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ANNULAR VAPORIZER

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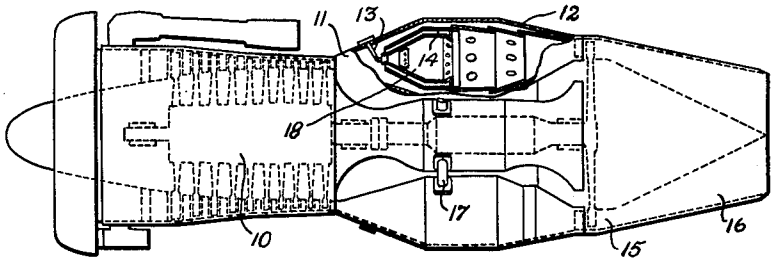


FIG 1.

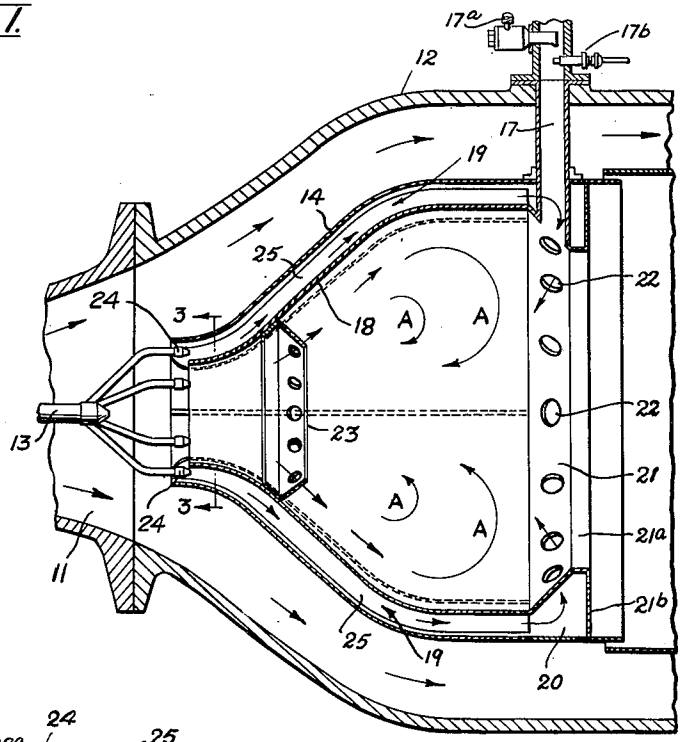


FIG 2.

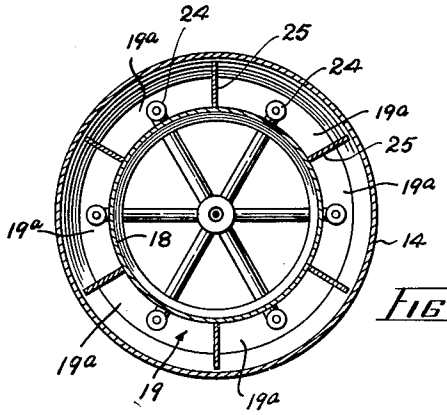


FIG 3.

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ANNULAR VAPORIZER

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3 Claims. (Cl. 60—39.71)

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This invention pertains to combustion chambers for gas turbine engines and particularly to combustion chambers of the vapourizer type.

A common arrangement of gas turbine engine embodies a compressor, whereby air is drawn into the engine and compressed, a combustion system, to which the air from the compressor is discharged and in which fuel is burned to generate a high velocity stream of hot gases, and a turbine, driven by the said stream of hot gases. There are several systems by which fuel may be introduced to the combustion system, including such devices as atomizing burners and vapourizing elements of various forms. This invention is applicable to the vapourizer type of installation and particularly to that construction, hereinafter referred to as the "wall-type vapourizer," described in my co-pending application Serial No. 145,060 dated February 18, 1950.

The aforesaid application describes a combustion system embodying a combustion chamber through which a stream of air is constrained to flow, a flame tube having open ends to receive part of the air and disposed substantially coaxially within the combustion chamber, means for introducing fuel into the flame tube and ignition means for initiating combustion within the flame tube; the vapourizing system in this construction comprises an annular vapourizing element forming an integral part of the flame tube wall and extending downstream substantially from the upstream end of the flame tube, an inlet in the vapourizing element for directing a portion of the air entering the flame tube into the upstream end of the said element, the means for introducing fuel being adapted to direct the fuel into the vapourizing element, and means for reversing the flow of the said portion of the air stream and the fuel as they emerge from the downstream end of the vapourizing element into the flame tube, whereby the air and fuel emerging from the said element are directed substantially upstream. Moreover the preferred means for introducing fuel includes a plurality of jets situated within and adjacent to the upstream end of the vapourizing element.

In order to prevent overheating of the vapourizing element and to obtain good vapourization of the liquid fuel before it emerges into the flame tube, it is important that the fuel should be uniformly distributed over the vapourizing surface. In the application of an annular wall-type vapourizer to an annular combustion chamber, this distribution can be achieved by locating the element on the radially inner wall of the flame tube (i. e. on the wall closer to the axis of the combustion chamber), spacing the jets symmetrically around the vapourizer intake and directing them so that they will all spray in a direction having a tangential component and in the same sense. Furthermore, in this construction, distribution of the fuel can be improved by the provision of swirl vanes situated up-stream of the jets in the inlet of the vapourizing element to give the air entering the vapourizer a rotation in the same sense as the tangential sprays from the fuel jets, so that the fuel tends to be carried onto the vapourizing surface by centrifugal action.

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If, however, an annular wall-type vapourizer is mounted on the outer wall of the flame tube of an annular combustion chamber or if such a vapourizer is applied to a tube-type combustion chamber, any centrifugal forces acting upon the air and fuel in the element will tend to carry the fuel away from the vapourizing surface, which may result in overheating and consequent failure of the vapourizer. Thus in such circumstances the swirl vanes cannot be utilized and every precaution must be taken to avoid rotation of the fuel and air mixture.

It is the main object of this invention to ensure the uniform distribution of fuel over the vapourizing surfaces of annular wall-type vapourizers, where the application of centrifugal forces to the fuel and air in the vapourizer may tend to impair the cooling of the vapourizing surface.

Other objects and advantages of the invention will be apparent from the following description of an application thereof to a tube-type combustion chamber.

In the accompanying drawing forming a part of this application and in which like reference characters designate like parts throughout the several views:

Fig. 1 is a side elevation of an engine having a tube-type combustion system, one combustion chamber being shown in section;

Fig. 2 is a section of the upstream portion of a combustion chamber, showing the flame tube and wall-type vapourizer; and

Fig. 3 is a section on the line 3—3 in Fig. 2, to an enlarged scale.

Air is drawn into the engine illustrated in Fig. 1 by the compressor 10 and is discharged through diffusers 11 into combustion chambers 12. Fuel is introduced through a fuel line 13 to each combustion chamber 12 and burned in a flame tube 14 lining the combustion chamber. From the flame tube the products of combustion are discharged into turbine 15. In the particular engine illustrated the turbine serves only to drive the compressor and engine auxiliaries, the ex-

haust from the turbine emerging from tail cone 16 to provide a propulsive thrust.

The combustion chamber arrangement and in particular the vapourizer which is the subject of this invention is illustrated in greater detail in Fig. 2. The casing of the combustion chamber 12 is attached to the diffuser 11, and the flame tube 14 is supported within the casing and spaced therefrom by two interconnectors 17 (only one of which is shown in Fig. 2) and by a conventional additional support (not shown) to provide three mounting points; the interconnectors 17 extend through the walls of the flame tube to enter the flame zone as indicated. The interconnectors, as will be known to those skilled in the art, are balance pipes provided to interconnect the flame zones of adjacent combustion chambers, and at least one of them houses a torch igniter 17a and an igniting spark plug 17b.

The wall-type vapourizer is formed by the inner vapourizing shell 18 which is situated within the flame tube 14 and is substantially uniformly spaced from the wall thereof. The shell 18 extends downstream substantially from the upstream end of the flame tube, adjacent the diffuser 11, to provide an annular vapourizer generally indicated by the reference numeral 19 terminating in an annular mixing chamber 20; the downstream end of the shell 18 providing the mixing chamber 20 is constituted by a frusto-conical wall 21 having a cylindrical extension 21a which is secured to the flame tube 14 by a radial flange 21b. A number of holes 22, facing upstream, are provided in the wall 21 of the shell 18. A perforated plate 23 is provided at the upstream end of the flame zone, spanning the inner shell 18 and effectively closing the flame tube to the direct entry of air from the diffuser, other than through the perforations in the plate. The plate is preferably slightly concave with respect to the entering air and the perforations are arranged symmetrically near its periphery, so that a central region of low pressure is induced in the air stream immediately downstream of the plate.

Fuel is introduced to the annulus 19 constituted by the space between the shell and the wall of the flame tube, by means of a series of jets 24 fed from the central supply line 13 and symmetrically disposed in a circle at the upstream end of the annulus 19. These jets are arranged to direct sprays of fuel into the upstream end of the annulus to impinge upon the radially outer surface of the vapourizing shell 18. Radially disposed partitions 25 are angularly spaced around the axis of the flame tube between adjacent jets 24 and extend longitudinally downstream between the flame tube 14 and the shell 18 dividing the annular vapourizer 19 into a plurality of sections 19a, each being a sector of the annulus constituting the vapourizer; each jet discharges into one such section of the vapourizer and the fuel therefrom is confined to its particular section until it has travelled to the mixing chamber 20. The partitions 25 are preferably rigidly mounted on the vapourizer shell 18 and spaced from the flame tube 14 so that a small expansion clearance is provided between their outer edges and the inner surface of the flame tube wall; in effect they then constitute radial fins disposed on the vapourizer shell.

In operation air from the compressor 10 passes through the diffuser 11 into the combustion chamber 12. The greater portion of the air is directed into the usual annular space between the combustion chamber and the flame tube 14, to provide a cooling jacket and to enter the flame tube in its lower stages as a cooling film along the walls or as diluent air, in the usual manner. The remainder enters the flame tube 14 at its upstream end and a part is directed into the vapourizer 19, while the rest flows through the perforations in the plate 23. Fuel introduced by the jets 24 is mixed with the air in the vapourizer, forming a combustible mixture which is discharged from the mixing chamber 20 through the holes 22. By virtue of the depression induced immediately downstream of the plate 23, the air entering the perforations in the said plate will turn inwardly, as indicated by the arrows A in Fig. 2, and will be thoroughly mixed with the discharge of the vapourizer. Combustion may be then initiated by the torch igniter 17a situated in one of the interconnectors 17, which protrude into this region of stability.

Once lighted, combustion is self-propagating and the mixture discharged from the vapourizer is ignited as it enters the flame zone bounded by the plate 23 and the shell 18 of the vapourizing element. The heat of combustion acting upon the said shell promotes rapid and complete vapourization of the liquid fuel flowing over the outer surface of the shell and, in turn, the vapourization cools the shell against overheating.

It will be understood that overheating of the vapourizing surface is likely to occur if the fuel is not distributed uniformly thereupon. It is important therefore that the diameter of the vapourizing surface should not decrease and preferably should increase progressively along the vapourizer, and the gravitational forces acting upon the fuel should not be allowed to divert the flow to the lower portions of the annulus. It is for the latter reason that the partitions 25 are provided since they divide the vapourizer into separate sections, thereby preventing the fuel from flowing to the lower portions, and effectively eliminating any swirl in the mixing air which might induce centrifugal forces.

Although an application of the invention to a tube-type combustion chamber has been described herein, partitions similar to the partitions 25 can be applied with equal effect to combustion systems of the annular type, particularly when the wall-type vapourizer is installed on the outer wall of the annular flame tube. It will be understood therefore that various changes in the shape, size and arrangement of the parts of the construction may be resorted to without departing from the scope of the claims.

What I claim as my invention is:

1. A wall-type vapourizing system for a gas turbine engine comprising an inner vapourizing wall of annular cross-section and enclosing a space for a flame zone, and an outer wall spaced outwardly from the outer surface of the inner wall and defining with the inner wall an annular space between the walls, a plurality of radially disposed substantially flat partitions extending generally longitudinally between the walls for substantially the full axial length of the said space and dividing the said space into sections each constituting a sector of an annulus, and means for introducing fuel into each section.

2. A wall-type vapourizing system for a gas turbine engine comprising an inner vapourizing wall of annular cross-section and enclosing a space for a flame zone, an outer wall spaced outwardly from the outer surface of the inner wall

and defining with the inner wall an annular space between the walls, a plurality of radially disposed substantially flat partitions extending generally longitudinally between the walls for substantially the full axial length of the said space and secured to the inner wall, the said partitions dividing the said space into sections each constituting a sector of an annulus, and means for introducing fuel into each section.

3. A wall-type vapourizing system for a gas turbine engine comprising an inner vapourizing wall of annular cross-section and enclosing a space for a flame zone, an outer wall spaced outwardly from the outer surface of the inner wall and defining with the inner wall an annular space between the walls, a plurality of radially disposed substantially flat partitions extending generally longitudinally between the walls for substantially the full axial length of the said space and secured to the inner wall, the partitions having their outer edges spaced from the outer wall and dividing the said space into sections each constituting a sector of an annulus, and means for introducing fuel into each section.

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