

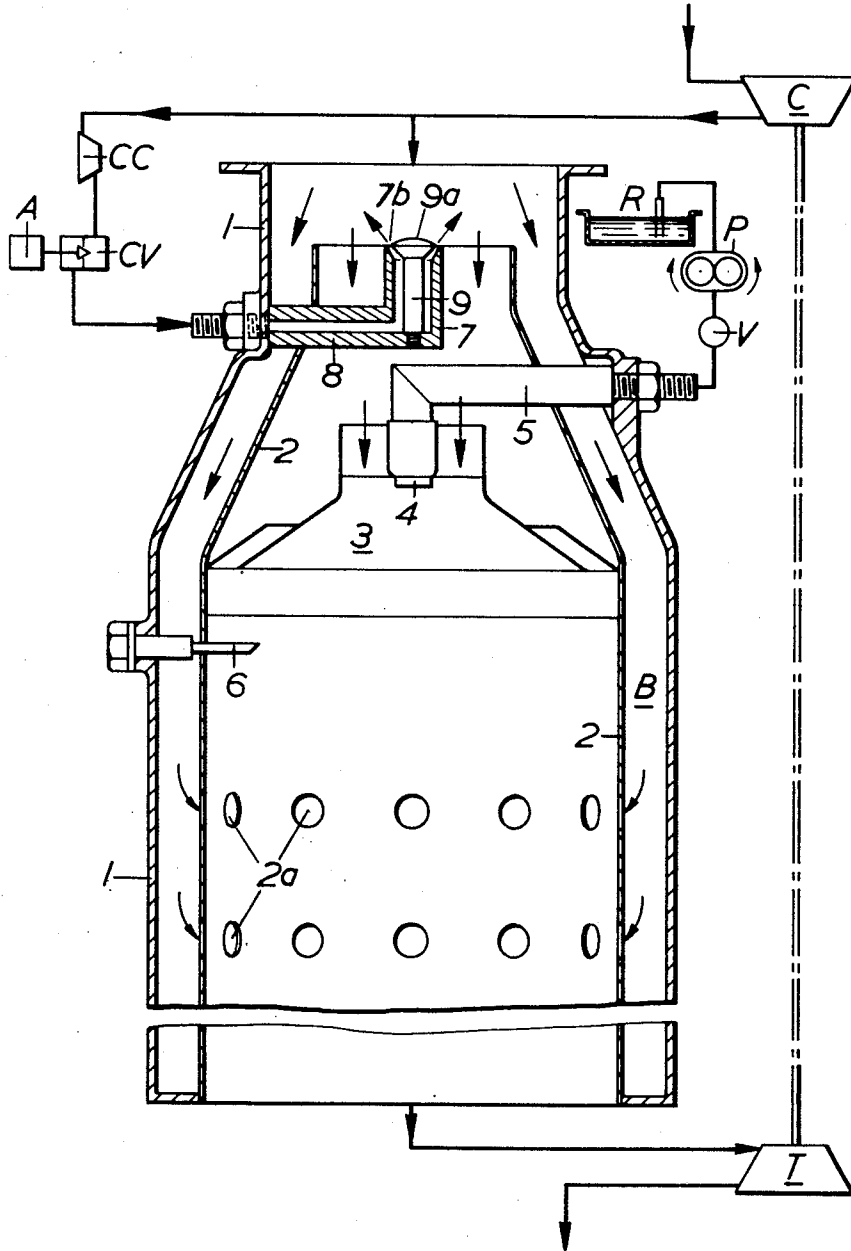
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P. MARTIN

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COMBUSTION CHAMBERS

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PETER MARTIN
Inventor

By *J. Schmitt*
Attorney

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COMBUSTION CHAMBERS

Peter Martin, Bentley, near Farnham, England, assignor to Her Majesty's Government of the United Kingdom of Great Britain and Northern Ireland, as represented by the Minister of Supply, London, England

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1 Claim. (Cl. 60—39.23)

In a continuously burning combustion system such as for example, that of a continuous combustion turbine plant, or that of some form of aircraft jet-propulsion plant employing a gas turbine or a ram jet system, the air supplied is often divided into two or more separate main streams, at least one of which is for initiating and supporting combustion while at least one other may for example be for diluting the hot combustion products with cooler air. In such arrangements or in other combustion systems where the air flow is divided into two or more main streams, it may be desirable to vary, on occasion, the distribution of air between these streams. There are difficulties in designing valves for this purpose which will operate satisfactorily and consistently at the high temperatures prevailing in the neighborhood of the combustion zone.

According to the invention, the distribution of air between streams in a combustion chamber is varied by injecting into a main stream a small supply of air under pressure in a manner to have a deflecting and diverting effect on the main stream.

The invention is illustrated by the accompanying drawing showing a combustion chamber partly in axial section and indicating how it is incorporated in a gas turbine plant.

In this plant a compressor C drawing in air from the atmosphere supplies compressed air to the combustion system and burner indicated generally at B. The combustion gases therefrom go to the turbine T which drives the compressor C. Fuel from the reservoir R is supplied by the pump P through the throttle valve V to the combustion system B. The latter is of the common form comprising a combustion chamber 1 and, inside the combustion chamber, a flame tube 2 which encloses the actual combustion space. The compressed air flows into the space within the chamber 1 and around the outside of the flame tube 2; however, a stream of some of this air, as combustion air, enters the upstream end of the flame tube 2. The liquid fuel injector 4 and its supply pipe 5, which is connected to the throttle V, are located within the tube 2 at or adjacent to this up-stream end. Slightly downstream of this is the igniting means 6. The chamber is a cylinder 1 reduced at one end at which it is open to admit a stream of air, and closed at the other. The flame tube 2 is cylindrical and mounted co-axially within the combustion chamber 1 but spaced apart from the inner wall of the chamber; it is open at each end for the passage of the air stream, and has its inlet end adjacent to but somewhat downstream of the inlet end of the chamber 1. The tube 2 at its downstream end extends through the closure wall of the closed end of the chamber 1. Usually the air will be flowing at a flame-extinguishing velocity and accordingly some means are provided for maintaining a stable zone of combustion inside the tube 2, into which zone the fuel is injected and ignited. This is shown as a closure 3 extending across the flame tube 2 but admitting air through swirl ports to set up a helical

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vortex, the stable zone of combustion being within the core of this vortex, in well-known manner. The injector 4 is located to inject the fuel into the stable zone. Downstream of the closure 3 the flame tube wall is pierced by a succession of further rings of ports 2a, for admitting the rest of the air as further combustion air or as dilution air mixing with the combustion products.

The invention is concerned with providing means—operable at will and possibly partly automatically controlled according to ambient atmospheric pressure—for varying the distribution of the incoming air by reducing the proportion of the air which enters the upstream end of the flame tube 2 as combustion air, relatively to that which flows between the tube 2 and the walls of the chamber 1, to enter the tube by the ports 2a. These are operable to supply a small auxiliary control jet of compressed air to the neighborhood of the upstream inlet to the flame tube 2 in a sense tending to oppose the entry of combustion air and accordingly to divert some of this air to the down-stream entry ports 2a. The control jet issues as an annular sheet of air from an annular slit. The control-air line enters the flame tube transversely through a streamlined tubular member 8 similar to fuel-tube 5, and which connects through a right-angled bend with the hollow body 7 lying along the axis of the flame tube 2 and chamber 1; this body 7 has an open end terminating in substantially the same plane as the inlet end of the flame tube 2, and a closed end nearer to the closure 4. Screwed into the wall of the closed end and extending along the axis of the body 7 with annular space around is a stem 9 terminating in a head 9a outside the body 7 and close to the end of the wall of the body so that between them they form a shallow annular slit 7b. The end of the body 7 and the underside of the head 9a are both conical but of different angles so that the issuing air has an upstream component and the gap between head and body decreases radially outwardly so that the air passage is either of constant area or convergent. Control air can be supplied to the interior of tube 8 from the main compressor C and a booster compressor CC, by opening of the control valve CV by its actuating device A.

In operation, the main stream of air from compressor C enters the combustion chamber 1, travels a short distance up to the inlet end of the flame tube 2 and then divides, as shown by the arrows. One branch of the stream enters the flame tube as combustion air; the second branch flows along the chamber, outside the flame tube, which it eventually enters through the ports 2a as additional or diluent air. When control valve CV is opened a small annular air jet issues from body 7, crossing the first main air stream branch transversely where this stream is entering the flame tube; accordingly part of this branch of the stream is diverted into the second branch and flows around the outside of the flame tube 2 to the downstream ports 2a. The flow of control air required for this action is small. The actuator A may be a known barometric device so as to effect diversion at high altitudes, or it may respond to the temperature in some part of the combustion chamber, or it may be actuated by the turbine speed governor or by some other means, according to the purpose for which the distribution of air streams within the combustion chamber is being varied. Thus in British patent No. 662,434 one stream of air is preheated by flowing between the flame tube and an enveloping jacket, fuel being introduced in to the air in this space for vaporisation before the air-fuel mixture enters the flame tube, and a valve, which may be thermo-statically controlled, can vary the air distribution; the present invention can be applied to such an arrangement, the supply of air for effecting diversion being possibly thermostatically controlled.

I claim:

In a combustion system, a combustion chamber having an open upstream end and a downstream end, a cylindrical flame tube within said chamber, said tube having an open upstream end coaxial with the upstream end of the combustion chamber to receive one part of a main air stream, said flame tube being smaller than the combustion chamber to provide a space therebetween for the passage of another part of said main air stream outside the flame tube, fuel injection means located axially of the flame tube downstream from said open upstream end of the tube, means operable to inject a supply of controlling air under pressure into said main stream and in a direction opposed to the flow of the main stream of air when it is desired to vary the distribution of the air between the two parts of the main stream, means for emitting said controlling air as a thin annular sheet directed outwardly from the flame tube axis transversely across the upstream inlet opening of the flame tube, said

emitting means comprising a hollow body located axially of the flame tube between the upstream inlet and said fuel injection means and a stem within the body terminating in a head having a conical surface in spaced juxtaposition to and overlying the end of said body thereby providing an annular slit for emitting said controlling air as a thin annular sheet, a control means for said injected air to vary the control flow and thus reduce the flow of air into the upstream inlet opening of the flame tube and divert the flow toward the space between the flame tube and the combustion chamber.

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