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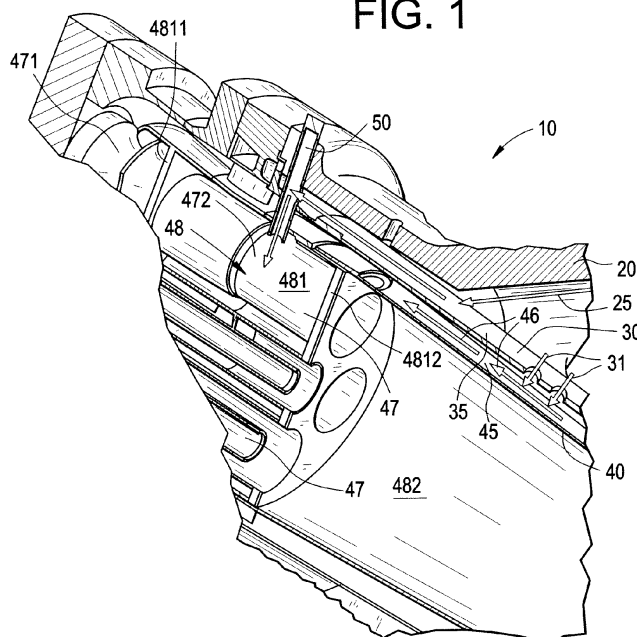
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(54) **Combustor having a pressure feed**

(57) A combustor (10) having a pressure feed is provided and includes an outer vessel (20), an intermediate vessel (30) disposed within the outer vessel (20) to form an outer annulus (35), an inner vessel (40) disposed within the intermediate vessel (30) to form an inner annulus (45) between the intermediate and inner vessels, by

which upstream portions (471) of fuel nozzles (47) disposed within the inner vessel are fed, and an internal volume (48) within the inner vessel about downstream portions (472) of the fuel nozzles (47) and a tubular assembly (50) by which the outer annulus (35) and the internal volume (48) are communicative.

**FIG. 1**



## Description

### BACKGROUND OF THE INVENTION

**[0001]** The subject matter disclosed herein relates to a combustor having a pressure feed.

**[0002]** For a typical combustor arrangement, a flowsleeve is inserted into an aft case that is attached to a compressor discharge case (CDC) or an integral aft case. The flowsleeve includes impingement holes formed therein. A liner is then inserted into the flowsleeve and a cap is assembled onto the flowsleeve or aft case such that fuel nozzles are operably disposed within the liner. The liner thus forms an annulus between the liner and the flowsleeve that leads to inlets of the fuel nozzles.

**[0003]** With this configuration, CDC air enters the CDC from a compressor and flows through the impingement holes and into the annulus between the liner and the flowsleeve as impingement air. Additional air can be provided to the annulus from transition piece impingement cooling flows. The impingement air and the additional air then flows upstream through the annulus toward the fuel nozzle inlets where it enters the fuel nozzles so that it can be mixed with fuel for combustion operations.

### BRIEF DESCRIPTION OF THE INVENTION

**[0004]** According to one aspect of the invention, a combustor having a pressure feed is provided and includes an outer vessel, an intermediate vessel disposed within the outer vessel to form an outer annulus, an inner vessel disposed within the intermediate vessel to form an inner annulus between the intermediate and inner vessels, by which upstream portions of fuel nozzles disposed within the inner vessel are fed, and an internal volume within the inner vessel about downstream portions of the fuel nozzles and a tubular assembly by which the outer annulus and the internal volume are communicative. The outer annulus is communicative with a first fluid, and second fluid is fed to upstream portions of fuel nozzles disposed within the inner vessel by the inner annulus.

**[0005]** According to another aspect of the invention, a method of assembling a combustor having a pressure feed is provided and includes forming an outer annulus between an outer vessel and an intermediate vessel, forming an inner annulus between the intermediate vessel and an inner vessel by which upstream portions of fuel nozzles disposed within the inner vessel are to be fed, defining an internal volume within the inner vessel about downstream portions of the fuel nozzles and positioning a tubular assembly by which the outer annulus and the internal volume are communicative.

**[0006]** These and other advantages and features will become more apparent from the following description taken in conjunction with the drawings.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0007]** Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

FIG. 1 is a perspective view of a combustor having a pressure feed;

FIG. 2 is an enlarged side view of the combustor of FIG. 1;

FIG. 3 is a schematic illustration of a sub-assembly of the combustor of FIG. 1 according to embodiments; and

FIG. 4 is a side schematic view of a combustor having a pressure feed in which a transfer tube is assembled into a cap assembly for a passively fed system.

**[0008]** The detailed description explains embodiments of the invention, together with advantages and features, by way of example with reference to the drawings.

### DETAILED DESCRIPTION OF THE INVENTION

**[0009]** With reference to FIGS. 1 and 2, a combustor 10 having a pressure feed is provided. The combustor 10 includes an outer vessel 20, such as a compressor discharge casing (CDC), which is receptive of a first fluid 25, such as compressor discharge air output from a compressor. The combustor 10 further includes an annular intermediate vessel 30, an annular inner vessel 40 and a tubular assembly 50. The intermediate vessel 30 may be a flowsleeve of the combustor 10 and/or a transition piece and may be formed to define impingement holes 31 therein. The impingement holes 31 are pictured proximate to the head end, as shown in FIG. 1, but it is understood that they may be defined further downstream at the transition piece or as an annular passage in addition to or instead of impingement holes. The intermediate vessel 30 is disposed within the outer vessel 20 to form an outer annulus 35 with which the first fluid 25 communicates.

**[0010]** The inner vessel 40 may be a liner of the combustor 10 that is disposed within the intermediate vessel 30 such that the inner vessel 40 forms an internal volume 48 and the inner vessel 40 and the intermediate vessel 30 form an inner annulus 45. The inner annulus 45 is defined between the intermediate vessel 30 and the inner vessel 40. By way of the inner annulus 45, a second fluid 46, such as impingement air, is fed to upstream portions 471 (i.e., inlets) of fuel nozzles 47 that are operably disposed within the inner vessel 40. The fuel nozzles 47 may include a central fuel nozzle and a plurality of outer fuel nozzles disposed around the central fuel nozzle. The second fluid 46 is provided as a portion of the first fluid 25 that flows from the outer annulus 35 into the inner

annulus 45 via the impingement holes 31.

**[0011]** The internal volume 48 is defined within the inner vessel 40 as first and second internal volume sections 481 and 482 with the second internal volume section 482 being disposed downstream from the first internal volume section 481. In accordance with embodiments, the first internal volume section 481 may be formed as a cap internal volume that is disposed about downstream portions 472 of the fuel nozzles 47. This cap internal volume is defined between internal volume wall 4811 and cap face 4812. The second internal volume section 482 is defined downstream from the cap face 4812 and the nozzles 47 and may be formed as a combustion zone.

**[0012]** The tubular assembly 50 provides for a pathway by which the first fluid 25 is transmittable from the outer annulus 35 to the internal volume 48. More particularly, the tubular assembly 50 provides for a pathway by which the first fluid 25 is transmittable from the outer annulus 35 to the first internal volume section 481.

**[0013]** As shown in FIG. 2, the tubular assembly 50 may include a tube 51 and seals 52 positioned around the tube 51 at the intermediate vessel 30 and the inner vessel 40 to prevent leakage of the first fluid 25. The tube 51 has a tubular sidewall 511 defining an interior 512. The tube 51 also has a closed end 513, an open end 514 opposite the closed end 513 and an aperture 515 providing access to the interior 512. The tube 51 is oriented in a radial direction with respect to the outer annulus 35 and is installed in the combustor 10 to extend from at least the outer annulus 35 to the first internal volume section 481. In accordance with embodiments, the tube 51 has a length whereby the closed end 513 may extend to an exterior of the outer vessel 20, the open end 514 is disposed within the first internal volume section 481 and the aperture 515 is positioned within the outer annulus 35.

**[0014]** Also, as shown in FIG. 2, the tubular assembly 50 may be configured to admit a cooler air supply by way of a cooler air feed 520. Such a cooler air supply may serve to mitigate combustion dynamics by providing for a variable cavity pressure. In addition, the cooler air supply may allow the cap face 4812 to operate at a relatively cool temperature and, with or without a possible addition of an inert gas, may assist in maintenance of a flame at a predefined safe distance from the cap face 4812.

**[0015]** The tubular assembly 50 may further include a plurality of tubes 51. In this case, each of the plurality of tubes 51 has seals 52 at the intermediate vessel 30 and the inner vessel 40 and is constructed as described above. The plurality of tubes 51 may be arrayed circumferentially about the combustor 10 based on flow requirements. The plurality of tubes 51 may also be disposed at axially staggered positions based on predefined and/or determined flow requirements.

**[0016]** In accordance with further embodiments, aperture 515 may be formed as a window in a circumferential portion of the tubular sidewall 511 and the tube 51 may be oriented such that the aperture 515 faces in the down-

stream direction. In this way, the first fluid 25 moving upstream toward the combustor head end can relatively easily flow into the interior 512 via the aperture 515.

**[0017]** In accordance with still further embodiments and, with reference to FIG. 3, the tubular assembly 50 may include a sub-assembly 60 by which an amount of the transmittable first fluid 25 is controllable. For example, as shown in FIG. 3, the sub-assembly 60 may include a tube-in-tube assembly 61 that is operably coupled to a controller 62. The tube-in-tube assembly 61 includes a secondary tube 611 having an aperture 612 that is disposed within the tube 51. The controller 62 rotates the secondary tube 611 within the tube 51 such that the aperture 612 becomes rotationally aligned with or misaligned with the aperture 515 to thereby increase or decrease the amount of the transmittable first fluid 25, respectively. Thus, when the aperture 612 is aligned with the aperture 515 and the tubular assembly 50 is open, as shown, about 10% of the first fluid 25 is transmittable to the first internal volume section 481 and 90% flows into the inner annulus 45 as the second fluid 46 (i.e., impingement air). By contrast, when the aperture 612 and the aperture 515 are mis-aligned and the tubular assembly 50 is closed, about 100% of the first fluid 25 flows into the inner annulus 45 as the second fluid 46.

**[0018]** The tubular assembly 50 allows for a feed of, for example, pressurized air from a compressor discharge casing to a cap internal volume and may be installed after the assembly of the flowsleeve, the liner and the cap. As a result, the cap internal volume 481 may be provided with a higher cap pressure leading to increased durability for the effusion plate either by increasing the pressure drop across the plate or by introducing an impingement plate to cool the back side of the plate. During periods of high combustion dynamics, the higher pressure drop may also help to prevent hot combustion products from being forced upstream into the effusion holes and may be a tool to mitigate some dynamics.

**[0019]** In accordance with further aspects and, with reference to FIG. 4, a cap assembly 100 may be provided and includes a forward case 101 and an aft case 102. The forward case 101 includes forward portions of the intermediate vessel 30 and the inner vessel 40 with a cap strut 103 supportively disposed therebetween. The aft case 102 is integrally connected with the CDC and includes aft portions of the intermediate vessel 30 and the inner vessel 40, which form the outer annulus 35. The inner vessel 40 forms a cap cavity 105 and a transfer tube 110 is assembled into the cap assembly 100 to passively feed the first fluid 25 from the outer annulus 35 to the cap cavity 105. In accordance with embodiments, the transfer tube 110 may be attached or welded to, for example, the forward case 101 of the cap assembly 100 at one or both ends thereof and may be further provided with a seal 111.

**[0020]** In accordance with still further aspects, a method of assembling a combustor 10 having a pressure feed is provided. The method includes forming an outer an-

nulus 35 between an outer vessel 20 and an intermediate vessel 30, forming an inner annulus 45 between the intermediate vessel 30 and an inner vessel 40 by which upstream portions 471 of fuel nozzles 47 disposed within the inner vessel 40 are to be fed, defining an internal volume 48 within the inner vessel 40 about downstream portions 472 of the fuel nozzles 47 and positioning a tubular assembly 50 by which the outer annulus 35 and the internal volume 48 are communicative.

**[0021]** While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

## Claims

1. A combustor (10) having a pressure feed, comprising:

an outer vessel (20);  
an intermediate vessel (30) disposed within the outer vessel (20) to form an outer annulus (35);  
an inner vessel (40) disposed within the intermediate vessel (35) to form an inner annulus (45) between the intermediate and inner vessels, by which upstream portions (471) of fuel nozzles (47) disposed within the inner vessel are fed, and an internal volume (48) within the inner vessel (40) about downstream portions (472) of the fuel nozzles (47); and  
a tubular assembly (50) by which the outer annulus (35) and the internal volume (48) are communicative.

2. The combustor (10) according to claim 1, wherein the outer vessel (20) comprises a compressor discharge casing, the intermediate vessel (30) comprises a flow sleeve having impingement holes (31) formed therein and the inner vessel 40 comprises a combustor liner.
3. The combustor (10) according to claim 1 or 2, wherein compressor discharge air is deliverable to the internal volume (48) by the tubular assembly (50).
4. The combustor (10) according to any of claims 1 to 3, wherein the outer vessel (20), the intermediate

vessel (30) and the inner vessel (40) form a cap assembly (100) to which the tubular assembly (50) is attached and sealed.

5. The combustor (10) according to any of claims 1 to 4, wherein the fuel nozzles (47) comprise a central fuel nozzle and a plurality of outer fuel nozzles.
6. The combustor (10) according to any preceding claim, wherein the tubular assembly (50) comprises a tube (51) oriented in a radial direction of the outer annulus (35).
7. The combustor (10) according to any of claims 1 to 5, wherein the tubular assembly (50) comprises a plurality of circumferentially arrayed tubes (51), each of the plurality of circumferentially arrayed tubes (51) being oriented in a radial direction.
8. The combustor (10) according to any of claims 1 to 5, wherein the tubular assembly (50) comprises a tube-in-tube sub-assembly (60) operably coupled to a controller (62).
9. The combustor (10) of any preceding claim, wherein the outer annulus (35) is communicative with a first fluid (25); and  
a second fluid (46) is fed to upstream portions (471) of fuel nozzles (47) disposed within the inner vessel by the inner annulus (45).
10. The combustor (10) according to claim 9, wherein the first fluid (25) comprises compressor discharge air, the second fluid (46) is a portion of the first fluid (25) flowing through the impingement holes (31) as impingement air.
11. The combustor according to claim 9 or 10, wherein the second fluid (46) is fed to inlets of the fuel nozzles (47) at the upstream portions (471) thereof.
12. A method of assembling a combustor (10) having a pressure feed, comprising:  
  
forming an outer annulus (35) between an outer vessel (20) and an intermediate vessel (30);  
forming an inner annulus (35) between the intermediate vessel (30) and an inner vessel (40) by which upstream portions of fuel nozzles (47) disposed within the inner vessel (40) are to be fed;  
defining an internal volume (48) within the inner vessel (40) about downstream portions (472) of the fuel nozzles (47); and  
positioning a tubular assembly (50) by which the outer annulus (35) and the internal volume (48) are communicative.

13. The method according to claim 12, further comprising positioning a sub-assembly (60) within the tubular assembly (50) by which an amount of transmittable fluid (25) is controllable.

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FIG. 1

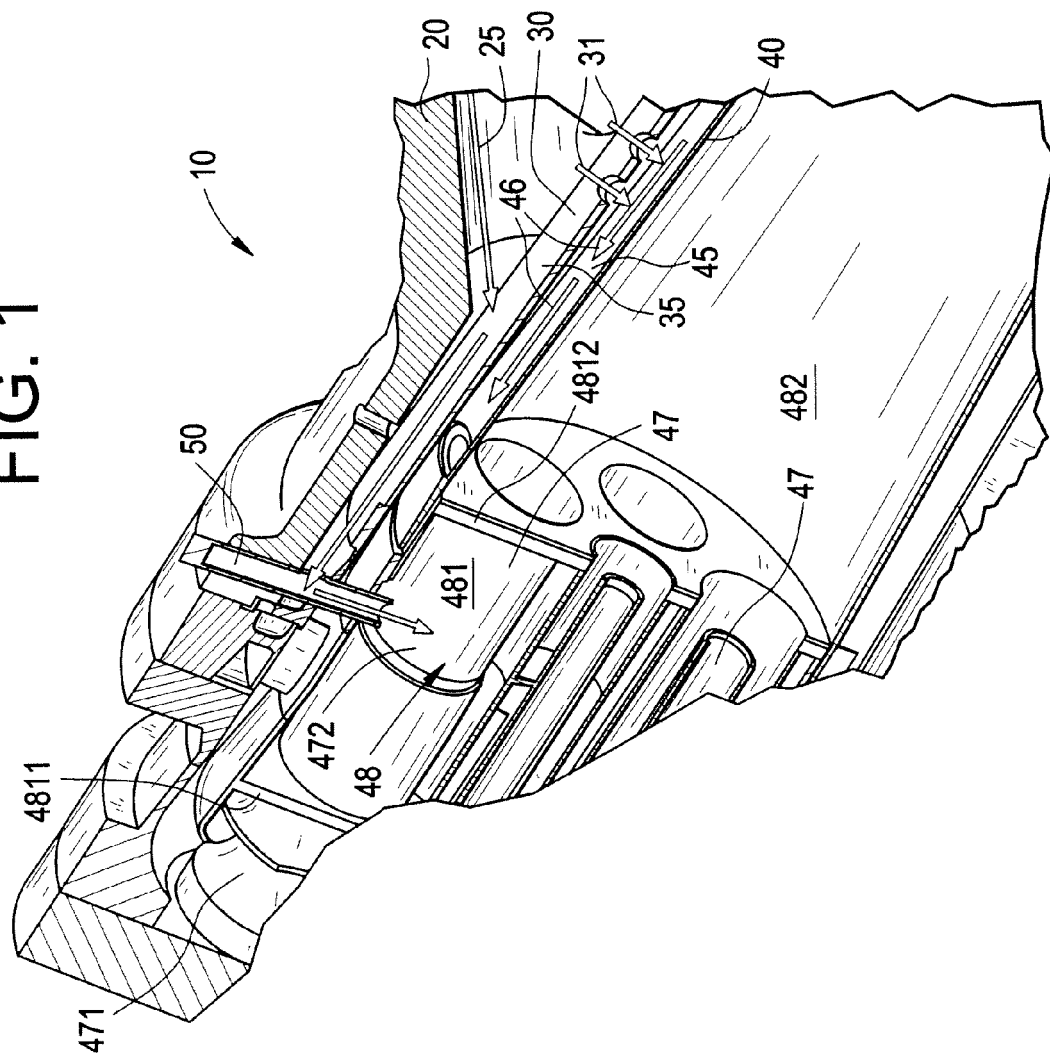


FIG. 2

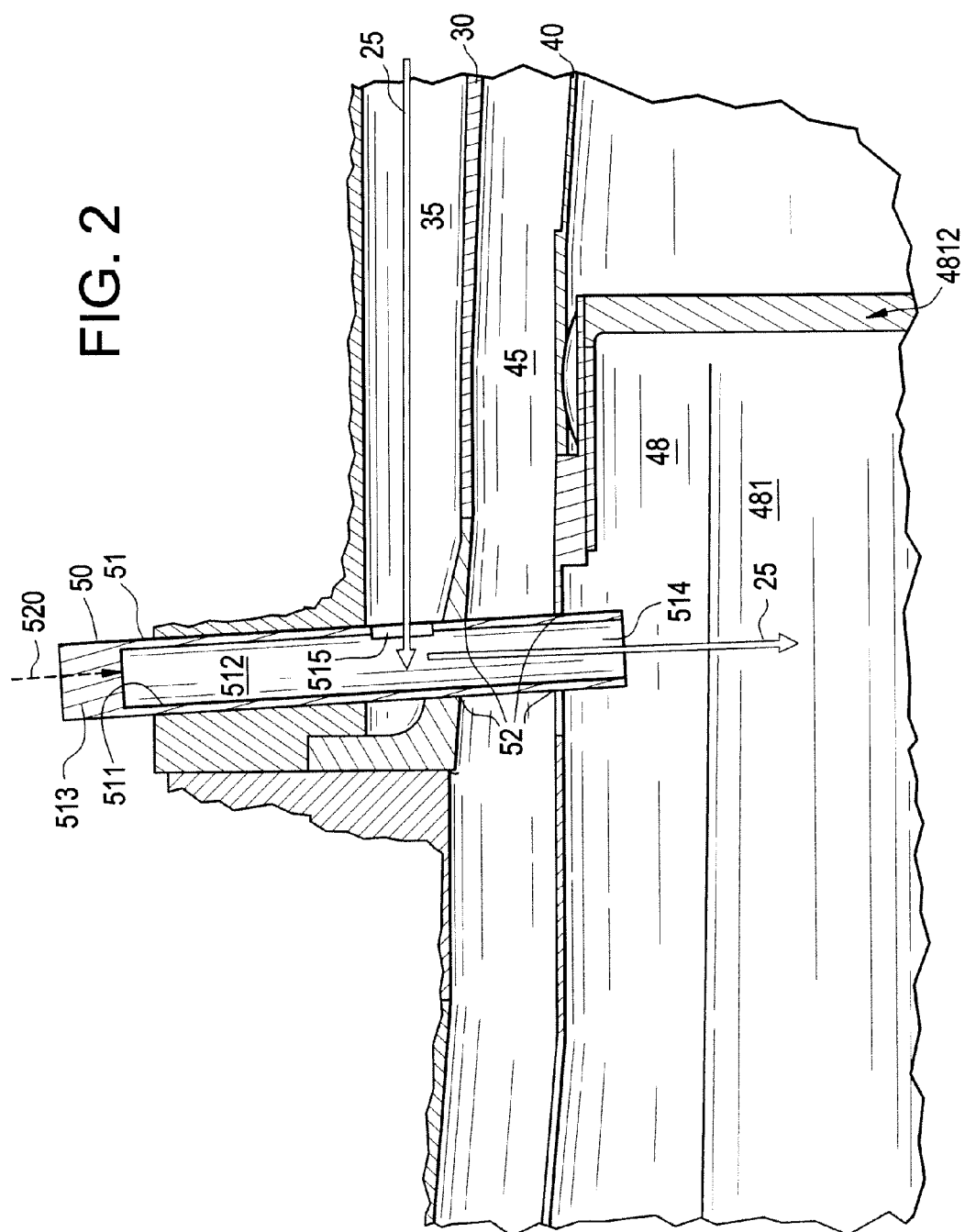


FIG. 3

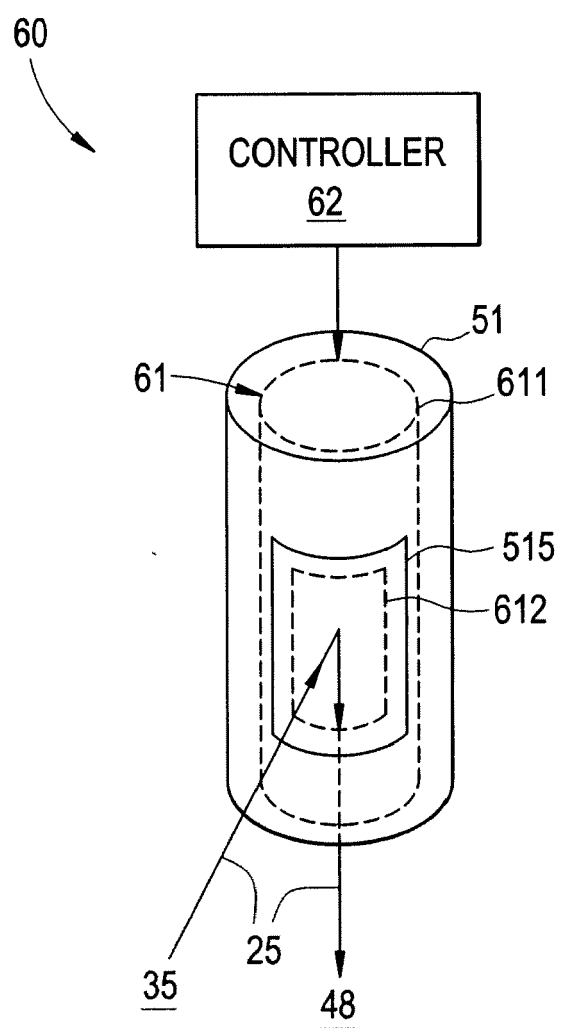




FIG. 4

