US 20030167776A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2003/0167776 A1**

(43) **Pub. Date: Sep. 11, 2003**

Coppola

(54) **TRANSITION PIECE FOR NON-ANNULAR GAS TURBINE COMBUSTION CHAMBERS**

(76) Inventor: **Alessandro Coppola**, Prato (IT)

Correspondence Address:
NIXON & VANDERHYE, PC
1100 N GLEBE ROAD
8TH FLOOR
ARLINGTON, VA 22201-4714 (US)

(21) Appl. No.: **10/311,251**

(22) PCT Filed: **Jun. 8, 2001**

(86) PCT No.: **PCT/EP01/06484**

(30) **Foreign Application Priority Data**

Jun. 16, 2000 (IT) MI00A001362

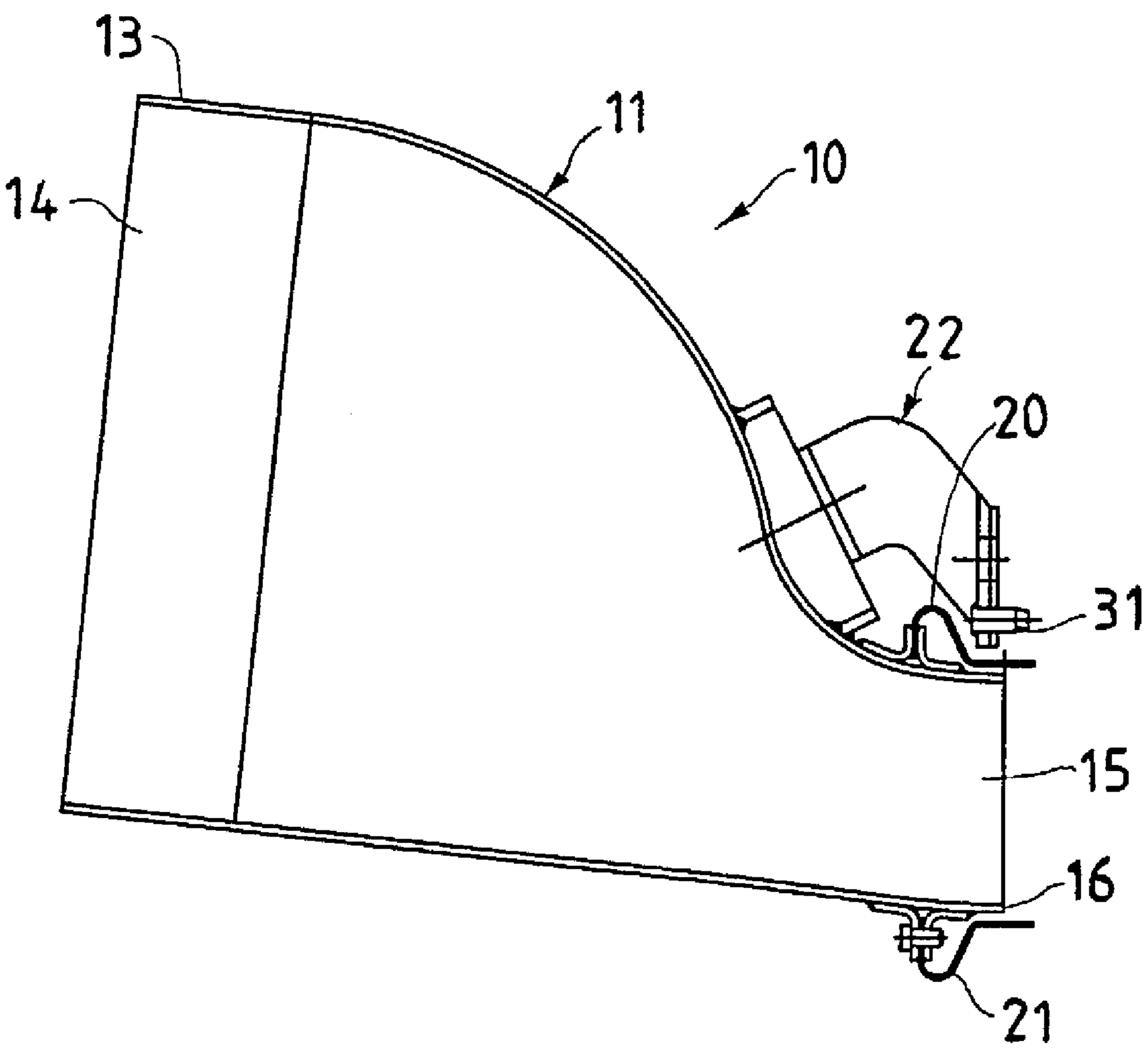
Publication Classification

(51) **Int. Cl.**[7] **F23R 3/42**

(52) **U.S. Cl.** **60/800**; 60/752

(57) **ABSTRACT**

A transition piece (**10**) for non-annular gas turbine combustion chambers has a projecting connection arm (**22**) for support on the turbine stator, wherein the projecting connection arm (**22**) makes it possible to obtain a lead-in axis with an angle of between 5° and 7° relative to an axis, which is parallel to the axis of the machine, and is perpendicular to the plane on which there lies the frame for interfacing of the transition piece (**10**) with the ring of nozzles of the first stage of the gas turbine.



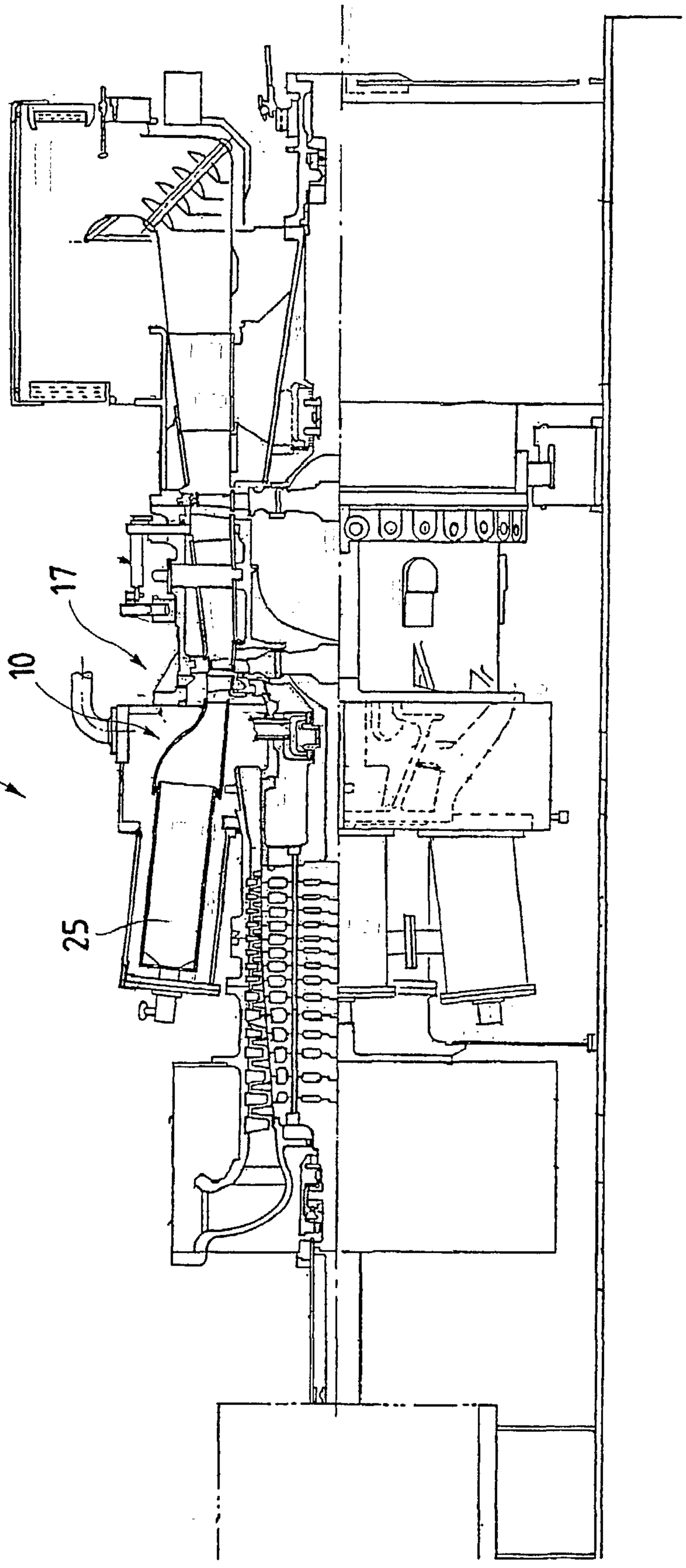


Fig.1

Fig.3

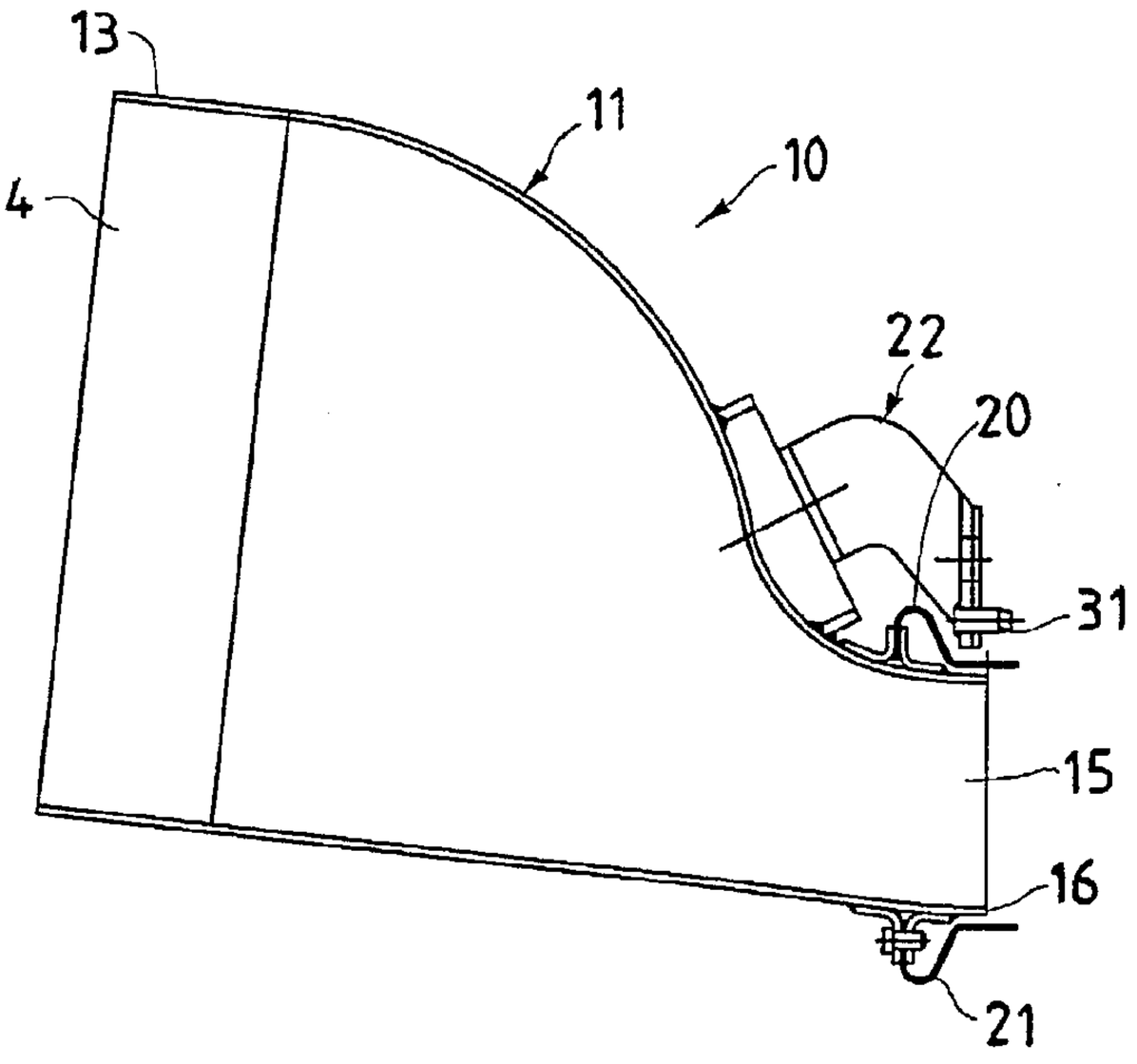


Fig.2

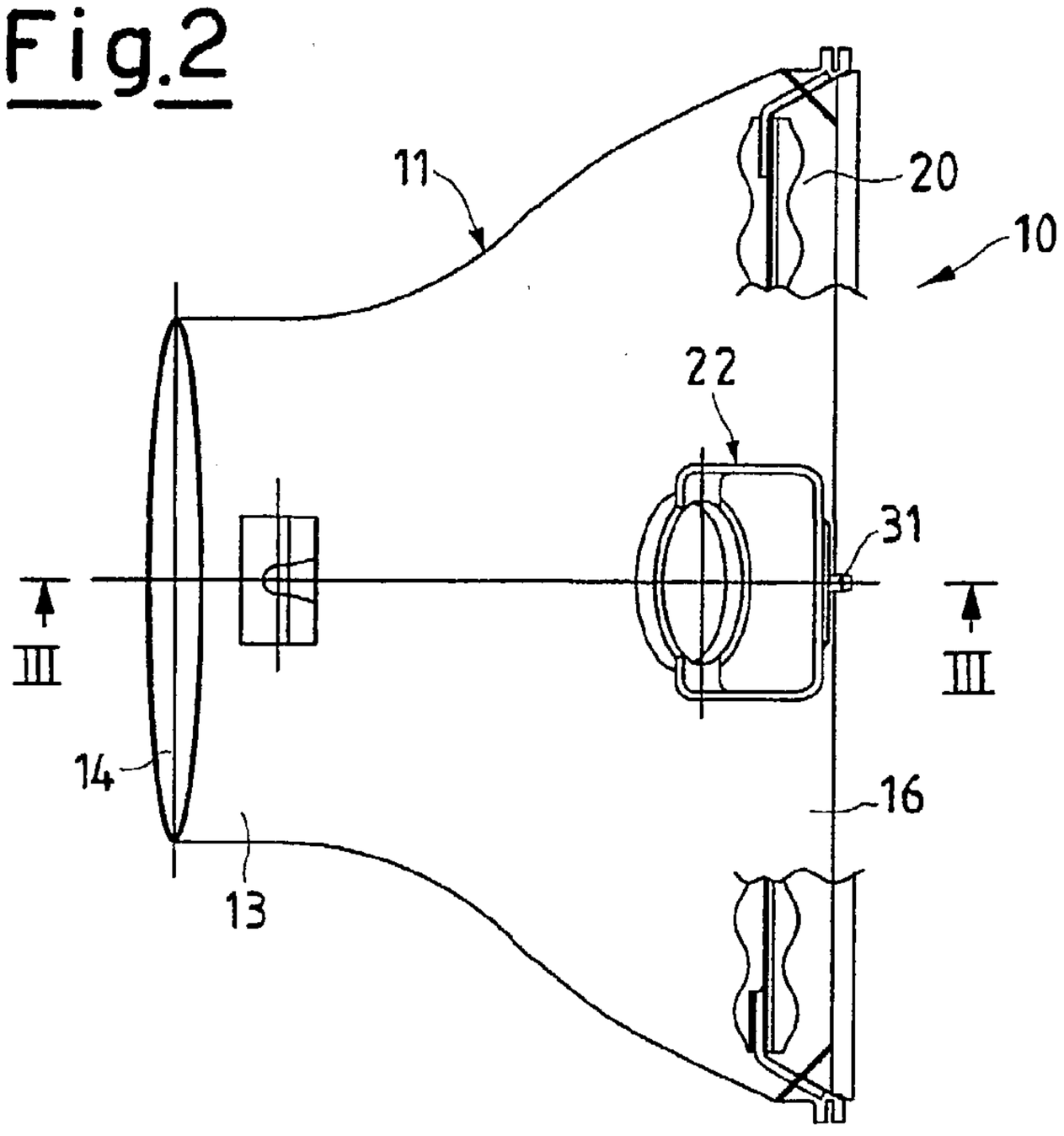


Fig.4

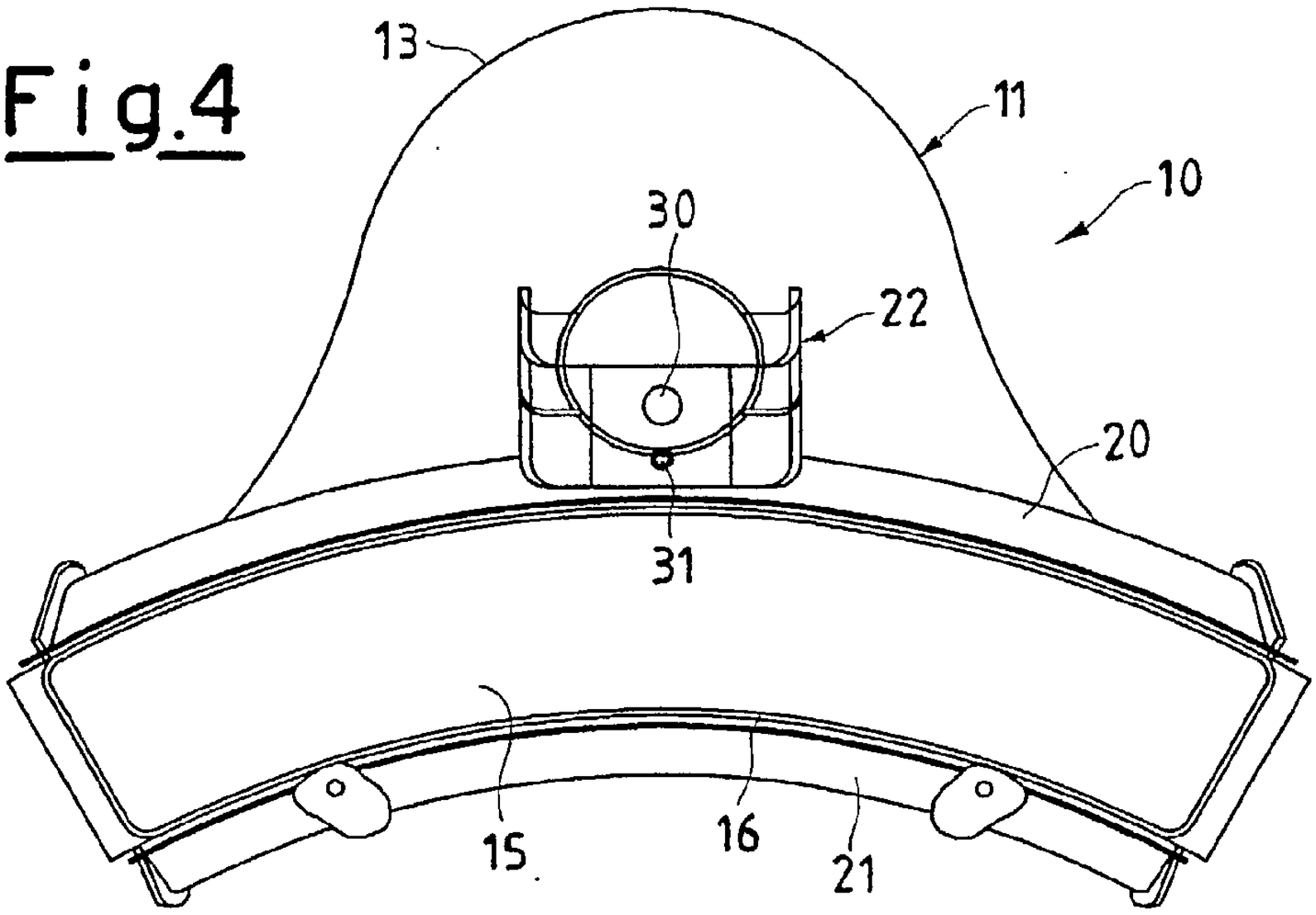
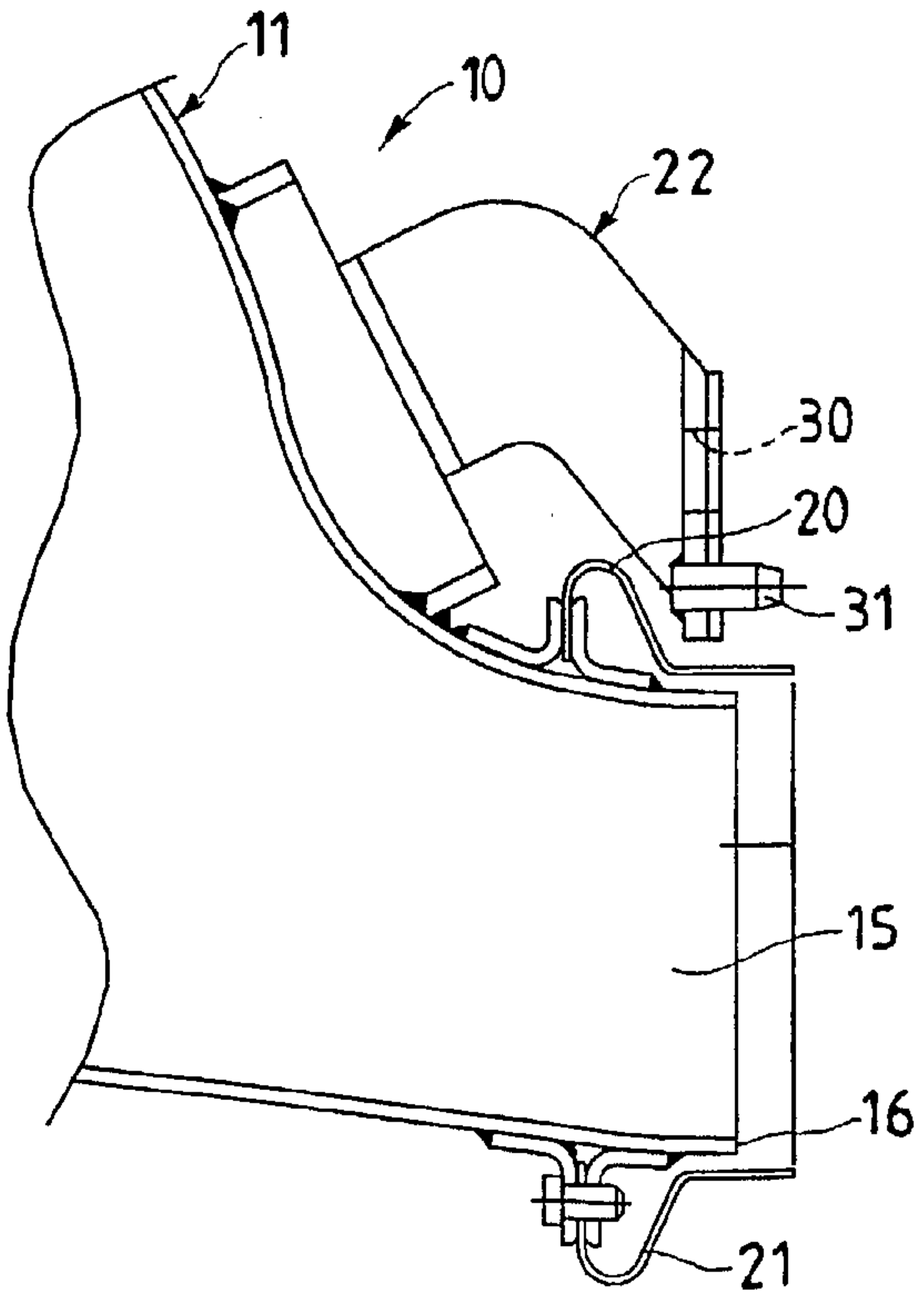


Fig.5



TRANSITION PIECE FOR NON-ANNULAR GAS TURBINE COMBUSTION CHAMBERS

[0001] The present invention relates to a transition piece for non-annular gas turbine combustion chambers.

[0002] As is known, gas turbines comprise a compressor, to which air from the external environment is supplied in order to pressurise the compressor.

[0003] The compressed air passes into a series of combustion chambers which end in a nozzle, into each of which an injector supplies fuel, which is mixed with the air in order to form a mixture of combustible air to be burnt.

[0004] Subsequently, the burnt gases are conveyed towards the turbine, which transforms the enthalpy of the burnt gases in the said combustion chamber into mechanical energy which is available to a user.

[0005] It is also known that the transition pieces in a gas turbine are substantially tubular elements, each of which is used to connect a combustion chamber, which belongs to the combustion system of the gas turbine, to the first stage of the said gas turbine.

[0006] More particularly, the combustion chambers comprise a plurality of elements with a generally cylindrical shape, which are provided with nozzles disposed around an annular development.

[0007] Similarly, the transition pieces are disposed with an annular development, in order to direct the flow of hot burnt gases from the combustion chambers to the first stage of the gas turbine.

[0008] The transition pieces have an upstream aperture for the flow of gas, which is generally cylindrical, and is used to receive the flow of gas directly from the corresponding combustion chamber, and are configured in a longitudinal direction such that their downstream ends comprise arcuate segments which open towards the first stage of the gas turbine.

[0009] This means that the transition pieces can direct the flow of gas with a high level of enthalpy obtained from spaced, generally cylindrical flow configurations, towards arcuate segments which form a ring-type configuration relative to the first stage of the gas turbine.

[0010] In order to introduce the technical problems which are faced and solved by means of the present invention, it should be noted that the continual quest which is in progress at present, for increases in the performance of gas turbines, and increases in the intervals between the various stoppages for maintenance, as well as the pressing need to reduce to a minimum the pollutant emissions produced by the gas turbine, necessitates optimisation of all the components inserted in the so-called hot gas path.

[0011] In particular, these components comprise the combustion chamber, the nozzles and the transition pieces, and are the ones which are subjected to the highest temperatures.

[0012] It should be emphasised at this point that, since the combustion system has an energising function in relation to the thermal carrier fluid, it is the true heart of the turbine engine, and thus defines its level of emission, and, according to the service life of its own components, also defines the intervals of functioning between machine stoppages, which are necessary in order to carry out inspections of the combustion chambers.

[0013] In addition, the requirement to develop the machines in operation, with increases in the compression ratios and fire temperatures, are a further reason for emphasising the criticality of the hot components.

[0014] Reduction of the emissions, with an increase in the service life of the components, and optionally also in the efficiency of the system, also constitutes a general target which undoubtedly has an impact on the clientele of heavy duty machines, and is a stimulating technological challenge for the designers.

[0015] In particular, in the case of machines which have had a certain length of service, it is possible to gather sufficient statistical data to determine the parameters and details which are critical in achieving overall improvements, such as to justify the cost of the design and subsequent marketing, optionally in uprate packages for the aftermarket.

[0016] A major technical problem therefore consists substantially of determining solutions which permit achievement of maximum satisfaction of the client for the three aforementioned aspects, all by means of innovative creations which are economically acceptable.

[0017] In order better to understand the technical problems which are involved in the present invention, at this point reference is made to the following state of the art.

[0018] The solutions which are currently used in order to achieve the three above-described objectives (greater efficiency, longer service life of the machine, and fewer pollutant emissions), are not in general combined in a single product, but are on the other hand implemented in ranges of alternative components.

[0019] In order to increase the service life, and thus the intervals of inspection of the combustion chambers, use is generally made of materials, such as stellite **6**, deposited onto elements which may become worn by relative vibratory motion, and of super-alloys with a nickel/cobalt base, with high levels of mechanical characteristics and of resistance to corrosion at high temperatures.

[0020] Use is also made of additions of a ceramic type, to reduce the temperatures of the metal (for the same cooling flows), and the design of the components is being optimised, on the basis of experience acquired.

[0021] In the case of known turbine engines, the original combustion system has been completely redesigned, both in terms of the overall arrangement and component elements.

[0022] The original system, having six combustion chambers, arranged in two rows of three parallel chambers stacked on both sides of the machine, in an arrangement at right-angles to the machine axis, with interposition of 90° connection elbows between the liners and transition pieces, has thus been replaced by an arrangement characterised by chambers inclined by only a few degrees in relation to the machine axis, and insertion of the liners directly in the transition piece, and therefore without the need for further connection elements.

[0023] In this embodiment, there is thus implementation of all the solutions known in the present state of the art, for

the three above-described objectives (efficiency, service life of the machine, and fewer pollutant emissions), such as to obtain a unit device which combines the advantages thus accumulated.

[0024] The object of the present invention is therefore to provide a transition piece for non-annular gas turbine combustion chambers, which permits optimisation of the performance in operation.

[0025] A further object of the invention is to provide a transition piece for non-annular gas turbine combustion chambers, which permits improved efficiency in operation.

[0026] Another object of the invention is to provide a transition piece for non-annular gas turbine combustion chambers, which permits a longer service life of the machine.

[0027] A further object of the invention is to provide a transition piece for a non-annular gas turbine combustion chamber system, which generates fewer pollutant emissions.

[0028] These objects and others are obtained by a transition piece for non-annular gas turbine combustion chambers, comprising a body which has a cylindrical section, relative to a first terminal end, which ends with an aperture for connection to a combustion chamber, and a second terminal end, which is connected to the first stage of a gas turbine, characterised in that it has a projecting connection arm, for support on the turbine stator, wherein the said projecting connection arm makes it possible to obtain a lead-in axis with an angle of between 5° and 7° relative to an axis, which is parallel to the axis of the machine, and is perpendicular to the plane on which there lies the frame for interfacing of the transition piece with the ring of nozzles which belong to the first stage of the said gas turbine.

[0029] According to a preferred embodiment of the present invention, the transition piece has a support arm, with a circular or elliptical base, which is present at the said second terminal end, and surrounds the flow aperture of the said transition piece, wherein the said support arm with a circular or elliptical base has an upper side and a lower side, for its own connection to the first stage of the said gas turbine.

[0030] According to a preferred embodiment of the present invention, the cylindrical section, relative to the first terminal end, has an anti-wear deposit made of Stellite 6 or another, similar material.

[0031] In addition, a deposit of the TBC type is provided on the entire inner surface of the said transition piece, in order to reduce the temperature of the metal.

[0032] According to a further preferred embodiment of the present invention, the distance between the centre of the lead-in of the said transition piece and the support plane of the flange for anchorage to the stator of the said gas turbine is between 350 mm and 380 mm.

[0033] According to a further preferred embodiment of the present invention, the body of the transition piece can be made of Nimonic 263 or of Hastelloy-X.

[0034] Further characteristics of the invention are defined in the claims attached to the present patent application.

[0035] Further objects and advantages of the present invention, as well as its structural and functional characteristics, will become apparent from the following description and the attached drawings, which are provided purely by way of explanatory, non-limiting example, and in which:

[0036] **FIG. 1** represents a view, partially in cross-section, of a gas turbine to which there is fitted the transition piece according to the present invention, for non-annular gas turbine combustion chambers;

[0037] **FIG. 2** represents a plan view of a transition piece according to the present invention, for non-annular gas turbine combustion chambers;

[0038] **FIG. 3** represents a view in cross-section according to the plane III-III, of the transition piece in **FIG. 2**;

[0039] **FIG. 4** represents a front view of the transition piece in FIGS. **2-3**; and

[0040] **FIG. 5** represents a view in cross-section of a detail belonging to the transition piece in FIGS. **2-4**.

[0041] With particular reference to the aforementioned figures, the transition piece according to the present invention, for non-annular gas turbine combustion chambers, is indicated globally by the reference number **10**.

[0042] The transition piece **10** consists of a body **11**, which receives upstream the flow of burnt gases, directly from the corresponding combustion chamber **25**, and is configured longitudinally such as to have a downstream end which opens towards the first stage **17** of the gas turbine **18**.

[0043] More particularly, the body **11** of the transition piece **10** has a cylindrical section **13**, relative to a first terminal end, which ends with an aperture **14** for connection to a combustion chamber **25**.

[0044] The body **11** of the transition piece **10** also has a second terminal end **16**, which is connected to the first stage **17** of a gas turbine **18**, and thus has a flow aperture **15**.

[0045] The transition piece **10** thus consists of a body **11**, which is provided with a support arm, with a circular or elliptical base, which is present at the second terminal end **16**, and surrounds the flow aperture **15**.

[0046] In particular, the support arm with a circular or elliptical base has an upper side **20** and a lower side **21**.

[0047] The body **11** is provided with characteristics of resilience, such as to minimise the stresses associated with its anchorage onto the stator of the said gas turbine **18**.

[0048] In addition, the body **11** is preferably made of Nimonic 263, or, alternatively, of Hastelloy-X, and is produced in a single component part, indicated by the reference number **11**, which reduces the parts necessary and the assembly time, and thus permits considerable savings.

[0049] The cylindrical section **13**, relative to the first terminal end, has an anti-wear deposit made of Stellite **6**, or of another material homologous with that used on the Hula Seals of the liners.

[0050] In addition, a deposit of the TBC type is provided on the entire inner surface of the body **11** of the transition piece **10**, in order to reduce the temperature of the metal.

[0051] The transition piece **11** also has a projecting connection arm, indicated as a whole by the reference number **22**, for support on the turbine stator.

[0052] At its own terminal end, the projecting connection arm **22** also has a hole **30**, for its own connection to the first stage of the gas turbine **18**, and a centring pin **31**.

[0053] The geometry of the transition piece **11** is thus completely re-shaped, compared with the known art.

[0054] In fact, it has a lead-in axis with an angle of between 5° and 7°, relative to an axis which is parallel to the axis of the machine, and is perpendicular to the plane on which there lies the frame for interfacing of the transition piece **10** with the ring of nozzles which belong to the first stage **17** of the gas turbine **18**.

[0055] In addition, it can be noted that the distance between the centre of the lead-in of the transition piece **10** and the support plane of the flange for anchorage to the stator of the gas turbine, is between 350 mm and 380 mm.

[0056] In particular, according to the invention described, the most significant functioning parameters are: Tmax of the gas<1300° C., and Pmax of the gas<10 Ata.

[0057] The description provided makes apparent the characteristics and advantages of the transition piece which is the subject of the present invention, for nonannular gas turbine combustion chambers.

[0058] The following concluding considerations and comments are now provided, in order to define the said advantages more clearly and accurately.

[0059] In particular, the elimination of the intermediate elbows, with the arrangement of the combustion chambers in the gap between the flanging on the stator of the turbine and the compressor suction air feed pipe (which is further limited in the lower area by the presence of the front support fork of the machine), in association with the provision of new liners with low LHE emission, with dilution air feed holes in the head, and calendered Hula seals with anti-wear material deposited, have led to the re-design of the transition piece, with materials used and a configuration which reflect the best which can be obtained for industrial gas turbines.

[0060] Since this application is designed for the aftermarket, and thus has pre-defined constraints of geometries and functional parameters, the design of the component elements, and their integration in the system, has led to the development of details which are innovative in terms of design and functionality.

[0061] In view of the operative conditions of the machine for which this application is planned, there has been definition of the specific geometry parameters necessary in order to obtain the functional characteristics required for integration of the combustion system as a whole.

[0062] The transition piece **11** thus formed has an optimal geometric profile, which, inter alia, makes it possible to keep the thermal stresses within acceptable limits.

[0063] The particular design of the transition piece **11** described makes it possible to obtain increased structural stability, with consequent reduction of the vibratory motion.

[0064] To summarise, a transition piece for non-annular gas turbine combustion chambers has been produced, which makes it possible also to obtain the significant advantages of ease of fitting and removal, as well as of improved overall mechanical reliability and efficiency of the machine to which it is fitted.

[0065] The theoretical and experimental results have been so satisfactory, that they show that the system can be used on widely distributed gas turbines.

[0066] It is apparent that many variations can be made to the transition piece which is the subject of the present invention, for non-annular gas turbine combustion chambers, without departing from the principles of novelty which are inherent in the inventive concept illustrated.

[0067] Finally, it is apparent that, in the practical embodiment of the invention, any forms and dimensions can be used for the details illustrated, according to requirements, and can be replaced by others which are equivalent from a technical point of view.

[0068] The scope of the invention is defined by the attached claims.

1. A transition piece **(10)** for non-annular gas turbine combustion chambers, suitable for connection between a non-annular gas turbine combustor **(25)** and a first stage **(17)** of the gas turbine **(18)**, said transition piece **(10)** comprising a tubular body **(11)** with a cylindrical section **(13)**, having an upstream end **(14)** for connection to the gas turbine combustor **(25)** and a downstream end **(16)**, surrounding a flow aperture **(15)**, for connection to the turbine **(18)** first stage **(17)**, characterised in that a mount connector device **(22)** is provided on the transition piece **(10)**, said mount connector device **(22)** comprising a tubular projection protruding upwardly from the body **(11)** of the transition piece **(10)** and then curving in a rearward direction for securing the transition piece **(10)** to said first stage **(17)** of the gas turbine **(18)**, said transition piece **(10)** thus having a geometric profile so that the direction of the gas flow flowing at said upstream end **(14)** forms an angle of 5-7 degrees with an axis perpendicular to the plane on which said flow aperture **(15)** lies.

2. A transition piece **(10)** according to claim 1, characterised in that said cylindrical section **(13)** has an anti-wear deposit, made of Stellite **6** or another similar material, at said upstream end **(14)**.

3. A transition piece **(10)** according to claim 1, characterised in that a deposit of the TBC type is provided on the inner surface of the transition piece **(10)**.

4. A transition piece **(10)** according to claim 1, characterised in that said tubular body **(11)** is made of Nimonic 263 or Hastelloy-X.

* * * * *