

July 28, 1953

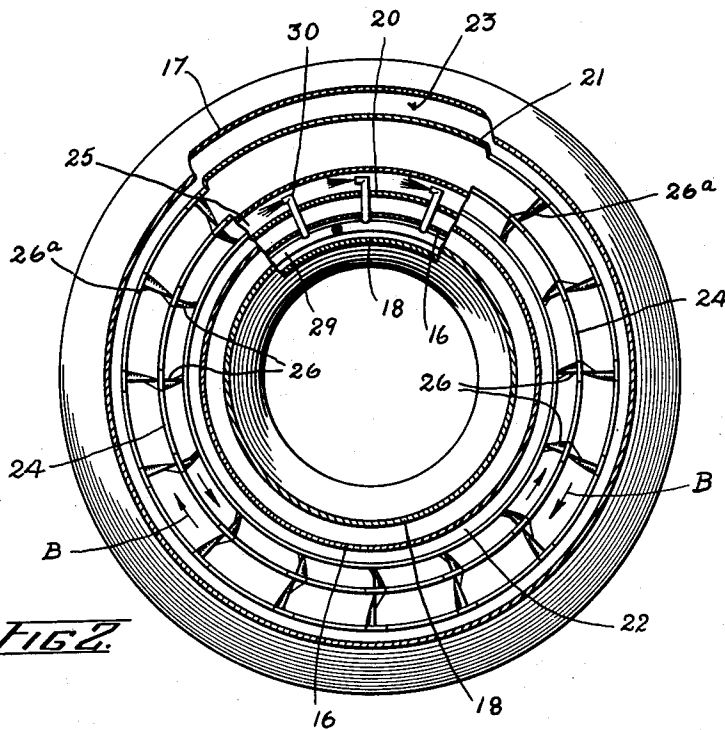
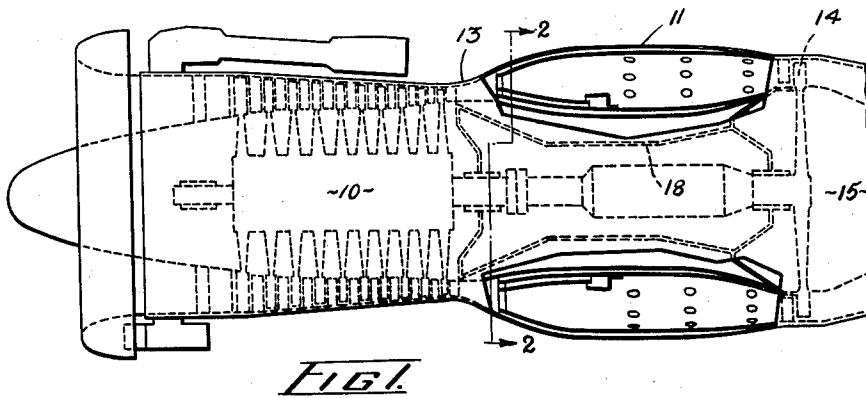
R. G. MESCHINO

2,646,664

ANNULAR FUEL VAPORIZER FOR GAS TURBINE ENGINES

Filed Feb. 18, 1950

2 Sheets-Sheet 1



INVENTOR
R. G. MESCHINO

By *W. H. Mayhew*
ATTORNEY

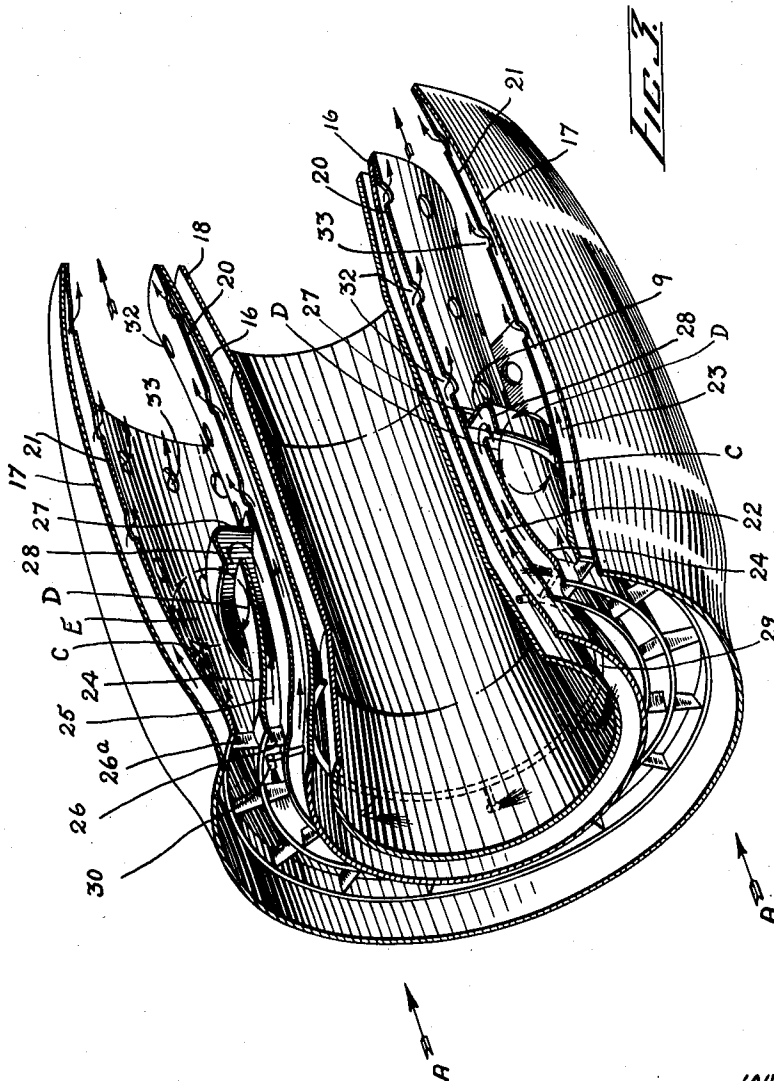
Filed Feb. 18, 1950

R. G. MESCHINO

2,646,664

ANNULAR FUEL VAPORIZER FOR GAS TURBINE ENGINES

2 Sheets-Sheet 2



INVENTOR
R. G. MESCHINO

By *Barth L. Mayhew*
ATTORNEY

UNITED STATES PATENT OFFICE

2,646,664

ANNULAR FUEL VAPORIZER FOR GAS
TURBINE ENGINESRonald Guerin Meschino, Toronto, Ontario, Canada,
assignor to A. V. Roe Canada Limited, Ontario,
Canada, a corporationApplication February 18, 1950, Serial No. 145,060
In Great Britain February 24, 1949

10 Claims. (Cl. 60—39.65)

1

This invention relates to vapourizing systems for the combustion chambers of gas turbine engines.

Those skilled in the art will be familiar with the principles of operation of a gas turbine engine wherein fuel is burned in a high pressure, high velocity air stream and discharged from the combustion chambers into a turbine. Combustion actually takes place within a liner (also known in the art as a "flame tube") situated inside the combustion chamber and in spaced relationship to the walls thereof, so that the liner is in effect jacketed by a stream of air which is progressively admitted to the liner to support combustion and to provide a working medium. Combustion is initiated at the upstream end of the liner by the introduction of fuel to a limited supply of primary air in a region of reverse flow, so that once started by an electric spark or some similar means, the flame becomes self-propagating.

Fuel may be introduced into the liners of combustion chambers of gas turbine engines either by means of an atomizing spray, in the form of vapour or as a rich mixture of vapour and air. In the last-mentioned case, liquid fuel and a supply of air are introduced into special vapourizing elements exposed externally to the heat of combustion so that the fuel passing through them is vapourized before it is discharged into the flame zone. In the past these vapourizing elements usually have been tubes extending directly into the flame zone, but it has been found difficult to distribute the fuel evenly over the internal surfaces of these tubes and since in the process of vapourizing, the fuel serves to cool the tubes, this uneven distribution has resulted in many tube failures due to excessive local heating. Furthermore, local heating has been aggravated by the deposition of carbon upon the external surfaces of the vapourizer tubes, necessitating such precaution as the provision of a film of insulating air over the said surfaces; but such complications have not proved to be completely effective.

The principal object of this invention is to provide a vapourizing element for a combustion chamber liner, which will not be subject to local over-heating and the risk of such failures as may result in pieces of the element becoming detached and being carried downstream to do serious damage to the turbine. Another object is to eliminate the likelihood of cracking of the fuel due to contact with high temperature surfaces, with its attendant gumming effects. Yet another object is to provide a vapourizing element which is easy and cheap to

2

manufacture, being of simple configuration and robust construction.

Further objects and advantages of the invention will be apparent from the following description of an application of the invention to a combustion system of the annular type. It will be understood, of course, that the invention can be similarly applied to combustion systems having tube type combustion chambers and that this description of a preferred construction is not to be taken as restrictive to any particular arrangement.

In the accompanying drawings forming a part of this application and in which like characters of reference are used to designate like parts throughout the same:

Fig. 1 is a view in side elevation, partly broken away, of a gas turbine engine embodying an annular combustion system constructed according to this invention;

Fig. 2 is a cross-sectional view of the annular combustion system of the engine, the said view being taken on the line 2—2 of Fig. 1; and

Fig. 3 is a cut-away perspective view of the said annular combustion system.

In the operation of the engine shown in Fig. 1 air is compressed in a compressor 10 and fed into a combustion system 11 through a diffuser 13. Fuel is injected into the combustion system and burnt in the stream of air, and the products of combustion are discharged at high velocity into a turbine 14, which drives the compressor and, according to the construction of the turbine, otherwise generates power from the energy contained in the hot gases. The final discharge of the gases from an exhaust 15 may be employed for jet propulsion of the unit.

The combustion system comprises an annular combustion chamber bounded by an inner wall 16 and an outer wall 17 arranged coaxially with the usual backbone member 18 of the engine. Between the walls 16 and 17 is the combustion chamber liner or "flame tube" having an inner wall 20 and an outer wall 21; these walls are supported in spaced relationship to the walls of the combustion chamber so that there are annular spaces 22 and 23 between the inner and outer walls, respectively, of the combustion chamber and the liner.

The annular entry to the flame tube, between the inner and outer wall 20 and 21, is divided into two concentric annuli by a wall 24. This wall, as shown in Fig. 3, runs substantially parallel to the inner wall 20 and extends downstream for a short distance, defining, with the wall 20, an annular space 25 which constitutes the inner of the two concentric annuli mentioned above;

at the upstream end of the annulus 25 are a number of swirl vanes 26 circumferentially spaced around the annulus to induce swirl to the air entering the said space. The outer of the two concentric annuli, which is the principal entry into the liner, is also traversed by a series of circumferentially spaced swirl vanes 26^a, extending between the outer wall 21 and the wall 24.

Spaced downstream of the end of the wall 24 is a transverse annular baffle 27, mounted on the inner wall 20 of the liner and carrying on its periphery, remote from the said wall 20, a forwardly extending flange 28, which overlaps the terminal portion of the wall 24 and is of substantially greater diameter than the said overlapped portion of the wall.

Fuel is introduced through a manifold 29 and a plurality of circumferentially spaced jets 30 situated in the space 25 immediately downstream of the swirl vanes 26. The jets 30 are arranged to inject fuel tangentially into the space 25 in the same sense as the swirl induced in the air by the said vanes.

In accordance with normal practice relating to combustion chamber liners the inner and outer walls 20 and 21 are perforated at intervals along their length (downstream of the baffle 27) by a number of holes 32 and 33, for the progressive admission of air from the spaces 22 and 23 between the walls of the liner and the combustion chamber, as will be explained hereunder.

In operation, air from the compressor enters the combustion system in the direction of the arrows A and a portion of the stream is directed along the annular spaces 22 and 23, forming a jacket of comparatively cold air around the liner. Another portion of the entering air is directed into the annular space 25, between the swirl vanes 26, and the remainder enters the upstream end of the combustion chamber liner between the swirl vanes 26^a, which impart a rotary motion to the air passing over them, as indicated by the arrows B; thus the air enters the liner in a helical stream and the centrifugal forces acting thereupon cause the air to flow along the outer wall 21 as indicated by the arrows C and provide a corresponding region of low pressure adjacent the wall 24.

Liquid fuel is injected through the jets 30 into the stream of air flowing through the annular space 25 and because of the tangential direction of this injection and the swirl imparted to the air stream by the vanes 26, the fuel is carried outward by centrifugal action until it impinges upon the inner surface of the wall 24. The mixture of fuel and air thus passing through the annular space 25 is turned through approximately 180° by the baffle 27 and its flange 28, so that the fuel-air mixture emerges into the low pressure region of the flame zone within the liner, along the outer surface of the wall 24, in the direction of the arrows D.

The main flow of air entering the flame tube in the direction of the arrows C and the flow of rich fuel-air mixture entering in the direction of the arrows D together generate a toroidal vortex E in the region of low pressure between them. This toroidal vortex extends entirely around the annulus of the liner and, in it, a thorough mixing of the two streams is achieved; the vortex forms the core of the combustion taking place in the liner and, as its peripheral elements are continually carried downstream, further air is added through the holes 32 and 33

to support combustion and provide the working fluid for the turbine. Once lighted, the combustion in the vortex is self-propagating.

The wall 24 is directly exposed to the combustion in the vortex and becomes, in consequence, very hot. Deterioration of the wall 24, which such high temperatures would normally cause, is prevented by the cooling effect of the fuel being sprayed by the jets onto its inner surface and by the additional influence of the air stream in the annular space 25. In cooling the wall the fuel is itself vaporized and the air-vapour mixture is heated, so that the gases emerging into the combustion zone of the liner are in a suitable condition for combustion. The vaporizing surface of the wall 24 is so extensive in comparison with the surface available in tube type vaporizer installations that it can achieve more complete vaporization at a lower temperature, thereby, eliminating gumming and carbon-deposition, improving combustion and enhancing the life of the vaporizer element. Furthermore since vaporization is complete there is no tendency to centrifugal separation of the fuel from the air as the flow of mixture is reversed by the baffle 27.

In the foregoing description the terms "inner," "outer" and the like have been used in reference to the longitudinal axis of the engine; for example, the "inner" wall of the liner is of lesser diameter than the "outer" wall thereof. However, such expressions as "within the combustion chamber," "internally to the flame tube" and the like have been used in the sense that the combustion chamber and its liner are substantially enclosed chambers or conduits, regardless of their external configuration; for example, the expression "within the flame tube" in an annular system, as described, would signify "external to the inner wall and internal to the outer wall" of the annulus, whereas in a tube type system it would signify simply "surrounded by the wall" of the tube. Such adverbial phrases may be applied generically to both annular and tube type combustion systems and are so used in the subjoined claims.

It will be understood that the above description has included certain features peculiar to an annular type combustion system and that in applying the invention to a tube type combustion system advantage cannot be taken of centrifugal effects in directing the flow of fuel and gases; furthermore, in some annular type systems, in the interest of accessibility of the fuel supply installation or other reasons, it may be desirable to situate the vaporizing element on the outer wall of the liner rather than on the inner wall and in such circumstances any centrifugal forces acting upon the fuel-air mixture would detract from the cooling of the vaporizing surface. The use of swirl vanes, as described, is not essential to the satisfactory operation of the invention. The principal feature is the vaporizing element taking the form of a double wall extending over the whole or a part of the liner, around the flame zone (the "doubler" may be either inside the liner, as herein described, or outside the liner) and this feature may be applied with advantage to any type of combustion chamber to develop a vortex core and an improved flame pattern over those now commonly in use, providing at the same time a cheaply manufactured and robust vaporizer, functioning at comparatively low temperatures and virtually eliminating all susceptibility to local overheating.

The application of the invention herein shown and described is to be taken therefore as a preferred example of the same and various changes in the shape, size, and arrangement of the parts may be resorted to, without departing from the spirit of the invention or the scope of the claims.

What I claim as my invention is:

1. A vapourizing system for a gas turbine engine embodying a combustion chamber through which a stream of air is caused to flow and a liner having open ends to receive part of the air and disposed substantially coaxially within the combustion chamber, comprising, a wall spaced from a wall of the liner and defining with the said liner wall an annular vapourizing space extending downstream substantially from the upstream end of the liner, an inlet in the said space for directing a portion of the air entering the liner into the upstream end of the said space, means for introducing fuel into the said space for conversion to fuel vapour, and a flow reversing surface extending into the flow path of the fuel vapour emerging from the downstream end of the said space into the liner whereby the fuel vapour is directed upstream.

2. A vapourizing system for a gas turbine engine embodying a combustion chamber through which a stream of air is caused to flow and a liner having open ends to receive a part of the air and disposed within and spaced from the combustion chamber, comprising, a wall disposed coaxially within and spaced from the liner and extending downstream substantially from the upstream end of the liner, the said wall with the liner defining an annular vapourizing space open at the upstream end for directing a portion of the stream of air into the said space, means for introducing fuel into the said space for conversion to fuel vapour, and a flow reversing surface extending into the flow path of the fuel vapour emerging from the downstream end of the said space into the liner whereby the fuel vapour is directed upstream.

3. A vapourizing system for a gas turbine engine as claimed in claim 2 in which the said flow-reversing surface is provided by an annular baffle disposed transversely of the liner downstream of the said wall.

4. A vapourizing system for a gas turbine engine as claimed in claim 2 in which said flow-reversing surface is provided by an annular baffle disposed transversely of the liner, the said baffle being in concentric spaced relationship to the downstream end of the said annular space and being provided with a flange extending upstream.

5. A vapourizing system for a gas turbine engine as claimed in claim 2, in which the fuel introducing means includes a plurality of jets situated within the said annular space adjacent the upstream end thereof.

6. A vapourizing system for a gas turbine engine embodying a combustion chamber through which a stream of air is constrained to flow and a liner having open ends to receive part of the stream of air and disposed substantially coaxially within the combustion chamber, comprising an annular vapourizing element coaxial with the liner and extending downstream substantially from the upstream end thereof, an inlet in the vapourizing element for directing a portion of the air entering the liner into the upstream end of the vapourizing element, means for introducing fuel into the vapourizing element, a baffle disposed adjacent the downstream end of the vapourizing element and extending into the flow

path of said portion of the air stream and the fuel emerging from the downstream end of the vapourizing element into the liner whereby the air and fuel emerging from the said element are directed substantially upstream, and means at the upstream end of the liner for imparting a swirl to the remaining portion of the air entering the liner.

7. A vapourizing system for a gas turbine engine embodying a combustion chamber through which a stream of air is constrained to flow and a liner having open ends to receive part of the stream of air and disposed substantially coaxially within the combustion chamber comprising, an annular vapourizing element substantially coaxial with the liner and extending downstream substantially from the upstream end thereof, an inlet in the vapourizing element for directing a portion of the air entering the liner into the upstream end of the vapourizing element, means in the vapourizing element for imparting a swirl to the said portion of the air, means for introducing 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 liner whereby the air and fuel emerging from the said element are directed substantially upstream.

8. A vapourizing system for a gas turbine engine as claimed in claim 7 in which the said swirl imparting means comprises a plurality of swirl vanes in the inlet of the vapourizing element.

9. A vapourizing system for a gas turbine engine as claimed in claim 7 in which the means in the vapourizing element for imparting a swirl to the said portion of the air comprises a plurality of swirl vanes in the inlet of the vapourizing element, and in which means are also provided at the upstream end of the liner for imparting a swirl to the remaining portion of the air entering the liner.

10. A vapourizing system for a gas turbine engine embodying a combustion chamber through which a stream of air is constrained to flow and a liner having open ends to receive part of the stream of air and disposed substantially coaxially within the combustion chamber comprising, a wall disposed coaxially with respect to the liner in spaced relationship thereto and extending downstream substantially from the upstream end of the liner, the said wall with the liner defining an annular spaced adapted to receive a portion of the air entering the flame tube, a plurality of swirl vanes disposed at the upstream end of the annular space for imparting a swirl to the said portion of the air, means for introducing fuel into the annular space, an annular baffle mounted transversely of the liner and in concentric spaced relationship to the downstream end of the said wall, and a flange on the baffle extending upstream beyond the downstream end of the wall and spaced therefrom.

RONALD GUERIN MESCHINO.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,278,499	Esnault-Pelterie	Sept. 10, 1918
2,471,892	Price	May 31, 1949
2,475,911	Nathan	July 12, 1949
2,498,728	Way	Feb. 28, 1950
2,541,900	Williams	Feb. 13, 1951
2,546,432	Darling	Mar. 27, 1951
2,552,851	Gist	May 15, 1951