June 2, 1953 W. D. POUCHOT 2,640,321

COMBUSTION APPARATUS WITH IGNITION MEANS THEREFOR

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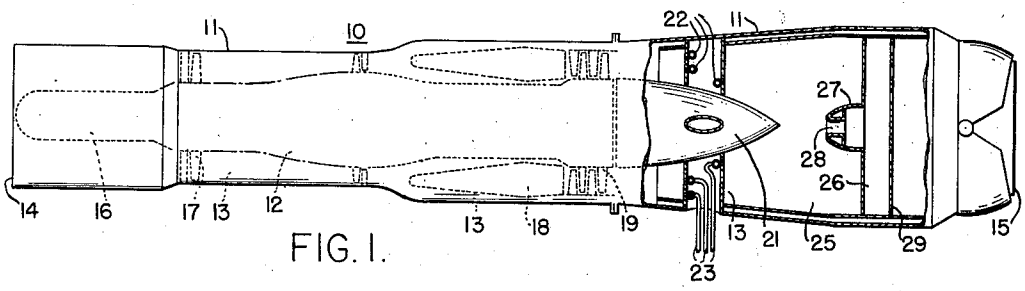

FIG. 1.

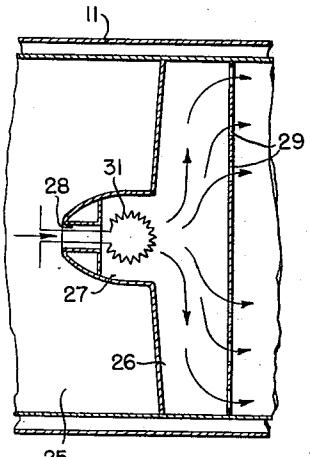

FIG. 2.

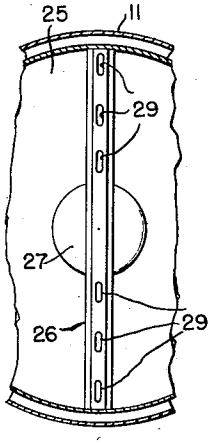

FIG. 3.

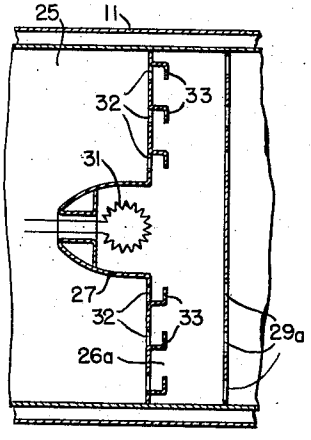

FIG. 4.

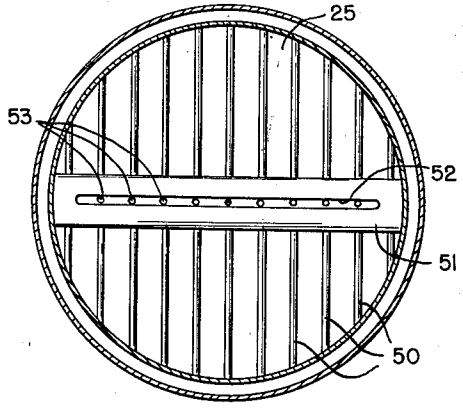

FIG. 5.

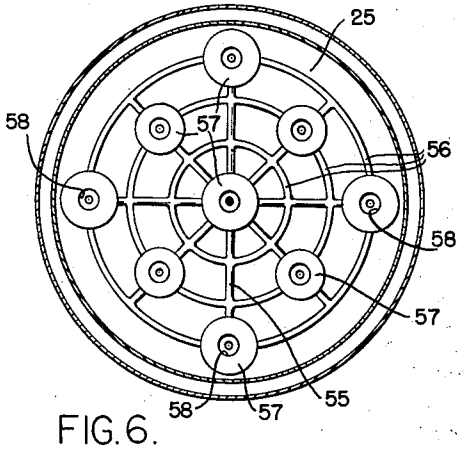

FIG. 6.

WITNESSES:

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COMBUSTION APPARATUS WITH IGNITION MEANS THEREFOR

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5 Claims. (Cl. 60—39.82)

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This invention relates to combustion apparatus, more particularly to ignition means therefor, and has for an object to provide improved mechanism for igniting a fuel-air mixture.

When a mixture of fuel and air is flowing through a combustion tube or chamber at high velocities, for example in afterburners for jet engines, difficulty is frequently encountered in preventing the flame formation being swept downstream and out of the tube or chamber before combustion of the fuel-air mixture is completed.

One means previously proposed for overcoming this difficulty comprised the provision of a grid of thin plates or webs disposed generally transversely of the combustion chamber together with a hollow airfoil section member positioned upstream of the grid and provided with an upstream inlet for a portion of the fuel-air mixture and a downstream outlet for burning fuel-air mixture, the hollow member being so disposed as to direct its flaming discharge onto a limited portion of each bar or web of the grill to heat the latter to a temperature sufficient to effect surface ignition of the fuel-air mixture flowing in contact therewith. In this prior arrangement it was necessary to rely on heat transfer through the material of the webs of the grid to extend the heating of the grill to a region thereof beyond that directly contacted by the discharge from the hollow heating member and hence to extend the surface combustion effect to cover the entire cross-sectional area, or the entire width, of the combustion chamber.

The present invention seeks to improve this prior arrangement by combining the hollow heating member and the grid. To this end, the grid members are made hollow and a heater is directly united therewith in such a manner that the burning gases pass from the heater into and through the hollow grid members to heat them internally to a temperature sufficient to produce auto-ignition of the fuel-air mixture flowing in contact with the outer surfaces of the grid members.

Accordingly, another object of the invention is to provide a surface ignition member together with means for internally heating substantially the entire length thereof.

These and other objects are effected by the invention as will be apparent from the following description and claims taken in connection with the accompanying drawing, forming a part of this application, in which:

Fig. 1 is an elevational view of an aircraft power plant incorporating the invention, a portion of the structure being broken away in the interest of clearness;

Fig. 2 is an enlarged fragmentary longitudinal sectional view showing details of the invention;

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Fig. 3 is an elevational view of the right hand end of the structure shown in Fig. 2;

Fig. 4 is a sectional view similar to Fig. 2, but showing a modified construction; and

Figs. 5 and 6 are enlarged transverse sectional views showing the upstream ends of two additional arrangements of the invention.

Referring now to the drawing in greater detail, the invention, while in no way limited to use therewith, is shown in connection with the afterburner of a power plant for jet propulsion of aircraft. This power plant, indicated in its entirety by the reference character 10, comprises an outer casing 11 and a composite core structure 12 coaxial with the longitudinal axis of the outer casing and spaced from the latter radially to provide therebetween an annular passage 13 for flow of air and gas substantially straight through the power plant from an inlet 14 at the front, or left as viewed in Fig. 1, to an exhaust nozzle 15 at the rear or opposite end.

The composite core structure 12 includes a fairing cone 16, axial-flow compressor 17, combustion apparatus 18, turbine 19 and tailcone 21. The operation of a power plant of this type is well understood in the art, and may be summarized as follows: Air entering the annular passage 13 through the inlet 14 is compressed in the compressor 17 and then heated in the combustion apparatus 18 by the burning of fuel therein. The heated air and hot products of combustion are expanded through the blading of the turbine 19 to motivate the latter which in turn drives the compressor 17 through a connecting shaft (not shown). The motive fluid expanded through the turbine is discharged from the power plant through the exhaust nozzle 15 in the form of a jet establishing a propulsive thrust.

In the power plant herein illustrated, the exhaust nozzle 15 is disposed a material distance downstream from the turbine 19 and tailcone 21, the space therebetween being utilized as an afterburner combustion space or chamber 25 for further heating the air and gases discharged from the turbine prior to their exhaust through the exhaust nozzle 15.

Fuel is supplied to the afterburner 25 through a plurality of annular manifolds 22 and supply lines 23 to effect a mixture of fuel and air for flow through, and combustion in, the afterburner.

Due to the relatively high velocity of the fuel-air mixture flowing through the afterburner combustion chamber, difficulty may be encountered in obtaining suitable flame distribution transversely of the combustion chamber unless special means are utilized to this end.

In accordance with the present invention, one or more surface ignition members are disposed transversely of the combustion chamber and serve to ignite the stream of fuel-air mixture

passing in close proximity thereto. Inasmuch as the surface ignition member or members extend substantially all of the way across the combustion chamber 25, they will effect ignition of the fuel-air mixture throughout substantially the full width of the stream thereof.

In the form of the invention shown in Figs. 1, 2 and 3, a single surface ignition device in the form of a tubular member 26 extends transversely of the combustion chamber 25. Wall structure is associated with the tubular member 26 adjacent the center of the upstream edge thereof to provide a heater 27 having an inlet 28 directed upstream for entry of a limited portion of the fuel-air mixture flowing through the afterburner.

The relatively high-velocity stream of fuel-air mixture entering the heater 27 expands after passing the narrow inlet 28, resulting in a velocity reduction of a degree sufficient to permit flame retention and propagation in the heater 27 and tube 26. Preferably, the tube 26 is of airfoil section and is provided with one or more openings 29 in its downstream edge for discharge of burning gases and hot products of combustion, the flow of burning gases lengthwise through the tube heating the walls thereof to or above the auto-ignition temperature of the fuel-air mixture flowing in contact with the outer ignition surfaces of the tube.

Any suitable means may be provided for initiating combustion within the heater 27, an electric ignition coil 31 being shown for this purpose in Figs. 2 and 4.

The modification of Fig. 4 differs from that of Figs. 2 and 3 in that additional fuel-air inlet openings 32 are provided in the upstream edge of the tube 26*a*, together with internal baffles 33 to prevent flow of entering fuel-air directly across the width of the tube and out through the outlets 29*a* directly opposite.

Figs. 5 and 6 show further desirable arrangements each involving the use of a plurality of tubes. In Fig. 5 a plurality of straight tubes 50 are disposed in parallel side-by-side relation, providing a grid structure disposed generally normal to the direction of flow of the fuel-air mixture through the combustion chamber. A single elongated heater 51 having an elongated slot-like fuel-air inlet 52 in its upstream edge, extends at right angles to the plurality of tubes 50 and discharges to the interior of each of the latter through outlets 53.

Each tube 50 is provided with one or more outlet openings in the downstream side thereof.

In the construction of Fig. 6, a plurality of radial tubes 55 and circular tubes 56 are arranged to provide a grid to which burning fuel and air are supplied from a plurality of heaters 57 having inlets 58 and discharging to the tube grid at intersections of radial and circular tubes, which tubes have one or more outlet openings in the downstream sides thereof.

It will be apparent that the heaters 51 and 57 of Figs. 5 and 6, respectively, may be provided with any suitable means (not shown) for initiating combustion within the heaters.

While the invention has been shown in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof.

What is claimed is:

1. In combustion apparatus, first wall structure defining a main combustion chamber adapted for flow of air therethrough; means near the upstream end of said chamber, considered in the direction of flow of air therethrough, for supplying fuel to the air flowing therethrough for admixture therewith; a tubular member disposed generally normal to the direction of flow of the fuel-air mixture through said chamber and providing an ignition surface; second wall structure defining a heating chamber having an inlet wall downstream of the fuel supply means, said inlet being directed upstream in the main combustion chamber for entry of a limited portion of the fuel-air mixture flowing through said main chamber, and said heating chamber having an outlet for burning gases communicating with the interior of the tubular member, and means associated with said heating chamber for initiating combustion therein, said tubular member having one or more outlet openings in the downstream side thereof, whereby burning gases and hot products of combustion discharged from the heating chamber to the interior of the tubular member may flow through the latter and heat the ignition surface thereof to the auto-ignition temperature of the main fuel-air mixture flowing in contact with the said surface.

2. Structure as specified in claim 1, wherein the tubular member has a series of outlet openings in the downstream side thereof throughout a major portion of its length.

3. Structure as specified in claim 1, wherein the tubular member has an outlet slot in the downstream side thereof extending throughout a major portion of its length.

4. Structure as specified in claim 1, wherein the tubular member has a plurality of inlet openings in its upstream side for entry thereto of limited quantities of fuel-air mixture for combustion therein.

5. In combustion apparatus, first wall structure defining a main combustion chamber adapted for flow of fuel-air mixture therethrough, a plurality of tubular members extending generally normal to the direction of flow of the mixture through the chamber and providing a plurality of ignition surfaces, second wall structure defining one or more heating chambers each having an inlet directed upstream in the main combustion chamber for admission to the heating chamber or chambers of a limited portion of the fuel-air mixture flowing through the main combustion chamber and having an outlet for burning gases communicating with the interiors of the tubular members, and means associated with said one or more heating chambers for initiating combustion therein, each of said tubular members having one or more outlet openings in the downstream sides thereof, whereby burning gases and hot products of combustion discharged from the heating chamber or chambers may flow through the tubular members and heat the ignition surfaces thereof to the auto-ignition temperature of the main fuel-air mixture flowing in contact with the said surfaces.

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