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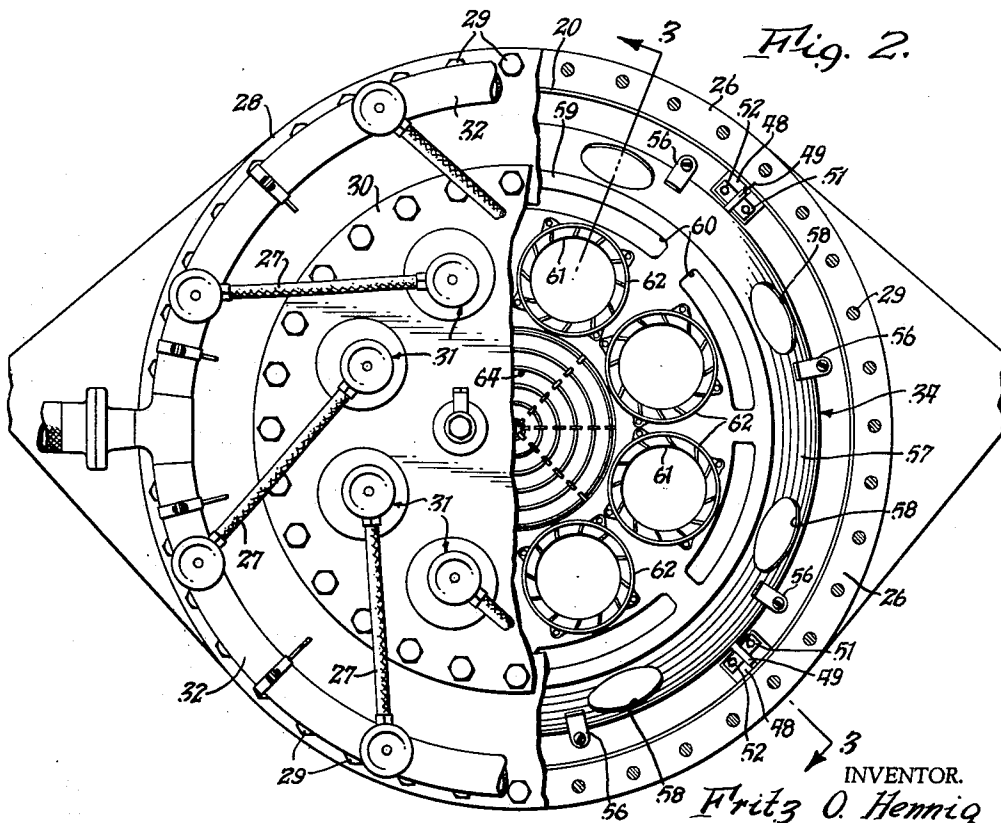
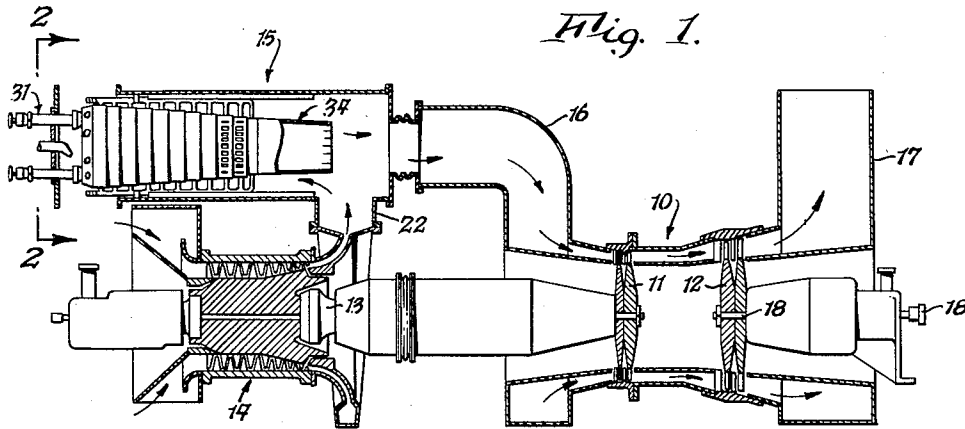
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3,044,263

COMBUSTOR WITH UNITARY LINER

Filed May 21, 1959

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

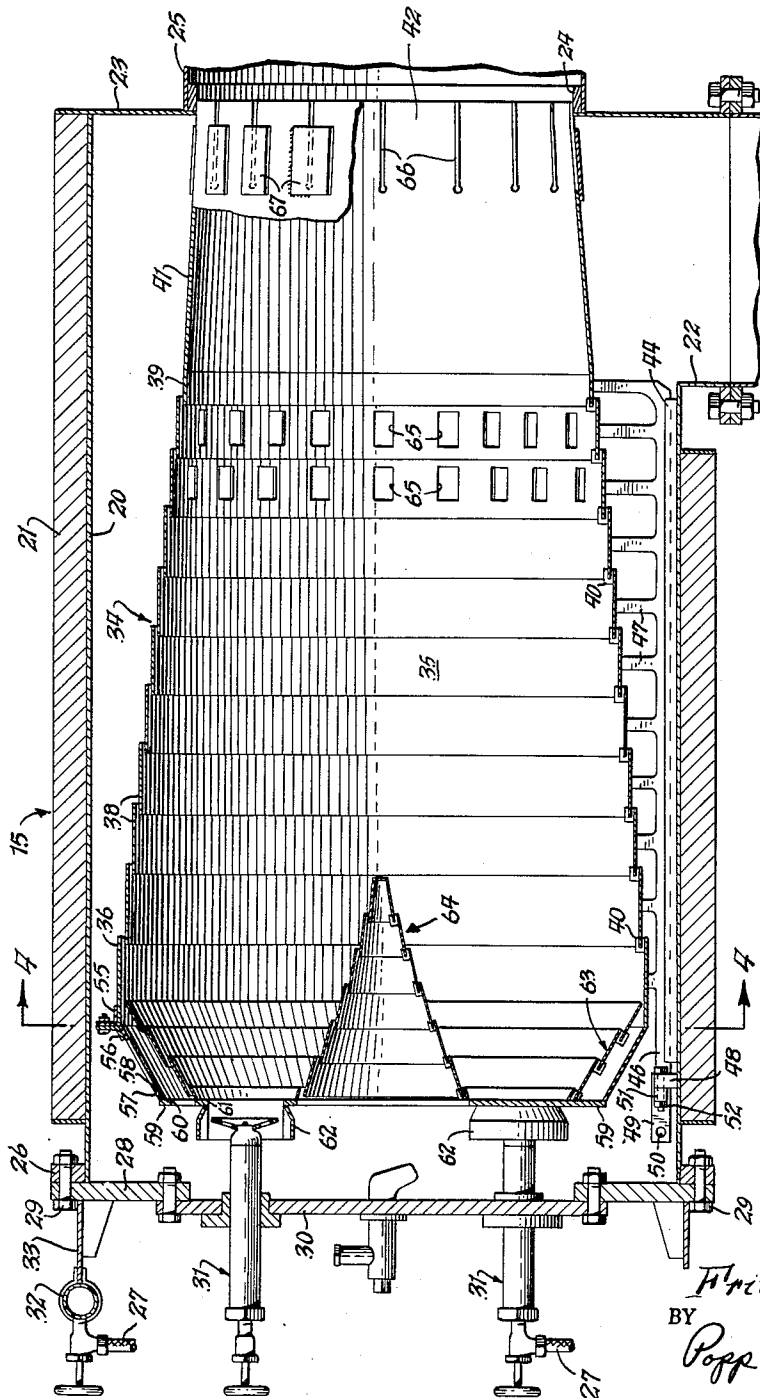


Fig. 3.

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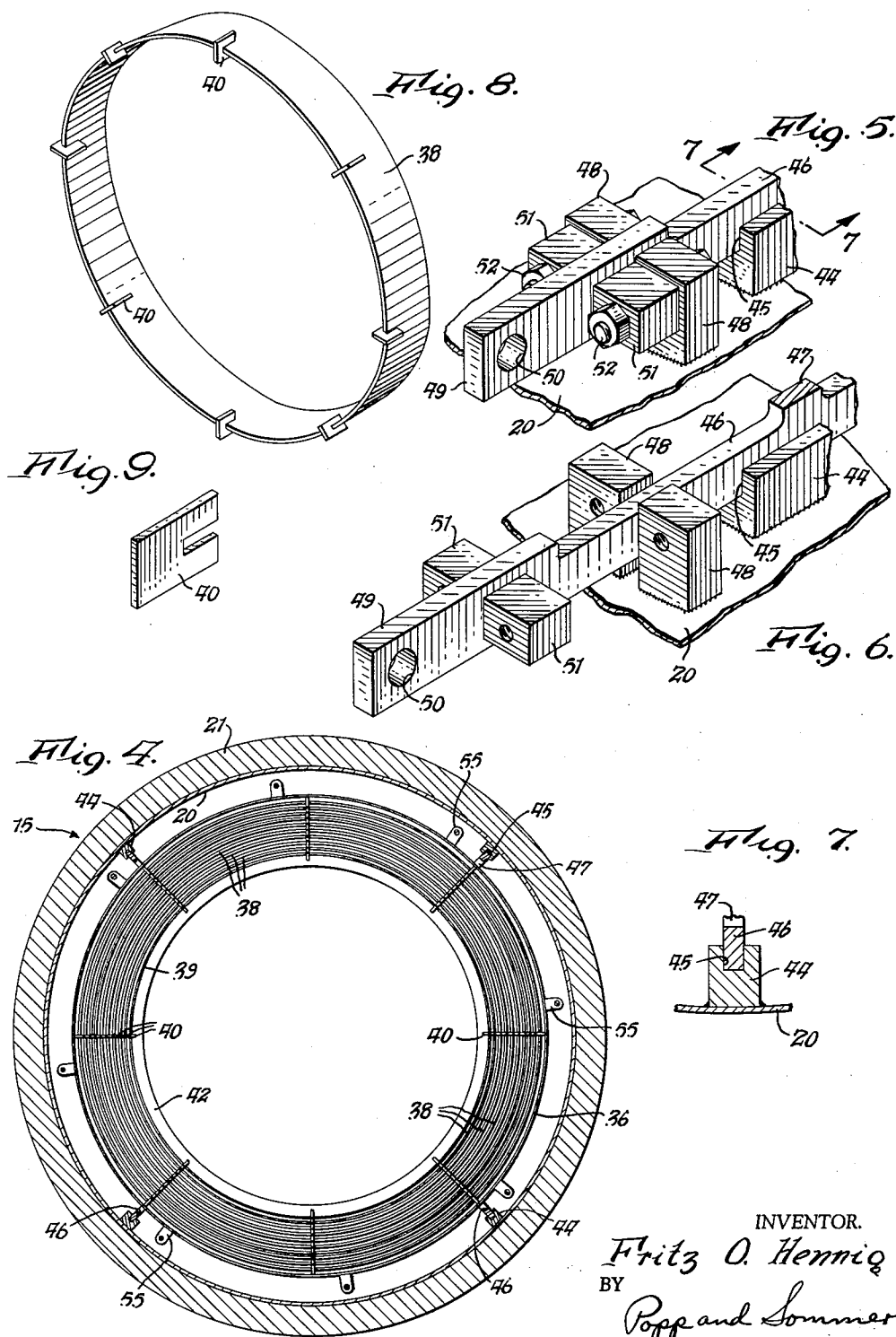
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COMBUSTOR WITH UNITARY LINER

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3 Sheets-Sheet 3



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1

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COMBUSTOR WITH UNITARY LINER

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5 Claims. (Cl. 60—39.65)

This invention relates to improvements in a combustor for burning fluid fuels in a gas turbine power plant.

The combustor to which the present invention relates is of the type which includes spaced inner and outer walls. The inner wall contains the combustion chamber and is made of high heat resistant sheet metal. The outer wall forms the pressure-resisting casing. Air is passed between the inner and outer walls to cool the inner wall, and the cooling air then mixes with the combustion gases to provide a large volume of driving gases of moderate temperature.

The primary object of this invention is to provide such a combustor in which the inner wall is formed by a unitary liner assembly so that the same can be easily and readily inserted into and removed from the outer shell for inspection, repair or replacement.

Another object is to provide such a liner assembly which is light in weight.

Other objects and advantages will be apparent from the following description and accompanying drawings wherein:

FIG. 1 is a vertical, central, longitudinal, sectional view through a representative gas turbine power plant including a combustor embodying the present invention and showing the liner assembly partially withdrawn from the outer shell.

FIG. 2 is essentially an end elevational view, on an enlarged scale, of the combustor and taken on line 2—2 of FIG. 1, certain portions being broken away to reveal hidden structure.

FIG. 3 is a longitudinal, sectional view of the combustor and taken on line 3—3 of FIG. 2, the liner assembly being shown as fully inserted and in secured position within the outer shell.

FIG. 4 is a vertical, transverse, sectional view thereof and taken generally on line 4—4 of FIG. 3.

FIG. 5 is a perspective, fragmentary view of one of several similar means for supporting the liner assembly on the outer shell and showing the means in a secured condition.

FIG. 6 is a perspective view similar to FIG. 5 but showing certain elements separated as they are during withdrawal of the liner assembly from the outer shell.

FIG. 7 is a vertical, transverse, sectional view of the liner assembly support means and taken on line 7—7 of FIG. 5.

FIG. 8 is a perspective view of one of the rings shown in FIG. 3 and forming a part of the liner assembly.

FIG. 9 is a perspective view of one of the spacers shown on the ring in FIG. 8.

Referring to FIG. 1, the numeral 10 represents generally a two-stage gas turbine having a first-stage rotor 11 and a second-stage rotor 12. The first-stage rotor 11, through appropriate shaft means 13, drives an axial flow compressor 14 which draws air in from the atmosphere, compresses it and discharges it into a combustor indicated generally at 15. The compressed air from the compressor 14 is mixed with fuel and ignited in the combustion chamber of the combustor 14 to provide pressurized driving gases which are led by a conduit 16 to the inlet of the turbine 10. These gases flow through the first-stage rotor 11 imparting rotational movement thereto which is utilized to drive the air compressor 14. Upon leaving the first-stage rotor 11, the gases are passed through the second-

2

stage rotor 12 and out an exhaust duct 17. The second-stage rotor 12 is shown as being mounted on a shaft 18 which may be coupled to any desired equipment (not shown) for driving the same.

The flow of the various gases through the power plant illustrated diagrammatically in FIG. 1 is indicated by arrows placed in the various passages of the apparatus. The operation of the gas turbine power plant apparatus so far described is fully understood by those skilled in the art and a further explanatory elaboration is deemed unnecessary.

The invention is concerned with improvements in the combustor 15. Referring to FIG. 3, the combustor is shown as including a housing or casing having an elongated, cylindrical outer shell 20 arranged with its axis horizontal and covered with insulation 21 and suitably reinforced and supported in conventional manner. Adjacent one end, the shell 20 is shown as provided with an air inlet 22 which is connected to the discharge of the air compressor 14. The end of the shell 20 adjacent the inlet 22 is closed by an end wall 23 having a central opening therein and surrounded on the outer side thereof by an annular flange 24. Embracing this flange 24 is one end of an expansion joint 25 the other end of which connects to the conduit 16.

The opposite open end of the outer shell 20 is provided with an outwardly projecting annular attaching flange 26 to which a cover 28 is removably connected. This cover 28 is in the form of an annular plate. The cover 28 and flange 26 have registered holes through which bolts 29 pass for securing the cover to the outer shell. The cover 28 has a central opening which is normally covered by a removable burner plate 30 on which a series of conventional burner assemblies, indicated severally at 31, are mounted. These burners are supplied with fluid fuel from a circular manifold 32 which is supported by an annular bracket 33 carried by the cover 28. Branch lines 27 connect the individual burners 31 to the fuel manifold 32.

It will be seen that if the bolts 29 are removed, the cover 28 and the burner equipment supported thereon can be moved axially away from the end of the outer shell 20 so as to provide full access to the interior thereof.

Arranged within the outer shell 20 in spaced relation thereto is the inner liner assembly indicated generally at 34 which bounds or defines the combustion chamber 35. It is essentially of frusto-conical form with the smaller end adjacent the inlet 22 and the larger end remote therefrom. The liner assembly 34 comprises a series of annular rings including an end ring 36, a plurality of intermediate rings 38 and a second end ring 39. The various rings 36, 38 and 39 are shown as being sheet metal cylinders of successively reduced diameter concentrically arranged and partially overlapping one another. The overlapping portions are mounted in spaced relation by a series of U-shaped plate spacers 40 as best shown in FIGS. 8 and 9.

Formed as an axial extension of the end ring 39 and preferably integrally therewith, is a frusto-conical section 41 terminating in a cylindrical end portion 42. This end portion 42 is shown as being slidably received within the annular flange 24 of the combustor housing.

The important feature of the present invention resides in the manner of supporting the liner assembly 34 within the outer shell 20. Referring to FIG. 4, the outer shell 20 on the inside thereof is shown as provided with a plurality of circumferentially spaced, elongated, channel members 44. Four such members are shown at equidistant circumferential intervals. Each channel member 44 is arranged so that its way 45, preferably flat sided, faces or opens radially inwardly. Slidably arranged within the way 45 of each channel member 44 is an elongated bar 46, preferably rectangular in cross section as shown. At intervals along the length of the bar 46

are a series of radially extending ribs or struts 47. These ribs are connected at their outer ends to the bar 46 as by being welded thereto and at their inner ends, these ribs are severally connected, as by welding, to the center of the corresponding ring 36, 38 or 39. For each bar 46 one rib 47 is provided for each cylindrical ring 36, 38 and 39. There being four bars 46, each of the rings 36, 38 and 39 is supported by four ribs 47. It will be noted that the radial lengths of the ribs 47 from ring to ring vary since the diameters of the rings vary.

In this manner, it will be seen that the various rings 36, 38 and 39 are severally supported at four circumferentially spaced places on four ribs or arms in turn carried by four slide bars 46. As previously explained, the cylindrical rings are maintained spaced from one another by the spacers 40.

Referring to FIGS. 5 and 6, the outer shell 20 on its inside and adjacent its removably covered end is provided with a pair of radially inwardly projecting spaced lugs 48 arranged adjacent the corresponding end of each of the channel members 44. The lugs 48 are spaced apart to receive therebetween the corresponding slide bar 46. The lugs 48 are suitably fastened to the outer shell as by being welded thereto. The outer end of each slide bar 46 extends longitudinally outwardly beyond the corresponding lugs 48 and is shown as having a radially inwardly, enlarged head 49 provided with a hole 50 adjacent its outer extremity and longitudinally inwardly of said hole is provided with a pair of lateral ears 51 on opposite sides of the head 49. The ears 51 are suitably connected to the head 49 as by being welded thereto. The ears 51 and lugs 48 are provided with registered holes adapted to receive nut and bolt assemblies 52.

When the lugs 48 and ears 51 are bolted together as shown in FIG. 5, the liner assembly is effectively secured in a predetermined position within the outer shell 20 against unintentional displacement both circumferentially and longitudinally. However, when the nuts and bolts 52 for each of the slide bars 46 are removed, the liner assembly as a unitary structure can be removed from the outer casing 20 by sliding the liner assembly axially of the outer shell through the end thereof made open by removal of the cover 28. During relative movement between the inner liner assembly and outer shell, the slide bars 46 slide in the channel members 44. The holes 50 facilitate connection of suitable pulling or pushing means (not shown) to the liner assembly.

The cylindrical end ring 36 is shown as having a series of radially outwardly projecting perforated ears 55 which cooperate with similar ears 56 provided on a frusto-conical shell member 57 having a series of openings 58 provided therein at circumferential intervals. The ears 55 and 56 are suitably bolted together. The outer and smaller end of this frusto-conical member 57 has an annular end wall 59 provided with a series of arcuate openings 60 and circular openings 61 a set of openings 60, 61 and 58 being shown as provided for each of the burners 31. Arranged on the outer side of the end wall 59 and suitably secured thereto is an annular fuel guide 62. Arranged within the frusto-conical shell member 57 is a louvered primary air diffuser indicated generally at 63. Arranged centrally of the liner assembly at the corresponding end thereof is a louvered conical assembly indicated generally at 64. The assemblies 63 and 64 are suitably mounted on the end wall 59.

It is apparent that the members 57, 59, 62, 63, and 64 are all carried by the end ring 36 and therefore form part of the liner assembly to move therewith during withdrawal or replacement of the liner assembly. However, these members can be separated from the end ring 36, if desired, by removing the fasteners connecting the ears 55 and 56 together.

Air discharged by the compressor 14 enters the combustion chamber apparatus through the inlet 22. Part of this air flows axially to the left as viewed in FIG. 3

between the liner assembly and the outer shell 20. Some of this air enters the annular openings between the spaced and overlapping rings 36, 38 and 39 as secondary air. Some of the air also flows the full length of the apparatus and turns to enter through the central louvered assembly 64, through the openings 58 and 60 and thence between the louvered assembly 64 into the fuel injection end of the combustion chamber, as primary air to be mixed with the atomized fuel discharged from the injection nozzles 31.

As is well known, the fuel and air mixture is combusted or burned within the liner assembly and the products of combustion move to the right out of the liner assembly through the end ring 39, annular parts 41, 42, into the downstream duct comprising the expansion joint 25 and conduit 16. As is also well known, certain of the rings, such as the two immediately adjacent the end ring 39, are provided with a series of openings 65 to allow additional air to enter the combustion chamber from the space between the liner assembly and the outer shell.

In order that the cylindrical end portion 42 of the liner assembly has some dimensional flexibility to fit the opening formed by the housing flange 24, the assembly is shown as provided with a series of circumferentially spaced, axially extending slots 66 which lead from the outer edge of the end portion 42 part-way back into the frusto-conical portion 41. The inner end portions of these slots 66 are covered individually by rectangularly outlined, curved plates 67 leaving the slots in the cylindrical end portion 42 uncovered. Each of the covering plates 67 is preferably welded along one long side and half of the short inner end to the surface of the end ring 39. In this manner, the cylindrical end portion 42 of the liner assembly has an increased flexibility to permit it to be more easily inserted and removed from the bore of the annular flange 24.

From the foregoing, it will be seen that the present invention provides an improved liner assembly for a combustor which is a unitary structure adapted to be easily and readily removed from and inserted into the outer surrounding casing or housing of the combustor.

What is claimed is:

1. In a combustor, the combination comprising an outer shell having an access opening, a liner assembly including a plurality of spaced rings, and means for supporting said liner assembly within and on said shell in spaced relation thereto and including a slide bar juxtaposed to said shell, guide means juxtaposed to and fast to said shell for radially and circumferentially guiding said bar during relative movement of said bar and means for supporting said rings on said bar including a single strut extending between each of said rings and said bar, whereby overall axial dimensional growth of said liner assembly due to temperature expansion is minimized and said liner assembly as a unitary structure can be slid into and out of said shell through said access opening by said bar sliding on said guide means.

2. In a combustor, the combination comprising an outer shell having an access opening, a removable cover for said opening, a liner assembly including a plurality of spaced rings, and means separate from said cover for supporting said liner assembly within and on said shell in spaced relation thereto and including a slide bar juxtaposed to said shell, guide means juxtaposed to and fast to said shell for radially and circumferentially guiding said bar during relative movement of said bar, means for supporting said rings on said bar including a single strut extending between each of said rings and said bar and means for securing said bar against movement relative to said shell, whereby overall axial dimensional growth of said liner assembly due to temperature expansion is minimized and when said bar is unsecured said liner assembly as a unitary structure can be slid into and out of said shell

5

through said access opening by said bar sliding on said guide means.

3. In a combustor, the combination comprising an outer shell having an access opening, a removable cover for said opening, a liner assembly including a plurality of spaced rings, and a plurality of support means separate from said cover and arranged at intervals about said liner assembly and collectively supporting the same within and on said shell in spaced relation thereto, each of said support means including a slide bar juxtaposed to said shell, guide means juxtaposed to and fast to said shell for radially and circumferentially guiding said bar during relative movement of said bar and single strut means connecting each of said rings to said bar, whereby overall axial dimensional growth of said liner assembly due to temperature expansion is minimized and said liner assembly as a unitary structure can be slid into and out of said shell by said bar sliding on said guide means.

4. In a combustor, the combination comprising an outer shell having an access opening at one end and an outlet opening at its other end, a liner assembly including an end ring and a plurality of other rings all spaced from one another, said end ring being slidably inserted in said outlet opening, and means for supporting said liner assembly within and on said shell in spaced relation thereto and including a slide bar juxtaposed to said shell, guide means juxtaposed and fast to said shell for radially and circumferentially guiding said bar and means for supporting said rings on said bar including a single strut extending between each of said rings and said bar, whereby overall axial dimensional growth of said liner assembly due to temperature expansion is minimized and said liner assembly as a unitary structure can be slid into and out of said shell through said access opening by said bar sliding on said guide means.

6

bly as a unitary structure can be slid into and out of said shell through said access opening by said bar sliding on said guide means.

5. In a combustor, the combination comprising an outer shell having an access opening at one end and an outlet opening at its other end, a liner assembly including an end ring and a plurality of other rings all spaced from one another, said end ring being slidably inserted in said outlet opening and means for supporting said liner assembly within and on said shell in spaced relation thereto and including a slide bar juxtaposed to said shell, guide means juxtaposed and fast to said shell for radially and circumferentially guiding said bar, means for supporting said rings on said bar including a single strut extending between each of said rings and said bar and means for securing said bar against movement relative to said shell, whereby overall axial dimensional growth of said liner assembly due to temperature expansion is minimized and when said bar is unsecured said liner assembly as a unitary structure can be slid into and out of said shell through said access opening by said bar sliding on said guide means.

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