(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 843 313 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.03.2015 Bulletin 2015/10

(51) Int Cl.:
F23R 3/60 *(2006.01)* ***F23R 3/46*** *(2006.01)*

(21) Application number: **14181178.6**

(22) Date of filing: **15.08.2014**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **27.08.2013 US 201314010638**

(71) Applicant: **General Electric Company**
Schenectady, New York 12345 (US)

(72) Inventors:
- **Bellino, Mark Carmine**
  Greenville
  South Carolina 29615 (US)
- **Reilly, Patrick Shawn**
  Greenville
  South Carolina 29615 (US)
- **Baummer, James Carroll**
  Greenville
  South Carolina 29615 (US)
- **Ostebee, Heath Michael**
  Greenville
  South Carolina 29615 (US)

(74) Representative: **Illingworth-Law, William**
Illingworth et al
Global Patent Operation - Europe
GE International Inc.
The Ark
201 Talgarth Road
Hammersmith
London W6 8BJ (GB)

(54) A method for removing an end cap of a combustor cap assembly

(57) A method 200 for removing an end cap assembly from a combustor cap assembly includes inserting 202 a push rod through an opening in a back plate portion of the cap assembly. One end of the push rod is engaged 204 with a radial support feature of the end cap assembly and a substantially linear force is applied 206 to the push rod. The force is distributed to the radial support feature, thereby preventing damage to a cap plate portion of the end cap assembly.

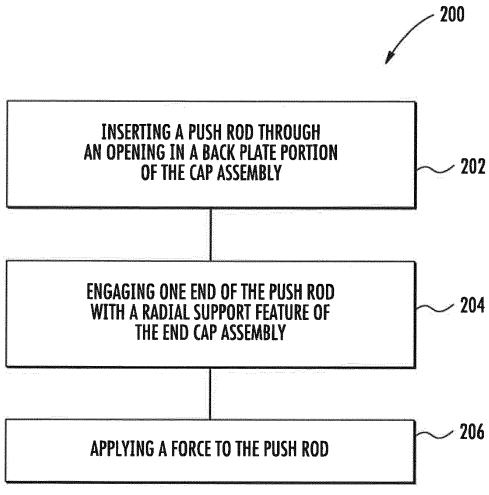

FIG. 14

EP 2 843 313 A1

Description

[0001] The present invention generally involves a cap assembly of a gas turbine combustor. More specifically, the invention relates to a method for removing an end cap assembly from the cap assembly for repair or replacement.

[0002] In particular gas turbine designs, a combustion section includes an outer casing and a plurality of combustors that is arranged in an annular array around the outer casing. Each combustor includes an end cover that is coupled to the outer casing and one or more axially extending fuel nozzles that extend inward from the end cover within the outer casing. Each combustor may also include an annular cap assembly that extends radially, circumferentially and axially within the outer casing. The fuel nozzles extend at least partially through one or more fuel nozzle passages that are defined within the cap assembly. The cap assembly may provide radial support for the fuel nozzles and/or may provide for mitigation of combustion dynamics.

[0003] A conventional cap assembly includes an outer barrel, an inner barrel assembly that is rigidly connected to the outer barrel, and an end cap assembly that is inserted into one end of the inner barrel assembly. The end cap assembly typically comprises an outer ring, a cap plate or effusion plate that extends radially and circumferentially around one end of the outer ring, and one or more axially extending fuel nozzle collars that each at least partially define the fuel nozzle passages of the cap assembly. A compression seal such as a spring or hula seal circumferentially surrounds the ring.

[0004] During assembly, the end cap assembly is pressed into the inner barrel assembly. The compression springs provide radial support to the end cap assembly and also may allow for thermal growth and/or relative movement between the inner barrel assembly and the end cap assembly during operation of the combustor. One or more mechanical fasteners such as rivets or bolts may extend between the inner barrel assembly and the ring of the end cap assembly to hold the end cap assembly in position. Over time, oxidation, thermal cycling and/or combustion dynamics may cause weakening and/or damage to the cap plate. As a result, the cap assembly must be removed from the combustor and the cap plate must be repaired or replaced.

[0005] Current methods for removing the end cap assembly from the inner barrel require disassembly of a major portion of the cap assembly. This process is complex and time consuming. In addition, known methods for removing the end cap assembly potentially result in damage such as deformation to or perforation of the cap plate, thus substantially increasing repair time and costs. Therefore, an improved method for removing the end cap assembly from the inner barrel which reduces repair time and decreases the potential for damage to the cap plate would be useful.

[0006] Aspects and advantages of the invention are set forth below in the following description, or may be obvious from the description, or may be learned through practice of the invention.

[0007] One embodiment of the present invention is a method for removing an end cap assembly from a combustor cap assembly. The method includes inserting a push rod through an opening in a back plate portion of the cap assembly, engaging one end of the push rod with a radial support feature of the end cap assembly and applying a force to the push rod.

[0008] Another embodiment of the present invention is a method for removing an end cap assembly from a combustor cap assembly. The method comprises inserting a plurality of push rods through a plurality of corresponding openings defined in a back plate of the cap assembly, engaging one end of each push rod with a radial support feature of the end cap assembly, mounting the cap assembly within a press and applying a force to the push rods via the press.

[0009] Another embodiment of the present invention includes a method for separating an end cap assembly from an inner barrel of a combustor cap assembly. The method comprises removing a plurality of mechanical fasteners that extend between the inner barrel and the end cap assembly, inserting a plurality of push rods through a corresponding plurality of openings defined within one or more retention plates of the cap assembly, engaging one end of each push rod with a radial support feature of the end cap assembly, positioning an outer barrel portion of the cap assembly atop one or more vertical supports and applying a force to the push rods.

[0010] Those of ordinary skill in the art will better appreciate the features and aspects of such embodiments, and others, upon review of the specification.

[0011] A full and enabling disclosure of the present invention, including the best mode thereof to one skilled in the art, is set forth more particularly in the remainder of the specification, including reference to the accompanying figures, in which:

FIG. 1 illustrates a perspective view of an exemplary cap assembly as may be found in a conventional combustor of a turbo-machine such as a gas turbine;

FIG. 2 illustrates an exploded perspective view of the cap assembly as shown in FIG. 1;

FIG. 3 provides a perspective view of a backside of an end cap assembly according to one embodiment of the present invention;

FIG. 3 provides a perspective view of a backside of an end cap assembly of the cap assembly as shown in FIGS. 1 and 2;

FIG. 4 provides an enlarged partial back side view of the cap assembly as shown in FIG. 1, according to one embodiment of the present invention;

FIG. 5 provides an assembled perspective view of the back side of the cap assembly as shown in FIG. 2, according to one embodiment of the present invention;

FIG. 6 provides a perspective cutaway view of the cap assembly as shown in FIG. 5;

FIG. 7 provides a perspective cutaway view of the cap assembly as shown in FIG. 6, according to one embodiment of the present invention;

FIG. 8 provides a perspective cutaway view of the cap assembly as shown in FIG. 6, according to one embodiment of the present invention;

FIG. 9 provides a perspective view of the cap assembly as shown in FIG. 8, according to one embodiment of the present invention;

FIG. 10 provides a perspective view of a push rod connected to an alignment plate according to one embodiment of the present invention;

FIG. 11 provides a perspective cutaway view of the cap assembly including the push rods and the alignment plate as shown in FIG. 10, according one embodiment of the present invention;

FIG. 12 provides a perspective cutaway view of the cap assembly as shown in FIG. 1, according to one embodiment of the present invention;

FIG. 13 provides a perspective view of a cap assembly mounted in an exemplary press, according to one embodiment of the present invention;

FIG. 14 illustrates a method for loosening and/or removing the end cap assembly from the cap assembly according to an exemplary embodiment of the present subject matter;

FIG. 15 illustrates a method for loosening and/or removing the end cap assembly from the cap assembly according to an exemplary embodiment of the present subject matter; and

FIG. 16 illustrates a method for loosening and/or removing the end cap assembly from the cap assembly according to an exemplary embodiment of the present subject matter.

[0012] Reference will now be made in detail to present embodiments of the invention, one or more examples of which are illustrated in the accompanying drawings. The detailed description uses numerical and letter designations to refer to features in the drawings. Like or similar designations in the drawings and description have been used to refer to like or similar parts of the invention. As used herein, the term "radially" refers to the relative direction that is substantially perpendicular to an axial centerline of a particular component, and the term "axially" refers to the relative direction that is substantially parallel to an axial centerline of a particular component.

[0013] Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that modifications and variations can be made in the present invention without departing from the scope thereof. For instance, features or steps illustrated or described as part of one embodiment may be used on another embodiment or in another step to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

[0014] Certain gas turbine combustors include one or more axially extending fuel nozzles that extend downstream from an end cover. The fuel nozzles are cantilevered to the end cover at one end and extend at least partially through a cap assembly that is disposed within the combustor. The cap assembly extends radially, circumferentially and axially within the combustor. Typically, the cap assembly provides radial support to the cantilevered fuel nozzles and may also help control combustion dynamics within the combustor. An exemplary cap assembly may include multiple subassemblies including an outer barrel assembly, an inner barrel assembly and an end cap assembly which includes a cap plate. The end cap assembly is positioned generally adjacent to an outlet end of the fuel nozzles.

[0015] In operation, fuel is injected into the combustor from the outlet end of the fuel nozzle where it is mixed with air and burned proximate to the cap plate of the end cap assembly. As a result, the cap plate is exposed to high thermal stresses caused by the combustion flame. In addition, the cap plate may be exposed to large mechanical stresses typically caused by combustor dynamics. Consequently, the cap plate may develop cracks or other damage which requires repair or replacement of the component. In order to repair the cap plate, the end cap assembly must be removed from the cap assembly. However, various factors such as oxidation and/or material deformation create challenges to separating the end cap assembly from the cap assembly without damaging the cap plate. Therefore, an improved method for removing the end cap assembly from the cap assembly and/or the inner barrel assembly which avoids damage to the cap plate is provided herein.

[0016] Referring now to the drawings, wherein like numerals refer to like components, FIG. 1 illustrates a perspective view of an exemplary cap assembly 10 as may be found in a conventional combustor of a turbo-machine such as a gas turbine, and FIG. 2 provides an exploded perspective view of the cap assembly 10 as shown in FIG. 1. As shown in FIGS. 1 and 2, the cap assembly 10 generally includes an outer barrel 12, an inner barrel as-

sembly 14 that is rigidly connected to the outer barrel 12 via one or more struts 16, and an end cap assembly 18 that is inserted into a forward end portion 20 of the inner barrel assembly 14. The outer barrel 12 is typically coupled to an outer casing (not shown) that surrounds the combustor.

[0017] FIG. 3 provides a perspective view of a backside of the end cap assembly 18 as shown in FIGS. 1 and 2. As shown in FIGS. 2 and 3, the end cap assembly 18 generally includes an outer ring or band 22. As shown in FIGS. 1 and 2, a cap plate or effusion plate 24 extends radially and circumferentially around one end of the outer band 22. The cap plate 24 may at least partially define a plurality of cooling passages (not shown). In particular designs, as shown in FIGS. 1 and 2 the cap plate 24 at least partially defines one or more fuel nozzle passages 26. As shown in FIGS. 1, 2 and 3, the end cap assembly 18 may further include one or more fuel nozzle sleeves 28. As shown in FIGS. 1 and 2, the fuel nozzle sleeves 28 are substantially coaxially aligned with the one or more fuel nozzle passages 26.

[0018] As shown in FIG. 2, a compression seal 30 such as a spring or hula seal circumferentially surrounds the outer band 22. Generally, the compression seal 30 provides radial support for the end cap assembly 18 during and/or after insertion into the end portion 20 of the inner barrel assembly 14 while allowing for relative movement and/or thermal growth between the end cap assembly 18 and the inner barrel assembly 14 during operation of the combustor.

[0019] As shown in FIG. 2, a plurality of radially extending retention holes 32 may be defined in the outer band 22. The retention holes 32 may generally align with a plurality of complementary retention holes 34 (FIG. 1) defined by an outer ring 36 of the inner barrel assembly 14. As shown in FIGS. 1 and 2, a plurality of mechanical fasteners 38 such as rivets or bolts may be inserted through the retention holes 32, 34 (FIG. 1) so as to fix the end cap assembly 18 to the inner barrel assembly 14.

[0020] In particular embodiments, as shown in FIG. 3, the end cap assembly 18 includes a radial support feature 40. In one embodiment, the radial support feature 40 includes an inner ring 42 and a plurality of support members or arms 44 that extend radially between the inner ring 42 and the outer band 22. In particular configurations, the support members 44 extend between the inner ring 42 and an outer ring 46 that is disposed along an inside wall of the outer band 22. The support members 44 may be disposed between adjacent fuel nozzle sleeves 28. The radial support feature 40 generally provides structural support to the end cap assembly 18 to prevent and/or reduce undesirable deformation of the end cap assembly 18 during operation of the combustor.

[0021] Referring back to FIG. 2, the cap assembly 10 includes a back plate 48 and a plurality of fuel nozzle collars 50 that extend through the back plate 48. The fuel nozzle collars 50 are substantially coaxially aligned with the fuel nozzle sleeves 28 of the end cap assembly 18. In particular designs, one or more retention plates 52 may be bolted, welded or otherwise mechanically connected to the back plate 48 to hold the fuel nozzle collars 50 in position. In other designs, the back plate 48 may hold the fuel nozzle collars 50 in position.

[0022] As shown in FIG. 2, one or more openings 54 may extend through each or some of the retention plates 52 and/or through the back plate 48. The openings 54 may be provided prior to assembly of the cap assembly 10. In other embodiments, the openings 54 may be machined, cut or formed in each or some of the retention plates 52 and/or the back plate 48 post assembly of the cap assembly 10 so as to facilitate disassembly of the cap assembly 10.

[0023] FIG. 4 provides an enlarged partial view of the back side of the cap assembly 10 according to one embodiment, and FIG. 5 provides an assembled perspective view of the backside of the cap assembly 10 as shown in FIG. 2, according to one embodiment of the present invention. As shown in FIG. 4, at least some of the openings 54 may include threads 55. The threads 55 may be cut into the one or both of the retention plates 52 and/or the back plate 48. In other embodiments, the threads 55 may be provided by an insert (not shown) that is seated within the opening 54. In other embodiments, the threads 55 may be provided by a fastener such as a nut that has been affixed to the retention plates 52 and/or the back plate 48. In certain configurations, as shown in FIGS. 2 and 5, a plurality of mechanical fasteners or plugs 56 such as rivets or bolts may be used to seal the openings 54 during operation of the combustor.

[0024] FIG. 6 provides a perspective cutaway view of the cap assembly 10 as shown in FIG. 5 with the openings 54 extending through the retaining plates 52 and the back plate 48. As shown in FIG. 6, the openings 54 are generally aligned with at least a portion of the radial support feature 40. For example, in particular embodiments, each of the openings 54 are aligned with a corresponding support member 44.

[0025] FIG. 6 also illustrates a portion of a system 100 for loosening and/or separating the end cap assembly 18 from the inner barrel assembly 14 and/or the cap assembly 10, according to one embodiment of the present subject matter. As shown in FIG. 6, the system 100 generally includes one or more push rods or pins 102 that extend through the openings 54 and engage with the radial support feature 40 of the end cap assembly 18. In one embodiment, one end of each push rod 102 is aligned with a corresponding support member 44 of the radial support feature 40. As shown, the push rods 102 are of a sufficient length so as to engage with the radial support feature 40 while extending through the inner barrel assembly 14 and outward through the back plate 48 and/or the retention plates 52 a sufficient distance so as to provide clearance with respect to the fuel nozzle collars 50.

[0026] In particular embodiments, as shown in FIG. 6, a substantially linear force F may be applied to each push rod 102 so as to loosen and/or remove the end cap as-

sembly 18 from the inner barrel assembly 14, as illustrated in FIG. 7. In particular embodiments, the force F may be applied via a manual tool such as a mallet (not shown) or the like. Because the force F is directed into the support member 44 of the radial support feature 40, damage to the cap plate 24 is avoided. In one embodiment, the force F may be applied to a single push rod 102 which is interchanged between the various openings to loosen and/or remove the end cap assembly 18 from the inner barrel assembly 14. For example, a single push rod 102 may be inserted into one of the openings 54 and the force applied by a hammer or other tool. The push rod 102 may then be interchanged between the various openings 54 until the end cap assembly 18 is loose or removed from the cap assembly 10.

[0027] FIG. 8 provides a perspective cutaway view of the cap assembly 10 as shown in FIG. 6, according to one embodiment of the present invention. As shown in FIG. 8, at least some of the push rods 102 may include threads 103. The threads 103 may be complementary to the threads 55 disposed at and/or in the openings 54. In this manner, the push rods 102 may be threaded into the openings 54 until the one end of each of the push rods 102 engages with a corresponding portion of the radial support feature 40 such as one or more of the support members 44. In this embodiment, as shown in FIG. 9, the force F may be provided by applying torque T to turn the push rods 102 towards the end cap assembly 10, thus loosening and/or removing the end cap assembly from the cap assembly.

[0028] FIG. 10 provides a perspective view of the push rods 102 connected to an alignment plate 104 according to one embodiment of the present subject matter. The alignment plate 104 may assure proper alignment of each push rod 102 with a corresponding opening 54 and may improve overall repair time. Although the alignment plate 104 is illustrated as a singular circular component, it should be known that the alignment plate 104 may have any shape and may comprise of multiple plates coupled together. For example, the alignment plate 104 may be triangular, square, rectangular, or oval shaped. In particular embodiments, the alignment plate 104 may be configured for coupling to a press.

[0029] FIG. 11 provides a perspective cutaway view of the cap assembly 10 including the push rods 102 and the alignment plate 104. As shown, a substantially linear force F may be applied to the alignment plate 104 so as to loosen and/or remove the end cap assembly 18 from the inner barrel assembly 14. The alignment plate 104 also may provide a substantially even distribution of the force F and may improve the time required to separate the end cap assembly 18 from the cap assembly 10.

[0030] FIG. 12 provides a perspective cutaway view of the cap assembly 10 according to one embodiment of the present invention. Once the push rods 102 have been inserted into the openings 54, the cap assembly 10 may be placed in an orientation such that the push rods 102 and/or the alignment plate 104 are in contact with a surface 106 such as a work bench, floor, repair fixture or the like. In this manner, the force F may be applied to the push rods 102 by providing an opposing or opposite force OF to at least one of the outer barrel 12 and the inner barrel assembly 14 so as to loosen and/or remove the end cap assembly 18 from the inner barrel assembly 14.

[0031] FIG. 13 provides a perspective view of the cap assembly 10 including the push rods 102 and the alignment plate 104 mounted in an exemplary press 106, according to one embodiment of the present subject matter. As shown in FIG. 13, the system 100 may include a press 106. The press 106 may be manually operated or automated. The press 106 may be a pneumatic, hydraulic, electric or any other type of press that is capable of providing the substantially liner force F to the push rods 102 and/or the alignment plate 104.

[0032] As shown in FIG. 13, the system 100 may include one or more vertical supports 108. The vertical supports 108 may be placed under the cap assembly 10 during removal of the end cap assembly 18 to provide clearance for the end cap assembly 10 to translate out of the inner barrel 18 assembly. For example, the vertical supports 108 may be positioned in an annular array under the outer barrel 12.

[0033] The system 100 shown and described herein with respect to FIGS. 6, 7, 8, 9, 10, 11, 12 and 13 provides a method for loosening and/or removing the end cap assembly 18 from the cap assembly 10 as illustrated in FIGS. 1, 2, 3, 4 and 5. For example, FIG. 14 illustrates a method 200 for loosening and/or removing the end cap assembly 18 from the cap assembly 10 according to an exemplary embodiment of the present subject matter.

[0034] At step 202, the method 200 includes inserting at least one of the push rods 102 through a corresponding one of the openings 54 in the back plate portion 48 of the cap assembly 10. Step 202 may further comprise boring the opening into the back plate 48 and/or the retention plate 52 prior to inserting the push rod 102 through the opening 54. Step 202 also may include removing a mechanical fastener 56 from the opening 54 prior to inserting the push rod 102. Step 202 also may include coupling the push rod 102 to the alignment plate 104 prior to or after inserting the push rod 102 through the opening 54. Step 202 also may include threading the push rod 102 into the opening 54.

[0035] At step 204, the method 200 includes engaging one end of the push rod 102 with the radial support feature 40 of the end cap assembly 18. For example, step 204 may include aligning and/or engaging the one end of the push rod 102 with one of the support members 44 such that the push rod 102 does not engage and/or otherwise interact with the cap plate 24.

[0036] At step 206, the method 200 includes applying force F to the push rod 102. The force F is generally sufficient to loosen and/or completely remove the end cap assembly 18 from the cap assembly 10. In particular embodiments, the force F may be applied via the press 106 and/or via a manual tool such as a mallet or the like.

The force F is transferred to through the push rod 102 to the radial support feature 40, thereby preventing deformation and/or damage to the cap plate 24 during disassembly. The force F also may be applied by providing an opposing or opposite force OF to at least one of the inner barrel assembly 14 or the outer barrel 12. In particular embodiments, the method 200 also includes removing the plurality of mechanical fasteners 38 that extend radially between the inner barrel 14 of the cap assembly 10 and the end cap assembly 18 prior to applying the force F to the push rod 102.

[0037] FIG. 15 illustrates a method 300 for loosening and/or removing the end cap assembly 18 from the cap assembly 10 according to another exemplary embodiment of the present subject matter. As shown at step 302, the method 300 includes inserting a plurality of the push rods 102 through a plurality of corresponding openings 54 defined in the back plate 48 of the cap assembly 10. In addition or in the alternative, the openings 54 may be defined within the retention plates 52. Step 302 may further comprise boring the openings into the back plate 48 prior to inserting the push rods 102. In addition, step 302 may include removing a plurality of mechanical fasteners 56 from each or some of the openings 54 prior to inserting the push rods 102. Step 302 also may include coupling the push rods 102 to the alignment plate 104 prior to or after inserting the push rods 102 through the openings 54.

[0038] At step 304, the method 300 includes engaging one end of each push rod 102 with the radial support feature 40 of the end cap assembly 18. For example, step 304 may include aligning and/or engaging the one end of each of the push rods 102 with one of the support members 44 such that the push rods 102 do not engage and/or otherwise interact with the cap plate 24.

[0039] At step 306, the method 300 includes mounting and/or positioning the cap assembly 10 within the press 106. Step 306 also may include positioning the outer barrel 12 of the cap assembly 10 atop the vertical supports 108.

[0040] At step 308, the method 300 includes applying the force F to the push rods 102 via the press. The force F may be provided by applying an opposing force via the press 106 to at least one of the outer barrel 12 or the inner barrel assembly 14 of the cap assembly 10. Step 308 may further include removing the plurality of mechanical fasteners 38 that extend radially between an inner barrel assembly 14 and the end cap assembly 18 prior to applying the force F to the push rods 102. The force F may be applied to the push rods via the alignment plate 104.

[0041] FIG. 16 illustrates a method 400 for loosening and/or removing the end cap assembly 18 from the inner barrel assembly 14 and/or the cap assembly 10 according to another exemplary embodiment of the present subject matter. As shown at step 402, the method 400 includes removing the plurality of mechanical fasteners 38 that extend between the inner barrel assembly 14 and the end cap assembly 18. The mechanical fasteners 38 may be removed by cutting, prying or any other suitable method. Step 402 may further comprise boring the openings 54 into the retention plates 52 and/or the back plate 48. Step 402 also may include removing the plurality of mechanical fasteners 56 from each or some of the openings 54. The mechanical fasteners 56 may be removed by cutting, prying or any other suitable method.

[0042] At step 404, the method 400 includes inserting a plurality of the push rods 102 through a corresponding plurality of the openings 54 defined within one or more of the retention plates 52 and/or the back plate 48 of the cap assembly 10. Step 404 also may include threading the push rods 102 into the openings 54. Step 404 also may include coupling the push rods 102 to the alignment plate 104 prior to or after inserting the push rods 102 through the openings 54.

[0043] At step 406, the method 400 includes engaging one end of each push rod 102 with the radial support feature 40 of the end cap assembly 10. For example, step 406 may include aligning and/or engaging the one end of each of the push rods 102 with one of the support members 44 such that the push rods 102 do not engage and/or otherwise interact with the cap plate 24.

[0044] At step 408, the method 400 includes positioning the outer barrel 12 of the cap assembly 10 atop one or more of the vertical supports 108 to provide clearance for the end cap assembly 18 to translate out of the inner barrel assembly 14.

[0045] At step 410, the method 400 includes applying a force F to the push rods. The force F is generally sufficient to loosen and/or completely remove the end cap assembly 18 from the cap assembly 10. In particular embodiments, the force F may be applied via a manual tool such as a mallet or the like. In particular embodiments, the force F is applied to the push rods by applying torque to the push rods. The force F is transferred to through the push rod 102 to the radial support feature 40, thereby preventing deformation and/or damage to the cap plate 24 during disassembly.

[0046] In addition, method 400 may further include positioning the cap assembly 10 within the press 106 and applying the force F via the press 106. Again, the force F is transferred to through the push rod 102 to the radial support feature 40, thereby preventing deformation and/or damage to the cap plate 24 during disassembly.

[0047] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they include structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the

claims.

[0048] Various aspects and embodiments of the present invention are defined by the following numbered clauses:

1. A method for removing an end cap assembly from a combustor cap assembly, comprising:

a. inserting a push rod through an opening in a back plate portion of the cap assembly;

b. engaging one end of the push rod with a radial support feature of the end cap assembly; and

c. applying a force to the push rod.

2. The method as in clause 1, wherein the push rod is threaded, the method further comprising threading the push rod into the opening until the one end of the push rod engages with the radial support feature.

3. The method as in any preceding clause, wherein the step of applying a force to the push rod further comprises applying torque to the push rod.

4. The method as in any preceding clause, wherein the step of applying a force to the push rod includes providing an opposing force to at least one of an outer barrel assembly or an inner barrel assembly of the cap assembly.

5. The method as in any preceding clause, further comprising removing a mechanical fastener from the opening prior to inserting the push rod through the opening.

6. The method as in any preceding clause, further comprising removing a plurality of mechanical fasteners that extend radially between an inner barrel of the cap assembly and the end cap assembly prior to applying the force to the push rod.

7. The method as in any preceding clause, further comprising coupling the push rod to an alignment plate.

8. A method for removing an end cap assembly from a combustor cap assembly, comprising:

a. inserting a plurality of push rods through a plurality of corresponding openings defined in a back plate of the cap assembly;

b. engaging one end of each push rod with a radial support feature of the end cap assembly;

c. mounting the cap assembly within a press; and

d. applying a force to the push rods via the press.

9. The method as in any preceding clause, further comprising boring the openings into the back plate prior to inserting the plurality of push rods through the plurality of openings.

10. The method as in any preceding clause, further comprising removing a fastener from each of the openings prior to inserting the plurality of push rods through the openings.

11. The method as in any preceding clause, wherein the step of applying a force to the push rods includes providing an opposing force via the press to at least one of an outer barrel assembly or an inner barrel assembly of the cap assembly.

12. The method as in any preceding clause, further comprising positioning an outer barrel of the cap assembly on a vertical support.

13. The method as in any preceding clause, further comprising coupling the push rods to an alignment plate, wherein the force is applied to the push rods via the alignment plate.

14. A method for separating an end cap assembly from an inner barrel of a combustor cap assembly, comprising:

a. removing a plurality of mechanical fasteners that extend between the inner barrel and the end cap assembly;

b. inserting a plurality of push rods through a corresponding plurality of openings defined within one or more retention plates of the cap assembly;

c. engaging one end of each push rod with a radial support feature of the end cap assembly;

d. positioning an outer barrel portion of the cap assembly atop one or more vertical supports; and

e. applying a force to the push rods.

15. The method as in any preceding clause, wherein the push rods are threaded, the method further comprising threading the push rods into the openings until the one end of each push rod engages with the radial support feature.

16. The method as in any preceding clause, wherein the step of applying a force to the push rods further comprises applying torque to the push rods.

17. The method as in any preceding clause, further comprising coupling the push rod to an alignment plate.

18. The method as in any preceding clause, wherein the force is applied to the push rods via the alignment plate.

19. The method as in any preceding clause, further comprising positioning the cap assembly within a press, wherein the force is applied to the push rods via the press.

20. The method as in any preceding clause, wherein the force is applied to the push rods via a manual tool.

Claims

1. A method (200) for removing an end cap assembly from a combustor cap assembly, comprising:

   inserting (202) a push rod through an opening in a back plate portion of the cap assembly;
   engaging (204) one end of the push rod with a radial support feature of the end cap assembly; and
   applying (206) a force to the push rod.

2. The method as in claim 1, wherein the push rod is threaded, the method further comprising threading the push rod into the opening until the one end of the push rod engages with the radial support feature.

3. The method as in claim 2, wherein the step of applying (206) a force to the push rod further comprises applying torque to the push rod.

4. The method as in claim 1, 2 or 3, wherein the step of applying (206) a force to the push rod includes providing an opposing force to at least one of an outer barrel assembly or an inner barrel assembly of the cap assembly.

5. The method as in any preceding claim, further comprising at least one of:

   removing a mechanical fastener from the opening prior to inserting the push rod through the opening;
   removing a plurality of mechanical fasteners that extend radially between an inner barrel of the cap assembly and the end cap assembly prior to applying the force to the push rod;
   coupling the push rod to an alignment plate, and

6. The method as in claim 1, comprising:

   inserting (302) a plurality of push rods through a plurality of corresponding openings defined in a back plate of the cap assembly;
   engaging (304) one end of each push rod with a radial support feature of the end cap assembly;
   mounting (306) the cap assembly within a press; and
   applying (308) a force to the push rods via the press.

7. The method as in claim 6, further comprising:

   boring the openings into the back plate prior to inserting the plurality of push rods through the plurality of openings, and/or
   removing a fastener from each of the openings prior to inserting the plurality of push rods through the openings.

8. The method as in claim 6 or claim 7, wherein the step of applying (308) a force to the push rods includes providing an opposing force via the press to at least one of an outer barrel assembly or an inner barrel assembly of the cap assembly.

9. The method as in claim 6, 7 or 8, further comprising:

   positioning an outer barrel of the cap assembly on a vertical support, and/or
   coupling the push rods to an alignment plate, wherein the force is applied to the push rods via the alignment plate.

10. A method (400) for separating an end cap assembly from an inner barrel of a combustor cap assembly, comprising:

    removing (402) a plurality of mechanical fasteners that extend between the inner barrel and the end cap assembly;
    inserting (404) a plurality of push rods through a corresponding plurality of openings defined within one or more retention plates of the cap assembly;
    engaging (406) one end of each push rod with a radial support feature of the end cap assembly;
    positioning (408) an outer barrel portion of the cap assembly atop one or more vertical supports; and
    applying (410) a force to the push rods.

11. The method as in claim 10, wherein the push rods are threaded, the method further comprising threading the push rods into the openings until the one end of each push rod engages with the radial support feature.

12. The method as in claim 11, wherein the step of ap-

plying (410) a force to the push rods further comprises applying torque to the push rods.

13. The method as in claim 10, 11 or 12, further comprising coupling the push rod to an alignment plate, wherein, preferably, the force is applied to the push rods via the alignment plate.

14. The method as in any one of claims 10 to 13, further comprising positioning the cap assembly within a press, wherein the force is applied to the push rods via the press.

15. The method as in any one of claims 10 to 14, wherein the force is applied to the push rods via a manual tool.

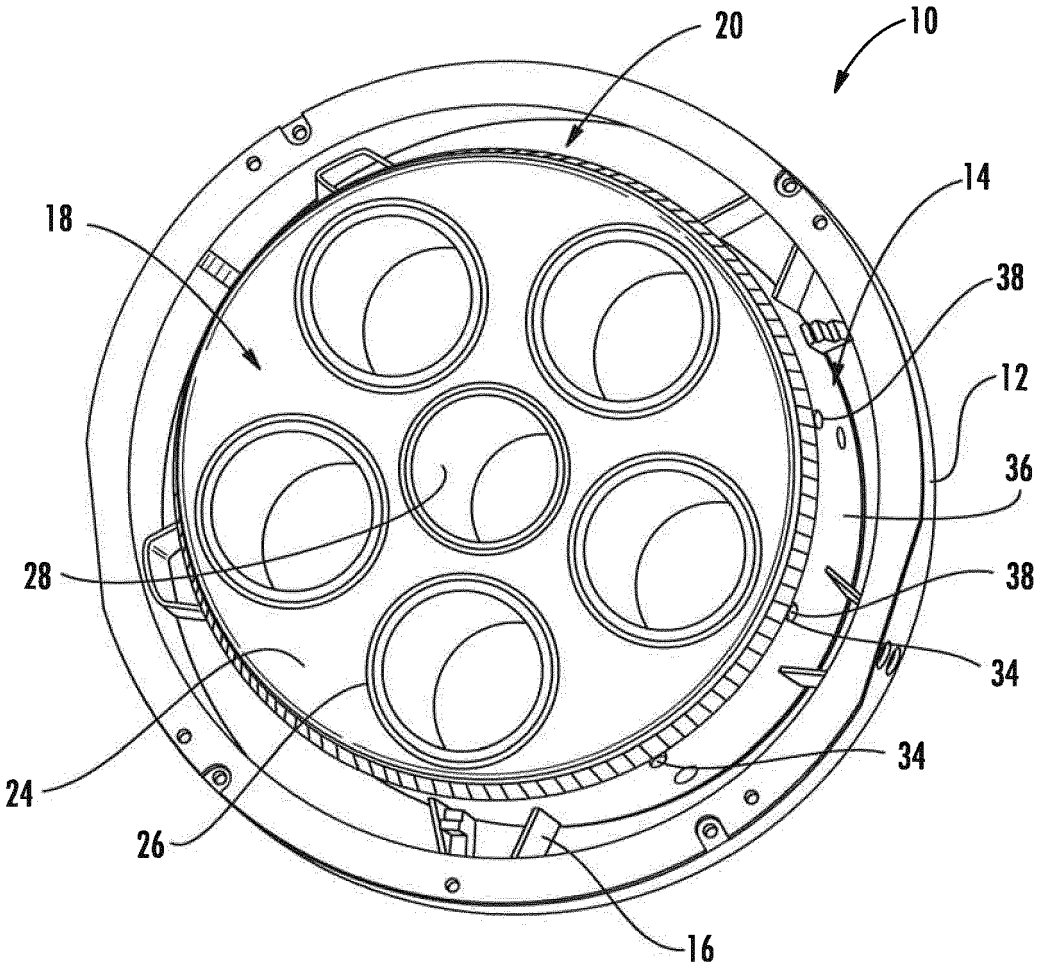

FIG. 1

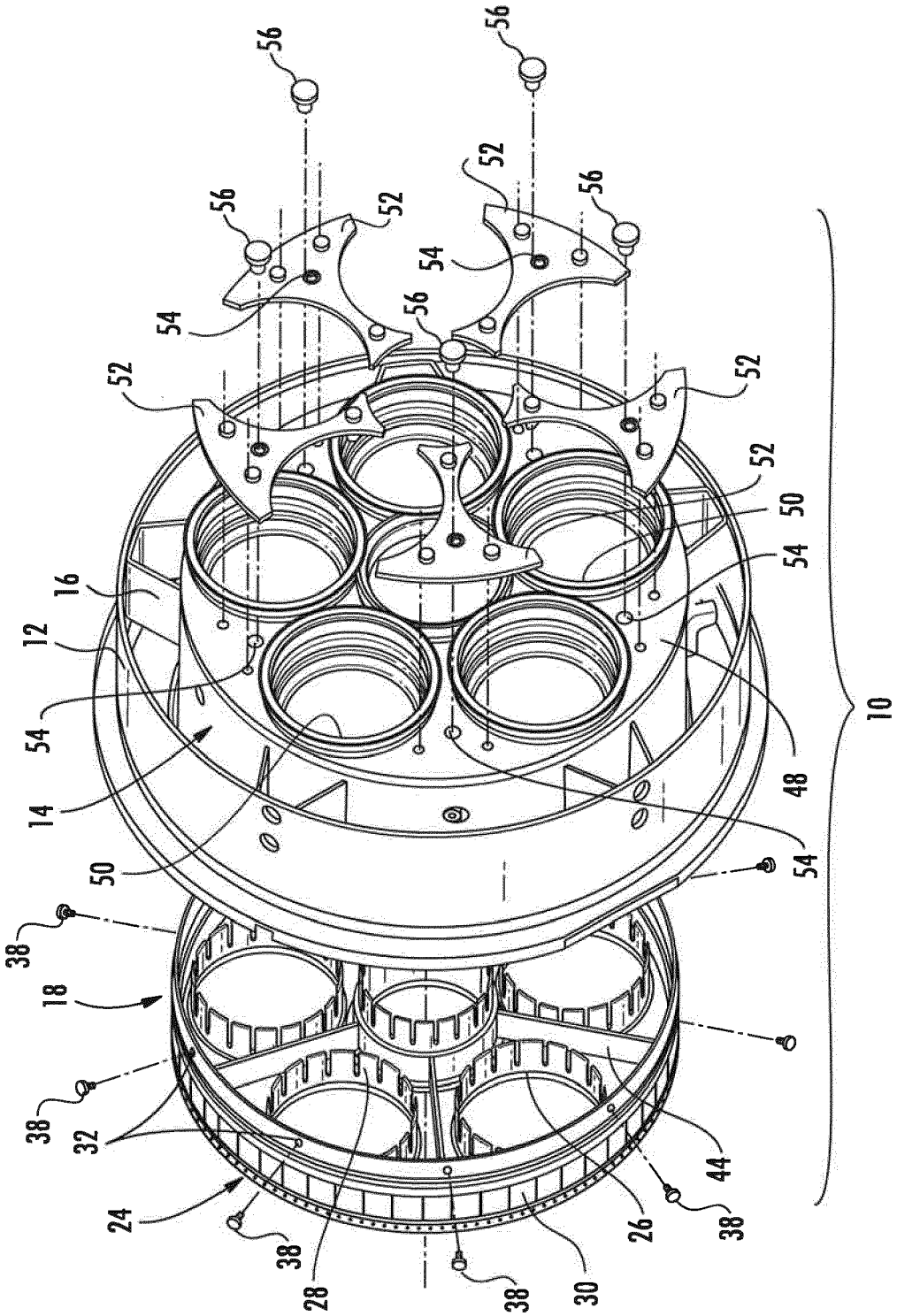

FIG. 2

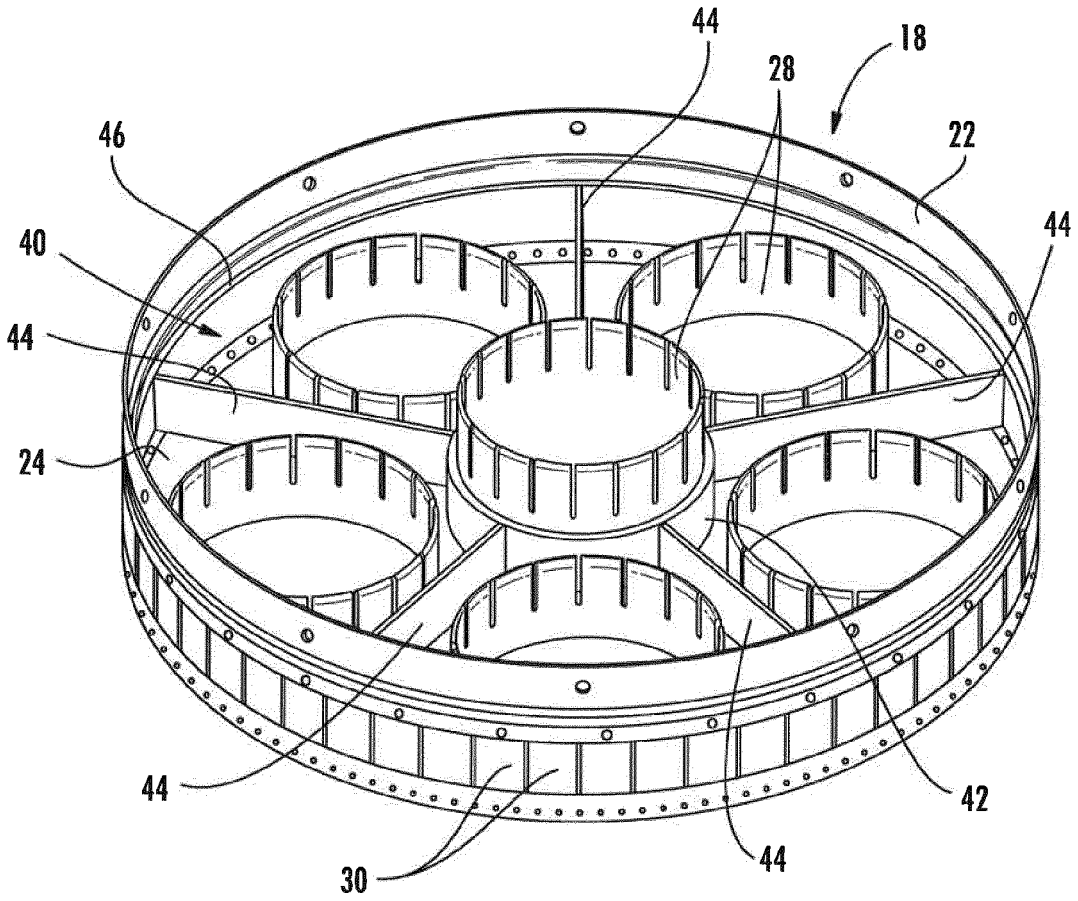

FIG. 3

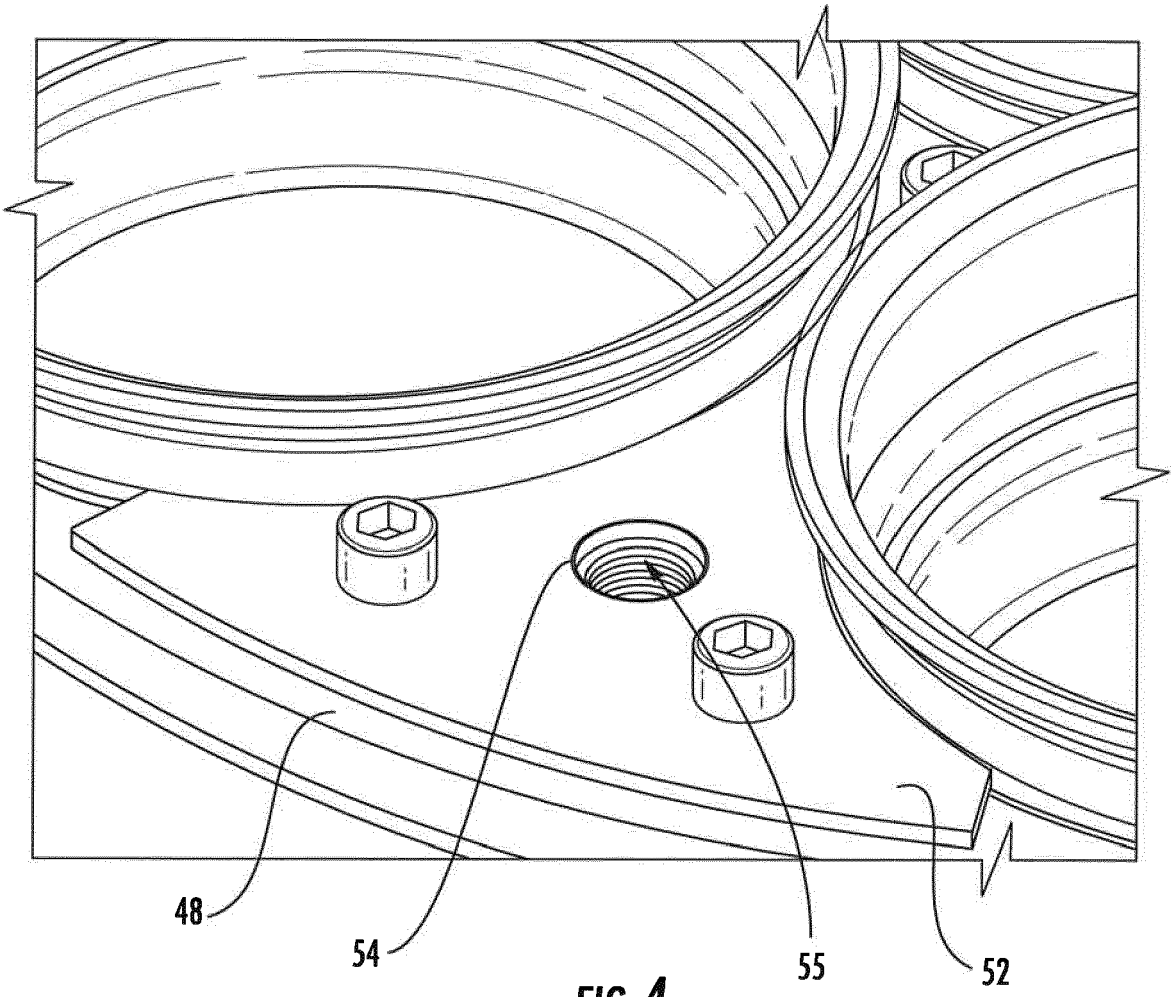

FIG. 4

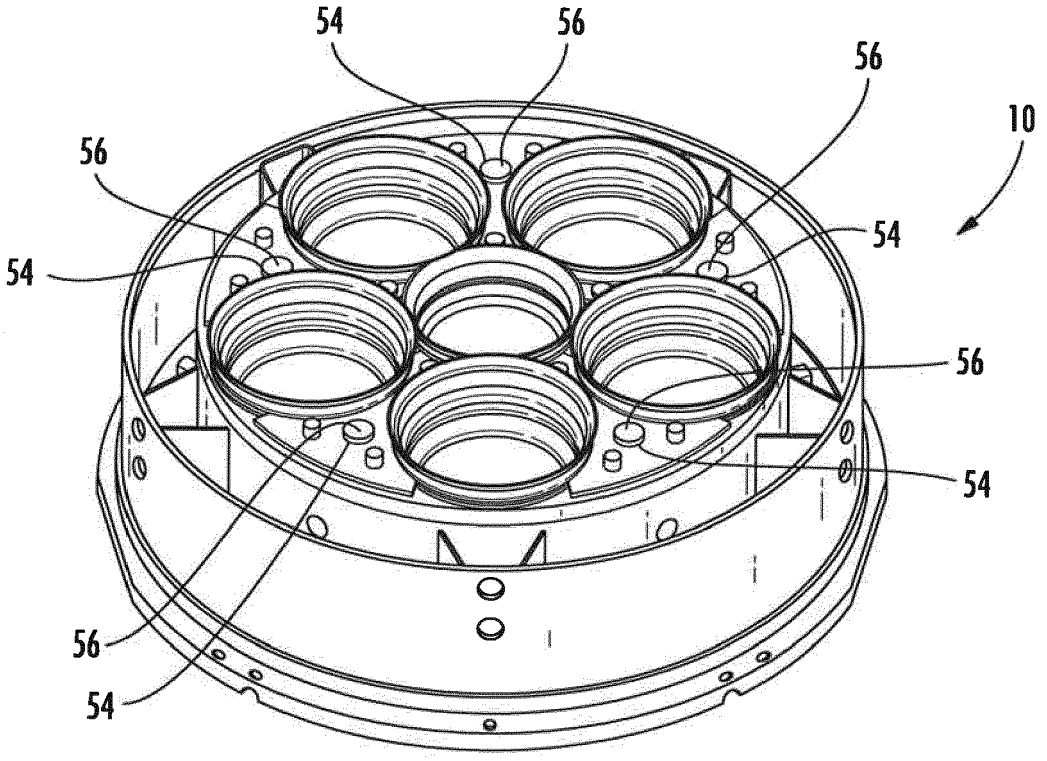

FIG. 5

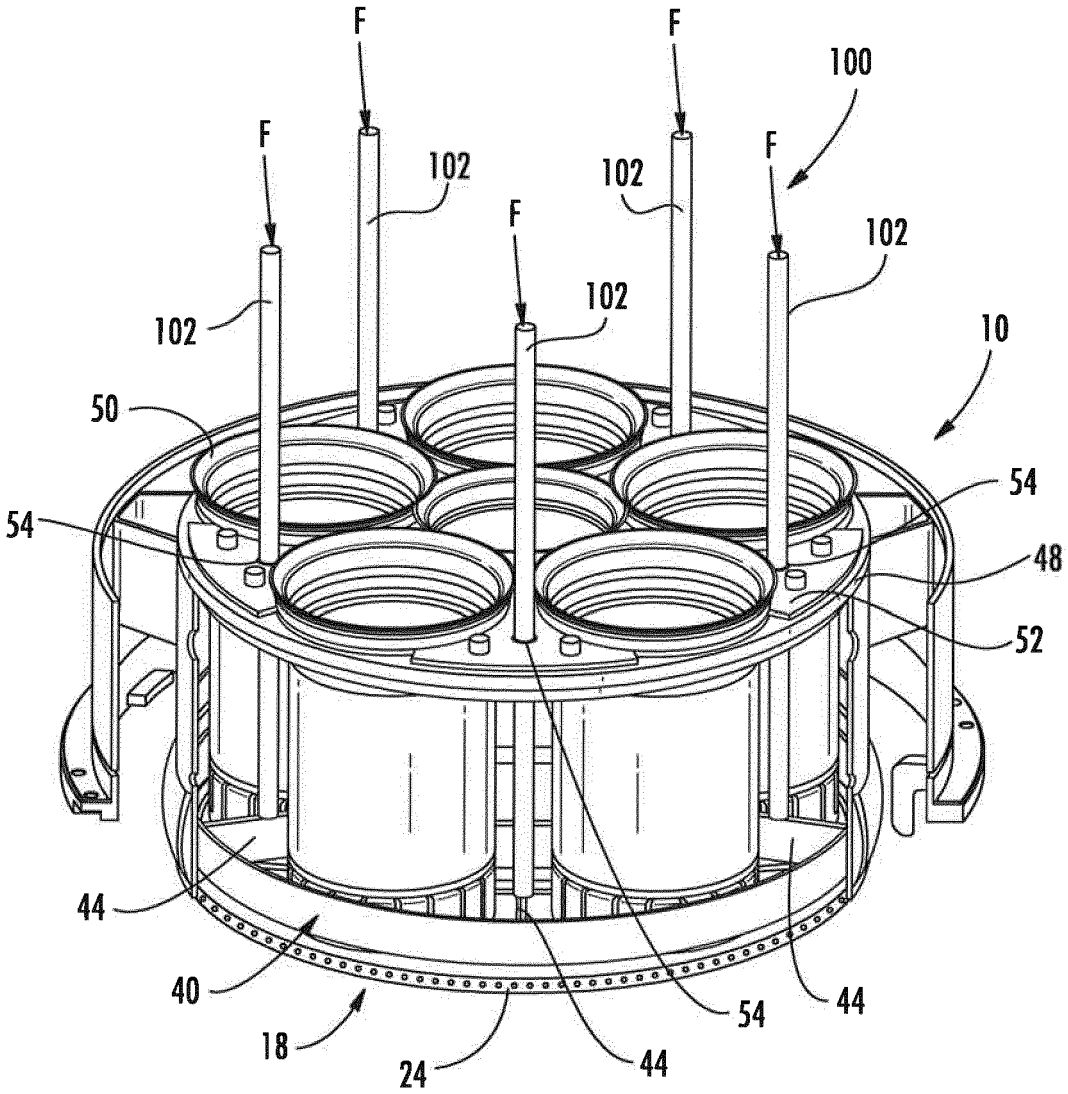

FIG. 6

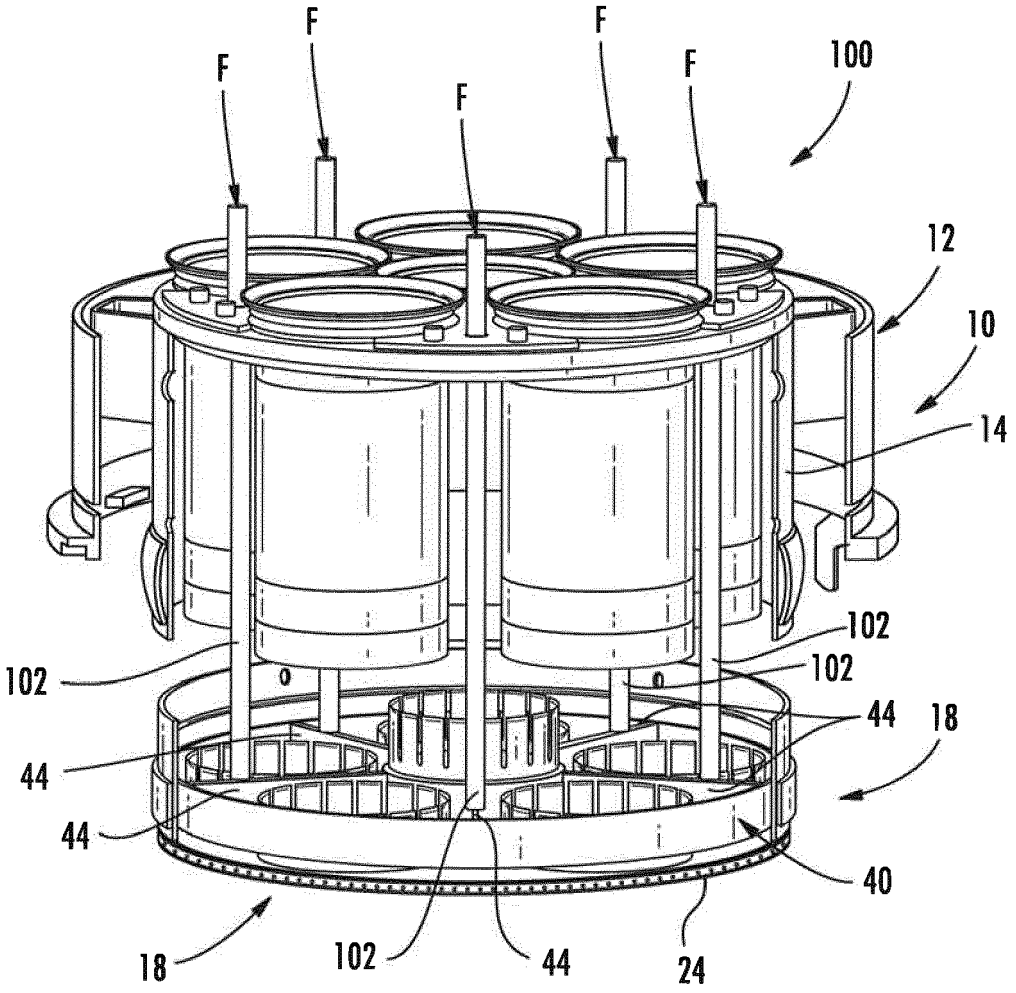

FIG. 7

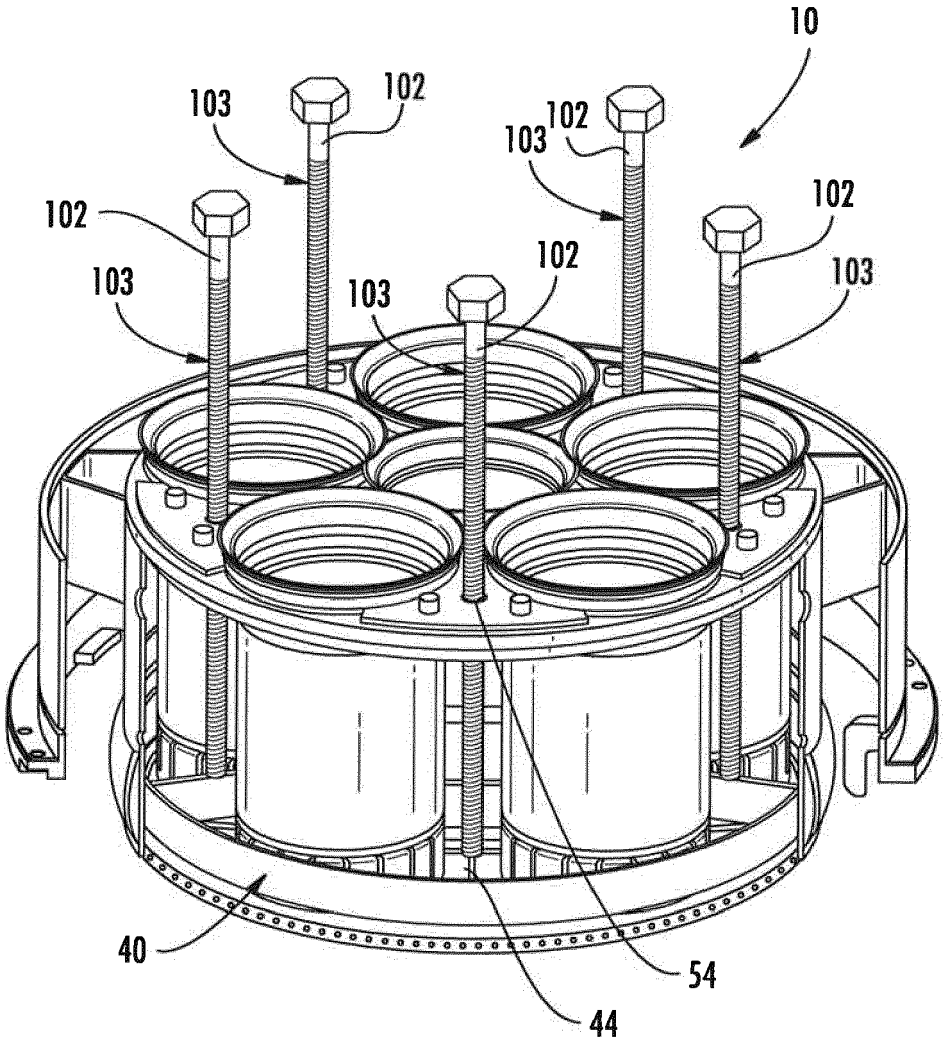

FIG. 8

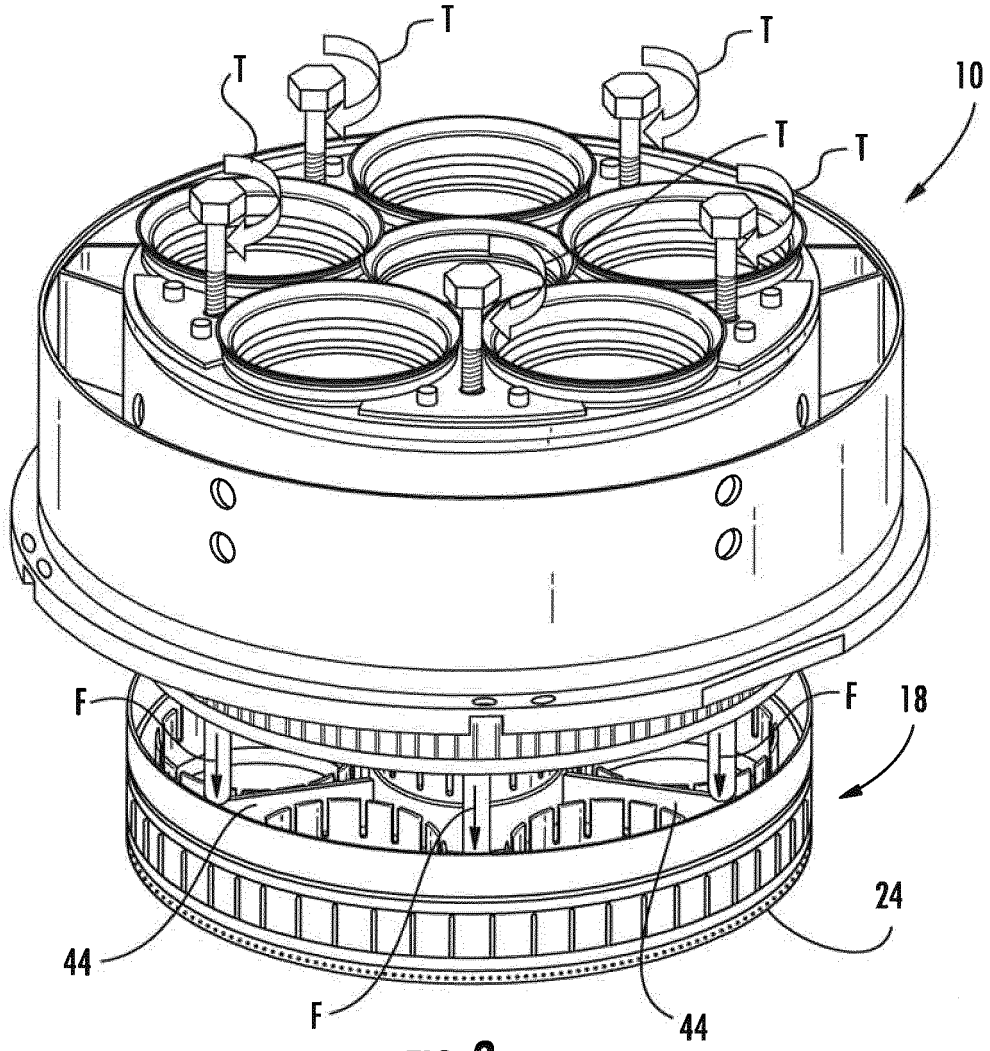

FIG. 9

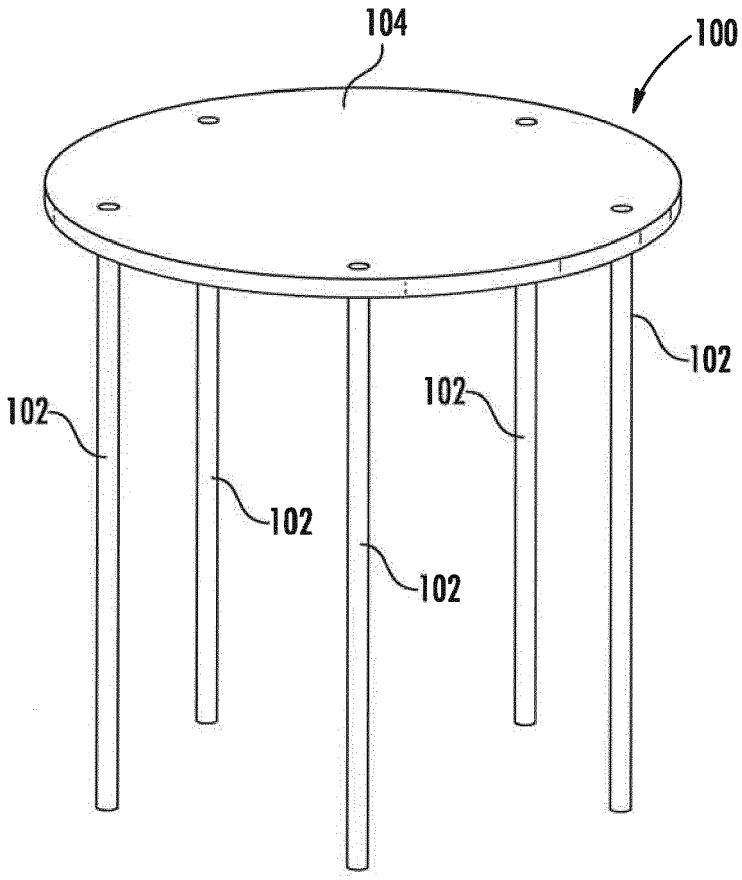

FIG. 10

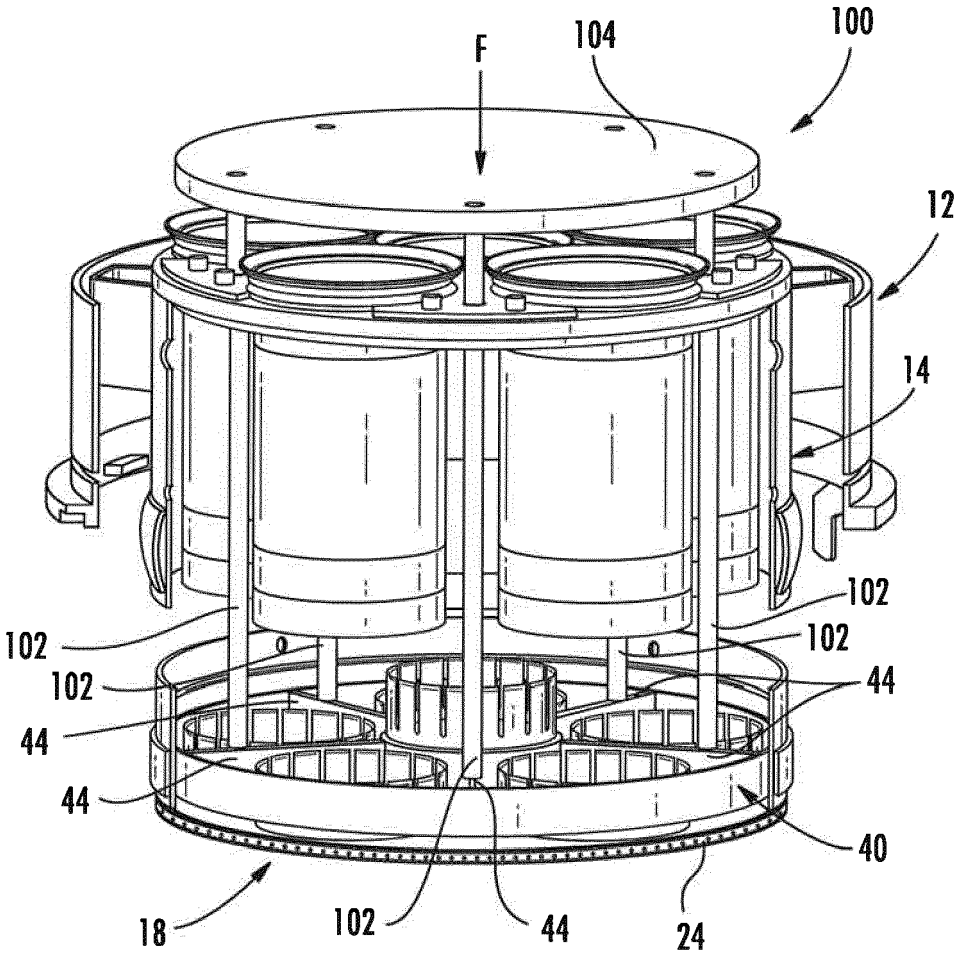

FIG. 11

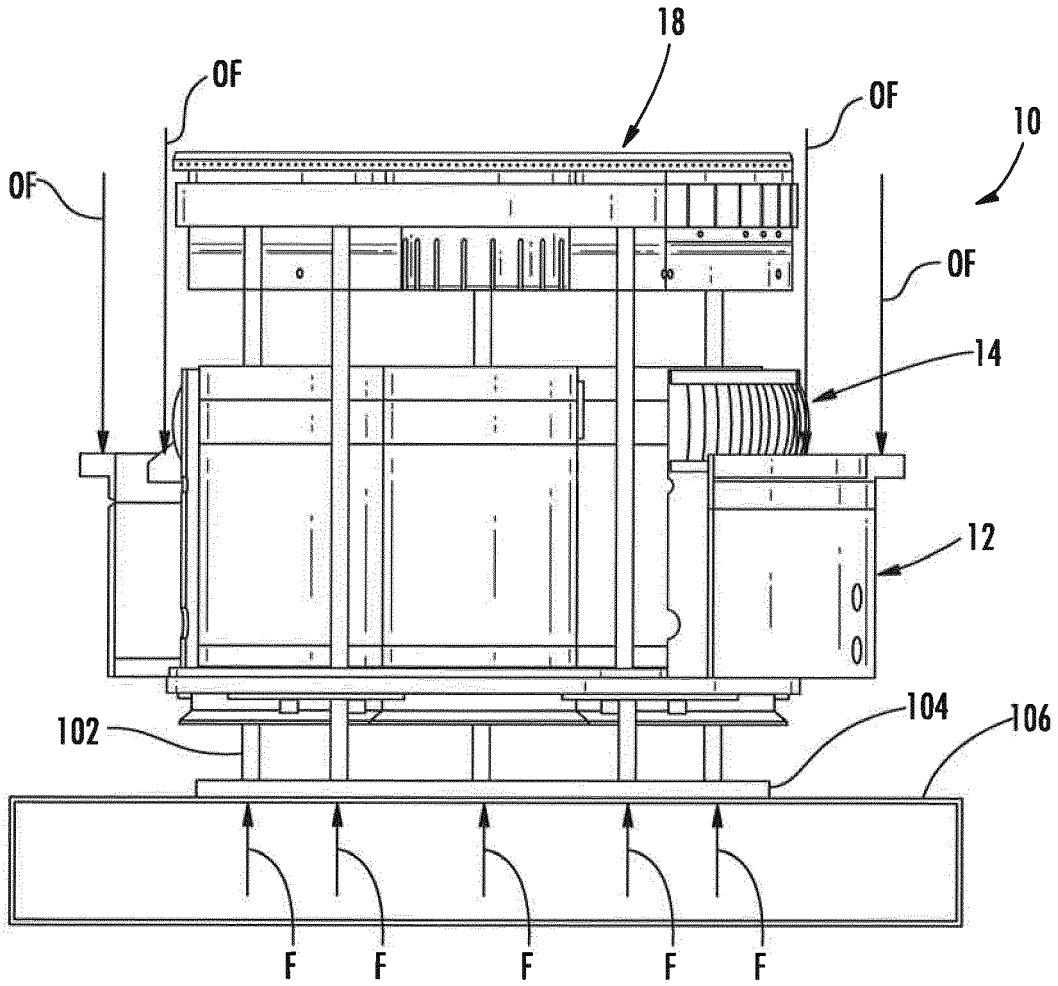

FIG. 12

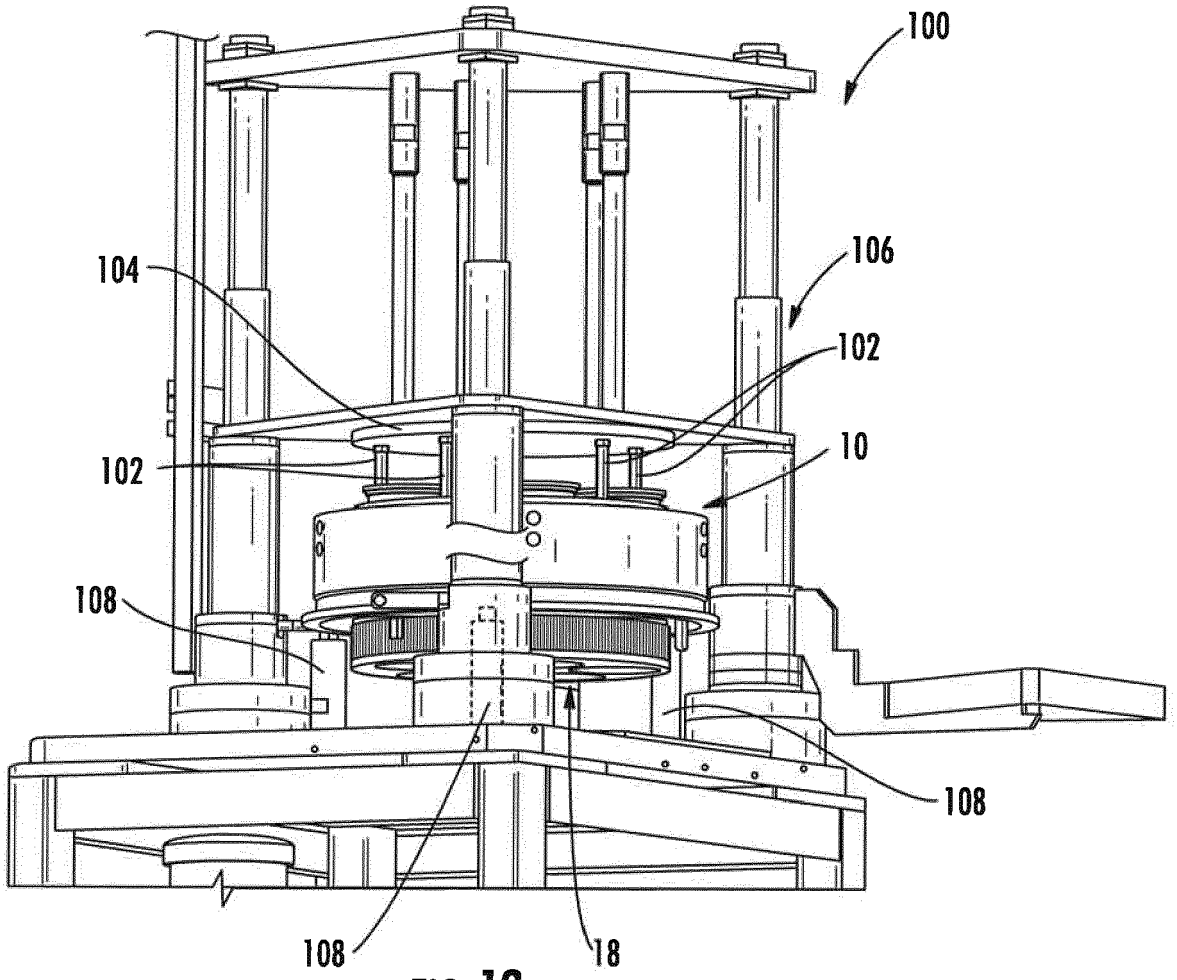

FIG. 13

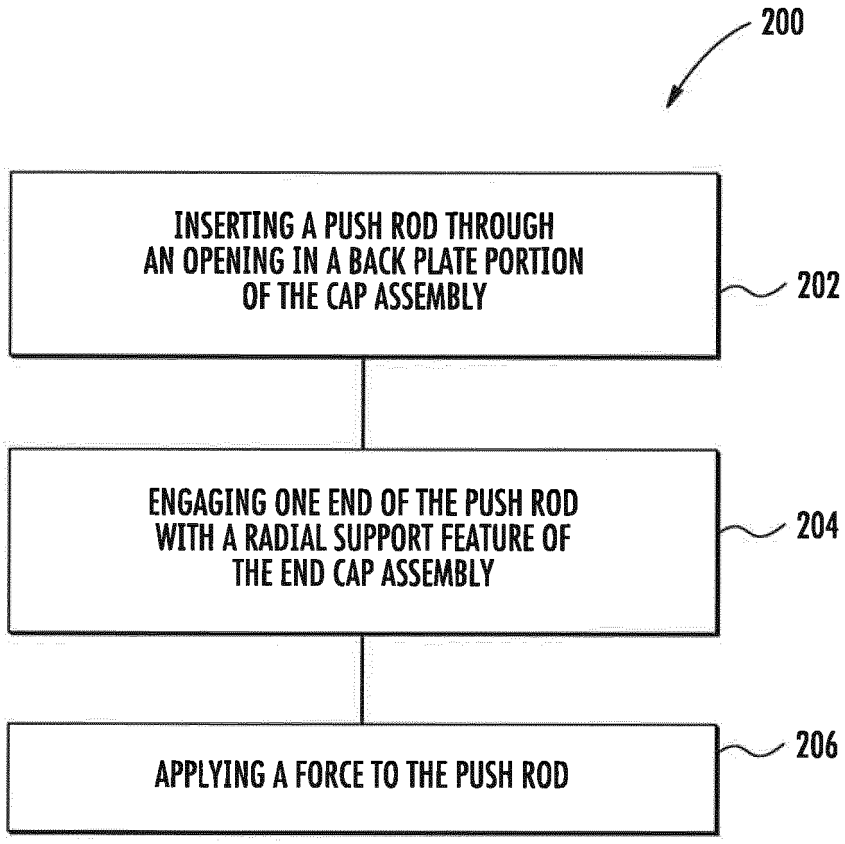
200
INSERTING A PUSH ROD THROUGH AN OPENING IN A BACK PLATE PORTION OF THE CAP ASSEMBLY
202
ENGAGING ONE END OF THE PUSH ROD WITH A RADIAL SUPPORT FEATURE OF THE END CAP ASSEMBLY
204
APPLYING A FORCE TO THE PUSH ROD
206

FIG. 14

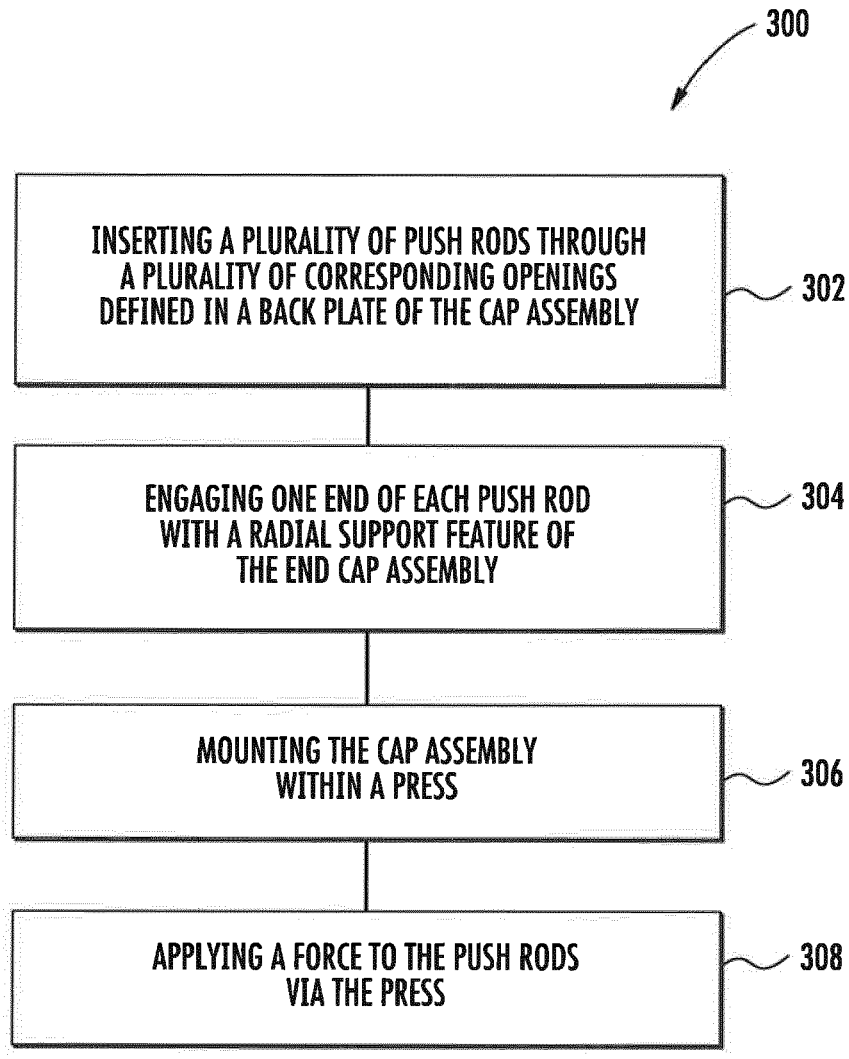
300
INSERTING A PLURALITY OF PUSH RODS THROUGH A PLURALITY OF CORRESPONDING OPENINGS DEFINED IN A BACK PLATE OF THE CAP ASSEMBLY
302
ENGAGING ONE END OF EACH PUSH ROD WITH A RADIAL SUPPORT FEATURE OF THE END CAP ASSEMBLY
304
MOUNTING THE CAP ASSEMBLY WITHIN A PRESS
306
APPLYING A FORCE TO THE PUSH RODS VIA THE PRESS
308

FIG. 15

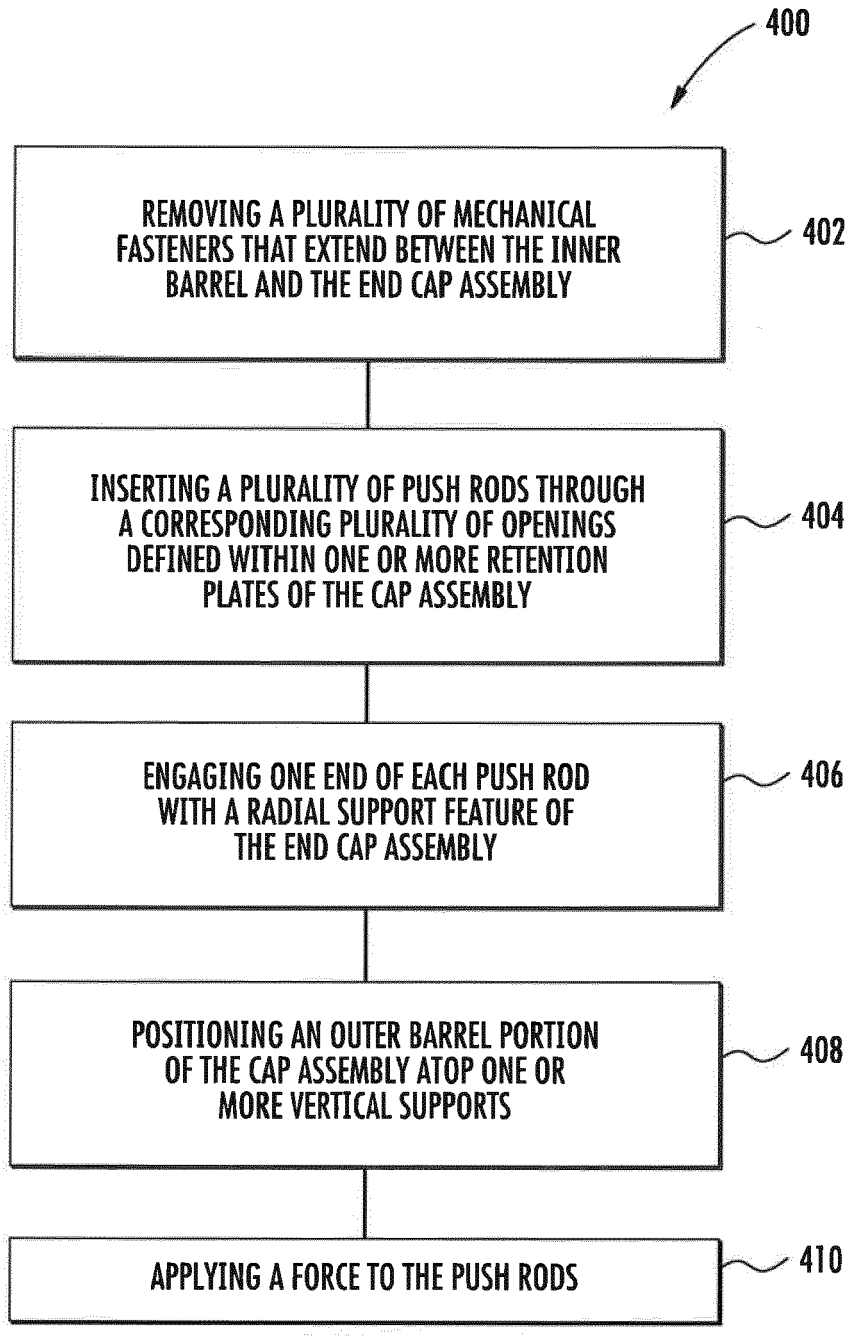
400
REMOVING A PLURALITY OF MECHANICAL FASTENERS THAT EXTEND BETWEEN THE INNER BARREL AND THE END CAP ASSEMBLY
402
INSERTING A PLURALITY OF PUSH RODS THROUGH A CORRESPONDING PLURALITY OF OPENINGS DEFINED WITHIN ONE OR MORE RETENTION PLATES OF THE CAP ASSEMBLY
404
ENGAGING ONE END OF EACH PUSH ROD WITH A RADIAL SUPPORT FEATURE OF THE END CAP ASSEMBLY
406
POSITIONING AN OUTER BARREL PORTION OF THE CAP ASSEMBLY ATOP ONE OR MORE VERTICAL SUPPORTS
408
APPLYING A FORCE TO THE PUSH RODS
410

FIG. 16

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 14 18 1178

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2009/188255 A1 (GREEN ANDREW [US] ET AL) 30 July 2009 (2009-07-30) * paragraphs [0024], [0025], [0028]; figures 2, 7, 9 *	1-5	INV. F23R3/60 F23R3/46
A	US 2006/200962 A1 (HU CHIH K [TW] HU CHIH KUO [TW]) 14 September 2006 (2006-09-14) * paragraphs [0012], [0015], [0016]; figures 4, 6 *	1-5	
A	US 4 295 260 A (DIVERS ROBERT M) 20 October 1981 (1981-10-20) * column 3, line 20 - line 54; figures 1-2 *	1-4	
A	US 2010/101065 A1 (MACCHIA ENZO [CA] ET AL) 29 April 2010 (2010-04-29) * paragraphs [0004], [0015], [0017]; figures 1-5 *	1	
A	US 2011/247193 A1 (HERBOLD JOHN WILLIAM [US]) 13 October 2011 (2011-10-13) * paragraphs [0006], [0025], [0026], [0040]; figures 3, 4 *	1,3	TECHNICAL FIELDS SEARCHED (IPC) B25B F23R B23P F01D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	19 January 2015	Harder, Sebastian

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 14 18 1178

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

19-01-2015

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009188255 A1	30-07-2009	NONE	
US 2006200962 A1	14-09-2006	NONE	
US 4295260 A	20-10-1981	NONE	
US 2010101065 A1	29-04-2010	CA 2673139 A1 US 2010101065 A1 US 2013276285 A1	24-04-2010 29-04-2010 24-10-2013
US 2011247193 A1	13-10-2011	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82