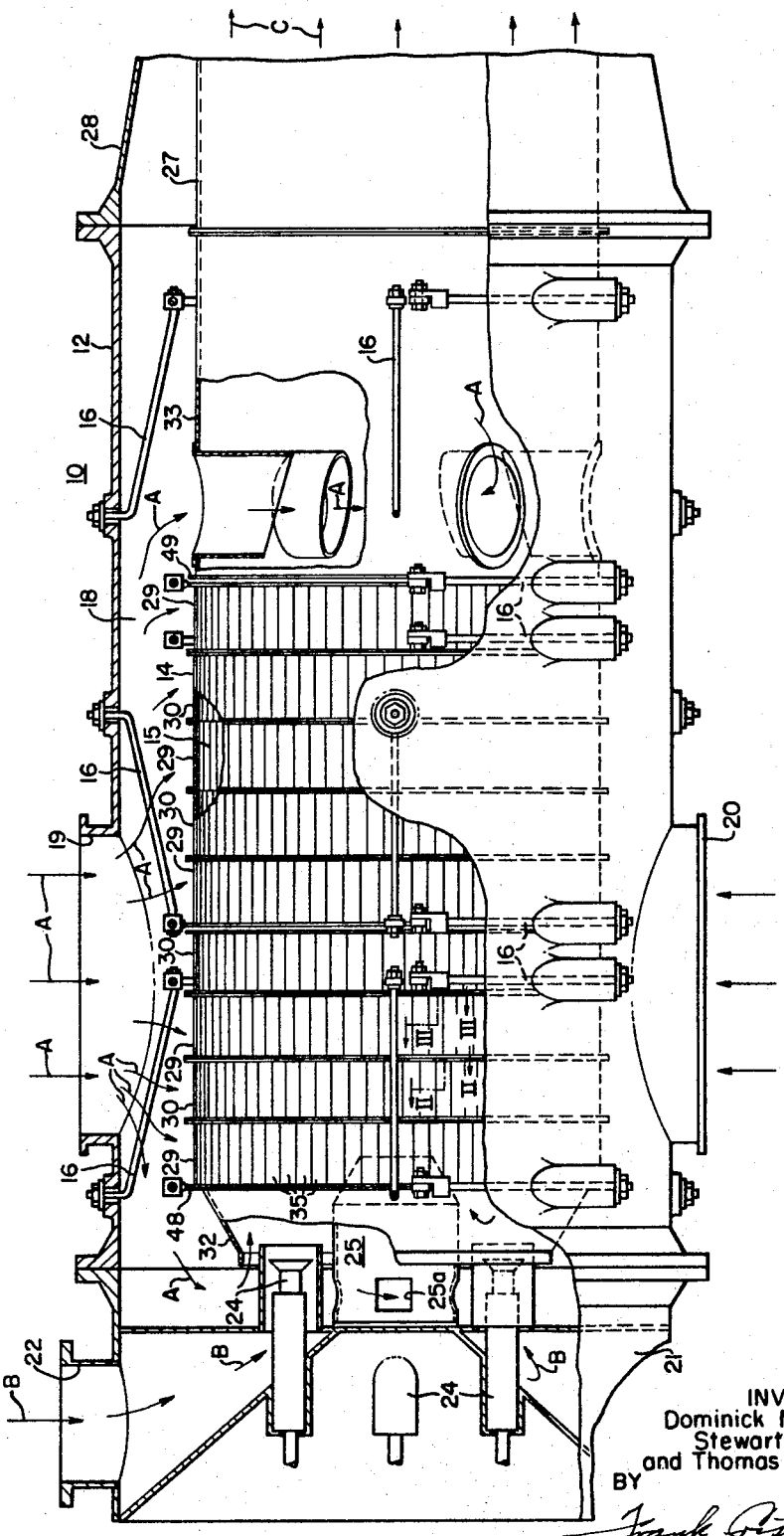
Jan. 21, 1969 D. M. FANTOZZI ETAL 3,422,620

COMBUSTION APPARATUS

Filed May 4, 1967 Sheet 1 of 2

FIG. 1.



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COMBUSTION APPARATUS

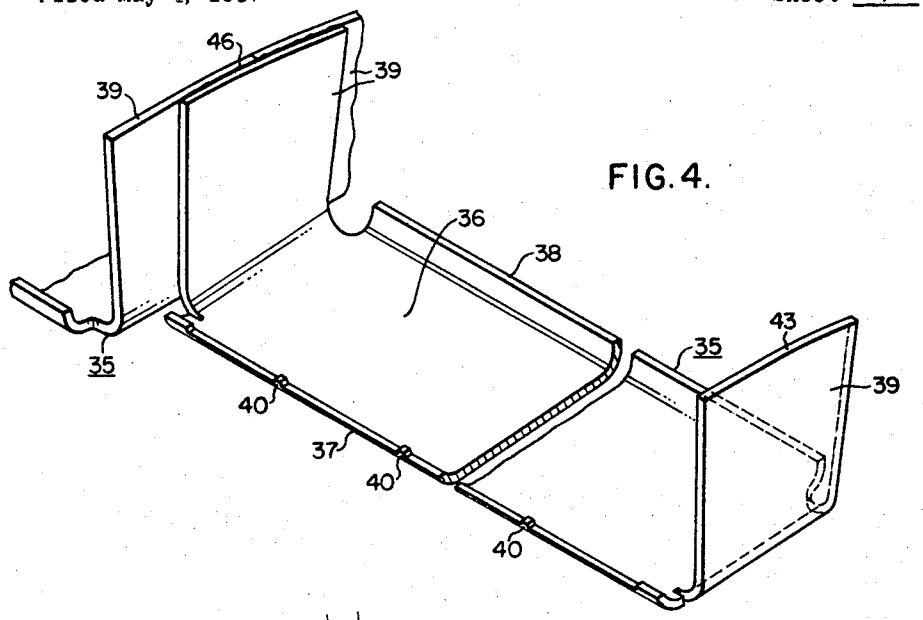


FIG. 4.

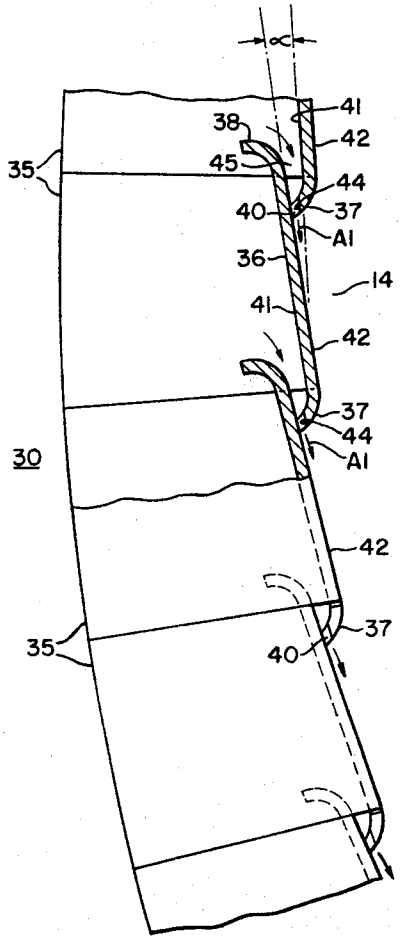


FIG. 2.

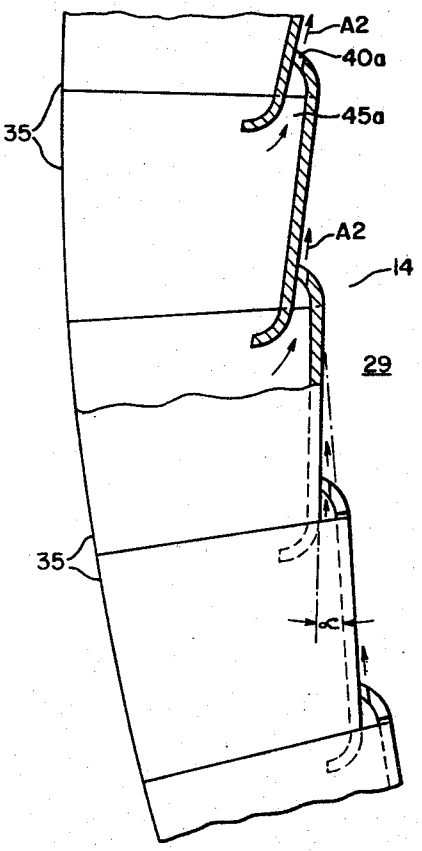


FIG. 3.

United States Patent Office 3,422,620 Patented Jan. 21, 1969

3,422,620

COMBUSTION APPARATUS

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U.S. Cl. 60—39.65 8 Claims
Int. Cl. F02c 3/14, 7/12

ABSTRACT OF THE DISCLOSURE

This invention provides a gas turbine combustor in which the tubular liner that defines the combustion chamber comprises at least one annular array of sheet metal plate members disposed in successively partially overlapping relation with each other in a manner forming an annular array of openings through which diluent air is admitted to the chamber in a plurality of circumferentially directed jets.

Background of the invention

The invention relates to gas turbine combustors, more particularly to a combustor of the type formed of sheet metal and has for an object to provide a combustor of this type that is less expensive to manufacture yet more reliable in service.

Heretofore, combustors of the type to which this invention relates have been formed with one or more integral tubular liner sections formed of sheet metal. One example is shown in T. J. Rahaim and K. L. Reicke Patent 3,007,308, issued Nov. 7, 1961 and assigned to the same assignee as this invention.

Summary

Briefly, the invention resides in forming a tubular liner of a combustor with at least one annular array of sheet metal plate members having flat portions disposed in partially overlapping spaced relation with each other and jointly with each other forming an annular array of rectangular openings. The plates are so disposed that converging passageways or nozzles are provided communicating with the openings so that the secondary air is admitted into the chamber at relatively high velocity across the inner surfaces of the plate members.

The plate members are provided with flange portions at their opposite ends for attaching to other tubular portions of the liner, or if several annular rows of plate members are employed, the several rows may be attached to each other at the flanges.

Also when more than one row of plate members is so employed, the plates in one row may overlap in one circumferential direction and the plates in the other rows may overlap in the same or opposite circumferential direction.

Brief description of the drawings

FIGURE 1 is a longitudinal view of gas turbine combustion apparatus with parts cut away to show the invention;

FIG. 2 is an enlarged sectional view taken on line II—II of FIG. 1;

FIG. 3 is an enlarged sectional view taken on line III—III of FIG. 1; and

FIG. 4 is a perspective view illustrating a complete plate member and portions of adjacent plate members.

Description of the preferred embodiment

Referring to the drawings in detail, there is shown gas turbine combustion apparatus generally designated **10** comprising an outer tubular casing structure **12** of generally circular cross-section within which is disposed a tubular combustion basket **14**, hereinafter termed a combustor, embodying the invention.

The combustion apparatus **10** is of a type generally well known in the art, as indicated in T. J. Rahaim and K. L. Reicke Patent 3,007,308 issued Nov. 7, 1961 and assigned to the same assignee as this invention, but the combustor **14** is an improvement over the combustor disclosed therein.

The combustor **14** defines a cylindrical combustion chamber **15** and is suspended in a substantially concentric position within the outer casing **12** by a plurality of flexible strut members **16**. The combustor **14** is of smaller cross-sectional diameter than the outer casing **12** and jointly therewith defines an annular space **18** to which pressurized air is admitted as indicated by the arrows A through a pair of diametrically opposed inlet openings **19** and **20**, from any suitable source (not shown).

The outer casing **12** further includes a manifolded end closure member **21** having an inlet opening **22** through which pressurized combustible gases (for example steel making blast furnace gases) may, when available, be admitted as indicated by the arrows B to the combustion chamber **15**.

The end closure member **21** is further employed to support an annular array of liquid or gaseous fuel injection nozzles **24** through which fuel (for example fuel oil or natural gas) is supplied in atomized form to the combustion chamber **15**.

In the center of the array of nozzles **24**, there is further provided an air probe **25** supplied with pressurized air through apertures **25***a* to assist in distribution of primary air in the combustion chamber **15**.

The combustor **14** and the outer casing **12** are connected at their downstream ends (at the right, as illustrated) by suitable duct structures **27** and **28**, respectively, to a suitable gas turbine (not shown) so that, in operation, hot motive combustion gases are provided thereto to motivate the turbine, as well known in the art.

As thus far described, the apparatus is substantially conventional and, in operation, a suitable spark plug (not shown) is employed to ignite one fuel oil nozzle to provide a pilot flame for igniting the combustible mixture formed in the combustion chamber **15** by the combustible gas admitted thereto through the inlet **22** and the air admitted thereto through the inlets **19** and **20**. The resulting hot gaseous products of combustion are conducted to the gas turbine (not shown) through the duct structure **27**, as indicated by the arrows C.

In the event that the supply of combustible gas is insufficient to provide the quantity of hot motive gases required by the power demand on the turbine, additional fuel is admitted to the combustion chamber **15** by the liquid fuel injector nozzles **24**, as required.

As well known in the art, the air admitted to the combustion chamber **15** is divided into three categories, (1) primary air required to sustain combustion with the fuel, (2) secondary air required to prevent overheating of the combustor **14** to dilute the hot products of combustion to a temperature that the combustor can tolerate, and (3) tertiary air to further dilute the hot products of combustion to a temperature level that the gas turbine can safely tolerate.

In accordance with the invention, the combustor **14** includes a series of tubular liner structures **29** and **30** of generally cylindrical shape attached to each other at their peripheries to form the major portion of the combustor **14**, an upstream end member **32** of frustoconical shape attached at its periphery to the first liner structure **29** (at the extreme left in the illustration), and a downstream liner member **33** of cylindrical shape attached at its left

periphery to the last liner structure 29 and at its right periphery to the duct member 27.

The liner structures 30 are formed by an annular array of discrete and separately formed sheet metal plate members 35, as best seen in FIGS. 2 and 4, disposed in successively partially overlapping relation with each other for the full circumferential extent of the liner.

The plates 35 are preferably substantially identical to each other and as best shown in FIG. 4 comprise a central portion 36 of substantially planar shape but having a pair of opposed upturned marginal portions 37 and 38, and a pair of upturned end portions or flanges 39. The marginal portions 37 and 38 are preferably curved and the marginal portion 37 is further provided with a plurality of spaced projecting portions 40. The central portion 36 has a pair of opposed planar surfaces 41 and 42 (see FIG. 2).

The flange members 39 are of narrower width than the central portion 36 and of increasing width from base to tip 43, so that when the plates are assembled with adjacent flanges 39 in end-to-end abutment, as best seen in FIG. 2, the central portions partially overlap each other.

When the plate members 35 are thus assembled, the planar surface 42 is considered the inner surface since it partially defines the combustion chamber 14, while the surface 41 is considered the outer surface. Also, the marginal portions 37 and 38 and the flanges 39 are considered radially outwardly extending since they are so disposed with regard to the central longitudinal axis of the liner structure 29.

It will be seen that the marginal portions 37 of one plate member 35 are disposed in abutting relation with the inner surface 42 of the adjacent overlapping plate member 35, such abutment being limited by the projections 40, so that jointly therewith a plurality of elongated rectangular openings 44 are formed. Adjacent plate members 35 are disposed at a small angle α with each other, as determined by the width of the planar surface portions 36, as well as the radial length of the upturned marginal portions 37. Accordingly, the outer surface 41 and the lapping portion of the inner surface 42 of adjacent plate members jointly define a converging passageway 45 communicating with the associated openings 44. The convergent shape of the passageway 45 is further augmented by the curved marginal portion 38.

In operation, a portion of the air A is employed as diluent air and is directed through the openings 40, in a plurality of discrete jets, as indicated by the arrows A1, to dilute the hot products of combustion. Since the passageways 45 are convergent, a high velocity is imparted to the air jets A1, and since the plate members are inclined with each other, the air jets A1 are directed tangentially and sweep the inner surfaces 42, thereby cooling the plate members or at least preventing dangerous overheating thereof.

Also, all of the passageways 45 direct the air jets A1 in the same circumferential direction, for example counterclockwise when viewed as in FIG. 2.

The liner structures 29 are substantially identical to the liner structures 30, except that as best shown in FIG. 3, the plate members 25 are disposed in oppositely overlapping direction and jointly form openings 40*a* similar to the openings 40 and converging passageways 45*a* similar to the pasageways 45, but effective to direct the diluent air in opposite circumferentially flowing air jets A2, i.e. in clockwise direction when viewed as in FIG. 3.

The plate members 35 in adjacent liner structures 29 and 30 are preferably staggered circumferentially, as indicated in FIG. 4, so that the flanges 39 in one row are in abutment but out of registry with the flanges 39 in the adjacent row, and adjacent flanges are joined to each other by weld joints 46 to form a unitary self-supporting structure.

The end member 32 (FIG. 1) is provided with a circumferential flange 48 to which the flanges 39 of the plates 35 in the first liner structure are attached as by welding (not shown) and in a similar manner the downstream liner member 33 is provided with a circumferential flange 49 to which the flanges 39 of the plates 35 in the last liner structure are attached as by welding (not shown).

It will now be seen that the invention provides a unitary tubular combustor in which the annular liner is at least partially formed of a plurality of individual plate members of substantially similar shape which may be readily formed by mass production methods at reduced expense, and in which such liner may be readily attached to associated combustor components by welding externally of the combustion chamber.

In the embodiment shown and described, the annular liner structures 29 and 30 are disposed in alternating arrangement so that the diluent or secondary air is alternately directed into the combuston chamber 15 in clockwise and counterclockwise direction. However, any other arrangement utilizing the structures 29 and 30 may be provided. For example, several liner structures 29 may be provided adjacent each other followed by several liner structures 30. Also, if desired, liner structures of one or the other type (29 or 30) may be employed.

We claim as our invention:

1. A gas turbine combustor comprising
a tubular liner structure at least partly defining a combustion chamber,
means for admitting fuel to said combustion chamber,
means for admitting primary air to said combustion chamber for supporting combustion of said fuel,
said tubular liner including at least one annular array of plate members disposed in successively partially overlapping relation with each other and jointly with each other forming annular array of openings, and
means for admitting secondary air to said combustion chamber through said openings to dilute the products of combustion formed by said fuel and primary air.

2. The structure recited in claim 1 wherein
the plates are provided with a central portion and a pair of outwardly extending end portions,
said end portions being disposed in end-to-end relation and jointly defining a pair of annular flanges.

3. The structure recited in claim 1, wherein
the plates are provided with a central portion having an inwardly facing surface and an outwardly extending marginal portion,
the marginal portion on one of said plate members abutting the inwardly disposed surface of the adjacent overlapping plate and jointly therewith forming at least one of the openings.

4. The structure recited in claim 1, wherein
the plates are provided with a central portion having an inwardly facing surface and an outwardly curved marginal portion,
the marginal portion on one of said plate members abutting the inwardly facing surface of the adjacent overlapping plate and jointly therewith forming at least one of the openings, and
the inwardly facing surface on said plate member and the outwardly curved marginal portion on said adjacent overlapping plate jointly defining a converging passageway communicating with the associated opening, whereby the secondary air flow is directed through the opening at relatively high velocity.

5. The structure recited in claim 1, wherein
the plates are substantially identical to each other, whereby the openings are of substantially identical size, shape and air flow characteristics,
each of the plates having an inwardly facing surface portion, and
the openings are effective to direct the secondary air in high velocity jet form along said inwardly facing surfaces.

6. The structure recited in claim 5, wherein

the openings are effective to direct the secondary air in a plurality of discrete jets all of which are in the same circumferential direction.

7. The structure recited in claim 1, wherein

the tubular liner includes a second annular array of plate members disposed in successively partially overlapping relation with each other and jointly with each other forming a second annular array of openings for admitting secondary air to the combustion chamber,

the plate members, in the first mentioned and second array, each being provided with a central portion and a pair of outwardly extending end portions,

said end portions being disposed in end-to-end relation with each other and jointly with each other defining a pair of juxtaposed annular flanges, and

means including a plurality of weld joints for attaching said juxtaposed flanges to each other to form an integral structure.

8. The structure recited in claim 7, wherein

the first array of openings are effective to admit the secondary air into the combustion chamber in one circumferential direction, and

the second array of openings are effective to admit the secondary air into the combustion chamber in the opposite circumferential direction.

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U.S. Cl. X.R.

60—39.66, 39.69; 431—173