

Nov. 2, 1954

R. W. ABBOTT

2,693,083

COMBINATION FLAME-HOLDER AND FUEL NOZZLE

Filed March 26, 1951

Fig. 1.

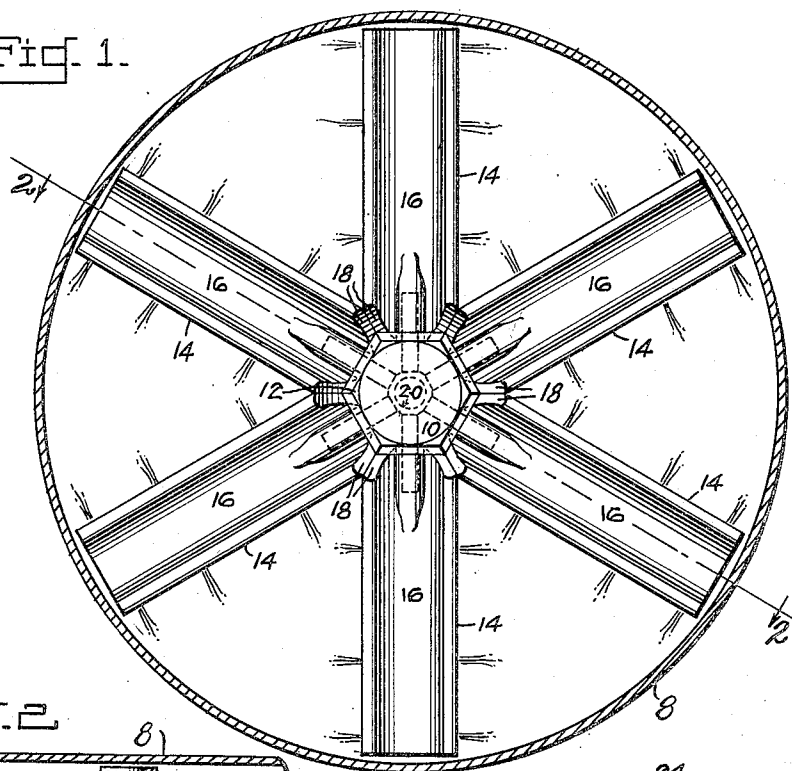


Fig. 2.

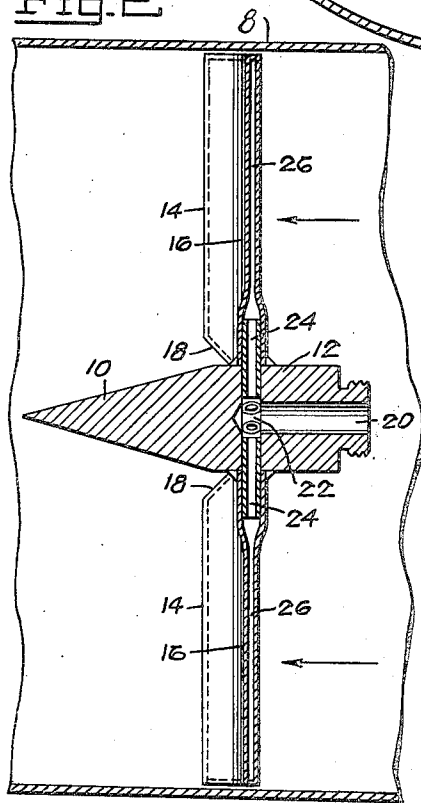


Fig. 3.

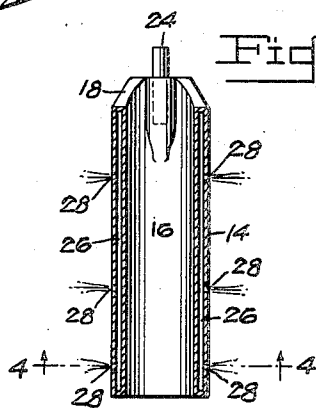
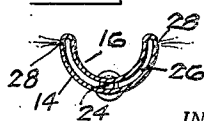


Fig. 4.



INVENTOR.
Roy W. Abbott

BY

G. J. Kassenich + A. W. Dew
ATTORNEYS

1

2,693,083

COMBINATION FLAME-HOLDER AND FUEL NOZZLE

Roy W. Abbott, Schenectady, N. Y., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army

Application March 26, 1951, Serial No. 217,460

7 Claims. (Cl. 60—39.72)

The present invention relates to a combination flameholder and fuel nozzle and has for its primary object the production of such a device with new and improved characteristics. It may be used wherever the combination is desirable but was designed with the limitations of ram-jet propulsion particularly in mind. Consequently a second object of the invention is the production of an improved flameholder and fuel nozzle for use in a ram-jet engine. When used in a ram-jet it will be combined with a combustion chamber and may properly be termed a combustor. Other objects and applications of the invention will however be evident from the description and appended drawings.

Before my invention, fuel for ram-jet combustion was usually fed upstream into the air and allowed to mix with the latter. Ignition was supplied and a flame held at some point downstream. Such feeding resulted in several disadvantages now overcome. When premixture between the fuel and the air is permitted the ratio of fuel to air must be held within narrow limits. These limits approximate very closely the stoichiometric ratio for the burning of the fuel. Very accurate control systems are therefore essential if the proper ratio is to be maintained.

Pulsating burning is frequently encountered when conventional fuel feed is used. Under ideal conditions flame propagation velocity may be higher than the approach velocity of the ram-jet. Flame is thus able to travel upstream from the flameholder to the injection nozzle. Under less ideal conditions the flame travels back to the flameholder. Such behavior results in temporary extinction and reignition cycles or pulsating combustion. The pulsations are detrimental to efficient operation of the ram-jet since incomplete combustion takes place during the cycles, wasting fuel. There is the further possibility that the flameholder itself will burn out during the reignitions since an initial flame may be hotter than the steady condition flame.

My invention eliminates the disadvantages enumerated above in a novel and efficient manner. It produces a quiet flame with a short front and excellent stability over a wide range of fuel-air ratios. The aerodynamic pressure drop through the flame holder is at a minimum while the exhaust temperature is in excess of 3400° F. How these results are obtained may be seen from the following description and the drawing, in which:

Fig. 1 shows a front view of my new flameholder and fuel nozzle;

Fig. 2 is a cross-sectional view along the line 2—2 of Fig. 1;

Fig. 3 is a detailed view of one of the arms of the flameholder evident in Fig. 1; and

Fig. 4 is a view partly in section along the line 4—4 of Fig. 3.

The major components of my device are a fuel injection system, a flame holding system and a flame stabilizer and are adapted to be held within a combustion chamber, indicated generally by reference character 8. The flame stabilizer is represented primarily by a solid cone 10. The cone is continuous with a hub 12 on which are mounted six equally spaced arms 14 which serve directly as flameholders. These arms are crescent shaped or concave in cross-section as is best seen in Figure 4. The concave portions of the arms form gutters 16 into which some fuel is drawn when the device is in operation. The arms are mounted along the hub in such

2

a manner that the concave portion of the crescent faces down-stream from the fuel supply. The gutters of the different arms are interconnected at the hub through triangular cutback portions 18.

The fuel injection system begins with the conduit 20 leading directly into the cavity 22 in the hub. Each of the arms 14 possesses an internal hollow 26. The hollows 26 are connected to the cavity 22 through small pipes 24. Six jets 28 are spaced in pairs along each arm 14, extending from the internal hollow to the external surface of the arms. As is best seen from Figure 4, the jets are positioned at the upper edge of the crescent shaped arms and on the surfaces facing away from the gutters. The pairs of jets are spaced along each arm so that each pair feeds fuel into arcs of equal area. The resultant fuel pattern is shown in Figure 1.

The operation of the device is evident from the foregoing description. Fuel passes from the internal conduits to the jets and is injected into the air. Enough is drawn into the downstream gutter of each leg for primary combustion. Ignition is supplied from an igniter (not shown) to the fuel in one of the gutters. The flame immediately spreads to the other gutters through the interconnection at the hub and to all the jets. The sharp downstream cone is brought slightly above ignition temperature from the heat of initial combustion and remains heated to assure more stable burning. Fuel passing through the flame holding arms acts to cool the holder and at the same time becomes preheated itself so that it will burn more readily when injected.

It is impossible for the flame to travel upstream of the holder as there is no fuel above it. Since the fuel is injected and the flame held from the same object, the flame front is so thin as to almost be considered a plane. With this front extinction and reignition cycles are eliminated, resulting in smooth and efficient combustion. The fuel air mixture around the injection area is rich with leaner mixtures progressing out radially; total fuel air ratio may therefore diverge widely. As a consequence most of the disadvantages enumerated as incident to the prior art have been eliminated.

What I claim is:

1. A combination flameholder and fuel nozzle comprising a hub, longitudinal arms with a crescent shaped cross-section extending radially from said hub and having radially extending gutters facing down-stream from the fuel supply thereby comprising flameholder units, radially extending hollows in said arms, an interior cavity in the hub connected to said internal hollows in the arms, nozzles extending from the said internal hollows to the external surfaces of the arms and a conical flame stabilizer supported coaxially of said hub and on the downstream side thereof.

2. A combination according to claim 1 and wherein said gutters and flameholders are all on the downstream side of the arms, and said gutters intercommunicate at said hub.

3. Apparatus according to claim 1 wherein said hollows are substantially coextensive with the arms both transversely and longitudinally thereof so that substantially the total surface of said flameholder units is contacted and cooled by fuel.

4. In a combination flame-holder and fuel nozzle, a hub having a central chamber, a tubular arm secured to and extending generally radially from said hub, said arm being trough-shaped to form a radial fuel passage generally crescent-shaped in cross-section, there being a plurality of jet-forming apertures through the wall of said arm in spaced relation along the edges thereof, and a passageway between the chamber in said hub and the said fuel passage in said arm.

5. A flame-holder and fuel nozzle as in claim 4, there being a plurality of said arms secured to and radiating from said hub in equi-angularly spaced relation, there also being a passageway from the chamber in said hub to each said arm, the trough of all said arms facing in one direction axially of said hub.

6. A flame-holder and fuel nozzle as in claim 5, and a generally conical flame stabilizer secured to said hub centrally thereof and extending in said direction.

2,693,083

3

7. A flame-holder as in claim 5, the jets formed by the apertures in each edge of one arm being directed toward those of the contiguous edge of the next adjacent arm.

4

References Cited in the file of this patent

UNITED STATES PATENTS

	Number	Name	Date
5	2,385,833	Nahigyan	Oct. 2, 1945
	2,416,389	Heppner et al.	Feb. 25, 1947
	2,529,506	Lloyd et al.	Nov. 14, 1950
	2,566,319	Deacon	Sept. 4, 1951
	2,568,921	Kroon	Sept. 25, 1951