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(54) **A COMBUSTOR ASSEMBLY**

(57) The present disclosure relates to a combustor assembly 16 for a gas turbine engine 10, the combustor assembly 16 comprising: a combustor wall 30 defining a combustion chamber 25 and comprising an opening periphery 33, the opening periphery 33 defining a first opening 32; a sealing element 34 comprising an annular body 35, the annular body 35 extending around a sealing element axis S and extending through the first opening 32, the sealing element 34 further comprising a flange 38 extending radially outward from the annular body 35 with respect to the axis S to a distal surface 58, the flange 38 slidably coupling the sealing element 34 and the combustor wall 30 and forming a seal or first partial seal be-

tween the sealing element 34 and the combustor wall 30, the annular body comprising an outer surface 37 and an inner surface 36, the inner surface 36 defining a second opening 49 configured to receive a fuel nozzle 40, wherein a first total clearance D_1, D_2 between the outer surface 37 and the opening periphery 33 in a first direction A is greater than a second total clearance d_1, d_2 between the outer surface 37 and the opening periphery 33 in a second direction B perpendicular to the first direction A such that the sealing element 34 is able to slide relative to the combustor wall 30 by a greater extent in the first direction A than in the second direction B.

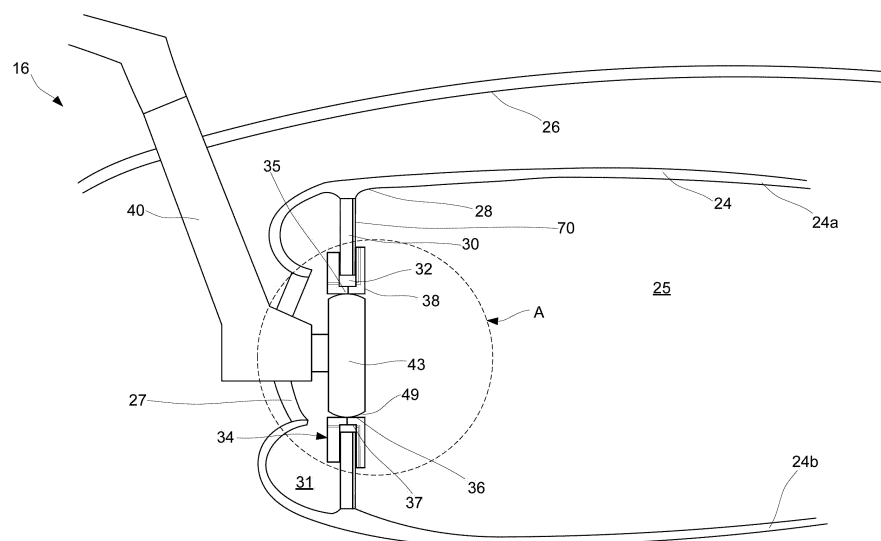


Figure 2

Description

Field of Invention

[0001] The present disclosure relates to a combustor assembly for a gas turbine engine.

Background

[0002] Gas turbine engines typically comprise a combustor in which combustion takes place. Fuel is combined with high pressure air and combusted, and the resulting high temperature gases are exhausted to drive the turbine. Typical combustors have an annular configuration. The combustor comprises a combustor liner or wall, which defines a combustion chamber. A fuel injector nozzle or fuel spray nozzle interfaces with the liner via an aperture and delivers fuel into the combustion chamber.

[0003] During operation of the engine, the combustor liner and the fuel spray nozzles are subject to relative movement as a result of being mounted at different locations within the engine and being exposed to different temperatures, and thus having different rates of thermal expansion. It is therefore important to control the relative positions of the combustor liner and the fuel spray nozzles to maximise combustion efficiency. It is known to provide a burner seal positioned between each of the fuel spray nozzles and the respective aperture of the combustor liner. The burner seal allows limited relative movement between the fuel spray nozzle and the liner. However, such arrangements require a large amount of space within the combustor to accommodate the burner seal, which reduces the space available for other components, such as the fuel spray nozzle, as the overall engine space is limited. This sets design limits for the combustor, which results in failing to maximise combustor performance and efficiency.

[0004] There is therefore a need to develop a combustor assembly which addresses some or all of the aforementioned problems.

Summary of Invention

[0005] According to a first aspect of the disclosure, there is provided a combustor assembly for a gas turbine engine, the combustor assembly comprising: a combustor wall defining a combustion chamber and comprising an opening periphery, the opening periphery defining a first opening; a sealing element comprising an annular body, the annular body extending around a sealing element axis and extending through the first opening, the sealing element further comprising a flange extending radially outward from the annular body with respect to the axis to a distal surface, the flange slidably coupling the sealing element and the combustor wall and forming a seal or partial seal between the sealing element and the combustor wall, the annular body comprising an outer surface and an inner surface, the inner surface defining

a second opening configured to receive a fuel nozzle, wherein a first total clearance between the outer surface and the opening periphery in a first direction is greater than a second total clearance between the outer surface and the opening periphery in a second direction perpendicular to the first direction such that the sealing element is able to slide relative to the combustor wall by a greater extent in the first direction than in the second direction.

[0006] A maximum dimension of the first opening in the first direction may be greater than a maximum dimension of the first opening in the second direction.

[0007] The second total clearance may be greater than zero along a continuous range of positions extending along the first direction.

[0008] A radius of curvature of the opening periphery at all points around the opening periphery may be greater than a radius of curvature of the outer surface at all points around the outer surface.

[0009] The second total clearance may be constant along a continuous range of positions extending along the first direction.

[0010] The opening periphery may be obround.

[0011] The opening periphery may be elliptical.

[0012] The cross-sectional profile of the outer surface on a plane perpendicular to the sealing element axis may be circular.

[0013] The combustor wall may form part of a combustor liner that extends around the sealing element axis. A maximum dimension of the first opening may extend radially with respect to the sealing element axis.

[0014] The sealing element may comprise at least one cooling air passage. The at least one cooling air passage may be defined at least in part by the flange. The at least one cooling air passage may comprise an outlet portion having an outlet configured to deliver cooling air to the combustion chamber. The outlet may be defined by the distal surface.

[0015] The outlet portion may extend parallel to a surface of the combustor wall with which the seal or partial seal is formed.

[0016] The outlet portion may extend radially with respect to the sealing element axis through the flange.

[0017] A radial distance between the outer surface and the outlet may be at least 1.5 times the maximum width of the outlet measured in a direction parallel to the sealing element axis.

[0018] A minimum total overlap of the flange and the combustor wall may be at least twice the radial distance between the outer surface and the outlet.

[0019] The sealing element may comprise a further flange extending radially outward from the annular body. The combustor wall may be partly disposed between the flange and the further flange. The further flange may slidably couple the sealing element and the combustor wall and form a further seal or partial seal between the sealing element and the combustor wall.

[0020] The at least one cooling air passage may further comprise an inlet portion. The inlet portion may be de-

fined at least in part by the further flange.

[0021] The combustor assembly may further comprise a plurality of cooling air passages. The plurality of cooling air passages may be disposed circumferentially about the sealing element axis.

[0022] The combustor wall may further comprise a heatshield.

[0023] The cross-sectional profile of the distal surface on a plane perpendicular to the sealing element axis may be circular.

Brief Description of the Drawings

[0024]

Figure 1 is a cross-sectional view of an example gas turbine engine;

Figure 2 is a cross-sectional view of an example combustor assembly of the gas turbine engine;

Figure 3 is a closeup cross-sectional view of the region marked A in Figure 2;

Figure 4 is a cross-sectional view through the plane C-C shown in Figure 3, showing a first variant of the combustor assembly;

Figure 5 is an end view of the example combustor assembly from a downstream side of the combustor assembly; and

Figure 6 is a cross-sectional view through the plane C-C shown in Figure 3, showing a second variant of the combustor assembly.

Detailed Description of the Disclosure

[0025] **Figure 1** is a cross-sectional view of a gas turbine engine 10 having a principal and rotational axis 11. The engine 10 comprises, in axial flow series, an air intake 12, a propulsive fan 13, an intermediate pressure compressor 14, a high-pressure compressor 15, combustion equipment 16, a high-pressure turbine 17, an intermediate pressure turbine 18, a low-pressure turbine 19 and an exhaust nozzle 20. A nacelle 21 generally surrounds the engine 10 and defines both the intake 12 and the exhaust nozzle 20.

[0026] The gas turbine engine 10 works in the conventional manner so that air entering the intake 12 is accelerated by the fan 13 to produce two air flows: a first air flow into the intermediate pressure compressor 14 and a second air flow which passes through a bypass duct 22 to provide propulsive thrust. The intermediate pressure compressor 14 compresses the air flow directed into it before delivering that air to the high-pressure compressor 15 where further compression takes place.

[0027] The compressed air exhausted from the high-

pressure compressor 15 is directed into the combustion equipment 16 where it is mixed with fuel and the mixture combusted.

[0028] The resultant hot combustion products then expand through, and thereby drive the high, intermediate and low-pressure turbines 17, 18, 19 before being exhausted through the nozzle 20 to provide additional propulsive thrust. The high 17, intermediate 18 and low 19 pressure turbines drive respectively the high-pressure compressor 15, intermediate pressure compressor 14 and fan 13, each by suitable interconnecting shafts.

[0029] Other gas turbine engines to which the present disclosure may be applied may have alternative configurations. By way of example such engines may have an alternative number of interconnecting shafts (e.g. two) and/or an alternative number of compressors and/or turbines. Further the engine may comprise a gearbox provided in the drive train from a turbine to a compressor and/or fan.

[0030] **Figure 2** is a cross-sectional view of an example combustor assembly 16 of the gas turbine engine 10. The combustor assembly 16 comprises a casing 26, which extends around the rotational axis 11 of the gas turbine engine 10. A liner 24 is positioned within the casing 26. The liner 24 defines a combustion chamber 25. The liner 24 comprises an annular shape. In particular, the liner 24 comprises a toroidal shape, extending circumferentially around a central axis which is substantially coaxial with the engine rotational axis 11. Accordingly, the liner can be said to comprise an outer wall 24a and an inner wall 24b which are radially spaced from one another with respect to the central axis of the liner 24. The inner wall 24a and outer wall 24b are connected at their upstream ends by a combustor wall 30 or bulkhead wall. The combustor wall 30 divides the combustor assembly 16 into a cooling chamber 31 and the combustion chamber 25. The terms "upstream" and "downstream" are used in this disclosure refer to the directions defined by the flow of fluid through the gas turbine engine 10.

[0031] The inner wall 24a and outer wall 24b extend upstream of the combustor wall 30 to form a domed combustor head 29. The combustor head 29 comprises a plurality of apertures 27. The plurality of apertures 27 are spaced circumferentially about the central axis. The plurality of apertures 27 are fluidically coupled to the compressor 15. Air delivered from the compressor 15 is able to enter the cooling chamber 31 via the apertures 27.

[0032] The combustor assembly 16 further comprises a plurality of fuel nozzles 40. The plurality of fuel nozzles 40 are configured to deliver fuel to the combustion chamber 25. The fuel nozzles 40 are suspended from the casing 26. Each fuel nozzle 40 extends through a respective one of the apertures 27. Each fuel nozzle 40 also extends into the combustion chamber 25 via a respective combustor wall opening 32 extending through the combustor wall 30. The combustor wall openings 32 form a circumferentially spaced array of combustor wall openings 32, which correspond to the circumferentially spaced aper-

tures 27.

[0033] The fuel nozzle 40 comprises a swirler 51 at an outlet end of the fuel nozzle 40. The swirler 51 is configured to deliver high-pressure air from the compressor 15 to the combustion chamber 25 and to mix the fuel and air by imparting a swirling motion to the air. An outlet of the fuel nozzle 40 is received within the swirler 51. In other examples, the fuel nozzle 40 may not comprise a swirler 51.

[0034] The combustor wall 30 comprises a first bearing surface 41 and a third bearing surface 45. The first bearing surface 41 is on a downstream side of the combustor wall 30. The first bearing surface 41 faces towards the combustion chamber 25. The third bearing surface 45 is formed on an opposing side of the combustor wall 30 with respect to the first bearing surface 41 and therefore faces away from the combustion chamber 25. The first and third bearing surfaces 41, 45 are located adjacent to the combustor wall opening 32. The first and third bearing surfaces 41, 45 extend circumferentially around the combustor wall opening 32. An interior surface 28 of the liner 24 is formed adjacent to the first bearing surface 41. The first bearing surface 41 is therefore located between the combustor wall opening 32 and the interior surface 28. The first bearing surface 41 and the interior surface 28 are integrally formed as part of the same wall section of the liner 24. The combustor assembly 16 comprises a heatshield 70 mounted to the downstream side of the combustor wall 30. The first bearing surface 41 is formed on a downstream side of the heatshield 70. The heatshield 70 provides additional protection to the combustor wall 30 from the hot combustion gases within the combustion chamber 25. The first and third bearing surfaces 41, 45 are planar surfaces. However, in other examples, the first bearing surface 41 may be concave and the third bearing surface 45 may be convex. It will be appreciated that the term "bearing surface" as used in this disclosure relates to a surface which is configured to contact another respective bearing surface.

[0035] The combustor assembly 16 further comprises a sealing element 34 disposed at least partially within the combustor wall opening 32. The sealing element 34 forms an interface between the fuel nozzle 40 and the combustor wall 30. This interface is shown in detail in **Figure 3**, which corresponds to the region marked A in **Figure 2**.

[0036] The sealing element 34 comprises an annular body 35, a first annular flange 38 and a second annular flange 60. The annular body 35 extends around a sealing element axis S. The annular body 35 extends through the combustor wall opening 32. The annular body 35 defines a sealing element opening 49 extending there-through. The annular body 35 comprises an inner surface 36 circumscribing the sealing element opening 49 and an outer surface 37. The first annular flange 38 extends radially outward from the annular body 35 with respect to the sealing element axis S, up to a distal surface 58. It will be appreciated that in this disclosure the term "distal

surface" relates to a surface of the sealing element which defines the furthest radial extent from the sealing element axis S.

[0037] The sealing element 34 comprises a second bearing surface 43. The second bearing surface 43 is formed on the first flange 38, in particular on an upstream surface of the first flange 38. In this instance, the second bearing surface 43 faces away from the combustion chamber 25. The second bearing surface 43 extends about the sealing element axis S. The second bearing surface 43 is planar. The first flange 38 also comprises a downstream surface 44, which faces the combustion chamber 25. The downstream surface 44 partially defines a boundary of the combustion chamber 25.

[0038] The first bearing surface 41 and the second bearing surface 43 are configured to contact and slide against one another. In addition, by contacting one another, the first bearing surface 41 and the second bearing surface 43 form a first seal between the sealing element 34 and the combustor wall 30. It will be understood that a "seal" as described in the present disclosure relates to a contact between two or more surfaces which substantially limits the flow of fluid therethrough. In other words, a seal within the scope of the present disclosure may be completely fluid-tight, or allow a negligible flow of fluid through, forming a partial seal.

[0039] The sealing element opening 49 is configured to receive the fuel nozzle 40. In particular, an inner surface 36 of the sealing element opening 49 is configured to contact an outer surface 39 of the fuel nozzle 40 such that the sealing element opening 49 forms a seal with the fuel nozzle 40. In the present example, the inner surface 36 of the sealing element opening 49 is configured to slidably engage the outer surface 39 of the fuel nozzle 40. This enables the fuel nozzle 40 to move relative to the sealing element 34. In this example, the fuel nozzle 40 is configured to move axially with respect to the sealing element opening 49. In addition, the fuel nozzle 40 is configured to rotate with respect to the sealing element opening 49 in a plane perpendicular to the sealing element axis S. In this example, the outer surface 39 of the fuel nozzle 40 is formed by the outer surface of the swirler 43.

[0040] In this example, the outer surface 39 of the fuel nozzle 40 forms part of a toroidal surface. The inner surface 45 of the annular body 35 is cylindrical. The fuel nozzle 40 can therefore also rotate with respect to the sealing element opening 49 in a plane parallel to the sealing element axis S. In other examples, the inner surface 36 of the annular body 35 may alternatively form part of a toroidal surface, or both the inner surface 36 of the annular body 35 and the outer surface 39 of the fuel nozzle 40 may form part of respective toroidal surfaces.

[0041] The sealing element 34 also comprises a second annular flange 60 extending from the annular body 35. The second flange 60 extends at an upstream position from the annular body 35 with respect to the first flange 38. The second flange 60 comprises a fourth bear-

ing surface 47, which faces towards the combustion chamber 25. The fourth bearing surface 47 also faces towards the third bearing surface 45 of the combustor wall 30. The first and the third bearing surfaces 41, 45 are disposed between the second and fourth bearing surfaces 43, 47. The fourth bearing surface 47 extends about the sealing element axis S. The fourth bearing surface 47 is planar. The third bearing surface 45 and the fourth bearing surface 47 are configured to contact and slide against one another. In addition, by contacting one another, the third bearing surface 45 and the fourth bearing surface 47 form a second seal between the sealing element 34 and the combustor wall 30. The combustor wall 30 is therefore partly disposed between the first flange 38 and the second flange 60. The sealing element 34 can be cast in two halves; a first half incorporating the first flange 38 and part of the annular body 35, and a second half incorporating the second flange 60 and the other part of the annular body 35. The two halves can be brazed together around the combustor wall opening 32 at a joint 68.

[0042] The sealing element 34 further comprises a plurality of air passageways 42. Each of the plurality of air passageways 42 extends through the sealing element 34 from a respective air inlet 63 to a respective air outlet 64. In alternative arrangements, a single air passageway 42 may be provided. The air inlets 63 are formed on an upstream side of the second annular flange 60 of the sealing element 34. The air inlets 63 are circumferentially spaced about the sealing element axis S. Each air passageway 42 extends axially through the second flange 60 from the air inlet 63 defining an inlet portion 62, which extends into the clearance between the periphery 33 and the outer surface 37. The passageway 42 subsequently extends from the clearance through the first flange 38, forming the outlet portion 48, which extends to the air outlet 64 formed on the distal surface 58 of the first flange 38. The air outlet 48 extends radially through the first flange 38.

[0043] The outlet portion 48 extends parallel to the first bearing surface 41 of the combustor wall 30. The outlet portion 48 comprises a radial distance h between the outer surface 37 of the annular body 35 and the outlet 64 formed at the distal surface 58. The outlet portion 48 comprises a width w extending in a direction parallel to the sealing element axis S. The radial distance h is at least 1.5 times the width w . This enables air flowing from the clearance to the outlet portion 48 to be turned so that the air flows parallel to the first bearing surface 41 and forms a film 66 across the combustor wall 30. More preferably, the radial distance h is at least twice the width w .

[0044] Figure 4 is a cross section of the example combustor assembly 16 through the plane marked C in Figure 3, showing a first variant of the combustor assembly 16. The plane C is perpendicular to the sealing element axis S. A clearance is formed between the periphery 33 of the combustor wall opening 32 and the outer surface 37 of the annular body 35. The clearance enables the com-

bustor wall 30 to move relative to the sealing element 34. The extent of the relative movement between the sealing element 34 and the combustor wall 30 is limited by the size of the clearance. The outer surface 37 of the annular body 35 is configured to contact and engage the periphery 33 to limit the motion of the annular body 35 within the combustor wall opening 32 and thereby limit the extent of the relative movement between the sealing element 34 and the combustor wall 30.

[0045] The periphery 33 of the combustor wall opening 32 is obround. The outer surface 37 of the annular body 35 has a circular cross-section. The periphery 33 has a dimension Y_1 in a first direction A, which is shown as the vertical in Figure 4. The dimension Y_1 in the first direction A is the maximum extent of the periphery 33 in the first direction A. In a second direction B, which is perpendicular to the first direction A and shown as the horizontal in Figure 4, the periphery 33 has a dimension X_1 . The dimension X_1 is the maximum extent of the periphery 33 in the second direction B. The dimension Y_1 of the periphery 33 in the first direction A is greater than the dimension X_1 in the second direction B.

[0046] Similarly, the outer surface 37 has a dimension Y_2 in the first direction A. The dimension Y_2 in the first direction A is the maximum extent of the outer surface 37 in the first direction A. The outer surface 37 has a dimension X_2 in the second direction B. The dimension X_2 in the second direction B is the maximum extent of the outer surface 37 in the second direction A. As the cross-section of the outer surface 37 is circular, the dimension Y_2 in the first direction A is equal to the dimension X_2 in the second direction B.

[0047] Accordingly, in the first direction A there is a first clearance D_1 between the top of the periphery 33 and the outer surface 37 and a second clearance D_2 between the bottom of the periphery 33 and the outer surface 37. A first total clearance between the outer surface 37 and the periphery 33 in the first direction A is therefore $D_1 + D_2$. In the second direction B, there is a first clearance d_1 between the left of the periphery 33 and the outer surface 37 and a second clearance d_2 between the right of the periphery 33 and the outer surface 37. A second total clearance between the outer surface 37 and the periphery 33 in the second direction is therefore $d_1 + d_2$. The first total clearance $D_1 + D_2$ in the first direction A is greater than the second total clearance $d_1 + d_2$ in the second direction B. This means that the sealing element 34 is able to slide relative to the combustor wall 30 by a greater extent in the first direction A than the second direction B.

[0048] The second total clearance $d_1 + d_2$ in the second direction B is greater than zero along a continuous range of positions extending along the first direction A. In this example, the second total clearance $d_1 + d_2$ in the second direction B is greater than zero along the entire extent of the periphery 33 in the first direction A. In addition, the second total clearance $d_1 + d_2$ in the second direction B is constant along a continuous range of positions extend-

ing along the first direction A.

[0049] The radius of curvature of the periphery 33 at all points around the periphery 33 is greater than a radius of curvature of the outer surface at all points around the outer surface. This ensures that the sealing element 34 can move freely relative to the combustor wall 30, without becoming stuck or jammed.

[0050] As discussed previously, the combustor liner 24 comprises an annular shape extending circumferentially around a central axis which is substantially coaxial with the engine rotational axis 11. In the present example, the direction A, on which the maximum dimension Y_1 of the combustor wall opening 32 lies, extends in the radial direction with respect to the central axis of the liner 24. The direction B, on which the minimum dimension X_1 of the combustor wall opening 32 lies, extends in a circumferential direction with respect to the central axis of the liner 24. This enables maximum relative movement between the sealing element 34 and the combustor wall 30 in the radial direction and limited relative movement in the circumferential direction. In other examples, the maximum and minimum dimensions Y_1 , X_1 may be aligned in other directions with respect to the central axis of the liner 24.

[0051] Figure 5 shows the combustor assembly 16 as viewed from a downstream end thereof. In other words, Figure 5 shows the combustor assembly 16 as viewed from the combustion chamber 25. In this example, the first flange 38 has a circular cross-section with respect to a plane perpendicular to the sealing element axis S. The plurality of air passageways 42 have respective air outlets 64 formed at the distal end 58 of the first flange 38. The air outlets 64 are circumferentially spaced about the sealing element axis S.

[0052] The air passageway 42 fluidly couples the cooling chamber 31 and the combustion chamber 25. The cooling chamber 31 contains air from the compressor 15 which is at a relatively lower temperature than the air within the combustion chamber 25, which is at a high temperature due to the combustion process taking place therewithin. Accordingly, the air passageway 42 is configured to deliver a flow of air from the cooling chamber 31 to the combustion chamber 25. As the air outlet 64 is formed at the distal end 58 of the first flange 38, air leaving the air outlet 62 forms a film 66 across the combustor wall 30. The circular cross-section of the first flange 38 ensures that air is distributed uniformly around the sealing element 34 to the combustor wall 30.

[0053] The first flange 38 overlaps the combustor wall 30 in a radial direction with respect to the sealing element axis S. The minimum total overlap $O_1 + O_2$ between the first flange 38 and the combustor wall 30 is at least twice the radial distance h of the outlet portion 48. This means that even when the annular body 35 is positioned at the extremity of the periphery 33 in either the first direction A or the second direction B, the first flange 38 always overlaps the combustor wall 30. This ensures that the sealing element 34 does not dislodge from within the combustor wall opening 32 even when the annular body

35 is positioned at the maximum extremity of the periphery 33.

[0054] Figure 6 is a cross section of the example combustor assembly 16 through the plane marked C in Figure 3, showing a second variant of the combustor assembly 16. It will be appreciated that Figures 2-4 apply to both the first variant and the second variant of the combustor assembly 16. The second variant of the combustor assembly 16 is substantially similar to the first variant, with like reference numerals denoting like features and modified features denoted with reference numerals having an added apostrophe.

[0055] As shown, the periphery 33' of the combustor wall opening 32' of the second variant is elliptical. The elliptical periphery 33' has a major axis corresponding to the longest diameter of the ellipse and a minor axis corresponding to the shortest diameter of the ellipse. The dimension Y_1' in the first direction A is the maximum extent of the periphery 33' in the first direction A and corresponds to the major axis of the ellipse in this example. The dimension X_1' is the maximum extent of the periphery 33' in the second direction B and corresponds to the minor axis of the ellipse in this example. The dimension Y_1' of the periphery 33' in the first direction A is greater than the dimension X_1' in the second direction B.

[0056] As shown, as with the first variant, the first total clearance $D_1' + D_2'$ in the first direction A is greater than the second total clearance $d_1' + d_2'$ in the second direction B. This means that the sealing element 34 is able to slide relative to the combustor wall 30 by a greater extent in the first direction A than the second direction B.

[0057] The second total clearance $d_1' + d_2'$ in the second direction B is greater than zero along a continuous range of positions extending along the first direction A. In this example, the second total clearance $d_1' + d_2'$ in the second direction B is greater than zero along the entire extent of the periphery 33' in the first direction A. Due to the elliptical shape of the periphery 33', the second total clearance $d_1' + d_2'$ in the second direction B is variable along the entire extent of the periphery 33' in the first direction A.

[0058] The radius of curvature of the periphery 33' at all points around the periphery 33' is greater than a radius of curvature of the outer surface at all points around the outer surface. This ensures that the sealing element 34 can move freely relative to the combustor wall 30, without becoming stuck or jammed.

[0059] During operation of the engine, fuel is injected or sprayed from the fuel nozzle 40 into the combustion chamber 25 along with high-pressure air from the compressor 15. The fuel-air mixture is combusted within the combustion chamber 25. A portion of air from the compressor 15 enters the cooling chamber 31 via the aperture 27 and flows through one or more of the air inlets 63 on the upstream side of the second flange 60 to enter a respective air passageway 42. After passing through the second flange 60, the air enters the clearance between the annular body 35 and the combustor wall 30, where

it subsequently enters the outlet portion 48 of the air passageway 42 formed in the first flange 38. The air flow is turned parallel to the combustor wall 30 due to the ratio of the radial length h to the width w of the outlet portion. The first flange 38 is exposed to high temperatures as it faces the combustion chamber 25, where combustion of a mixture of fuel and high-pressure air causes the temperature of the first flange 38 to increase. As the relatively cool air flows along the outlet portion 48 of the first flange 38, heat is transferred from the first flange 38 to the air within the outlet portion 48, thereby cooling the first flange 38. The air therefore provides internal cooling for the sealing element 34. The air leaves the outlet portion 48 at the air outlet 64. As the air outlet 64 is formed at the distal surface 58 of the first flange 38, the air leaves the outlet portion 48 in a direction substantially parallel to the combustor wall 30, such that the air forms a film 66 across the first bearing surface 41 of the combustor wall 30. The film of air 66 acts to cool the first bearing surface 41 and the interior surface 28 of the combustor wall 30 and thereby protects the combustor wall 30 from the hot combustion gases within the combustion chamber 25. In addition, the circular cross-section of the first flange 38 ensures that the film of air 66 is distributed uniformly with respect to the fuel nozzle 40 at all angular positions. This means that the film of air 66 flows into the combustion chamber 25 in a uniform manner and reduces the likelihood of disrupting the flow of combustion gases in the combustion chamber 25.

[0060] The sliding contact between the first and third bearing surfaces 41, 45 of the combustor wall 30 and the second and fourth bearing surfaces 43, 47, respectively, enables the sealing element 34 to move relative to the combustor wall 30. As the fuel nozzle 40 forms a seal with the sealing element opening 49 of the sealing element 34, the hot combustion gases are substantially prevented from leaking out of the combustion chamber 25 to the upstream side of the sealing element 34. Additionally, because the sealing element 34 forms an interface between the fuel nozzle 40 and the combustor wall 30, the fuel nozzle 40 is also able to move relative to the combustor wall 30. This enables the fuel nozzle 40 to move relative to the combustor wall 30 as a result of thermal expansion and contraction due to the changing temperatures of the combustor assembly 16 in use, whilst remaining fluidly coupled to the combustion chamber 25 at all possible relative positions.

[0061] As the first total clearance $D_1 + D_2$ between the outer surface 37 and the periphery 33 in the first direction A is greater than the second total clearance $d_1 + d_2$ between the outer surface 37 and the periphery 33 in the second direction B, the sealing element 34, and therefore the fuel nozzle 40, is able to move relative to the combustor wall 30 by a greater extent in the first direction A than in the second direction B. Due to thermal expansion of the combustor assembly 16 in use, the fuel nozzle 40 tends to move relative to the combustor wall 30 by a greater extent in one direction than in others. Typically,

the greatest relative movement of the fuel nozzle 40 and the combustor wall 30 occurs in the radial direction with respect to the central axis of the liner 24. The relative movement due to thermal expansion between the fuel nozzle 40 and the combustor wall 30 in the circumferential direction with respect to the central axis of the liner 24 is typically much less in comparison. Accordingly, the combustor assembly 16 of the present disclosure allows the fuel nozzle 40 to move relative to the combustor wall 30 in the direction of greatest thermal movement i.e., in the radial direction in this example, and limits the movement of the fuel nozzle 40 relative to the combustor wall 30 in directions where thermal movement does not occur to a great extent. As a result, the arrangement of the present disclosure saves space within the combustor assembly that would otherwise be wasted by allowing relative movement between the sealing element 34 and the combustor wall 30 in all directions. This allows a larger sealing element 34 and/or a larger fuel nozzle 40 to be used relative to the size of the combustion chamber 25, in comparison to existing combustor assemblies. A larger fuel nozzle 40 allows a greater flow of air from the compressor into the combustion chamber in the area where the fuel and air are first mixed, which is of benefit for improved combustion system performance. A greater air-fuel ratio in the combustion chamber 25 reduces the likelihood of incomplete combustion and thereby reduces the production of emissions, such as soot. A more optimal air-fuel ratio in the combustion chamber 25 improves the stability of the combustion process and reduces the risk of flame extinction. Accordingly, the performance and efficiency of combustion can be improved.

[0062] It will be understood that the disclosure is not limited to the embodiments above-described and various modifications and improvements can be made without departing from the concepts described herein. Except where mutually exclusive, any of the features may be employed separately or in combination with any other features and the disclosure extends to and includes all combinations and sub-combinations of one or more features described herein.

[0063] Although it has been described that the first bearing surface 41 and the interior surface 28 are integrally formed as part of the same wall section of the liner 24, in other examples the first bearing surface 41 and the interior surface 28 may be formed on separate walls which are attached together.

[0064] Although it has been described that the first bearing surface 41 is formed on the heatshield 70, in other examples, the combustor assembly 16 may not comprise a heatshield and the first bearing surface 41 may be formed on a downstream side of the combustor wall 30.

[0065] Although it has been described that the first flange 38 has a circular cross section with respect to a plane perpendicular to the sealing element axis S, in other examples, the first flange 38 may not have a circular cross-section, and may have a different cross-section,

for example, square, rectangular, or elliptical.

[0066] Optionally, one or both of the sealing element 34 and the combustor wall 30 may comprise an anti-rotation feature to prevent relative rotation between the sealing element 34 and the combustor wall 30 in a plane perpendicular to the sealing element axis 30. This can ensure that the sealing element 34 is maintained in a consistent orientation with respect to the combustor wall 30.

Claims

1. A combustor assembly (16) for a gas turbine engine (10), the combustor assembly (16) comprising:

a combustor wall (30) defining a combustion chamber (25) and comprising an opening periphery (33), the opening periphery (33) defining a first opening (32);

a sealing element (34) comprising an annular body (35), the annular body (35) extending around a sealing element axis (S) and extending through the first opening (32), the sealing element (34) further comprising a flange (38) extending radially outward from the annular body (35) with respect to the axis (S) to a distal surface (58), the flange (38) slidably coupling the sealing element (34) and the combustor wall (30) and forming a seal or partial seal between the sealing element (34) and the combustor wall (30), the annular body (35) comprising an outer surface (37) and an inner surface (36), the inner surface (36) defining a second opening (49) configured to receive a fuel nozzle (40), wherein a first total clearance (D_1 , D_2) between the outer surface (37) and the opening periphery (33) in a first direction (A) is greater than a second total clearance (d_1 , d_2) between the outer surface (37) and the opening periphery (33) in a second direction (B) perpendicular to the first direction (A) such that the sealing element (34) is able to slide relative to the combustor wall (30) by a greater extent in the first direction (A) than in the second direction (B).

2. The combustor assembly (16) for a gas turbine engine (10) as claimed in Claim 1, wherein a maximum dimension of the first opening (32) in the first direction (A) is greater than a maximum dimension of the first opening (32) in the second direction (B).
3. The combustor assembly (16) as claimed in Claim 1 or Claim 2, wherein the second total clearance (d_1 , d_2) is greater than zero along a continuous range of positions extending along the first direction (A).
4. The combustor assembly (16) as claimed in any one

of the preceding claims, wherein a radius of curvature of the opening periphery (33) at all points around the opening periphery (33) is greater than a radius of curvature of the outer surface (37) at all points around the outer surface (37).

5. The combustor assembly (16) as claimed in any one of the preceding claims, wherein the second total clearance (d_1 , d_2) is constant along a continuous range of positions extending along the first direction (A).
6. The combustor assembly (16) as claimed in any one of the preceding claims, wherein the cross-sectional profile of the outer surface (37) on a plane perpendicular to the sealing element axis (S) is circular.
7. The combustor assembly (16) as claimed in any one of the preceding claims, wherein the combustor wall (30) forms part of a combustor liner (24) that extends around the sealing element axis (S), and wherein a maximum dimension of the first opening extends radially with respect to the sealing element axis (S).
8. The combustor assembly (16) as claimed in any one of the preceding claims, wherein the sealing element (34) comprises at least one cooling air passage (42), wherein the at least one cooling air passage (42) is defined at least in part by the flange (38), wherein the at least one cooling air passage (42) comprises an outlet portion (48) having an outlet configured to deliver cooling air to the combustion chamber (25), wherein the outlet is defined by the distal surface.
9. The combustor assembly (16) as claimed in Claim 8, wherein the outlet portion (48) extends parallel to a surface (41) of the combustor wall (30) with which the seal or partial seal is formed.
10. The combustor assembly (16) as claimed in Claim 8 or Claim 9, wherein the outlet portion (48) extends radially with respect to the sealing element axis (S) through the flange (38).
11. The combustor assembly (16) as claimed in any one of Claims 8 to 10, wherein a radial distance (h) between the outer surface (37) and the outlet (64) is at least 1.5 times the maximum width (w) of the outlet (64) measured in a direction parallel to the sealing element axis (S).
12. The combustor assembly (16) as claimed in any one of Claims 8 to 11, wherein a minimum total overlap (O_1 , O_2) of the flange (38) and the combustor wall (30) is at least twice the radial distance (h) between the outer surface (37) and the outlet (64).
13. The combustor assembly (16) as claimed in any one

of the preceding claims, wherein the sealing element (34) comprises a further flange (60) extending radially outward from the annular body (35), wherein the combustor wall (30) is partly disposed between the flange (38) and the further flange (60), the further flange (60) slidably coupling the sealing element (34) and the combustor wall (30) and forming a further seal or partial seal between the sealing element (34) and the combustor wall (30).

14. The combustor assembly (16) as claimed in any one of Claims 8 to 13, further comprising a plurality of cooling air passages (42) as defined in any of claims 10 to 16, wherein the plurality of cooling air passages (42) are disposed circumferentially about the sealing element axis (S).
15. The combustor assembly (16) as claimed in any one of the preceding claims, wherein the cross-sectional profile of the distal surface (58) on a plane perpendicular to the sealing element axis (S) is circular.

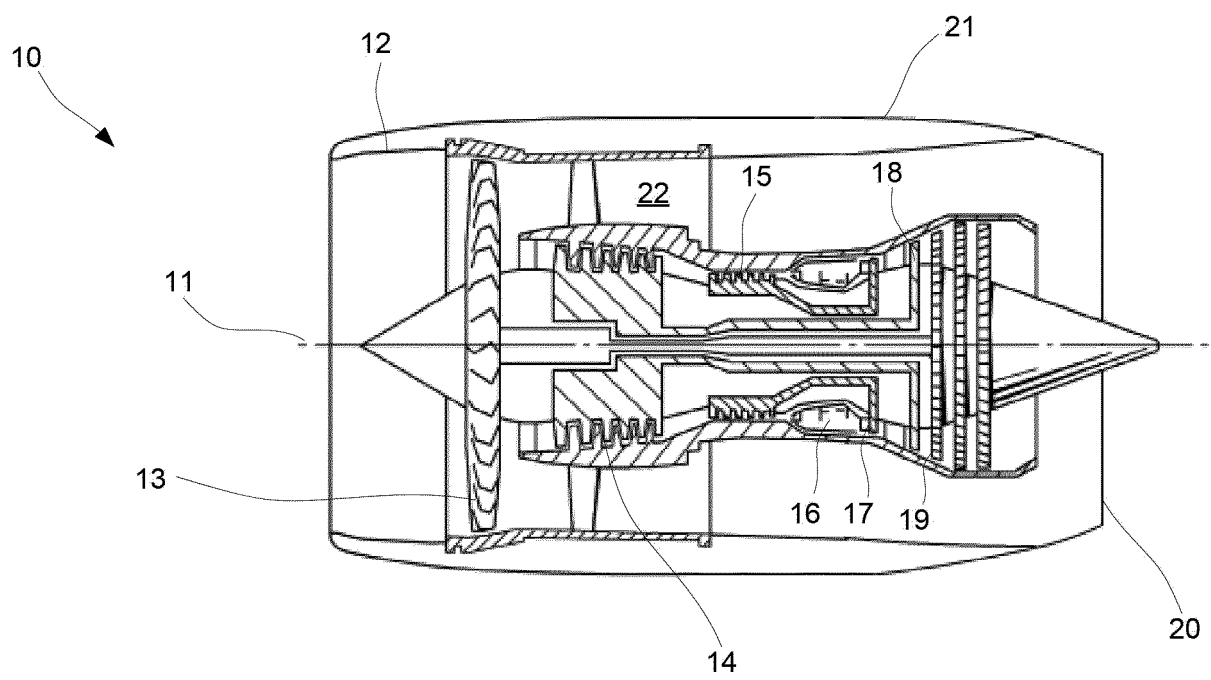


Figure 1

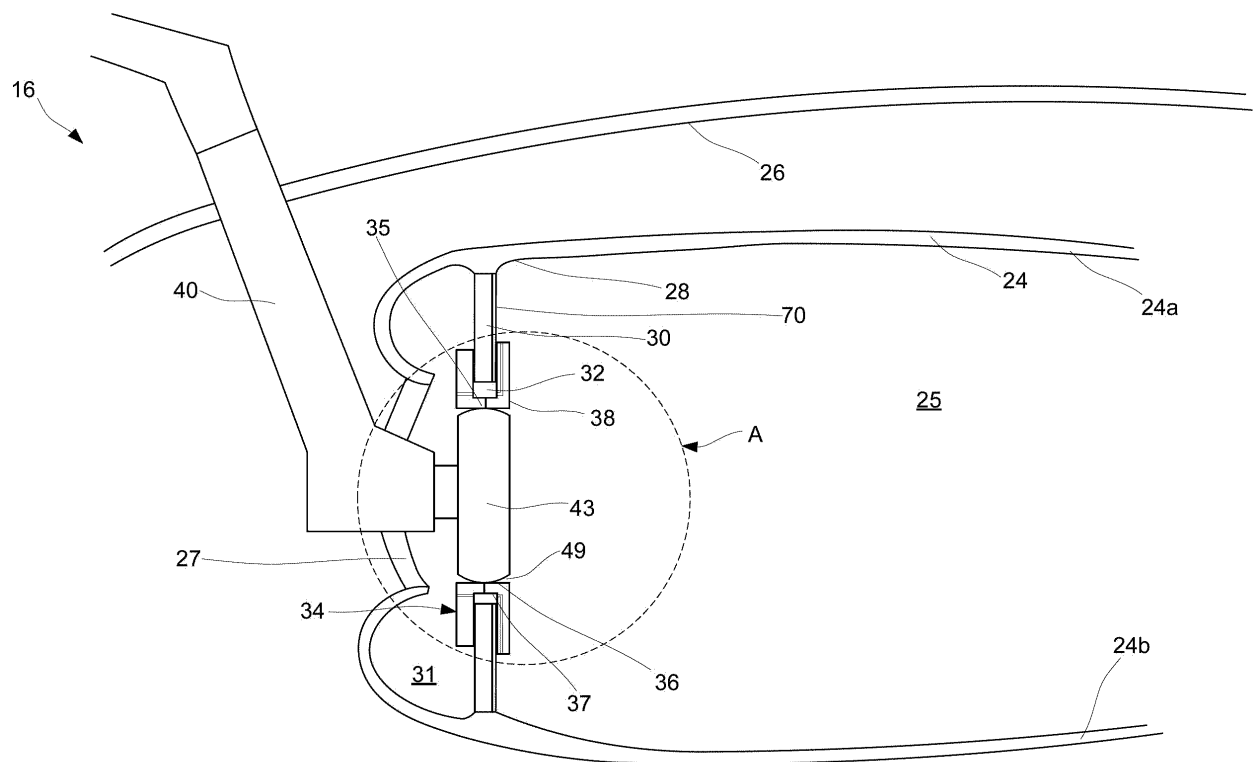


Figure 2

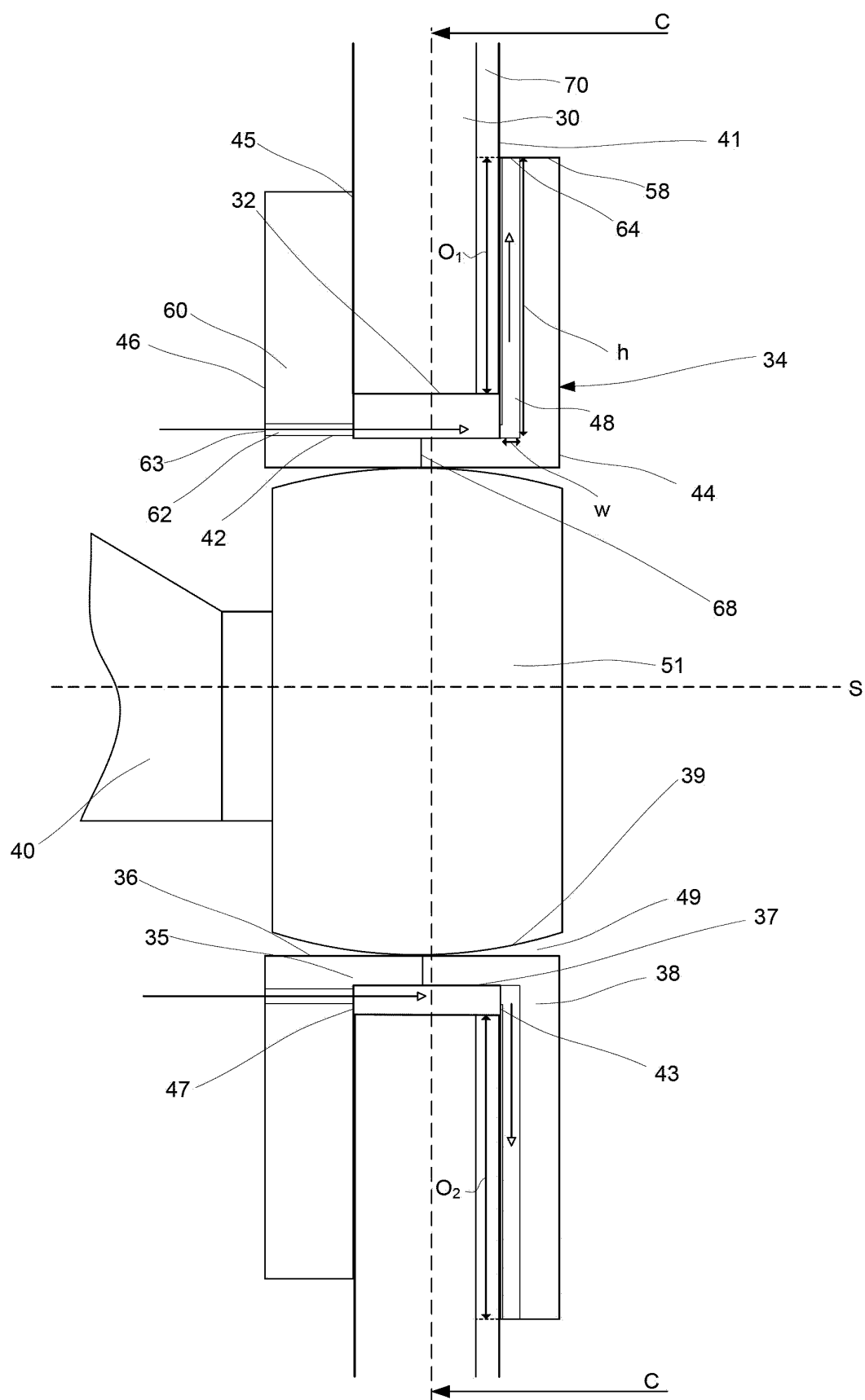


Figure 3

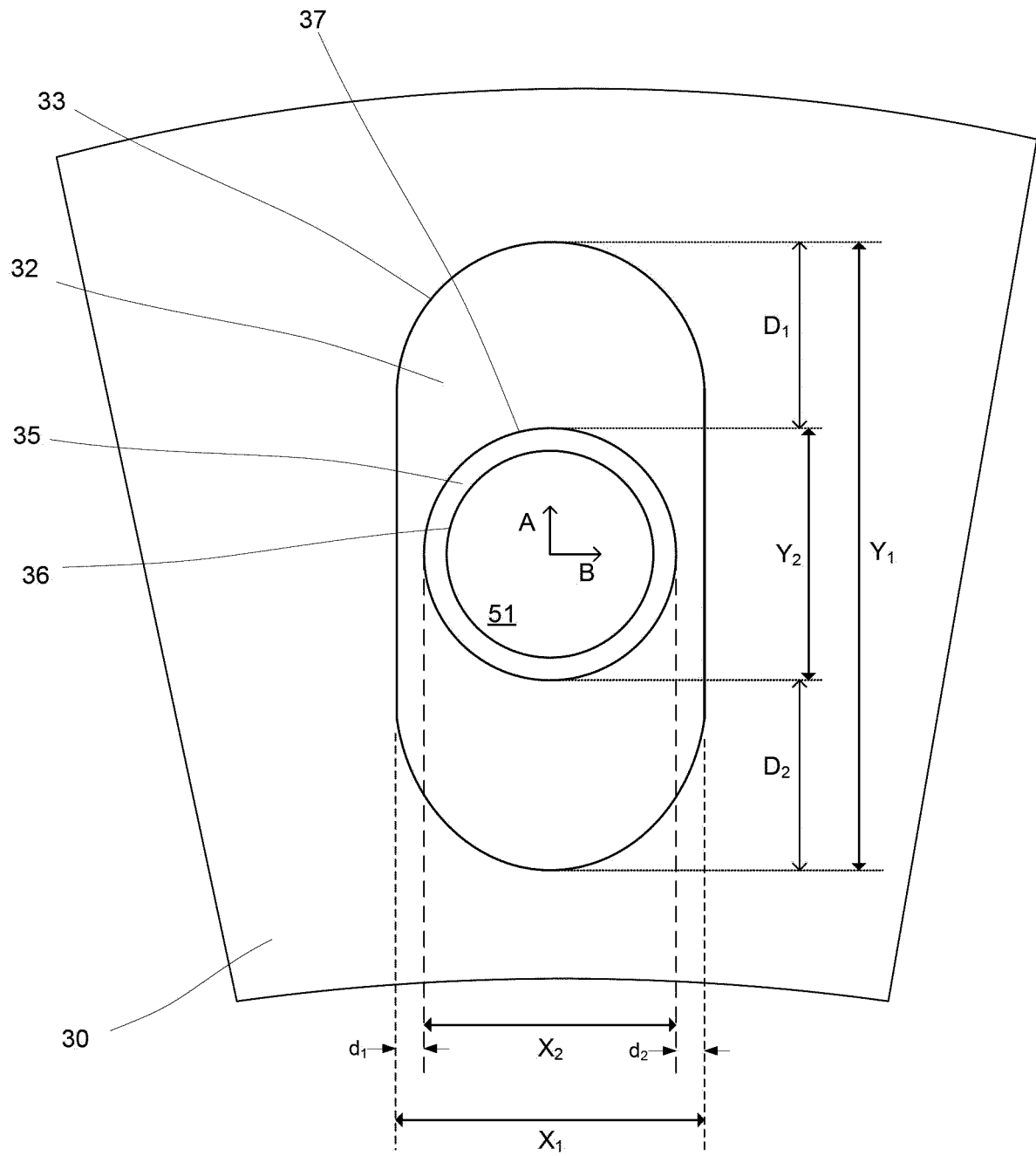


Figure 4

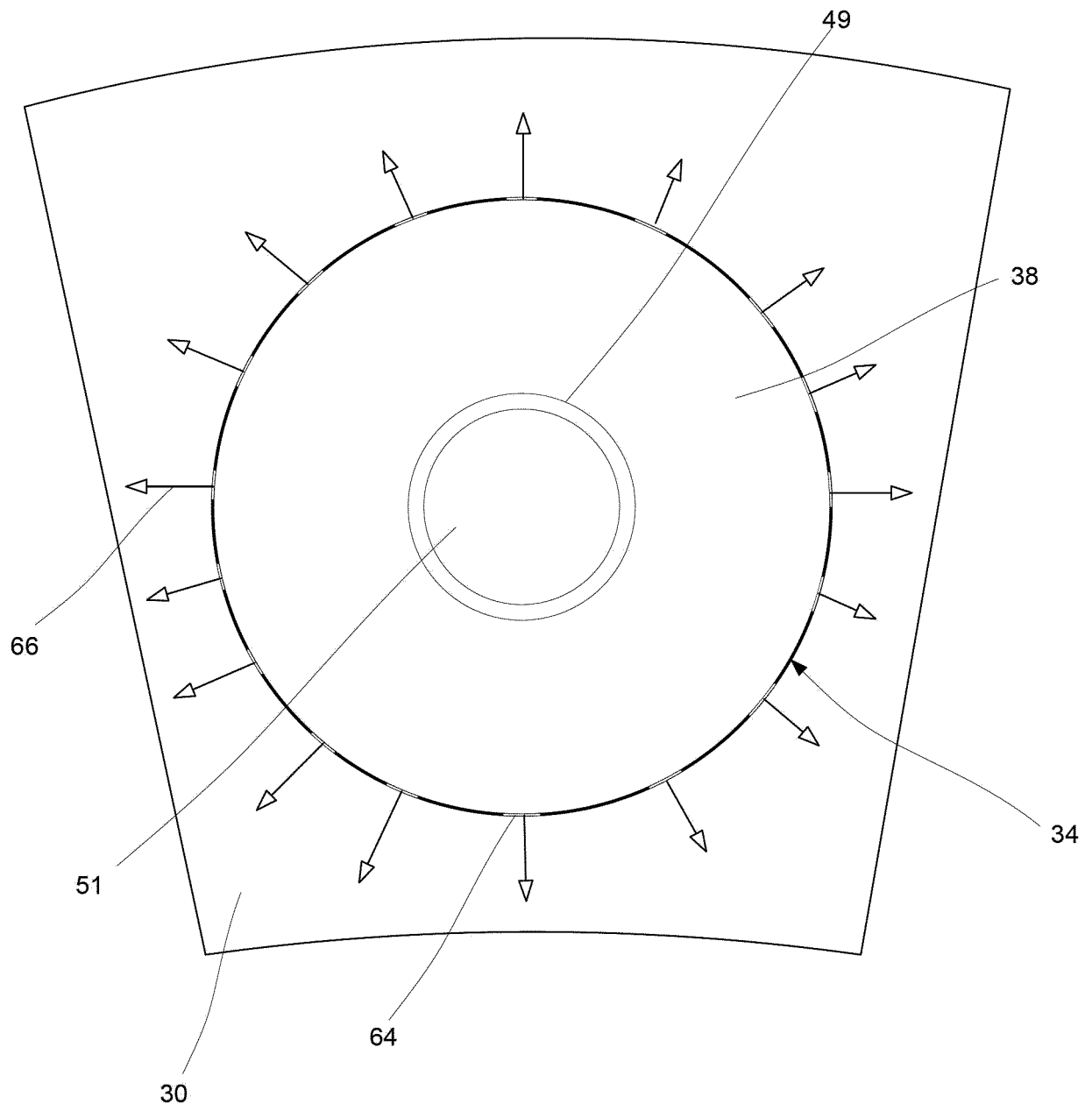


Figure 5

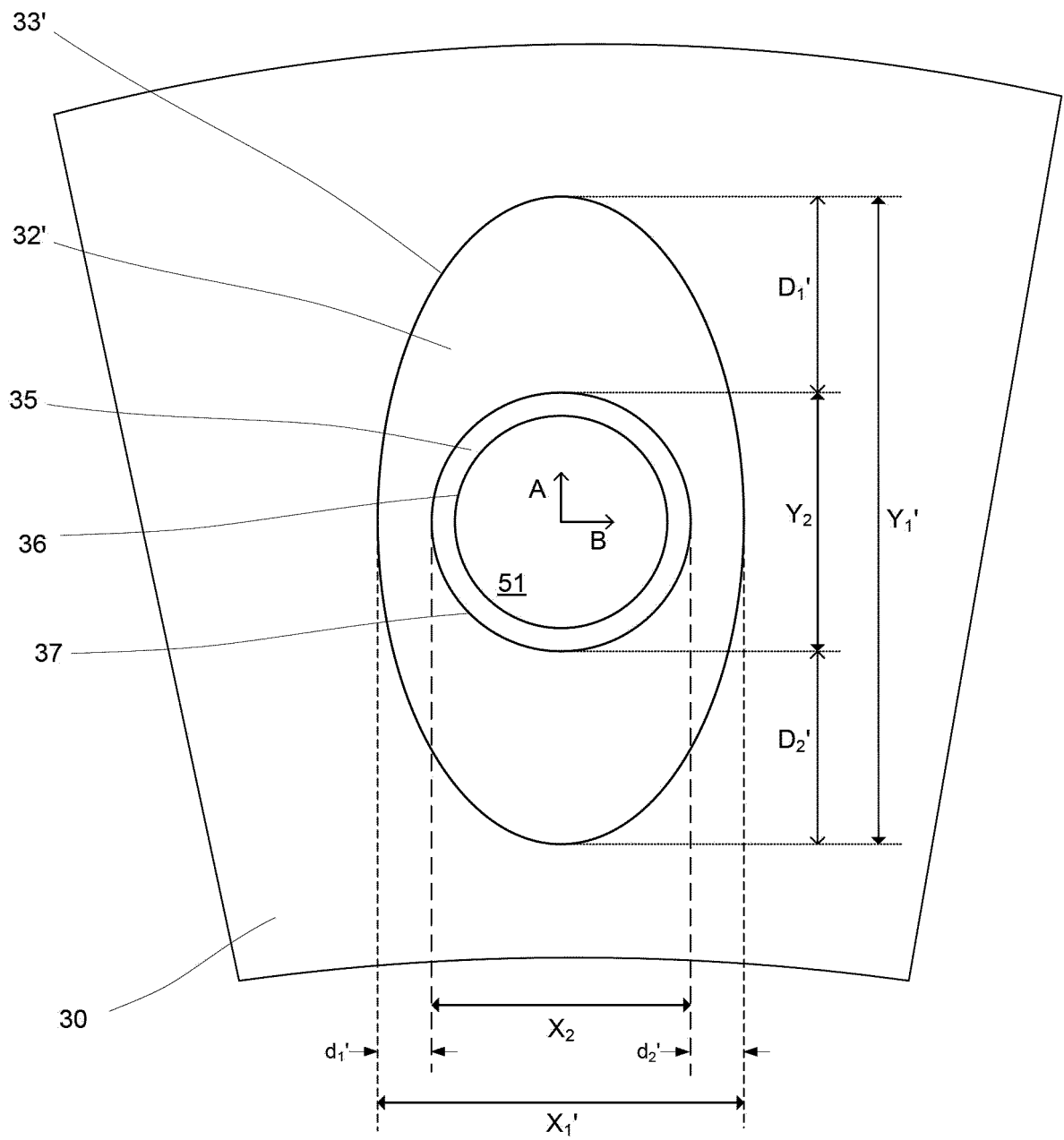


Figure 6