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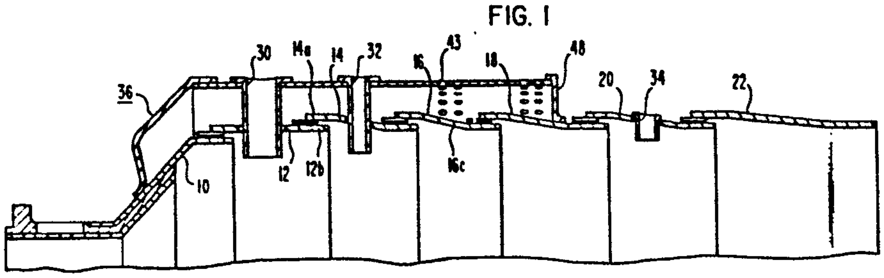
(54) **Impingement cooled gas turbine combustor with internal film cooling.**

(57) A gas turbine combustor, having a side wall formed of side wall members (12, 14, 16, 18, etc.,) in telescopic relation to form annular air admission gaps 24 to obtain film cooling, a cylindrical jacket 36 encompasses at least the upstream stages of the combustor and is provided with impingement ports (38-45) located in an axial direction to provide impingement cooling upon the relatively hotter portions of the side wall members before the air in the jacket performs its film-cooling effect by entering the combustor through the annular air admission gaps.

FIG. 1




EP 0 178 820 A1

Croydon Printing Company Ltd

# IMPINGEMENT COOLED GAS TURBINE COMBUSTOR WITH INTERNAL FILM COOLING

This invention relates to gas turbine combustors, and in particular to a combustor construction that provides both impingement and film cooling for the combustor wall.

Gas turbine combustor wall temperatures are maintained at or below design values by a combination of external convection and internal film convection. In the existing commercial design of the assignee of this application, the external cooling of the combustor is the result of the shell air passing over the external faces of the combustor walls before entering the combustor as nozzle air, primary and dilution air, and film cooling air. As a result, the average heat transfer coefficient is relatively small, such as less than 100 BTU/hr.-ft.$^2$-°F, (568 W/m$^2$-K) and with even smaller values at some localized areas. Most of the heat load is removed by the film cooling, which results in a heat transfer coefficient at least three times that of the noted average.

An object of this invention is to further improve wall cooling of the combustor by increasing the external cooling while maintaining a high level of internal film cooling.

According to the present invention, a gas turbine combustor comprises a tubular side wall, the side wall formed by a succession of tubular side wall members disposed in a telescopic arrangement spacer means for supporting an outwardly located upstream end portion of each of said side wall members outwardly of and relative to an inwardly located downstream end portion of the adjacent upstream side wall member to provide an annular coolant air admission slot between the end portions of the side wall members, characterized by the downstream end portions of the side wall members having a tubular lip extending downstream from the downstream end of the spacer means, the combustor including a cylindrical jacket encompassing the upstream one of said side wall members and at least a plurality of successive downstream side wall members, said jacket including at least one row of circumferentially closely spaced impingement ports for each side wall member, said at least one row being located in an axial direction closely upstream of said annular coolant air admission slot to provide impingement air cooling upon the relatively hotter portion of said side wall members relatively far downstream from the next upstream annular air admission slot, before said impingement air passes through said annular air slots in communication with the interior of said jacket.

Conveniently, the cylindrical jacket encompassing the upstream portion of the side wall is formed by a plurality of successive side wall members in a telescopic arrangement, with the jacket including at least one row of circumferentially closely spaced impingement ports for each of the side wall members, with at least one row being located in an axial direction closely upstream of the annular coolant air admission slots formed at the joints of the side wall members to provide impingement air cooling upon the relatively hotter portions of the side wall members relatively far downstream from the next upstream annular air admission slot, this impingement cooling occurring before the air passes through the annular air slots into the combustor proper.

The invention will now be described by way of example, with reference to the accompanying drawings in which:

Figure 1 is a fragmentary sectional view through a wall of a combustor provided with the jacket;

Figure 2 is a fragmentary face view, partly broken, illustrating the relation of the impingement ports and air scoops to the radially inner combustor side wall; and

Figure 3 is an enlarged sectional view at one juncture of successive side wall members.

Figure 1 shows a combustor proper and includes the upstream dome 10 and a series of successively downstream side wall members denoted 12, 14, 16, 18, 20, and 22 which together form the side wall of the cylindrical combustor. As illustrated, the side wall members are basically arranged in telescopic relation with the upstream margin of each side wall member, as at 14a, overlapping the downstream portion, as at 12b, of the radially inner successive upstream side wall member 12. At the overlapping juncture of the successive side wall members, spacer means 24, which may conveniently take the form of a corrugated band, is interposed between the parts 14a and 12b of the successive side wall members. Since the band is disposed so that the crests and valleys extend axially, an air admission slot 26 is provided. The direction of flow through the slot is as indicated in Figure 3 by the arrow. As is apparent from Figure 3, and as is noted to be the preferred embodiment in the noted patent application, the band 24 projects upstream farther than the portion 14a of the side wall member 14, and the downstream portion 12b of the side wall member 12 includes a lip 12c projecting farther downstream than the downstream end of the band 24.

Fuel is fed through means not shown to the upstream portion 28 (Fig. 1) of the combustor and is mixed with combustion air delivered to the interior of the combustor through primary air scoops 30 and 32. The hot mixture flows in the downstream direction as indicated by the directional arrow in Figure 1 with dilution air being introduced into the more downstream portion of the combustor through the dilution scoops 34.

It is noted that the quantity of primary air required for combustion is basically fixed according to the particular combustion conditions. The other two quantities of air which enter the combustor are the cooling air and the dilution air. To the extent that cooling of the combustor can be optimized so that less cooling air is needed, the quantity available for dilution is increased and this is considered desirable.

To the end of improving the cooling effect of that air used for cooling, a cylindrical jacket 36 (Fig. 1) encompasses the upstream side wall member 12 and at least a plurality of successive downstream side wall members, in this case at least 14, 16, and a portion of 18. Rows of circumferentially closely spaced impingement ports are provided in the jacket to admit cooling air into the annular space between the jacket and combustor proper. In the currently preferred embodiment, two axially spaced rows are provided to accommodate each annular air admission slot, although the number of rows and holes per row can be different in accordance with the temperature level required. As best seen in Figure 2, the rows are identified by the numerals 38, 39, 40, 41, 42, 43, 44, and 45. The axial location of the downstream row of each set of two rows is important in carrying out the invention. The reason for this is that the film cooling effect upon the side wall members is better in the vicinity of the annular air admission slots before the integrity of the film is dissipated to a degree and, accordingly, the hotter portions of the side wall members are in the vicinity closely upstream from the annular air admission slot as in the location designated 16c in Figure 1. Thus, the row of holes 43 is located, in an axial direction, closely upstream of the annular slot formed between the side wall members 16 and 18. The other row of holes 42 of the set 42 and 43 is located, in an axial direction, again only slightly upstream of the row 43 to ensure that the portion of the side wall member between the film cooling area and the next successive annular slot downstream will be adequately cooled. After the air entering the impingement ports has impinged upon the respective facing side wall members, this air then flows to the annular air admission slots and flows into the combustor proper performing its film cooling function.

It is noted in the particular constructions shown in Figure 1 that the downstream end 48 of the cooling jacket is upstream from the annular air admission slot formed between the side wall members 18 and 20. While the jacket could extend further downstream in an axial direction, at this point in the combustor the cooling problems are not as great as farther upstream in the primary zone. However, it is considered preferable that the row of holes 45 be inclined to direct the impingement air toward the corner formed between the end wall 48 of the jacket, and the side wall member 18. The air which impinges through the holes 44 and 45 against side wall member 18 must flow upstream within the annular space between the jacket and combustor proper and will enter the combustor through the annular slot between side wall members 16 and 18. Thus, there will be a tendency for the cooling air entering the farther upstream impingement ports to also have a component of air flowing upstream to the next upstream annular slot.

The arrangement as described is intended to utilize, to the degree possible, the cooling air most effectively. Thus, for a given heat load, and depending upon the particular design one can either reduce wall temperatures substantially with the same amount of air as in the present design using film cooling only, or obtain the same wall temperature with less air, thus making more air available for the primary combustion zone to reduce NOX or to the dilution zone to improve the pattern factors of the combustor.

CLAIMS:

1. A gas turbine combustor, comprising a tubular side wall, the side wall formed by a succession of tubular side wall members disposed in a telescopic arrangement spacer means for supporting an outwardly located upstream end portion of each of said side wall members outwardly of and relative to an inwardly located downstream end portion of the adjacent upstream side wall member to provide an annular coolant air admission slot between the end portions of the side wall members, characterized by the downstream end portions of the side wall members having a tubular lip extending downstream from the downstream end of the spacer means, the combustor including a cylindrical jacket encompassing the upstream one of said side wall members and at least a plurality of successive downstream side wall members, said jacket including at least one row of circumferentially closely spaced impingement ports for each side wall member, said at least one row being located in an axial direction closely upstream of said annular coolant air admission slot to provide impingement air cooling upon the relatively hotter portion of said side wall members relatively far downstream from the next upstream annular air admission slot, before said impingement air passes through said annular air slots in communication with the interior of said jacket.

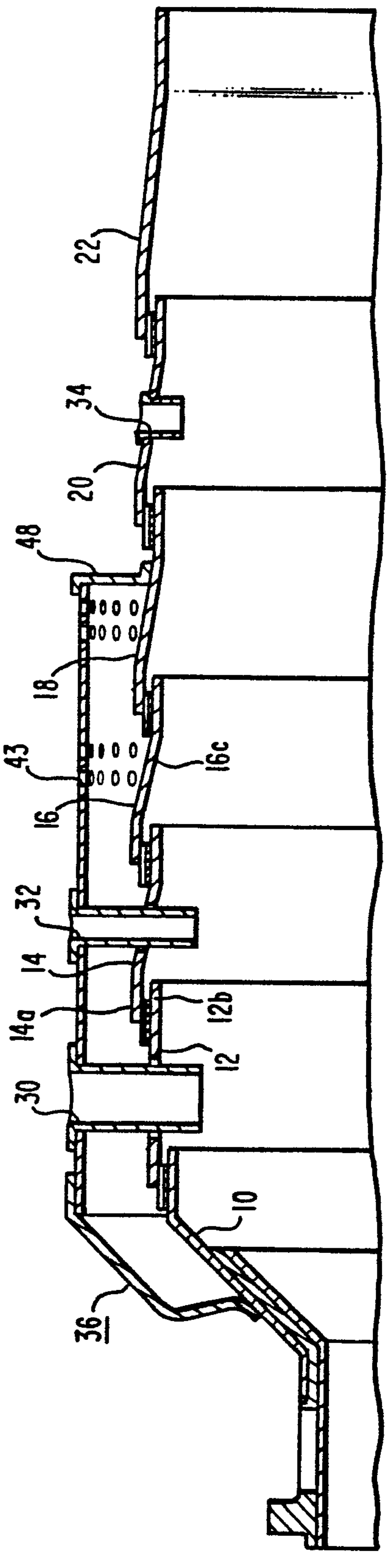
2. A combustor as claimed in claim 1 characterized by a second row of circumferentially closed spaced impingement ports for each side wall member, said second

row being located in an axial direction closely upstream of said at least one row of impingement ports.

3. A combustor as claimed in claim 1 or 2 characterized in that said cylindrical jacket encompasses at least four successive side wall members.

4. A gas turbine combustor, constructed and adapted for use substantially as hereinbefore described and illustrated with reference to the accompanying drawings.

FIG. 1



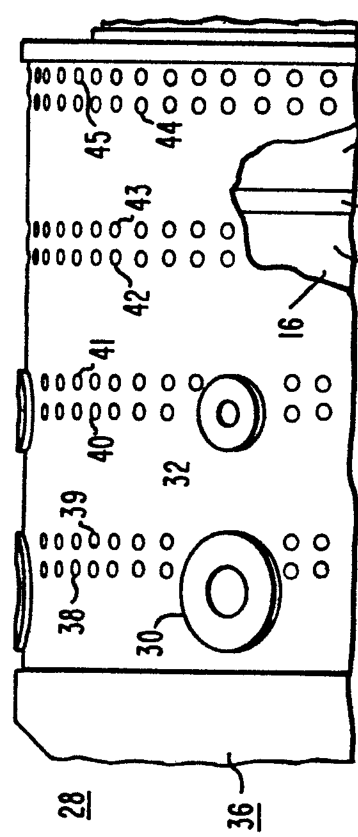




FIG. 2

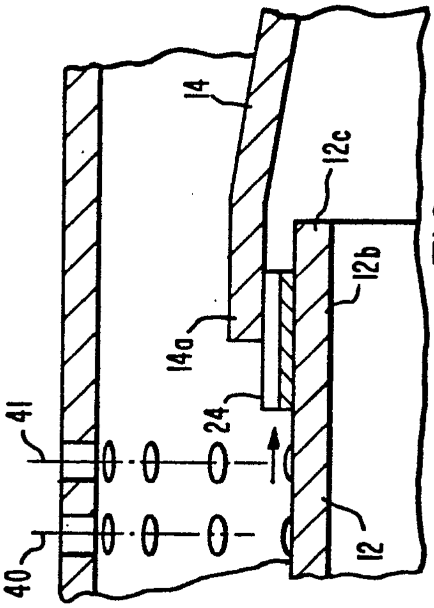



FIG. 3

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# EUROPEAN SEARCH REPORT

0178820

EP 85 30 7034

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int Cl 4) |
|---|---|---|---|
| Y | GB-A-2 095 816 (WESTINGHOUSE ELECTRIC)<br>* Figure 1; abstract *<br>--- | 1-3 | F 23 R 3/08<br>F 23 M 5/08 |
| Y | US-A-4 109 459 (EKSTEDT)<br>* Figure 2; column 2, lines 43-48; column 5, lines 46-52; column 5, line 63 - column 6, line 11 *<br>--- | 1-3 | |
| A | US-A-3 369 363 (CAMPBELL)<br>* Figures 1,2; column 4, lines 26-36 *<br>----- | 1 | |
| | | | TECHNICAL FIELDS SEARCHED (Int Cl 4) |
| | | | F 23 M<br>F 23 R |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 10-01-1986 | PESCHEL G. |

CATEGORY OF CITED DOCUMENTS

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