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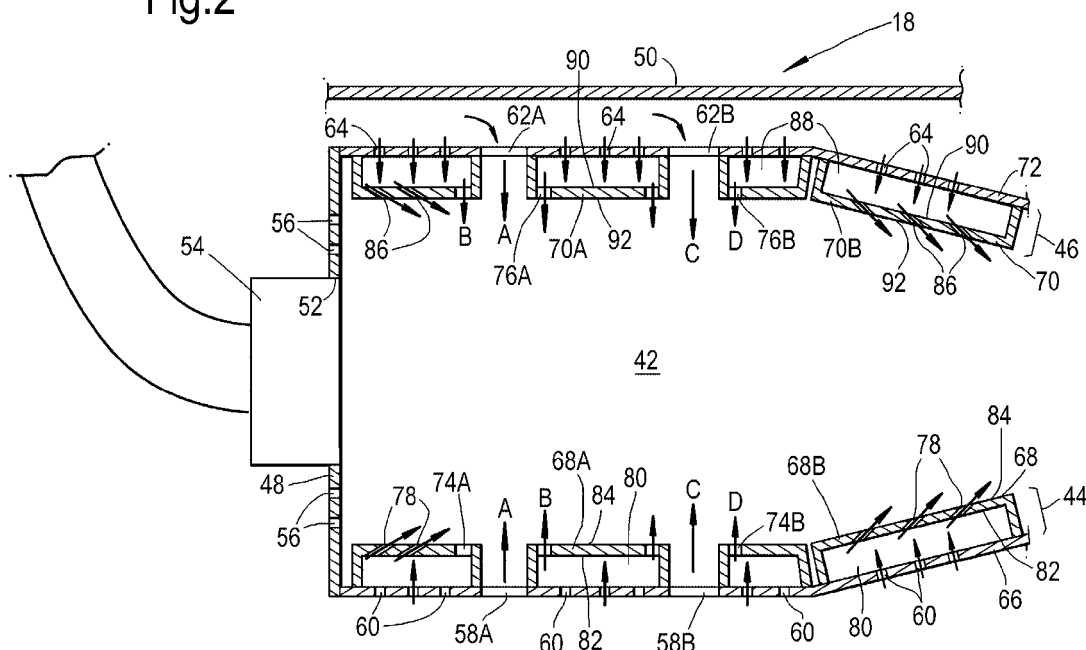
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(54) **A method of operating a combustion chamber**

(57) A method of operating a "rich burn" combustion chamber (42) comprises supplying 10% of the air through an inlet (52) in an upstream wall (48), supplying 64% to 80% of the air for mixing and supplying 10% to 26% of the air for cooling at least one double skin wall (44, 46) and the upstream wall (48). The method further comprises supplying a first portion of the 64% to 80% of the air for mixing through mixing ports (58A, 58B, 62A, 62B) into the combustion chamber (42) and supplying a second

portion of the 64% to 80% of the air for mixing to provide convective cooling of the at least one double skin wall (44, 46) before being supplied through additional mixing ports (74A, 74B, 76A, 76B) into the combustion chamber (42) and supplying the 10% to 26% of the air for cooling the at least one double skin wall (44, 46) and the upstream wall (48) to provide convective cooling and/or effusion cooling of the at least one double skin wall (44, 46) and the upstream wall (48). The amount of air available for mixing is increased and engine emissions are reduced.

Fig.2



Description

[0001] The present invention relates to a method of operating a combustion chamber and in particular to a method of operating a gas turbine engine combustion chamber.

[0002] Most gas turbine engine combustion chambers use a "rich-burn" design. In these "rich-burn" design combustion chambers the fuel injectors supply a mixture of air and fuel at a ratio that is much richer than the stoichiometric value of approximately 15. To meet emission requirements and engine operating requirements, the rich mixture of air and fuel is then diluted with air supplied through rows of mixing ports in the walls of the combustion chamber. The walls of combustion chambers have been provided with one, two or three rows of mixing ports. The total flow of air to the combustion chamber is divided and a first portion is supplied to the fuel injector, a second portion is supplied to the mixing ports and a third portion is supplied to cool the walls of the combustion chamber.

[0003] A problem with the "rich-burn" design is that as the gas turbine engine operating cycle has become more arduous, additional air is required to cool the walls of the combustion chamber and additional air is required to be supplied to the fuel injectors. Thus, "rich burn" combustion chambers have an insufficient amount of air for the mixing ports once the requirements of the fuel injectors and the wall cooling have been fulfilled. This results in a reduction in the amount of air available for the mixing ports, which therefore reduces the ability to reduce, or minimise, the emissions from the combustion chamber.

[0004] Accordingly the present invention seeks to provide a novel method of operating a combustion chamber which reduces, preferably overcomes, the above mentioned problem.

[0005] Accordingly the present invention provides a method of operating a combustion chamber, the combustion chamber comprising an upstream wall having at least one inlet for a fuel injector and primary air, at least one double skin annular wall, the at least one double skin annular wall comprising an inner wall and an outer wall, the at least one double skin annular wall having at least one mixing port extending there-through, the inner wall or the outer wall having at least one additional mixing port extending there-through adjacent the mixing port, the method comprising supplying air for the combustion chamber,

the method comprising supplying 10% of the air for the combustion chamber through the inlet in the upstream wall, supplying 64% to 80% of the air for mixing, and supplying 10% to 26% of the air for cooling the at least one double skin annular wall and the upstream wall, the method further comprising supplying a first portion of the 64% to 80% of the air for mixing through the at least one mixing port into the combustion chamber and supplying a second portion of the 64% to 80% of the air for mixing to provide convective cooling of the at least one double skin annular wall before being supplied through

the additional mixing port into the combustion chamber and supplying the 10% to 26% of the air for cooling the at least one double skin annular wall and the upstream wall to provide convective cooling and/or effusion cooling of the at least one double skin annular wall and the upstream wall.

[0006] The method may comprise supplying half of the air for mixing through the at least one mixing port into the combustion chamber and supplying half of the air for mixing to provide convective cooling of the at least one double skin annular wall before being supplied through the at least one additional mixing port into the combustion chamber.

[0007] The at least one mixing port extending through the at least one double skin annular wall comprising at least one primary mixing port extending through the at least one double skin annular wall and at least one secondary mixing port extending through the at least one double skin annular wall and arranged downstream of the at least one primary mixing port, the at least one additional mixing port in the inner wall or outer wall comprising at least one additional primary mixing port extending through the inner wall or the outer wall adjacent the primary mixing port and at least one additional secondary mixing port extending through the inner wall or the outer wall adjacent the secondary mixing port,

the method comprising supplying 10% of the air for the combustion chamber through the inlet in the upstream wall, supplying 32% to 40% of the air for primary mixing, supplying 32% to 40% of the air for secondary mixing and supplying 10% to 26% of the air for cooling the at least one double skin annular wall and the upstream wall, the method further comprising supplying a first portion of the 32% to 40% of the air for primary mixing through the at least one primary mixing port into the combustion chamber and supplying a second portion of the 32% to 40% of the air for primary mixing to provide convective cooling of the at least one double skin annular wall before being supplied through the at least one additional primary mixing port into the combustion chamber, supplying a first portion of the 32% to 40% of the air for secondary mixing through the at least one secondary mixing port into the combustion chamber and supplying a second portion of the 32% to 40% of the air for secondary mixing to provide convective cooling of the at least one double skin annular wall before being supplied through the at least one additional secondary mixing port into the combustion chamber and supplying the 10% to 26% of the air for cooling the at least one double skin annular wall and the upstream wall to provide convective cooling and/or effusion cooling of the at least one double skin annular wall and the upstream wall.

[0008] The method may comprise supplying 10% of the air for the combustion chamber through the inlet in the upstream wall, supplying 35% to 40% of the air for primary mixing, supplying 35% to 40% of the air for secondary mixing and supplying 10% to 20% of the air for cooling the at least one double skin annular wall and the

upstream wall,
the method further comprising supplying a first portion of the 35% to 40% of the air for primary mixing through the at least one primary mixing port into the combustion chamber and supplying a second portion of the 35% to 40% of the air for primary mixing to provide convective cooling of the at least one double skin annular wall before being supplied through the at least one additional primary mixing port into the combustion chamber, supplying a first portion of the 35% to 40% of the air for secondary mixing through the at least one secondary mixing port into the combustion chamber and supplying a second portion of the 35% to 40% of the air for secondary mixing to provide convective cooling of the at least one double skin annular wall before being supplied through the at least one additional secondary mixing port into the combustion chamber and supplying the 10% to 20% of the air for cooling the at least one double skin annular wall and the upstream wall to provide convective cooling and/or effusion cooling of the at least one double skin annular wall and the upstream wall.

[0009] The method may comprise supplying 10% of the air for the combustion chamber through the inlet in the upstream wall, supplying 40% of the air for primary mixing, supplying 40% of the air for secondary mixing and supplying 10% of the air for cooling the at least one double skin annular wall and the upstream wall, the method further comprising supplying a first portion of the 40% of the air for primary mixing through the at least one primary mixing port into the combustion chamber and supplying a second portion of the 40% of the air for primary mixing to provide convective cooling of the at least one double skin annular wall before being supplied through the at least one additional primary mixing port into the combustion chamber, supplying a first portion of the 40% of the air for secondary mixing through the at least one secondary mixing port into the combustion chamber and supplying a second portion of the 40% of the air for secondary mixing to provide convective cooling of the at least one double skin annular wall before being supplied through the at least one additional secondary mixing port into the combustion chamber and supplying the 10% of the air for cooling the at least one double skin annular wall and the upstream wall to provide convective cooling and effusion cooling of the at least one double skin annular wall and/or the upstream wall.

[0010] The method may comprise supplying half of the air for primary mixing through the at least one primary mixing port into the combustion chamber and supplying half of the air for primary mixing to provide convective cooling of the at least one double skin annular wall before being supplied through the at least one additional primary mixing port into the combustion chamber.

[0011] The method may comprise supplying half of the air for secondary mixing through the at least one secondary mixing port into the combustion chamber and supplying half of the air for secondary mixing to provide convective cooling of the at least one double skin annular

wall before being supplied through the at least one additional secondary mixing port into the combustion chamber.

[0012] The at least one double skinned annular wall may comprise a plurality of circumferentially spaced primary mixing ports and a plurality of circumferentially spaced secondary mixing ports.

[0013] The at least one double skinned annular wall may comprise a plurality of circumferentially spaced additional primary mixing ports and a plurality of circumferentially spaced additional secondary mixing ports.

[0014] The at least one additional primary mixing port may be arranged around the at least one primary mixing port.

[0015] The at least one additional secondary mixing port may be arranged around the at least one secondary mixing port.

[0016] The combustion chamber may be an annular combustion chamber comprising a radially inner double skinned annular wall and a radially outer double skinned annular wall.

[0017] The combustion chamber may be a tubular combustion chamber comprising a single double skinned annular wall.

[0018] The present invention will be more fully described by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a cross-sectional view through a turbofan gas turbine engine having a combustion chamber according to the present invention.

Figure 2 is an enlarged cross-sectional view through the combustion chamber shown in figure 1.

Figure 3 is an enlarged cross-sectional view of a wall and a mixing port in the wall of the combustion chamber shown in figure 2.

Figure 4 is an alternative enlarged cross-sectional view of a wall and a mixing port in the wall of the combustion chamber shown in figure 2.

Figure 5 is another enlarged cross-sectional view of a wall and a mixing port in the wall of the combustion chamber shown in figure 2.

[0019] A turbofan gas turbine engine 10, as shown in figure 1, comprises in flow series an inlet 12, a fan section 14, a compressor section 16, a combustion section 18, a turbine section 20 and an exhaust 22. The fan section 14 comprises a fan 24. The compressor section 16 comprises in flow series an intermediate pressure compressor 26 and a high pressure compressor 28. The turbine section 20 comprises in flow series a high pressure turbine 30, an intermediate pressure turbine 32 and a low pressure turbine 34. The fan 24 is driven by the low pressure turbine 34 via a shaft 40. The intermediate pressure

compressor 26 is driven by the intermediate pressure turbine 32 via a shaft 38 and the high pressure compressor 28 is driven by the high pressure turbine 30 via a shaft 36. The turbofan gas turbine engine 10 operates quite conventionally and its operation will not be discussed further. The turbofan gas turbine engine 10 has a rotational axis X.

[0020] The combustion section 18 comprises an annular combustion chamber 42, which is shown more clearly in figure 2. The annular combustion chamber 42 has a radially inner annular wall 44, a radially outer annular wall 46 and an upstream wall 48 connecting the upstream ends of the radially inner annular wall 44 and the radially outer annular wall 46. The annular combustion chamber 42 is surrounded by a casing 50. The upstream wall 48 has a plurality of circumferentially spaced fuel injector apertures 52 and each fuel injector aperture 52 has a respective one of a plurality of fuel injectors 54. The upstream wall 48 also has a plurality of smaller diameter cooling apertures 56 through which a flow of coolant, air, is arranged to flow in operation. The radially inner annular wall 44 has a plurality of circumferentially spaced mixing ports 58 through which a flow of mixing air is arranged to flow into the annular combustion chamber 42 in operation. The radially outer annular wall 46 has a plurality of circumferentially spaced mixing ports 62 through which a flow of mixing air is arranged to flow into the annular combustion chamber 42 in operation. The fuel injector apertures 52 in the upstream wall 48 define inlets for primary air for the annular combustion chamber 42.

[0021] The radially inner annular wall 44 is a double skin annular wall and the radially outer annular wall 46 is a double skin annular wall. The radially inner annular wall 44 comprises a radially inner wall 66 and a radially outer wall 68 and the radially outer annular wall 46 comprises a radially inner wall 70 and a radially outer wall 72. The radially outer wall 68 of the radially inner annular wall 44 comprises a plurality of tiles 68A and 68B and the radially inner wall 70 of the radially outer annular wall 46 comprises a plurality of tiles 70A and 70B. The double skin radially inner annular wall 44 has a plurality of circumferentially spaced primary mixing ports 58A extending there-through and a plurality of circumferentially spaced secondary mixing ports 58B extending there-through and the secondary mixing ports 58B are arranged downstream of the primary mixing ports 58A. The double skin radially outer annular wall 46 has a plurality of circumferentially spaced primary mixing ports 62A extending there-through and a plurality of circumferentially spaced secondary mixing ports 62B extending there-through and the secondary mixing ports 62B are arranged downstream of the primary mixing ports 62A. The radially outer wall 68 of the double skin radially inner wall 44 has a plurality of circumferentially spaced additional primary mixing ports 74A extending there-through adjacent the primary mixing ports 58A, the radially outer wall 68 of the double skin radially inner wall 44 also has a

plurality of circumferentially spaced additional secondary mixing ports 74B extending there-through adjacent the secondary mixing ports 58B. The radially inner wall 70 of the double skin radially outer wall 46 has a plurality of circumferentially spaced additional primary mixing ports 76A extending there-through adjacent the primary mixing ports 62A, the radially inner wall 70 of the double skin radially outer wall 46 also has a plurality of circumferentially spaced additional secondary mixing ports 76B extending there-through adjacent the secondary mixing ports 62B. Each of the additional primary mixing ports 74A is arranged around the respective primary mixing port 58A and each of the additional secondary mixing ports 74B is arranged around the respective secondary mixing port 58B. Similarly each of the additional primary mixing ports 76A is arranged around the respective primary mixing port 62A and each of the additional secondary mixing ports 76B is arranged around the respective secondary mixing port 62B.

[0022] The radially inner wall 66 of the double skin radially inner annular wall 44 also has a plurality of smaller diameter cooling apertures 60 through which a flow of coolant, air, is arranged to flow in operation. The coolant, air, is arranged to flow through the apertures 60 into chambers 80 defined between the radially inner wall 66 and the tiles 68A and 68B of the radially outer wall 68 of the double skin radially inner wall 44. The coolant is arranged to impinge upon the radially inner surfaces 82 of the tiles 68A and 68B to provide impingement cooling and then to flow over the radially inner surfaces 82 of the tiles 68A and 68B to provide convective cooling of the tiles 68A and 68B. The tiles 68A and 68B of the radially outer wall 68 of the double skin radially inner annular wall 44 have a plurality of effusion cooling apertures 78 through which a flow of coolant, air, is arranged to flow in operation from the chambers 80 and over the radially outer surfaces 84 of the tiles 68A and 68B. Some of the coolant in the chambers 80 is arranged to flow through the additional primary mixing ports 74A and the additional secondary mixing ports 74B.

[0023] The radially outer wall 72 of the double skin radially outer annular wall 46 also has a plurality of smaller diameter cooling apertures 64 through which a flow of coolant, air, is arranged to flow in operation. The coolant, air, is arranged to flow through the apertures 64 into chambers 88 defined between the radially outer wall 72 and the tiles 70A and 70B of the radially inner wall 70 of the double skin radially outer wall 46. The coolant is arranged to impinge upon the radially outer surfaces 90 of the tiles 70A and 70B to provide impingement cooling and then to flow over the radially outer surfaces 90 of the tiles 70A and 70B to provide convective cooling of the tiles 70A and 70B. The tiles 70A and 70B of the radially inner wall 70 of the double skin radially outer annular wall 46 have a plurality of effusion cooling apertures 86 through which a flow of coolant, air, is arranged to flow in operation from the chambers 88 and over the radially inner surfaces 92 of the tiles 70A and 70B. Some of the

wall 44 and the double skin radially outer annular wall 46 and the upstream wall 48 provides convective cooling and/or effusion cooling of the double skin radially inner annular wall 44, the double skin radially outer annular wall 46 and the upstream wall 48.

[0027] In the examples given above half of the air for mixing is supplied through the mixing ports 58A, 58B, 62A and 62B into the combustion chamber 42 and half of the air for mixing is used to provide impingement and/or convective cooling of the double skin radially inner annular wall 44 and the double skin radially outer annular wall 46 before being supplied through the additional mixing ports 74A, 74B, 76A and 76B into the combustion chamber 42. In particular half of the air for primary mixing A is supplied through the primary mixing ports 58A and 62A into the combustion chamber 42 and half of the air for primary mixing B is used to provide impingement and/or convective cooling of the double skin radially inner annular wall 42 and the double skin radially outer annular wall 46 before being supplied through the additional primary mixing ports 74A and 76A into the combustion chamber 42 and half of the air for secondary mixing C is supplied through the secondary mixing ports 58B and 62B into the combustion chamber 42 and half of the air for secondary mixing D is used to provide impingement and/or convective cooling of the double skin radially inner annular wall 44 and the double skin radially outer annular wall 46 before being supplied through the additional secondary mixing ports 74B and 76B into the combustion chamber 42.

[0028] Figure 3 shows an embodiment of the double skin radially outer annular wall 46 and shows a tile 70A of the radially inner wall 70 and the radially outer wall 72. The radially outer wall 72 has apertures 64 to provide impingement cooling of the radially outer surface 90 of the tiles 70A, alternatively the radially outer surface 90 of the tiles 70A may be convectively cooled or the radially outer surface 90 of the tiles 70A may be provided with radially outwardly extending ribs, or projections, to provide cooling of the tiles 70A. Each mixing port 62A is defined by a boss 94 which is integral, e.g. cast integral, with the tile 70A and abuts the radially inner surface of the radially outer wall 72. Each additional mixing port 76A, or 76B, comprises one or more slots in the tile 70A which are arranged around, e.g. concentrically around, the boss 94.

[0029] Figure 4 shows another embodiment of the double skin radially outer annular wall 46 and shows a tile 70A of the radially inner wall 70 and the radially outer wall 72. The radially outer wall 72 has apertures 64 to provide impingement cooling of the radially outer surface 90 of the tiles 70A, alternatively the radially outer surface 90 of the tiles 70A may be convectively cooled or the radially outer surface 90 of the tiles 70A may be provided with radially outwardly extending ribs, or projections, to provide cooling of the tiles 70A. The tiles 70A also have effusion cooling apertures 86 at predetermined locations to cool hot spots on the tiles 70A. Each mixing port 62A

is defined by a boss 96 which extends radially through the radially outer wall 72 and a tile 70A of the radially inner wall 70 and the boss 96 has a flange 98 which abuts, and is secured to, the radially outer surface of the radially outer wall 72. Each additional mixing port 76A, or 76B, comprises an annular slot defined between the tile 70A and the boss 96. Each additional mixing port 76A or 76B is concentric with the boss 96.

[0030] Figure 5 shows a further embodiment of the double skin radially outer annular wall 46 and shows a tile 70A of the radially inner wall 70 and the radially outer wall 72. The radially outer wall 72 has apertures 64 to provide impingement cooling of the radially outer surface 90 of the tiles 70A, alternatively the radially outer surface 90 of the tiles 70A may be convectively cooled or the radially outer surface 90 of the tiles 70A may be provided with radially outwardly extending ribs, or projections, to provide cooling of the tiles 70A. Each mixing port 62A is defined by a boss 100 which extends radially through the tile 70A of the radially inner wall 70 and the boss 100 has a flange 102 which abuts, and is secured to, the radially inner surface of the radially outer wall 72. Each additional mixing port 76A, or 76B, comprises an annular slot defined between the tile 70A and the boss 100. Each additional mixing port 76A or 76B is concentric with the boss 100. Each boss 100 has a portion 104 which extends radially into the combustion chamber 42 and enhances mixing in the combustion chamber 42. The portion 104 is chamfered such that the downstream end 106 extends radially further into the combustion chamber 42 than the upstream end 108. The additional mixing air flowing through the additional mixing port 76A, 76B also cools the portion of the boss 100 extending into the combustion chamber 42.

[0031] Although the present invention has been described with reference to an annular combustion chamber comprising a radially inner double skinned annular wall and a radially outer double skinned annular wall, the present invention is equally applicable to a tubular combustion chamber comprising a single double skinned annular wall.

[0032] The present invention provides more air than is currently supplied for mixing purposes. The present invention uses some, or all, of the air currently used to provide film cooling of the inner wall of the double skinned annular wall(s) to provide convection cooling and/or effusion cooling of the double skinned annular wall(s) and this air is then supplied through the additional mixing port in the inner wall of the double skinned annular wall(s) to function as mixing air to provide supplementary mixing air. The present invention provides these additional mixing ports adjacent to, around, the mixing ports. The additional mixing ports may be concentric annular slots around the mixing ports or as a plurality of slots arranged concentrically with the mixing ports. In addition, the present invention uses some of the air currently supplied through the mixing ports and used as mixing air to provide convection cooling and/or effusion cooling of the double

skinned annular wall(s) and this air is then supplied through the additional mixing port in the inner wall of the double skinned annular wall(s) to function as mixing air to provide supplementary mixing air.

[0033] In the present invention the air supplied through the mixing ports is used as an ejector, or energiser, for the air supplied through the corresponding additional mixing port.

[0034] The advantage of the present invention is that it increases the amount of air available for mixing in a "rich burn" combustion chamber and therefore improves the mixing process within the combustion chamber and hence reduces engine emissions. In addition the present invention significantly increases the amount of air available for cooling of the double skinned annular wall(s) compared to current designs. The increased mass flow of air for cooling of the double skinned annular wall(s) reduces the level of temperature rise in the cooling air, so improving the cooling performance and at the same time any temperature rise that does occur in the cooling air is beneficial in improving the mixing performance in the combustion chamber, because this spent cooling air is supplied through the additional mixing port(s). The supply of mixing air through the double skinned annular wall(s) results in a pressure drop in the cooling air and hence in the cooling air supplied through the additional mixing port(s) as mixing air. This pressure drop reduces the ability of the cooling air flowing through the additional mixing port(s) to mix efficiently with the combustion products in the combustion chamber. That is why the present invention does not supply all the air required for mixing through the double skinned annular wall(s) to cool the double skinned annular wall(s) before being used as mixing air. An optimum use of the air is to supply half of the air directly through the mixing port(s) as mixing air and to supply half of the air for cooling the double skinned annular wall(s) and then through the additional mixing port(s) as mixing air so as to provide sufficient momentum to achieve efficient mixing of the mixing air and combustion products in the combustion chamber.

Claims

1. A method of operating a combustion chamber (42), the combustion chamber (42) comprising an upstream wall (48) having at least one inlet (52) for a fuel injector (54) and primary air, at least one double skin annular wall (44, 46), the at least one double skin annular wall (44, 46) comprising an inner wall (66, 70) and an outer wall (68, 72), the at least one double skin annular wall (44, 46) having at least one mixing port (58A, 58B, 62A, 62B) extending there-through, the inner wall (66, 70) or the outer wall (68, 72) having at least one additional mixing port (74A, 74B, 76A, 76B) extending there-through adjacent the mixing port (58A, 58B, 62A, 62B), the method comprising supplying air for the combus-

tion chamber (42),

the method comprising supplying 10% of the air for the combustion chamber (42) through the inlet (52) in the upstream wall (48), supplying 64% to 80% of the air for mixing, and supplying 10% to 26% of the air for cooling the at least one double skin annular wall (44, 46) and the upstream wall (48), the method further comprising supplying a first portion of the 64% to 80% of the air for mixing through the at least one mixing port (58A, 58B, 62A, 62B) into the combustion chamber (42) and supplying a second portion of the 64% to 80% of the air for mixing to provide convective cooling of the at least one double skin annular wall (44, 46) before being supplied through the additional mixing port (74A, 74B, 76A, 76B) into the combustion chamber (42) and supplying the 10% to 26% of the air for cooling the at least one double skin annular wall (44, 46) and the upstream wall (48) to provide convective cooling and/or effusion cooling of the at least one double skin annular wall (44, 46) and the upstream wall (48).

2. A method as claimed in claim 1 wherein the at least one mixing port (58A, 58B, 62A, 62B) extending through the at least one double skin annular wall (44, 46) comprising at least one primary mixing port (58A, 62A) extending through the at least one double skin annular wall (44, 46) and at least one secondary mixing port (58B, 62B) extending through the at least one double skin annular wall (44, 46) and arranged downstream of the at least one primary mixing port (58A, 62A), the at least one additional mixing port (74A, 74B, 76A, 76B) in the inner wall (66, 70) or outer wall (68, 72) comprising at least one additional primary mixing port (74A, 76A) extending through the inner wall (66, 70) or the outer wall (68, 72) adjacent the primary mixing port (58A, 62A) and at least one additional secondary mixing port (74B, 76B) extending through the inner wall (66, 70) or the outer wall (68, 72) adjacent the secondary mixing port (58B, 62B), the method comprising supplying 10% of the air for the combustion chamber (42) through the inlet (52) in the upstream wall (48), supplying 32% to 40% of the air for primary mixing, supplying 32% to 40% of the air for secondary mixing and supplying 10% to 26% of the air for cooling the at least one double skin annular wall (44, 46) and the upstream wall (48), the method further comprising supplying a first portion of the 32% to 40% of the air for primary mixing through the at least one primary mixing port (58A, 62A) into the combustion chamber (42) and supplying a second portion of the 32% to 40% of the air for primary mixing to provide convective cooling of the at least one double skin annular wall (44, 46) before being supplied through the at least one additional primary mixing port (74A, 76A) into the combustion chamber (42), supplying a first portion of the 32% to

40% of the air for secondary mixing through the at least one secondary mixing port (58B, 62B) into the combustion chamber (42) and supplying a second portion of the 32% to 40% of the air for secondary mixing to provide convective cooling of the at least one double skin annular wall (44, 46) before being supplied through the at least one additional secondary mixing port (74B, 76B) into the combustion chamber (42) and supplying the 10% to 26% of the air for cooling the at least one double skin annular wall (44, 46) and the upstream wall (48) to provide convective cooling and/or effusion cooling of the at least one double skin annular wall (44, 46) and the upstream wall (48).

3. A method as claimed in claim 2 comprising supplying 10% of the air for the combustion chamber (42) through the inlet (52) in the upstream wall (48), supplying 35% to 40% of the air for primary mixing, supplying 35% to 40% of the air for secondary mixing and supplying 10% to 20% of the air for cooling the at least one double skin annular wall (44, 46) and the upstream wall (48),
the method further comprising supplying a first portion of the 35% to 40% of the air for primary mixing through the at least one primary mixing port (58A, 62A) into the combustion chamber (42) and supplying a second portion of the 35% to 40% of the air for primary mixing to provide convective cooling of the at least one double skin annular wall (44, 46) before being supplied through the at least one additional primary mixing port (74A, 76A) into the combustion chamber (42), supplying a first portion of the 35% to 40% of the air for secondary mixing through the at least one secondary mixing port (58B, 62B) into the combustion chamber (42) and supplying a second portion of the 35% to 40% of the air for secondary mixing to provide convective cooling of the at least one double skin annular wall (44, 46) before being supplied through the at least one additional secondary mixing port (74B, 76B) into the combustion chamber (42) and supplying the 10% to 20% of the air for cooling the at least one double skin annular wall (44, 46) and the upstream wall (48) to provide convective cooling and/or effusion cooling of the at least one double skin annular wall (44, 46) and the upstream wall (48).
4. A method as claimed in claim 2 or claim 3 comprising supplying 10% of the air for the combustion chamber (42) through the inlet (52) in the upstream wall (48), supplying 40% of the air for primary mixing, supplying 40% of the air for secondary mixing and supplying 10% of the air for cooling the at least one double skin annular wall (44, 46) and the upstream wall (48),
the method further comprising supplying a first portion of the 40% of the air for primary mixing through the at least one primary mixing port (58A, 62A) into

the combustion chamber (42) and supplying a second portion of the 40% of the air for primary mixing to provide convective cooling of the at least one double skin annular wall (44, 46) before being supplied through the at least one additional primary mixing port (74A, 76A) into the combustion chamber (42), supplying a first portion of the 40% of the air for secondary mixing through the at least one secondary mixing port (58B, 62B) into the combustion chamber (42) and supplying a second portion of the 40% of the air for secondary mixing to provide convective cooling of the at least one double skin annular wall (44, 46) before being supplied through the at least one additional secondary mixing port (74B, 76B) into the combustion chamber (42) and supplying the 10% of the air for cooling the at least one double skin annular wall (44, 46) and the upstream wall (48) to provide convective cooling and effusion cooling of the at least one double skin annular wall (44, 46) and/or the upstream wall (48).

5. A method as claimed in claim 2, claim 3 or claim 4 comprising supplying half of the air for primary mixing through the at least one primary mixing port (58A, 62A) into the combustion chamber (42) and supplying half of the air for primary mixing to provide convective cooling of the at least one double skin annular wall (44, 46) before being supplied through the at least one additional primary mixing port (74A, 76A) into the combustion chamber (42).
6. A method as claimed in any of claims 2 to 5 comprising supplying half of the air for secondary mixing through the at least one secondary mixing port (58B, 62B) into the combustion chamber (42) and supplying half of the air for secondary mixing to provide convective cooling of the at least one double skin annular wall (44, 46) before being supplied through the at least one additional secondary mixing port (74B, 76B) into the combustion chamber (42).
7. A method as claimed in any of claims 2 to 6 wherein the at least one double skinned annular wall (44, 46) comprises a plurality of circumferentially spaced primary mixing ports (58A, 62A) and a plurality of circumferentially spaced secondary mixing ports (58B, 62B).
8. A method as claimed in any of claims 2 to 7 wherein the at least one double skinned annular wall (44, 46) comprises a plurality of circumferentially spaced additional primary mixing ports (74A, 76A) and a plurality of circumferentially spaced additional secondary mixing ports (74B, 76B).
9. A method as claimed in any of claims 2 to 8 wherein the at least one additional primary mixing port (74A, 76A) is arranged around the at least one primary

mixing port (58A, 62A).

10. A method as claimed in any of claims 2 to 9 wherein the at least one additional secondary mixing port (74B, 76B) is arranged around the at least one secondary mixing port (58B, 62B). 5
11. A method as claimed in claim 1 comprising supplying half of the air for mixing through the at least one mixing port (58A, 58B, 62A, 62B) into the combustion chamber (42) and supplying half of the air for mixing to provide convective cooling of the at least one double skin annular wall (44, 46) before being supplied through the at least one additional mixing port (74A, 74B, 76A, 76B) into the combustion chamber (42). 10 15
12. A method as claimed in any of claims 1 to 11 wherein the combustion chamber (42) is an annular combustion chamber comprising a radially inner double skinned annular wall (44) and a radially outer double skinned annular wall (46). 20
13. A method as claimed in any of claims 1 to 11 wherein the combustion chamber is a tubular combustion chamber comprising a single double skinned annular wall. 25
14. A method as claimed in any of claims 1 to 13 wherein the combustion chamber (42) is a gas turbine engine combustion chamber. 30

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Fig.1

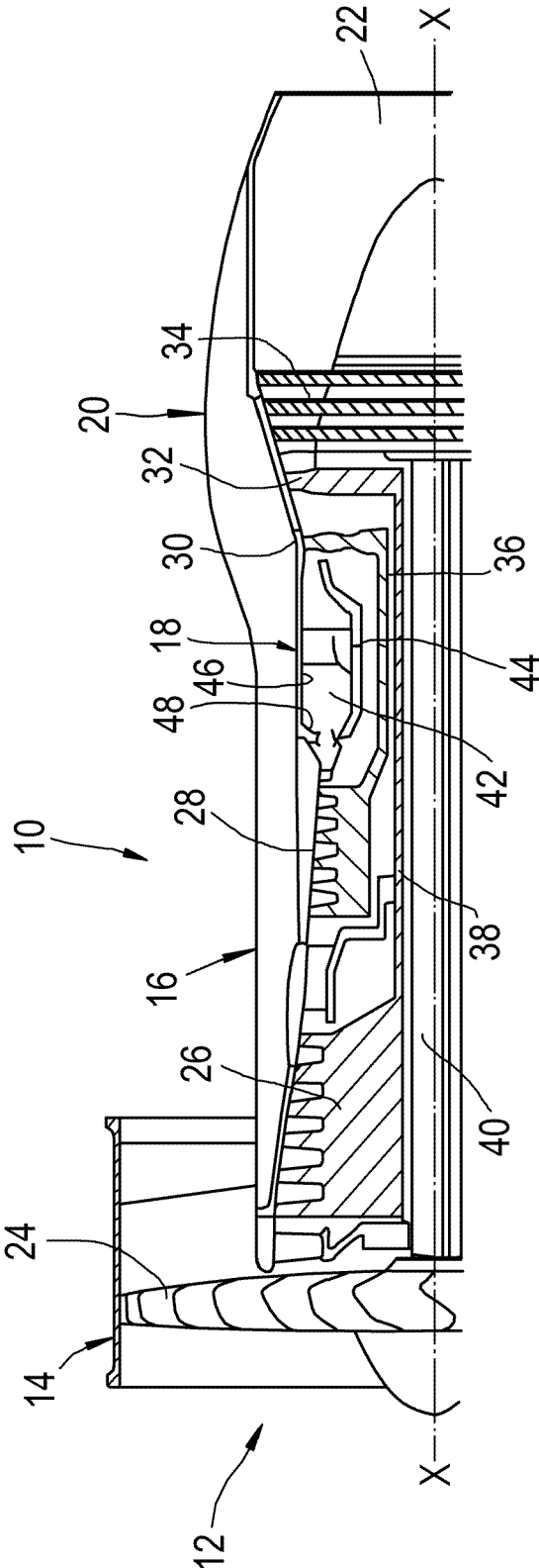


Fig.2

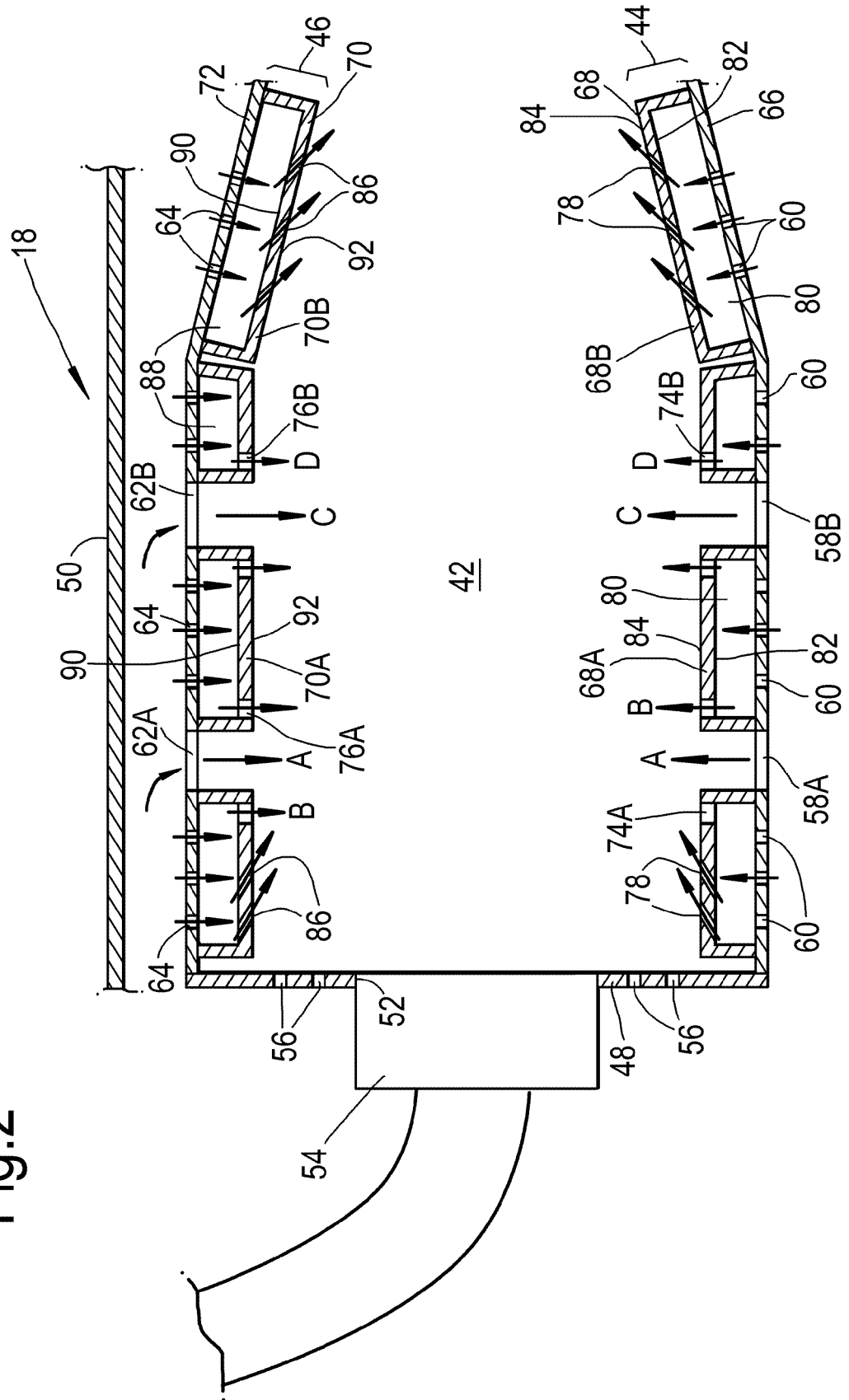


Fig.3

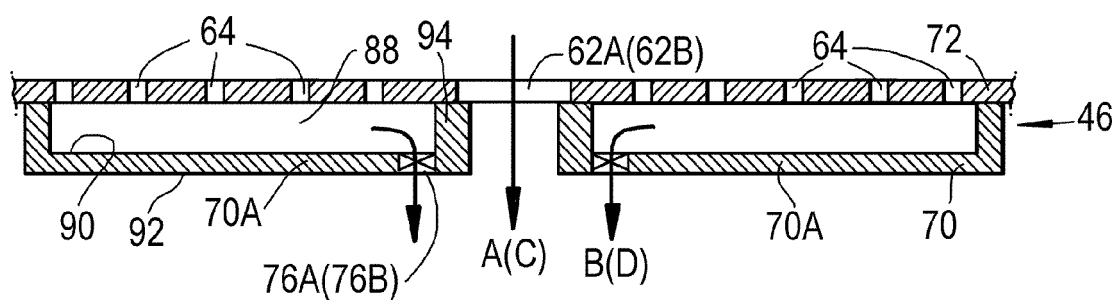


Fig.4

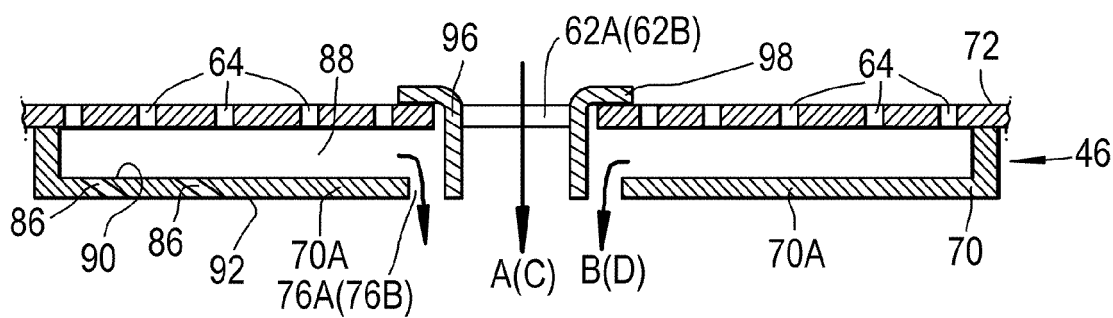


Fig.5

