April 3, 1951 B. O. BUCKLAND 2,547,619

COMBUSTOR WITH SECTIONAL HOUSING AND LINER

Filed Nov. 27, 1948

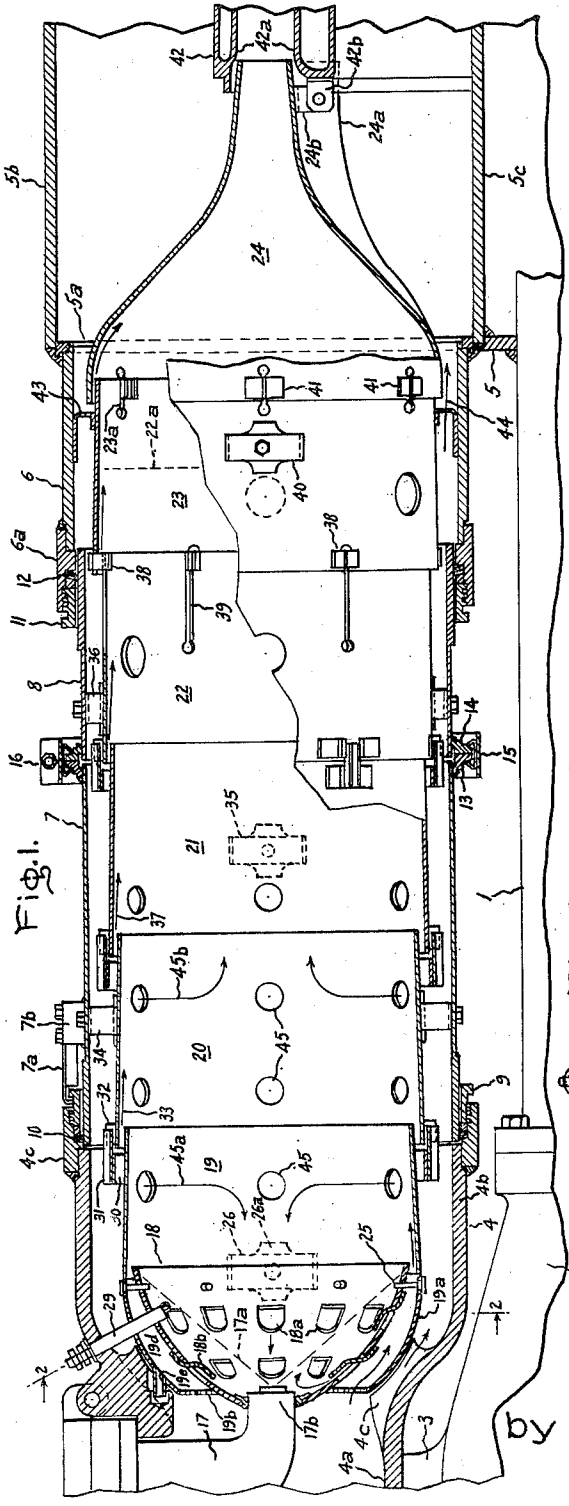


Fig. 1.

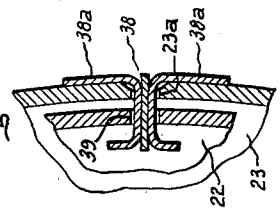


Fig. 4.

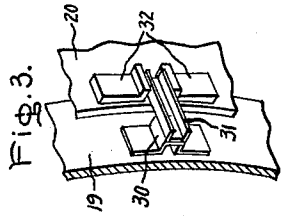


Fig. 3.

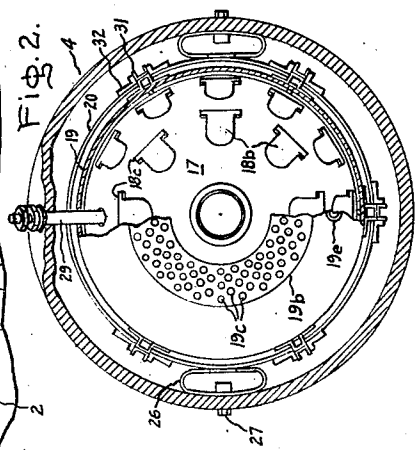


Fig. 2.

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COMBUSTOR WITH SECTIONAL HOUSING AND LINER

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Application November 27, 1948, Serial No. 62,333

6 Claims. (Cl. 60—44)

1

This invention relates to combustion devices, particularly to a combustor for burning fluid fuels in a gas turbine powerplant. This application is a continuation-in-part of the application of Alan Howard, Chester S. Rice, and Bruce O. Buckland, Serial No. 754,002, filed June 11, 1947, and assigned to the same assignee as the present application.

The object of the present invention is to provide an improved combustor for a powerplant of the type described having both the outer housing and the inner liner fabricated in separate sections so that a portion of the outer housing may be readily removed for free access to the inner liner sections for inspection, servicing, or replacement.

Other objects and advantages will be apparent from the following description taken in connection with the accompanying drawing in which Fig. 1 is a longitudinal view in section of a gas turbine combustor incorporating the invention; Fig. 2 is a transverse sectional view of the combustor taken on the irregular plane 2—2 in Fig. 1; Fig. 3 is a perspective view of one of the connecting devices used to hold the liner sections in proper relation; while Fig. 4 is a detail view in section of another connecting device used between certain of the liner sections.

Referring now more particularly to Fig. 1, the main frame of the powerplant includes a cylindrical frame member 1 secured by a bolted flange at one end to a mid-frame casing 2. Casing 2 is provided with a plurality of radially extending lugs 3 which are welded to, or may be cast integral with, a casing 4 defining transition passages connecting the annular discharge of an axial flow compressor (not shown) with the circumferentially spaced circular combustor inlet openings. The inlet end portion of the transition passage is indicated at 4a while the cylindrical housing 4b defines one supporting wall for the outer combustor casing. To the other end of the main frame cylinder 1 is welded a transverse annular plate member 5 having a plurality of circumferentially spaced circular openings 5a, there being one of these openings for each combustor of course. Each opening is surrounded by an axially extending cylinder 6 welded to the plate 5 and forming the other combustor support wall. Thus, it will be seen that the combustor is supported between two fixed cylindrical wall portions formed integral with, or welded to, the main frame structure.

Since in a device of this type the inner liner defining the combustion space is subject to comparatively rapid deterioration, it is essential that ready access be provided to the liner for inspection and servicing. A principal problem which the present invention is intended to solve is to provide an improved combustor arrangement permitting ready access to and quick removal of the inner liner where the end sections which support the combustor are fixed rigidly to the main frame.

2

The outer combustor casing consists of a first cylindrical section 7 and a second section 8. In order to provide a gas-tight seal between the end of section 7 and the adjacent end of the cylindrical casing 4, a packing arrangement is provided including a stuffing box ring member 4c welded to the end of casing 4b as shown in Fig. 1, a gland nut 9 threadedly received in the bore of the stuffing box 4c, and one or more resilient packing rings 10 contained within the stuffing box 4c surrounding the end portion of liner section 7 and of course arranged to be compressed by the gland nut 9.

The other outer casing section 8 is likewise sealed in a stuffing box ring 8a by a gland nut 11 compressing packing rings 12 into tight contact with the outer surface of the adjacent portion of casing section 8. The adjacent ends of outer casing sections 7, 8 are connected by means of a pipe coupling including pair of flanges 13, 14 welded to the respective ends of sections 7, 8, the flanges being clamped tightly together by means of a suitable "clamp band" indicated generally at 15. This may consist of a circumferential band split at least at one location with radially projecting "ears" adjacent the split, with a bolt or other suitable clamping device cooperating with the ears to draw the band circumferentially into tight engagement with the flanges 13, 14. This clamping device is indicated diagrammatically at 16. The details of the clamp band are not material to an understanding of the present invention, but it may be noted that a suitable type of clamp band structure is shown in the patent to W. D. Crater, 2,424,436, issued July 22, 1947, and assigned to the same assignee as the present application.

Secured to the outer wall of the transition or mid-frame casing 4 is a fuel nozzle indicated generally at 17. The details of this fuel spray nozzle are not material to an understanding of the present invention, being disclosed more fully in the copending application of Bruce O. Buckland and Donald C. Berkey, Serial No. 62,634, filed November 30, 1948, and assigned to the same assignee as the present application. It may be noted however, that this nozzle is of a type especially adapted to produce a spray pattern in the form of a hollow cone 17a, the vertex angle of which remains almost exactly constant over the entire range of operation.

The combustion space proper is defined by an inner liner consisting of an end dome assembly 18, 19, which is supported in telescopic relation with succeeding intermediate liner sections 20, 21

and discharge end liner sections 22, 23 and a hot gas transition section 24.

The end dome proper, indicated generally at 18, is a substantially hemispherical shell made of a temperature resisting sheet metal such as stainless steel and having a central portion defining an opening adapted to snugly receive the nozzle tip 17b. The right-hand end of dome 18 is supported by means of a plurality of radially extending pins 25, which may be secured, as by welding, to the end liner section 19 and project freely through holes in the dome 18. Thus, the end dome 18 and the end liner section 19 are coaxially located but may freely expand and contract relative to each other.

The end liner section 19 is in turn supported by a pair of flexible brackets 26 located diametrically opposite as shown best in Fig. 2. These brackets each consist of an elliptical loop of flexible sheet metal having portions welded at 26a to the outer surface of liner section 19, while a second portion is secured by means of a suitable threaded fastening 27 to the other wall 4b of the transition section. This resilient suspension likewise permits the end liner section 19 to expand and contract radially relative to the casing walls 4b. As may be seen in Figs. 1 and 2, the inlet of liner section 19 forms an air inlet shroud 19a surrounding the end dome 18 and having an annular end baffle 19b with perforations 19c for admitting a metered quantity of air to the space 19d between dome 18 and shroud 19a. A somewhat similar shroud arrangement is disclosed in the copending application of K. D. McMahan, Serial No. 705,866, filed October 26, 1946, Patent No. 2,510,645, and assigned to the same assignee as the present application. Just outside the baffle 19b, shroud 19a is provided with two or more circumferentially spaced projections, which may be in the form of short pins or tubes 19e extending loosely into sockets in bosses 4c formed integral with casing 4. These projections serve to locate the shroud 19a when the fuel nozzle 17 is removed.

The second liner section 20 is supported in proper coaxial relation with the end section 19 by a plurality of longitudinal keys, as follows. As may be more readily seen in Figs. 2 and 3, the initial liner section 19 has spotwelded thereto a plurality of circumferentially spaced prong members comprising a channel member 30 to which is welded, in back-to-back relation, another axially extending channel member 31. The cooperating portions of the second liner section 20 have welded thereto circumferentially spaced pairs of brackets 32. It will be apparent that the brackets 32 comprise a keyway while the channel member 31 constitutes a longitudinal key. As may be seen in Fig. 1, there is a substantial radial clearance between key member 31 and the adjacent outer surface of the liner section 20. As shown in Fig. 3, the sides of the channel 31 fit without clearance between the brackets 32. With this arrangement, the liner sections are accurately located concentrically, while being free to expand radially relative to each other, being also free to move longitudinally by reason of the key-and-keyway connection. This locating means insures that the adjacent liner sections will be held exactly coaxial while freely permitting differential thermal expansion therebetween.

Section 20 is of sufficiently larger diameter than section 19 that a narrow radial clearance space is formed between the telescoping end portions, which clearance space serves as an annular nozzle to direct a film of cooling and insulating air along the inner surface of liner section 20 in the manner of the arrow 33. The support for the liner section 20 is provided by a pair of diametrically opposite flexible brackets 34, which are similar to the members 26 described above. It will be observed that the supporting brackets 34 are spaced 90° angularly from the brackets 26 of the first liner section 19, while the similar brackets 35 supporting section 21 are again spaced 90° from the brackets 34. Similarly, brackets 36 support the liner section 22 and are located in the same axial plane with the brackets 34.

As will be readily apparent from Fig. 1, the righthand end of liner section 20 forms a key-and-keyway connection with the telescoping end portion of section 21, in the manner described in connection with sections 19, 20. Here again there is sufficient clearance between the telescoping end portions that a thin annular film of cooling and insulating air is formed on the inner surface of the next section 21, as indicated by arrow 37. A similar key-and-keyway connection serves to support section 21 in telescopic relation with liner section 22. On the other hand, section 22 is located relative to section 23 by means of a pin-and-slot connection, comprising bracket members 38 spot-welded at 38a (Fig. 4) to the outer surface of section 23 and projecting freely inwardly through slots 39 in section 22. This permits the section 22 to slide telescopically into the end section 23, for a purpose which will appear hereinafter.

Discharge end liner section 23 is supported on flexible brackets 40 and forms at its right-hand end a pin-and-slot connection with the inlet end of the transition section 24, by means of radially extending brackets 41 similar to the brackets 38. The transition section 24 projects freely through the opening 5a provided in plate 5, and changes from the circular section of the combustor exit to an arcuate discharge section indicated at 24a. These arcuate discharge portions 24a are of such circumferential extent that the several transition sections associated with the respective combustors together form a continuous 360° discharge annulus emptying into the nozzle ring assembly, a portion of which is illustrated diagrammatically at 42.

As will be understood to those familiar with the so-called "Nerad type combustor," the combustor end dome 18 and the respective liner sections 19, 20, 21, 22, 23, are provided with combustion air inlet holes arranged in a particular way to obtain a peculiarly characteristic air flow pattern within the combustion space, as more particularly described in the copending application of Anthony J. Nerad, Serial No. 750,015, filed May 23, 1947, and assigned to the same assignee as the present application. As described fully in that application, the combustion air flows radially inward through the combustion air ports 45, some of this air meeting at the axis of the liner and flowing to the left as indicated by the arrows 45a, while other portions flow to the right as indicated by the arrows 45b. The portion indicated by arrows 45a flows back towards the nozzle 17, where it entrains and vaporizes the fuel droplets in the spray cone 17a. The burning fuel-air mixture then flows axially down the combustion space between the longitudinal rows of combustion air jets entering through the ports 45. It may also be noted that the end dome 18

has circumferential rows of cooling and insulating air inlet ports formed by U-shaped cutouts 18a having cooperating therewith inwardly projecting tongues 18b, which may either be "struck out" from the metal forming the end dome 18, or may be separately formed and spot-welded to the end dome by means of the tabs 18c, as seen in Fig. 2. This type of end dome is described more completely in the copending application of Walter L. Blatz, Serial No. 644,888, filed February 1, 1946, and assigned to the same assignee as the present application.

It will be observed that a certain amount of air under pressure finds its way from the cylindrical air supply passage around the liner through the clearance spaces defined between the exterior surface of transition section 24 and the periphery of the opening 5a in the transverse support plate 5, as indicated by arrow 44 in Fig. 1. The air leaking through this clearance space may be metered by perforations in an annular baffle 43 welded to outer support wall 6 and slidably engaging the liner section 23. This air circulates in the chamber defined between the transition section 24 and the enclosing casing walls 5b, 5c thus serving to cool the outer surfaces of transition section 24. This cooling air may eventually find its way into the main motive fluid flow path through clearances defined between the transition section discharge nozzle 24a and the adjacent cooperating surfaces 42a of the nozzle ring assembly, which clearances are maintained by reason of the bracket 24b welded to the discharge portion 24a and pivoted to a bracket 42b welded to nozzle ring 42.

To prevent the outer casing sections 7, 8 from accidentally sliding, as a unit, to the right in the end packings 10, 12, a plurality of circumferentially spaced retainer fingers 7a are bolted to blocks 7b secured to the section 7, and have end portions engaging an annular groove in the gland nut 9, as clearly shown in Fig. 1. Thus, any unbalanced pressure forces which may be imposed on the casing sections 7, 8 cannot cause them to slide to the right and produce an air leak at the packing 10.

The method of disassembly of the outer casing and inner liner of the combustor is as follows. First the clamping band 15 is removed and the packing gland nut 11 loosened. Outer casing section 8 with liner section 22 attached may now be slid telescopically into the cylindrical support wall 6, during which movement the pins 38 slide in the elongated slots 39. Also the key-ways 32 at the left-hand side of liner segment 22 become disengaged from the cooperating keys at the right-hand side of section 21. Sliding the outer section 8 into the fixed cylinder carries the liner section 22 to a limiting position denoted by the dotted line 22a. Gland nut 9 may now be loosened and the left-hand casing section 7, with intermediate liner sections 20, 21, attached, may be moved axially to the right, so that the left-hand edge of section 20 is disengaged from the keys 31 of section 19. The dimensions of the cooperating parts are so related that the outer casing section 7 and liner sections 20, 21 may be removed as a unit through the space between the fixed flanges 4c, 6a.

With casing section 7 and liner sections 20, 21 removed, ample space is provided for access to the initial liner section 19 carrying the end dome 18, and at the other end to the two discharge end liner sections 22, 23, and the transition section 24. With spark plug 29 removed, the dome assembly 18, 19 may be removed by disassembling the bolts 27 holding the brackets 26 to the outer housing walls 4b. The manner in which the dome assembly may be moved to the right and removed through the access opening provided between flanges 4c, 6a will be apparent from Fig. 1. The discharge liner end sections 22, 23, may be removed by removing the bolts associated with brackets 36, 40 and sliding the two sections to the left and removing them through the access opening. It will be apparent that during this motion, the slots 23a at the right-hand end of section 23 disengage from the brackets 41 of transition section 24.

From the above description of the structure and method of disassembly, it will be apparent that my invention provides a comparatively simple means for rendering readily accessible the critical combustion chamber liner parts of a gas turbine combustor. By making the inner liner in sections, one section at a time can be replaced as it becomes necessary, thus reducing the cost of maintenance. Tests of a gas turbine locomotive powerplant incorporating combustors substantially as shown in the drawing and described above, which tests extended over a period in excess of 700 hours of operation with hot gas, have shown that the arrangement is thoroughly practicable for use in exacting applications such as locomotive service, where reduction to a minimum of the time required for maintenance, inspection, and overhaul is a most important factor in the overall economy of the machine.

It will be apparent to those skilled in the art that many changes may be made in the mechanical details of combustors incorporating the invention, and the appended claims are intended to cover all such modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a combustor for a thermal powerplant having a frame with a first support wall with a circular open end portion and a second substantially cylindrical support wall fixed to the frame in coaxial relation with said first wall and having an open end portion facing and axially spaced from the open end of the first wall, the combination of an inner liner assembly defining an elongated substantially cylindrical reaction space and comprising an end dome assembly located within and coaxial with the first supporting wall and defining at one end a central opening adapted to receive fuel injecting means, said dome assembly having also a cylindrical portion defining an open end remote from the fuel injecting means, means resiliently supporting the end dome assembly from the first supporting wall whereby differential thermal expansion in a radial direction may freely occur therebetween, an intermediate liner assembly circular in cross section and having at one end a portion surrounding the adjacent open end portion of the dome assembly in telescopically slidable relation therewith, and a discharge end liner assembly of circular cross section and having one end portion surrounding the adjacent end of the intermediate liner assembly in telescopically slidable relation and forming at the other end a discharge opening for hot reaction products, an outer combustor housing including a first cylindrical section surrounding the intermediate liner assembly in radially spaced relation therefrom and having a first end portion adapted to be secured to the open end of the first supporting

wall and a second end portion located substantially in the plane of the intersection of the intermediate assembly with the discharge end liner assembly, a second cylindrical outer housing section surrounding in radially spaced relation the discharge end liner assembly, said second outer housing section having a first end portion adapted to be secured to the adjacent end of the first housing section and a second end portion adapted to be secured to the open end of the second supporting wall, said discharge end liner assembly comprising a cylindrical section arranged within the second supporting wall and flexibly supported therefrom in radially spaced relation and another cylindrical liner section adapted to slide telescopically into the first-mentioned end liner section, means flexibly securing said second-mentioned end liner section to the second outer housing section in radially spaced relation therewith. means flexibly securing said intermediate liner assembly to the first outer housing section in radially spaced relation, first fastening means securing the end of the first outer housing section to the adjacent end of the first supporting wall, second fastening means securing the end of the second outer housing section to the adjacent end of the second supporting wall, and third fastening means securing together the adjacent ends of said first and second outer housing sections, the relative dimensions of the inner liner sections and outer housing sections being so related to the frame and supporting walls that with said first, second, and third fastening means removed the second outer housing section may slide telescopically into the second support wall whereupon the first outer housing section with the intermediate liner section attached may be removed as a unit from the space defined between the respective open ends of said supporting walls.

2. In a combustor for a thermal powerplant having a frame, a first substantially cylindrical combustor support wall fixed to the frame and defining a circular end opening, a second substantially cylindrical combustor support wall fixed to the frame and substantially coaxial with and having an open end axially spaced from and facing the open end of the first wall, an end dome assembly comprising a wall of substantially circular cross section having a closed end defining a central opening adapted to receive fuel injection means and a second open end located substantially in the plane of the open end of the first support wall, means supporting the end dome assembly within and in radially spaced relation to the first support wall, a first intermediate assembly comprising a first substantially cylindrical outer housing section and an intermediate liner assembly supported within radially spaced relation thereto, said intermediate liner assembly having a first end portion adapted to surround the adjacent end of the end dome assembly in telescopically slidable relation therewith and a second open end portion located substantially in the plane of the adjacent end of the first outer housing section, a discharge end liner section located within and fixed to the second support wall in radially spaced relation and having a circular open end portion substantially in the plane of the open end of the second support wall, a second intermediate assembly including a second cylindrical outer housing section adapted to slide axially in telescopic relation into the second support wall and having an end portion adapted to be secured to the adjacent end of the first outer housing section, and a second intermediate inner liner section supported from the second outer housing section in radially spaced relation therewith and having a first end portion adapted to surround in telescopically slidable relation the adjacent end of the first intermediate liner assembly, said second intermediate liner section having a second end portion adapted to enter the adjacent end of the discharge liner section in telescopically slidable relation, means fastening the adjacent ends of the first and second outer housing sections together and other means for fastening the opposite ends of the outer housing sections to said first and second supporting walls respectively, the dimensions of said supporting walls, inner liner sections, and outer housing sections being so related that with said fastening means removed the second intermediate assembly may be moved axially into the second support wall whereupon the first intermediate assembly may be moved axially toward the second support wall and then removed transversely through the space defined between said support walls thus giving free access to the end dome assembly and the discharge end section.

3. In a combustor for a thermal powerplant having a frame with a first combustor support wall defining a circular open end portion and a second substantially cylindrical support wall fixed to the frame in coaxial relation with the first wall and having an open end portion facing and axially spaced from the open end of the first wall, the combination of an inner liner assembly defining an elongated substantially cylindrical reaction space and comprising an end dome assembly located within and coaxial with the first supporting wall and defining at one end a central opening adapted to receive fuel injecting means, said dome assembly having at the other end a cylindrical open end portion, means resiliently supporting the end dome assembly from the first supporting wall whereby differential thermal expansion in a radial direction may freely occur therebetween, an intermediate liner assembly having at one end a portion surrounding the adjacent open end of the dome assembly in telescopically slidable relation therewith, and a discharge end liner assembly having one end portion surrounding the adjacent end of the intermediate liner assembly in telescopically slidable relation therewith and forming at the other end a discharge opening for hot reaction products, an outer combustor housing including a first cylindrical section surrounding the intermediate liner assembly in radially spaced relation therewith and having a first end portion adapted to be secured to the open end of the first supporting wall and a second end portion located substantially in the plane of the intersection of the intermediate assembly with the discharge end liner assembly, said first end portion of the first outer housing section being slidably arranged relative to the first support wall and having packing means therebetween, the combustor outer housing including also a second cylindrical outer section surrounding the discharge end liner assembly in radially spaced relation therewith and having a first end portion adapted to be secured to the adjacent end of the first outer housing section and a second end portion slidably received in the second supporting wall and having packing means therebetween, said discharge end liner assembly comprising a cylindrical section arranged within the second supporting wall and resiliently supported therefrom in radially spaced relation and another cylindrical liner section arranged within and resil-

iently supported from the second outer housing section and adapted to slide telescopically into the first-mentioned discharge end liner section, readily removable fastening means securing the discharge end liner sections to the second outer housing section and to the second support wall respectively, readily removable fastening means securing the intermediate liner assembly to the first outer housing section, and readily removable fastening means securing the end dome assembly in said first support wall, retainer means associated with the first outer housing section and the first support wall for preventing accidental relative axial movement therebetween, readily removable pipe coupling means securing together the adjacent ends of the outer housing sections, the relative dimensions of the inner liner sections and outer housing sections being so related to each other and to the supporting walls that with said retainer means and pipe coupling means removed the second outer housing section may slide telescopically into the second support wall carrying the discharge end liner sections therewith, whereupon the first outer housing section with the intermediate liner section attached may be removed as a unit from the space defined between the respective open ends of said supporting walls.

4. In a combustor for a thermal powerplant having a frame with a first support wall with a circular open end portion and a second substantially cylindrical support wall fixed to the frame in coaxial relation with said first wall and having an open end portion facing and axially spaced from the open end of the first wall, the combination of an inner liner assembly defining an elongated substantially cylindrical reaction space and comprising an end dome assembly located within and coaxial with the first supporting wall and defining at one end a central opening adapted to receive fuel injecting means with the other end open for the discharge of reaction products, readily removable fastening means resiliently supporting the end dome assembly within the first supporting wall in radially spaced relation thereto whereby differential thermal expansion in a radial direction may freely occur therebetween, an intermediate liner assembly having at one end a portion surrounding the adjacent open end portion of the dome assembly in telescopically slidable relation therewith, and a discharge end liner assembly having one end portion surrounding the adjacent end of the intermediate liner assembly in telescopically slidable relation therewith and forming at the other end a discharge opening for hot reaction products, an outer housing including a first cylindrical section surrounding the intermediate liner assembly and having a first end portion adapted to be secured to the open end of the first supporting wall and a second end portion located substantially in the plane of the intersection of the intermediate liner assembly with the discharge end liner assembly, a second cylindrical outer housing section surrounding the discharge end liner assembly, said second outer housing section having a first end portion adapted to be secured to the adjacent end of the first outer housing section and a second end portion adapted to be sealed to the open end of the second supporting wall, readily removable means flexibly supporting said intermediate liner assembly in radially spaced relation within the first outer housing section, readily removable fastening means resiliently securing the discharge end liner assembly in radially spaced relation within the second outer housing section, first retainer means securing the end of the first outer housing section to the adjacent end of the first supporting wall, pipe coupling means connecting the adjacent end portions of the first and second outer housing sections, and releasable packing means associated with said second support wall and the adjacent portion of the second outer housing section, the relative dimensions of the inner liner sections and outer housing sections being so related to the frame and supporting walls that, with the retainer means and pipe coupling means removed and the packing means released, the second outer housing section with the discharge end liner assembly attached may slide telescopically into the second support wall whereupon the first outer housing section with the intermediate liner section attached may be removed as a unit from the space defined between the respective open ends of said supporting walls.

5. In a combustion device of the type described, means for supporting adjacent liner sections in concentric, radially spaced, telescopic relation including a bracket member secured to the outer surface of the inner liner section at a location spaced axially from the forward end of the inner section and having a radially extending portion terminating in an axially extending member defining a key arranged longitudinally of the section, said axially extending key member being spaced radially from the outer surface of the outer liner section, and bracket means secured to the outer surface of the outer liner section and defining a longitudinally disposed keyway adapted to receive the key portion of said first-mentioned bracket with comparatively close circumferential clearances but appreciable radial clearance whereby radial expansion of one liner section relative to the other is freely permitted while concentricity is maintained accurately, the liner sections being at the same time free to slide axially relative to each other for purpose of disassembly.

6. In a combustion device of the type described, means for supporting the adjacent liner sections in concentric, radially spaced, telescopic relation including a bracket member secured to the outer surface of one liner section at a location spaced axially from the end of the section and having a radially extending portion terminating in an axially extending member defining a key arranged longitudinally of the sections, said key member overlying and spaced radially from the outer surface of the other liner section, and other bracket means secured to the outer surface of the other section and defining a longitudinally disposed keyway adapted to receive the key portion of said first-mentioned bracket with substantially no circumferential clearance but appreciable radial clearance, whereby radial expansion of one liner section relative to the other is freely permitted while concentricity is maintained accurately, the liner sections being at the same time free to slide axially relative to each other for assembly and disassembly.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,268,464	Seippel	Dec. 30, 1941