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(54) **COMBUSTOR HAVING A PRESSURE FEED**

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(57) **ABSTRACT**

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.

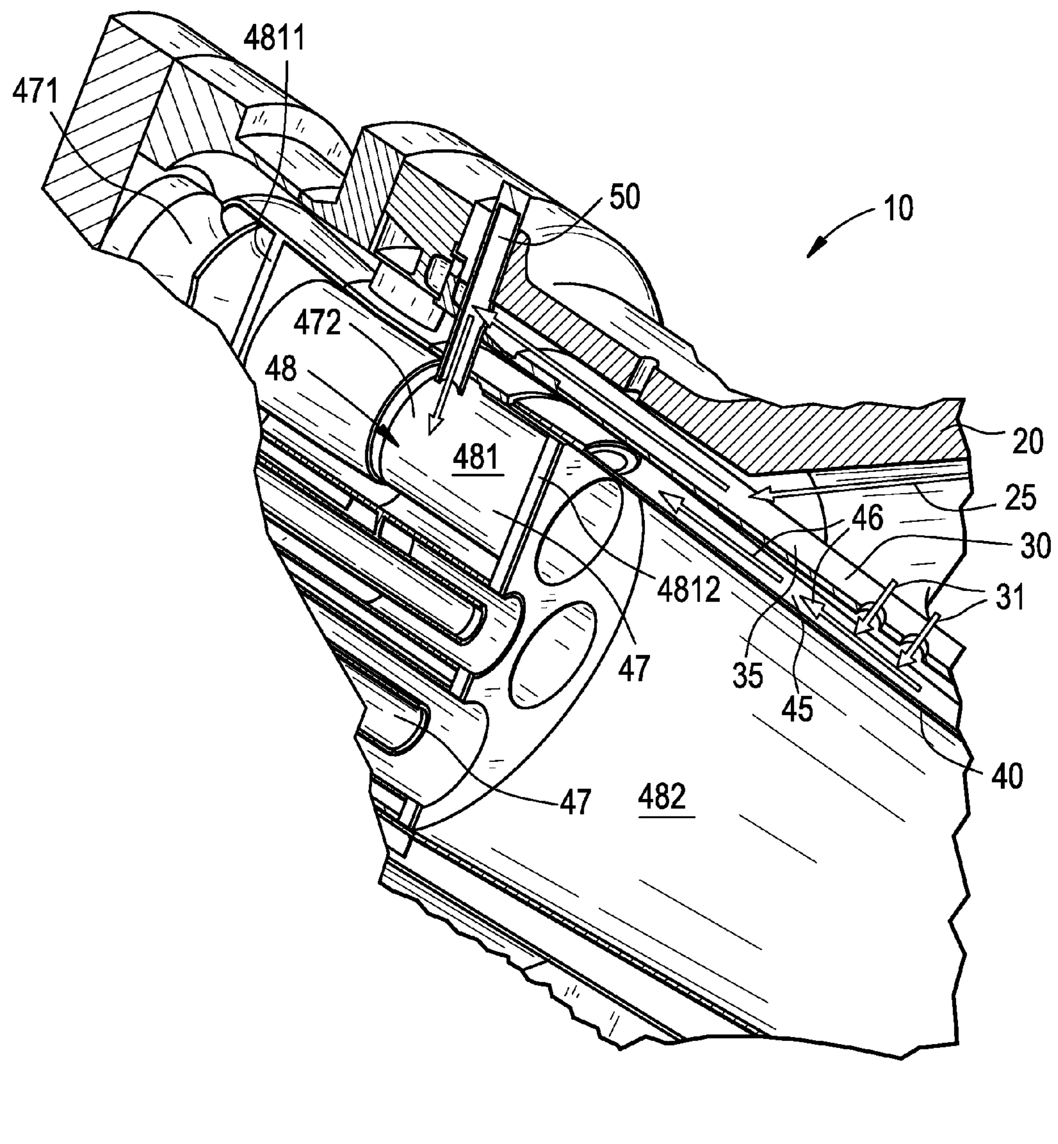
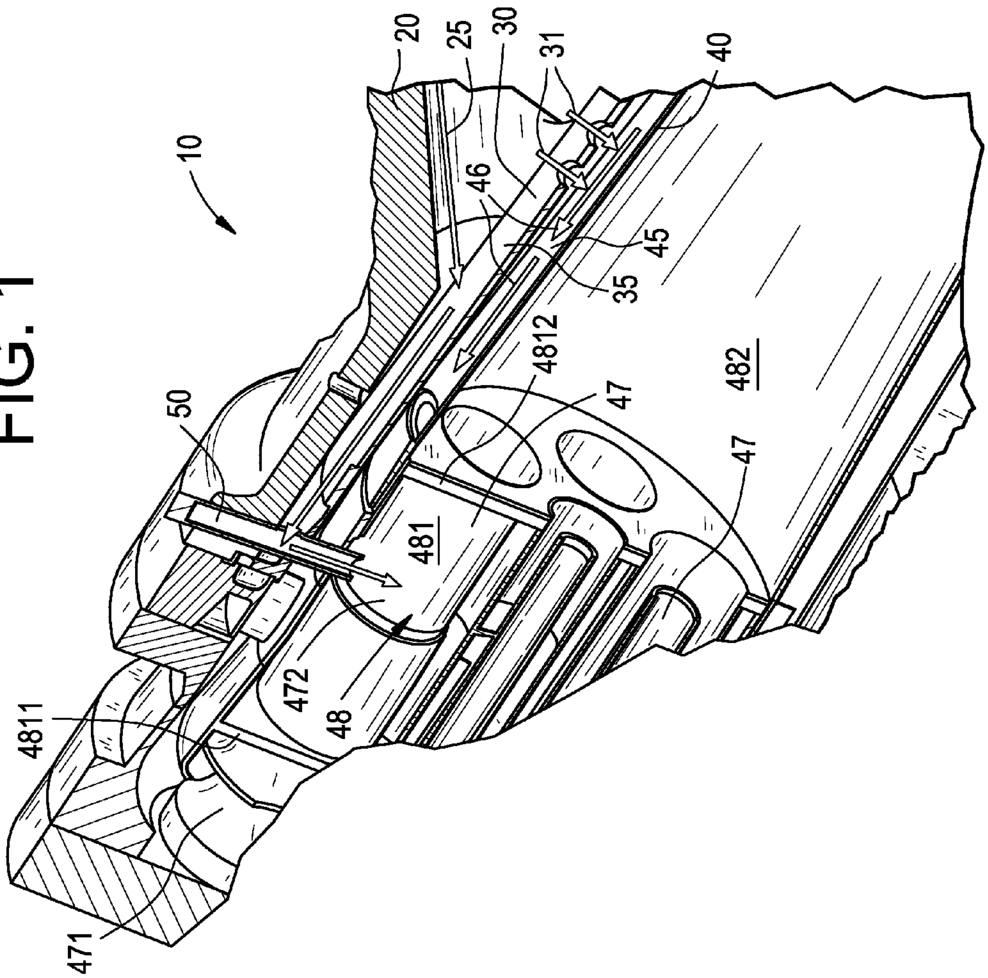


FIG. 1



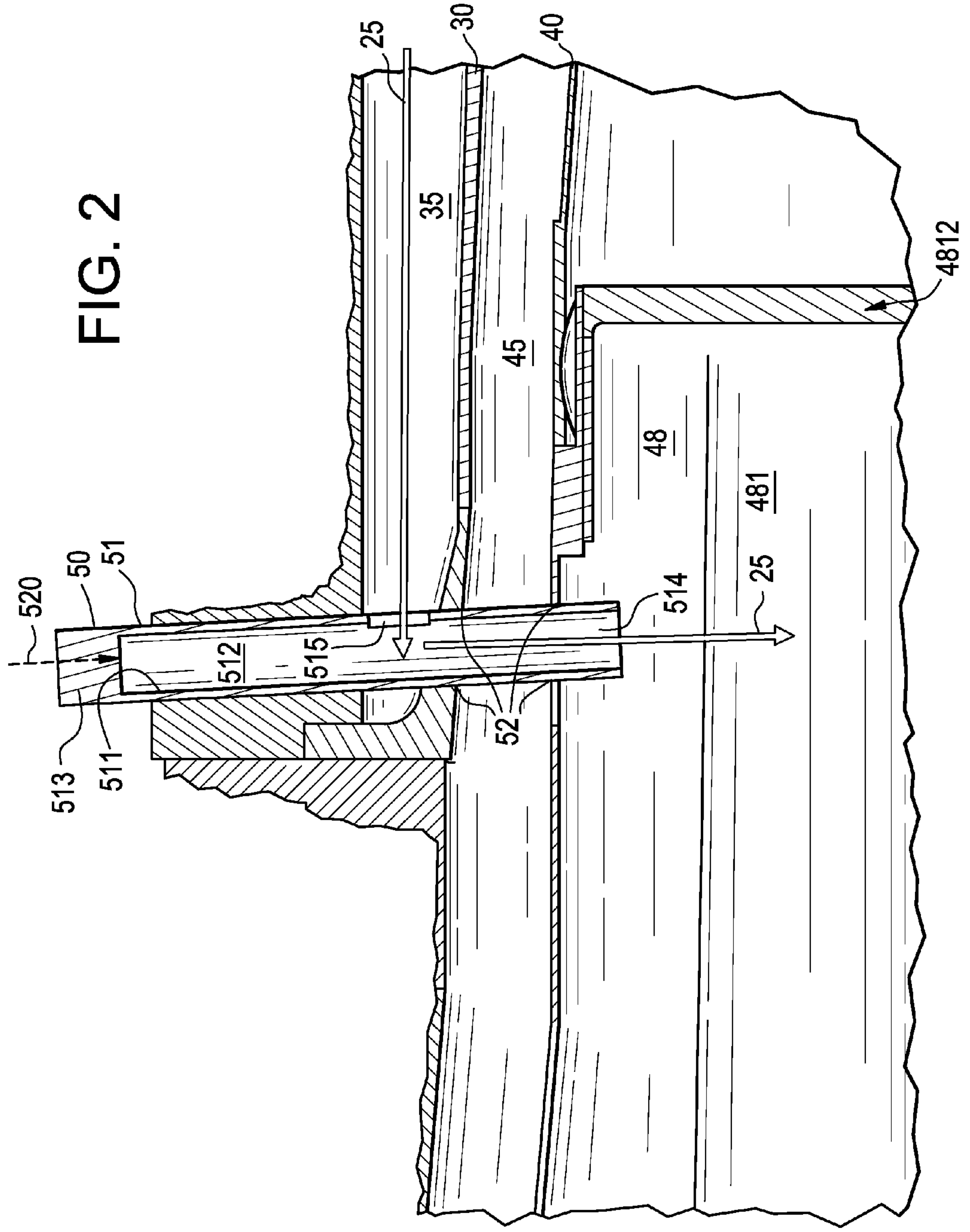


FIG. 2

FIG. 3

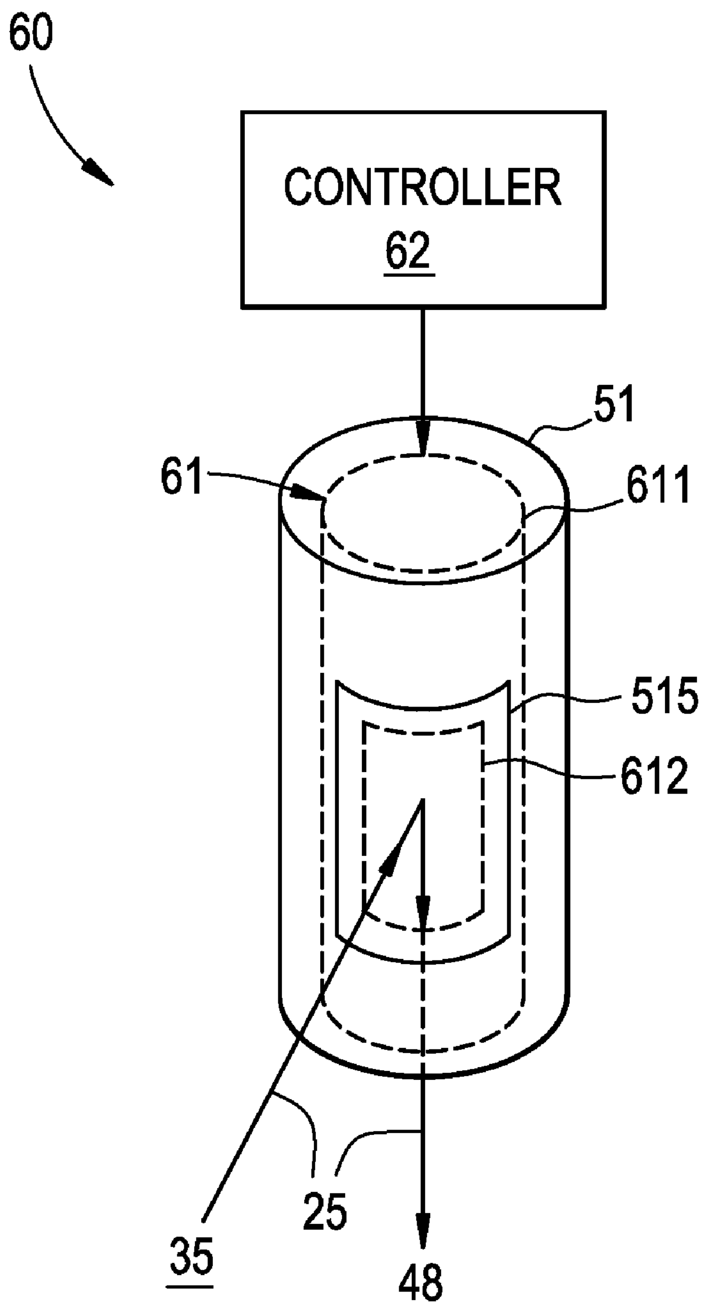
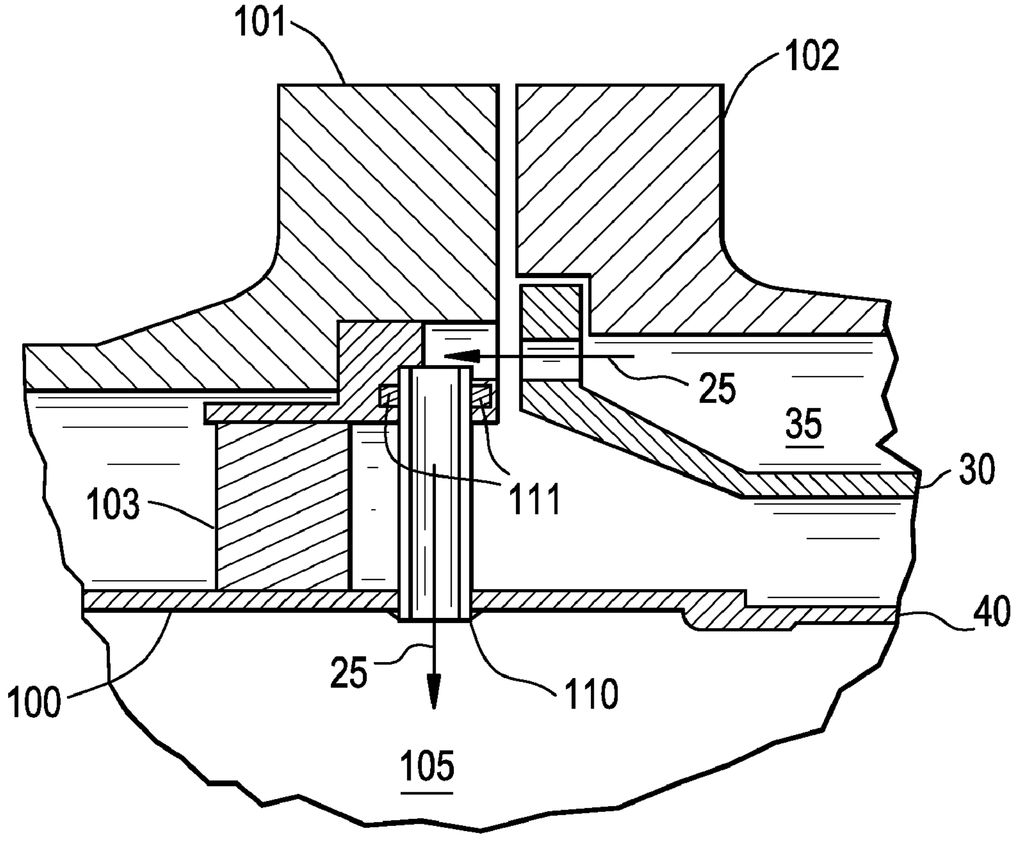


FIG. 4



COMBUSTOR HAVING A PRESSURE FEED

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.

[0005] According to another 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 communicative with a first fluid, an inner vessel disposed within the intermediate vessel to form an inner annulus between the intermediate and inner vessels, by which a second fluid is fed to upstream portions of fuel nozzles disposed within the inner vessel, and an internal volume within the inner vessel about downstream portions of the fuel nozzles and a tubular assembly by which the first fluid is transmittable from the outer annulus to the internal volume.

[0006] According to yet 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.

[0007] 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

[0008] The subject matter, which is regarded as the invention, is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features, and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

[0009] FIG. **1** is a perspective view of a combustor having a pressure feed;

[0010] FIG. **2** is an enlarged side view of the combustor of FIG. **1**;

[0011] FIG. **3** is a schematic illustration of a sub-assembly of the combustor of FIG. **1** according to embodiments; and

[0012] 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.

[0013] 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

[0014] 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.

[0015] 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**.

[0016] 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.

[0017] 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**.

[0018] 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**.

[0019] 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**.

[0020] 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 pre-defined and/or determined flow requirements.

[0021] 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 downstream 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**.

[0022] 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 mis-aligned 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**.

[0023] 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 pate. 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.

[0024] 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**.

[0025] 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 annulus **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.

[0026] 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.

1. A combustor having a pressure feed, comprising:
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.

2. The combustor according to claim **1**, wherein the outer vessel comprises a compressor discharge casing, the intermediate vessel comprises a flow sleeve having impingement holes formed therein and the inner vessel comprises a combustor liner.

3. The combustor according to claim **1**, wherein compressor discharge air is deliverable to the internal volume by the tubular assembly.

4. The combustor according to claim **1**, wherein the outer vessel, the intermediate vessel and the inner vessel form a cap assembly to which the tubular assembly is attached and sealed.

5. The combustor according to claim **1**, wherein the fuel nozzles comprise a central fuel nozzle and a plurality of outer fuel nozzles.

6. The combustor according to claim **1**, wherein the tubular assembly comprises a tube oriented in a radial direction of the outer annulus.

7. The combustor according to claim **1**, wherein the tubular assembly comprises a plurality of circumferentially arrayed tubes, each of the plurality of circumferentially arrayed tubes being oriented in a radial direction.

8. The combustor according to claim **1**, wherein the tubular assembly comprises a tube-in-tube sub-assembly operably coupled to a controller.

9. A combustor having a pressure feed, comprising:

an outer vessel;

an intermediate vessel disposed within the outer vessel to form an outer annulus communicative with a first fluid;

an inner vessel disposed within the intermediate vessel to form an inner annulus between the intermediate and inner vessels, by which a second fluid is fed to upstream portions of fuel nozzles disposed within the inner vessel, and an internal volume within the inner vessel about downstream portions of the fuel nozzles; and

a tubular assembly by which the first fluid is transmittable from the outer annulus to the internal volume.

10. The combustor according to claim **9**, wherein:

the outer vessel comprises a compressor discharge casing and the first fluid comprises compressor discharge air,

the intermediate vessel comprises a flow sleeve having impingement holes formed therein, the second fluid being a portion of the first fluid flowing through the impingement holes as impingement air, and

the inner vessel comprises a combustor liner.

11. The combustor according to claim **9**, wherein compressor discharge air is deliverable to the internal volume by the tubular assembly.

12. The combustor according to claim **9**, wherein the outer vessel, the intermediate vessel and the inner vessel form a cap assembly to which the tubular assembly is attached and sealed.

13. The combustor according to claim **9**, wherein the fuel nozzles comprise a central fuel nozzle and a plurality of outer fuel nozzles.

14. The combustor according to claim **9**, wherein the second fluid is fed to inlets of the fuel nozzles at the upstream portions thereof.

15. The combustor according to claim **9**, wherein the tubular assembly comprises a tube oriented in a radial direction of the outer annulus.

16. The combustor according to claim **9**, wherein the tubular assembly comprises a plurality of circumferentially arrayed tubes, each of the plurality of circumferentially arrayed tubes being oriented in a radial direction.

17. The combustor according to claim **9**, wherein the tubular assembly comprises a sub-assembly by which an amount of the transmittable first fluid is controllable.

18. The combustor according to claim **17**, wherein the sub-assembly comprises:

a tube-in-tube assembly; and

a controller operably coupled to the tube-in-tube assembly.

19. A method of assembling a combustor having a pressure feed, comprising:

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.

20. The method according to claim **19**, further comprising positioning a sub-assembly within the tubular assembly by which an amount of the transmittable first fluid is controllable.

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