising:

(a) removing a filter assembly, including a bowl containing a filter cartridge, from a filter head; and

(b) during the step of removing, retaining the filter cartridge to the bowl by gripping, with a pair of opposing fingers radially extending toward each other, a button on a core piece attached to the bowl.

101. An adapter ring for use with a filter bowl, the adapter ring comprising:

(a) a circular band defining an open aperture; the band having an outer radial surface and an inside radial surface; the inside radial surface defining an aperture wall;

(b) at least first and second protrusions extending from the aperture wall and into the open aperture; the at least first and second protrusions engaging a lock-out mechanism in a filter bowl, when the adapter ring is operably installed in the filter bowl;

(i) the first protrusion being spaced from the second protrusion in a vertical direction along the aperture wall;

(ii) the first protrusion being circumferentially spaced from the second protrusion along the aperture wall.

102. An adapter ring according to claim **101** wherein:

(a) the open aperture defines an inner diameter;

(b) the first protrusion extends into the open aperture no greater than 40% of the inner diameter of the open aperture;

(c) the second protrusion extends in the open aperture no greater than 40% of the inner diameter of the open aperture; and

(d) the vertical distance between the first and second protrusions is 2-30% of the inner diameter.

103. An adapter ring according to claim **102** further comprising:

(a) at least a third protrusion extending from the aperture wall and into the open aperture;

(i) the third protrusion being circumferentially spaced from the first protrusion and the second protrusion;

(ii) the third protrusion being vertically spaced from only one of either the first protrusion or the second protrusion.

104. A method of using an adapter ring to unlock a core piece and an inner filter support; the method comprising:

(a) orienting an adapter ring having at least first and second protrusions into a filter bowl having an open mouth;

(i) the filter bowl having an inner filter support mounted therein;

(ii) the filter bowl further having a core piece within the inner filter support; the core piece holding a basket having a grooved wall extending axially in a direction toward the open mouth of the bowl; the basket defining a central longitudinal axis; the basket being rotationally movable about the central longitudinal axis;

(iii) the core piece and the inner filter support engaging against each other as part of a lockout mechanism;

(b) while orienting, pushing the first protrusion against the grooved wall of the basket and then the second protrusion against the grooved wall of the basket to rotate the basket and disengage the core piece and the inner filter support; and

(c) after disengaging, axially moving the core piece relative to the inner filter support.

105. A method according to claim **104** further including:

(a) after the step of disengaging, operably installing a filter cartridge within the filter bowl; the filter cartridge having a tubular construction of filter media.

106. A filter assembly comprising:

(a) a bowl including a surrounding wall defining an interior volume, an open mouth, and an end opposite of the mouth;

(i) the bowl end defining a drainage aperture in fluid communication with the interior volume;

(b) a filter cartridge removably oriented within the interior volume of the bowl; the filter cartridge including a tubular construction of filter media defining an open filter interior;

(c) a porous inner filter support oriented within the open filter interior; the inner filter support having an inner wall and outer wall defining a spring-holding seat therebetween;

(d) a core piece operably oriented within an interior of the porous inner filter support; the core piece including a plug movably oriented between a sealed position and a drainage position within the drainage aperture of the bowl; the core piece including a center member having guide fins radially extending therefrom;

(e) a spring located in the spring-holding seat and a lower edge of the guide fins; the spring axially moving the core piece and plug from the sealed position and a drainage position;

(i) the sealed position including the plug blocking fluid flow between the interior volume of the bowl and the drainage aperture; and

(ii) the drainage position including the plug being oriented relative to the bowl to permit flow from the interior volume of the bowl through the drainage aperture.

107. A method for draining liquid from a filter assembly; the method comprising:

(a) at least partially unscrewing a bowl containing a filter cartridge from a filter head and permitting a spring to axially move a core piece having a plug from a sealed position to a drainage position; the bowl having an interior volume and a fluid outlet port; the spring being in a spring-holding seat between an inner filter support inner wall and outer wall and an edge of guide fins; the guide fins radially extending from a center member of the core piece;

(i) the sealed position including the plug blocking fluid flow between the interior volume of the bowl and the fluid outlet port by blocking flow through a section of the inner filter support; and

(ii) the drainage position including the plug being oriented relative to the inner filter support to permit flow through the section of the inner filter support, permitting fluid flow between the interior volume of the bowl and the fluid outlet port of the bowl.

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