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COMBUSTION SYSTEM FOR A GAS TURBINE ENGINE

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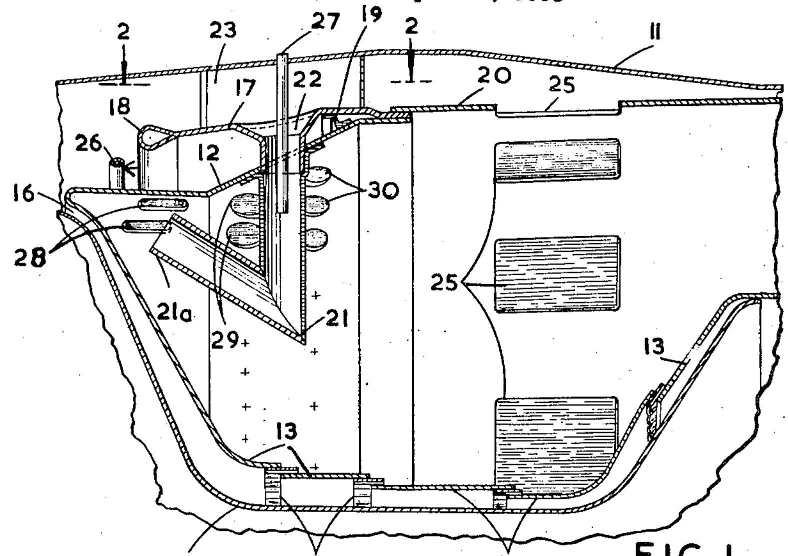

FIG. 1.

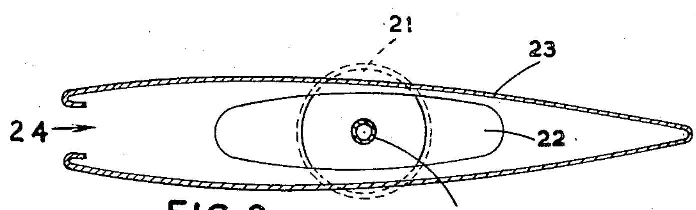

FIG. 2.

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COMBUSTION SYSTEM FOR A GAS TURBINE ENGINE

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5 Claims. (Cl. 60—39.71)

The invention relates to a two-stage combustion system for a gas turbine engine, and has for its main object to provide high operating velocity and to avoid using a conventional entry diffuser whereby to enable the weight and length of the plant to be correspondingly reduced.

The combustion system of the invention includes an annular manifold which has its upstream end open to receive a portion of the output from an air compressor, of the engine, and a main supply of fuel, such air and fuel being for main combustion purposes, the inner wall of the manifold forming an upstream wall portion of the flame chamber, and means for delivering a pilot supply of compressor air and fuel in the upstream direction to a closed upstream end of the flame chamber for providing re-circulating pilot combustion within the latter, the inner wall of the manifold being provided with ports through which the mixture of main combustion air and fuel enters the flame chamber for admixture with the pilot flame.

The combustion system of the invention is particularly adapted for use with an "annular-type" flame chamber and, in such a case, the main and pilot supplies of combustion air can be derived from a passage which is radially outside the outer periphery of the flame chamber, or is radially within its inner periphery, and which receives the compressor output.

According to a further feature, the means for conducting the pilot supply of air and fuel takes the form of a plurality of radial pipes having inlet ends in an annulus outside the manifold and receiving a portion of the compressor output, and outlet ends within an upstream portion of the flame chamber and facing upstream therein. The inlet end of each radial pipe is within an air collector which extends radially across the annulus outside the manifold and has a mouth directed upstream in the said annulus.

Preferably the pilot supply of fuel is delivered into the interiors of the radial pipes.

One embodiment of the invention is described with reference to the accompanying drawings in which:

Figure 1 is an axial section through part of an annular-type of combustion system; and

Figure 2 is an enlarged section on the line 2—2 of Figure 1.

Referring to the drawings, an outer annular casing is shown at **11**, and the outer and inner walls of the annular flame chamber, which is closed at its upstream end, at **12** and **13** respectively. The wall **13** is formed from overlapping sections with intervening corrugated strips **14**, and the wall **13** together with a wall **15** provide a narrow annular passage, having a mouth **16**, for cooling air which passes along the corrugations of the strip **14** for film cooling the interior of the wall **13** of the flame chamber.

An annular splitter wall **17**, with a rounded upstream edge **18**, coaxially surrounds the outer wall **12** of the upstream end of the flame chamber and has an overlapping sealing engagement with it at the downstream end, the walls **17** and **12** forming an annular manifold with an open upstream end. Between the downstream

ends of the walls **17** and **12** is a sealing ring **19**, and the downstream end of the wall **17** fits sealingly into a downstream extension **20** of the flame chamber. The sealing ring **19** is to prevent main air and fuel from entering the flame chamber through any leakage space which might develop in the joint between the walls **17** and **12**.

Each of a plurality of elbow pipes **21** has an air inlet in the form of a depression **22** in the wall **17**, and an outlet **21a** facing upstream. Respective fairings **23**, which extend sealingly between the walls **11** and **17** and enclose the associated depressions **22**, have their sides spaced at the upstream ends to provide air inlets **24** (Figure 2).

The edge **18** of the splitter divides the main air flow from the compressor into inner and outer annuli, the outer one supplying the tubes **21** through the fairing inlets **24** and, by flowing between adjacent fairings, the diluent air which passes into the chamber through ports **25** in the extension **20**. The inner annular air flow is into the annular manifold formed between the walls **17** and **12**. Just in front of the mouth of this manifold, main fuel is delivered from spray holes of an annular manifold **26**, and pipes **27** deliver pilot fuel into the interiors of the elbow pipes **21**.

Owing to the manifold formed by the walls **12** and **17** being closed at the downstream end, the pressure of the main air causes the mixture of main combustion air and main fuel to enter the flame chamber through circular series of ports, three such series being shown, or indicated by crosses, at **28**, **29**, and **30**. Pilot flames produced at the outlets **21a** of the elbow pipes **21** are encountered by some of the main fuel and air mixture coming through the ports **28** and initiate combustion thereof. These burning gases flow in a downstream direction around the elbow pipes, to heat these and pre-heat the pilot supplies of fuel and air in them, and mix with the remaining main fuel and air mixture coming through the ports **29** and **30** to ignite it. The main products of combustion pass downstream and are diluted by the air entering through the ports **25**.

Due to the wide fuel flow range required for modern gas turbines one sized fuel flow holes in the manifold **26** would not be sufficient as the pressure range could be 600 to 1. To avoid this difficulty the manifold can either be provided with proprietary burners or there can be a series of manifolds each having a different size of holes.

For a given mass flow of air through the combustion system a fixed proportion of the appropriate maximum fuel is used as pilot fuel, and the pilot fuel supply can be independent of any throttle control. Thus, when a given proportion of the maximum fuel is used as pilot fuel, a throttle acting on the remainder can give a wide range of operating flexibility to the engine, without influencing the pilot combustion.

What we claim as our invention and desire to secure by Letters Patent of the United States is:

1. A combustion system, for a gas turbine engine, including a casing, a flame chamber within and spaced from said casing forming an annulus between them, said flame chamber having a closed upstream end, a manifold in said annulus said manifold having a closed downstream end, said manifold having its inner wall provided by an upstream wall portion of said flame chamber, said casing adapted to receive the output air from a compressor of the engine, said manifold having an open upstream end to receive a portion of said compressor output air, means for supplying fuel to said open upstream end of said manifold to mix with the compressor output air therein, the mixture of said supplies of air and fuel to said manifold being for main combustion purposes, and means for delivering a pilot supply of air and fuel in the up-

stream direction to said closed upstream end of said flame chamber for providing recirculating pilot combustion within the latter, said inner wall of said manifold having ports in a position upstream of the pilot air and fuel delivery means, said closed downstream end of said manifold causing main combustion air and fuel mixture after entering said manifold to be diverted laterally through said ports into said flame chamber for admixture with combustion gases in the zone of said pilot combustion.

2. A combustion system, for a gas turbine engine, including a cylindrical casing, an annular flame chamber coaxially spaced within said casing to form an annulus between them, said flame chamber having a closed upstream end, a manifold in said annulus, said manifold having a closed downstream end, said manifold having its inner wall provided by an upstream outer peripheral wall portion of said flame chamber, said casing adapted to receive the output air from a compressor of the engine, said manifold having an open upstream end to receive a portion of said compressor output air, means for supplying fuel to said open upstream end of said manifold to mix with the compressor output air therein, the mixture of said supplies of air and fuel to said manifold being for main combustion purposes, and means for delivering a pilot supply of air and fuel in the upstream direction to said closed upstream end of said flame chamber for providing recirculating pilot combustion within the latter, said inner wall of said manifold having ports in a position upstream of the pilot air and fuel delivery means, said closed downstream end of said manifold causing main combustion air and fuel mixture after entering said manifold to be diverted laterally through said ports into said flame chamber for admixture with combustion gases in the zone of said pilot combustion.

3. A combustion system, for a gas turbine engine, including a casing, a flame chamber within and spaced from said casing forming an annulus between them, a manifold in said annulus, said manifold having a closed downstream end, said manifold having its inner wall provided by an upstream wall portion of said flame chamber, said casing adapted to receive the output air from a compressor of the engine, said manifold having an open upstream end to receive a portion of said compressor output air, means for supplying fuel to said open upstream end of said manifold to mix with the compressor output air therein, the mixture of said supplies of air and fuel to said manifold being for main combustion purposes, a plurality of pipes extending substantially radially into said flame chamber, said pipes having inlet ends communicating with said annulus for receiving the pilot air and adapted to receive pilot fuel, said pipes having outlet ends directed upstream in an upstream portion of said flame chamber for delivering said pilot supplies thereto for providing recirculating pilot combustion within said flame chamber, and said inner wall of said manifold having ports in a position upstream of the pilot air and fuel delivery means, said closed downstream end of said manifold causing main combustion air and fuel mixture after entering said manifold to be diverted laterally through said ports into said flame chamber for admixture with combustion gases in the zone of said pilot combustion.

4. A combustion system, according to claim 3, in which the pipes are of a substantially angular J shape, the pipes having stems which are directed being substantially radially and the pipes having feet which diverge in the upstream direction.

5. A combustion system, for a gas turbine engine, including a casing, a flame chamber within and spaced from said casing forming an annulus between them, a manifold in said annulus, said manifold having a closed downstream end, said manifold having its inner wall provided by an upstream wall portion of said flame chamber, said casing adapted to receive the output air from a compressor of the engine, said manifold having an open upstream end to receive a portion of said compressor output air, means for supplying fuel to said open upstream end of said manifold to mix with the compressor output air therein, the mixture of said supplies of air and fuel to said manifold being for main combustion purposes, a plurality of pipes extending substantially radially into said flame chamber, a like number of air collectors extending radially across said annulus, each collector having a mouth directed upstream, said pipes having inlet ends respectively communicating with said collectors for receiving the pilot air, means for delivering pilot fuel into said inlet ends of said pipes, said pipes having outlet ends directed upstream in an upstream portion of said flame chamber for delivering said pilot supplies thereto for providing recirculating pilot combustion within said flame chamber, and said inner wall of said manifold having ports in a position upstream of the pilot air and fuel delivery means, said closed downstream end of said manifold causing main combustion air and fuel mixture after entering said manifold to be diverted laterally through said ports into said flame chamber for admixture with combustion gases in the zone of said pilot combustion.

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