

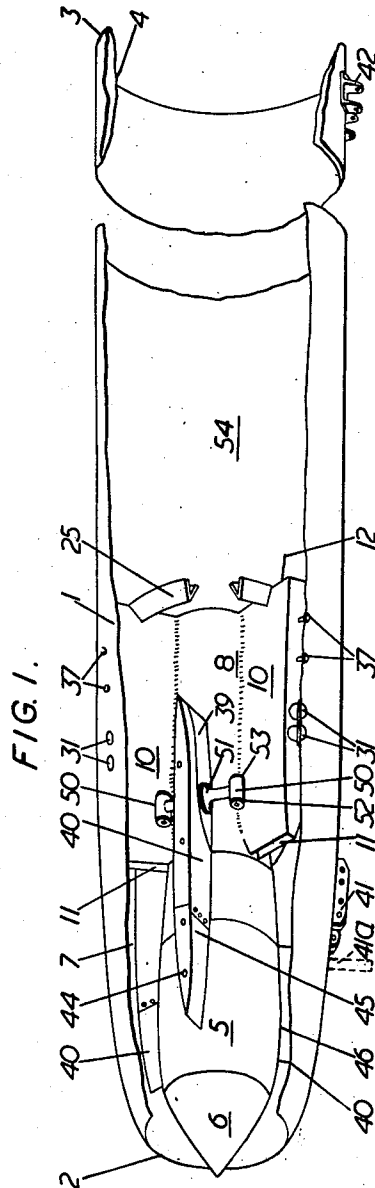
April 5, 1960

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FUEL BURNERS IN DUCTS

2,931,175

Filed Jan. 27, 1958

3 Sheets-Sheet 1



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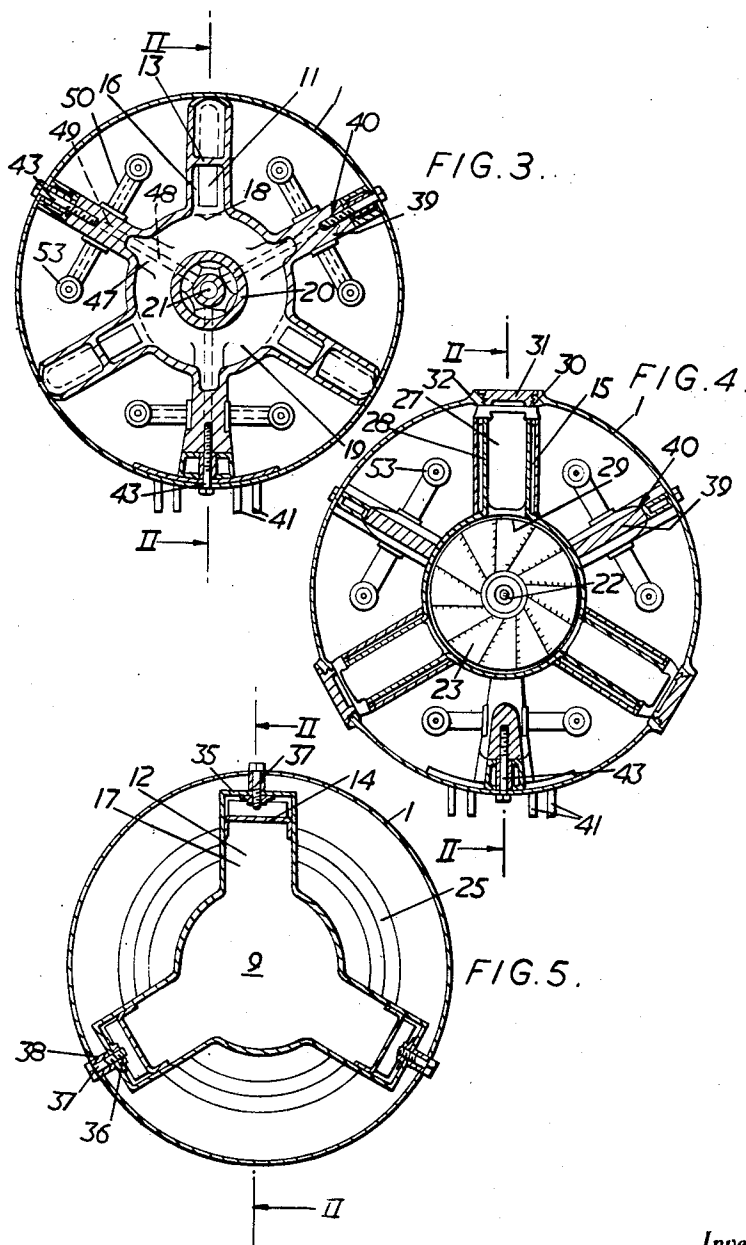
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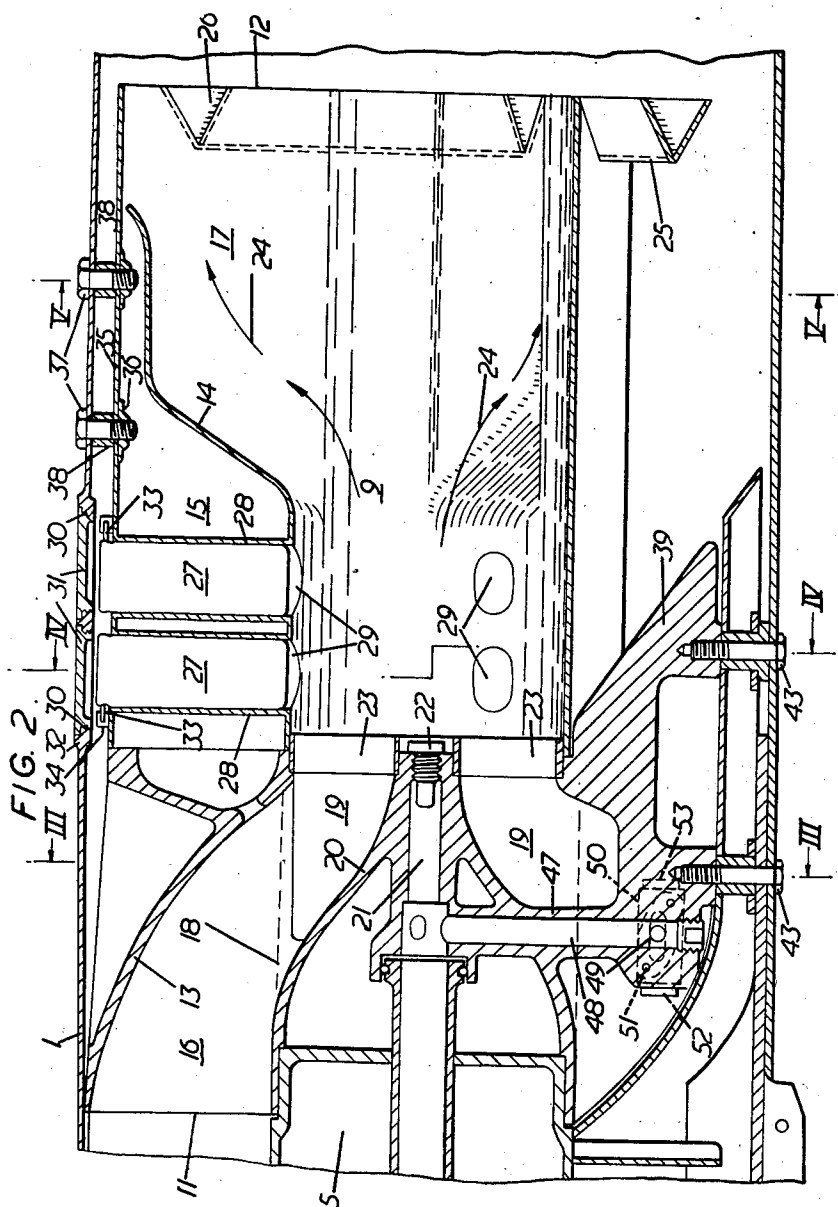
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FUEL BURNERS IN DUCTS

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Application January 27, 1958, Serial No. 711,213

Claims priority, application Great Britain
January 29, 1957

11 Claims. (Cl. 60—39.82)

This invention relates to equipment for burning fluid fuel in a fast-moving stream of gaseous combustion-supporting medium confined within a duct. Such equipment may for example form part of a ramjet engine or an after-burner for a turbo-jet engine.

It is well known that the principal elements of equipment of this kind are: means for dispersing the fuel into the fast-moving stream, means for igniting the fuel, and a flame holder. The latter commonly takes the form of an assemblage of radially extending and/or ring-shaped gutters having their open sides facing downstream. The equipment also frequently includes means enclosing a pilot combustion zone wherein the flows of combustion-supporting medium and fuel are maintained at values most favourable for the maintenance of stable combustion.

The object of the present invention is to provide an assembly of such elements which will combine operating efficiency with economy of manufacturing cost and convenience of handling.

According to the invention, equipment for the purpose set forth comprises an island member in the duct having a hollow rear end portion constituting a pilot combustion zone open at its downstream end, a plurality of hollow vanes open at each end extending lengthwise along a rear part of the island member and outwardly across the passage between the island member and the duct, each vane comprising two internal partitions dividing the hollow interior into a middle chamber and front and rear end chambers, openings in the wall of the island member connecting the front and rear end chambers with the pilot combustion zone, means in each middle chamber for supporting an igniter of a kind capable of projecting a flame, openings in the wall of the island member through which flame from the igniters may enter the pilot combustion zone, openings in the duct, normally closed by closure members, through which the igniters may be inserted and withdrawn, and means for dispersing fuel into the pilot combustion zone and into the passage between each adjacent pair of hollow three-chamber vanes. The means for dispersing fuel into the passage may itself be between the vanes or lie a little upstream from them.

In this assembly the rear end chambers of the hollow vanes constitute flame holding gutters opening into and radiating from the pilot combustion zone. Preferably these gutters are supplemented by one or more ring-shaped flame-holding gutters arranged intermediately between the duct and the pilot combustion zone, the ring-shaped gutters opening into the radiating gutters.

According to a feature of the invention the depth of the rear chambers, that is their dimension lengthwise of the duct, is two or more times the depth of the ring-shaped gutters.

According to another nature of the invention the rear vane partitions, constituting the bottoms of the radiating gutters, slope generally outwardly and rearwardly so that

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the depth of the gutters at their junction with the part of the island member constituting the pilot combustion zone is greater than the depth of the gutters near the duct.

According to another feature of the invention the forward vane partitions, constituting the outer walls of passages conveying combustion-supporting medium into the pilot combustion zone, slope generally inwardly and rearwardly so as to deflect the combustion-supporting medium entering through the open forward end of the vanes progressively towards the openings in the island member connecting the passages with the pilot combustion zone.

According to another feature of the invention the island member is formed with a manifold chamber surrounding a central rearwardly extending projection provided with a fuel conduit and carrying a fuel jet arranged to disperse fuel in the downstream direction into the pilot combustion zone, the manifold chamber being separated from the pilot combustion zone by a ring of swirl-producing blades radiating from the projection, and being connected to the front end chambers of the hollow three-chamber vanes by the openings in the wall of the island member to which reference has already been made.

According to another feature of the invention the part of the island member carrying the rearwardly extending projection is provided with at least as many radiating projections each provided with a fuel conduit as there are hollow three-chamber vanes, these radiating projections extending into the passage between the island member and the duct between each adjacent pair of hollow three-chamber vanes and carrying fuel jets for dispersing fuel into the passage.

Preferably one such radiating projection is provided extending into the passage between the island member and the duct between each adjacent pair of hollow three-chamber vanes, each projection carrying a fuel jet arranged to project fuel in an upstream direction and a fuel jet arranged to project fuel in a downstream direction.

In a preferred embodiment having the features of the last preceding paragraph each radiating projection forms part of a fin knife-edged at each end and extending between the island member and the duct, the part of each fin constituted by the radiating projection carrying on each side a lateral projection provided with a fuel conduit, each lateral projection carrying, in axial alignment with one another, a fuel jet arranged to project fuel in an upstream direction and a fuel jet arranged to project fuel in a downstream direction.

According to another feature of the invention the parts of the vanes constituting the front end chambers of the vanes are made as a unitary casting with the part of the island member constituting the manifold chamber and the central and radiating projections. The remaining parts, that is to say the part of the island member constituting the wall of the pilot combustion zone and the parts of the vanes constituting the middle chambers (igniter housings) and the rear end chambers (radiating gutters), together with the ring-shaped gutter or gutters if used, are made of heat-resisting sheet material.

Where the equipment according to the invention is used as part of a ramjet engine the temperature of those parts referred to as being made as a unitary casting remains sufficiently low for such casting to be made of a light weight metal alloy.

Further features of the invention will be apparent from the following description of a constructional example applied to a ramjet engine in which reference is made to the accompanying drawings in which:

Figure 1 is a cut-away perspective view of the engine;

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Figure 2 is a section through the combustion equipment parts taken along a vertical plane through the axis of the engine as indicated by the lines II—II in Figures 3 to 5; and

Figures 3 to 5 are sections on the lines III—III, IV—IV and V—V in Figure 2.

As may be seen from Figure 1 the engine comprises a duct 1 having an open forward end 2 and an open rear end 3. At the rear end the duct is constricted by an inner wall 4 constituting a convergent-divergent nozzle through which the propulsive jet issues. Within a forward part of the duct is arranged an island member 5 having a conical forward end 6 protruding through the end 2 of the duct. The annular gap between the conical end 6 and the end 2 of the duct constitutes an air intake opening and the passage 7 between the island member and the duct leading rearwardly from the air intake opening constitutes a diffuser in which the velocity of the air is reduced and its pressure is increased in known manner. The arrangement of these parts has no essential connection with the present invention and further description of them is therefore considered unnecessary. The invention resides in the arrangement of the combustion equipment section of the engine, which is the part shown in Figure 2, and this part will now be described.

The island member 5 has a hollow rear end portion 8 enclosing a pilot combustion zone 9 open at its downstream end. Three hollow vanes 10 evenly spaced around a rear part of the island member extend lengthwise of the member and outwardly across the passage 7. Each vane 10 has an open forward end 11 and an open rearward end 12 and comprises two internal partitions 13 and 14 dividing the hollow interior into a middle chamber 15, a front end chamber 16 and a rear end chamber 17. The front end chambers 16 are connected by openings 18 in the wall of the island member to a manifold chamber 19 surrounding a central rearwardly extending projection 20 provided with a fuel conduit 21 and carrying a fuel jet 22 arranged to disperse fuel in the downstream direction into the pilot combustion zone 9. The front end chambers 16 thus act as passages conveying air from the passage 7 into the pilot combustion zone 9 by way of the manifold chamber 19. To assist the dispersion of fuel and products of combustion in the pilot combustion zone 9 a ring of swirl producing blades 23 is provided radiating from the projection 20 adjacent the burner 22. As will be seen, the partitions 13 constituting the outer walls of the passages conveying air into the pilot combustion zone slope generally inwardly and rearwardly so as to deflect the air entering through the open forward end 11 progressively towards the openings 18.

The part 8 of the island member constituting the wall of the pilot combustion zone 9 is slotted in way of the rear end chambers 17 of the vanes so that flame from the pilot combustion zone can disperse outwardly through these chambers as indicated by the arrows 24 and issue from their downstream open ends 12. The chambers thus act as radiating flame holding gutters. To assist outward dispersion of the flame the partitions 14 constituting the bottom of the gutters slope generally outwardly and rearwardly so that the depth of the gutters at their junction with the wall 8 is greater than the depth of the gutters near the duct 1. These radiating gutters are supplemented by a ring-shaped flame holding gutter 25 of V-shaped section arranged intermediately between the duct 1 and the pilot combustion zone wall 8. The ring-shaped gutter 25 opens into the radiating gutter chambers 17 at openings 26, that is to say the gutter 25 is made in three arcuate portions each portion extending from an opening 26 in a side wall of one of the vanes 10 to an opening 26 in the side wall of the next adjacent vane. As will be seen from the drawing the average depth of the radiating gutters, that is to say their dimension lengthwise of the duct, is about four to five times the

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depth of the ring-shaped gutter, this feature assisting materially in obtaining a good outward spread of the flame from the pilot combustion zone.

The middle chamber 15 of each vane is used to house two pyrotechnic igniter cartridges 27. These cartridges are supported with their axes disposed radially by tubular supports 28 attached to the wall 8 of the pilot combustion zone around holes 29 in the wall through which flame from the cartridges may enter the pilot combustion zone. Holes 30 in the duct 1 permit easy insertion and removal of the cartridges, this being an important advantage of the arrangement according to the invention since considerations of safety require that the cartridges shall not be fitted until immediately before the engine is required for use. After the cartridges have been inserted, the holes 30 are closed by covers 31 which screw into threads formed in bosses 32 surrounding the holes. While a single cartridge might in favourable circumstances serve to start combustion, duplication is necessary to guard against the possibility of a fault in the cartridge, and experience has shown the desirability of having as many as six cartridges in order to guarantee a perfect start under all operating conditions. The cartridges include electrical ignition devices connected to terminal members 33 projecting laterally from the cartridges at their outer ends. As the cartridges are inserted, electrical connection is made between the terminal members 33 and contact devices 34 carried by an outer wall 35 forming part of the structure of the vane 10. All the contact devices 34 are electrically connected by suitable wiring (not shown) to a common contact device (not shown) carried by the duct 1. The wall 35 also carries nut plates 36 receiving the threaded ends of bolts 37 which, with the aid of spacing sleeves 38, assist in the attachment of the internal parts to the duct 1.

The part of the island member comprising the projection 20 and enclosing the manifold chamber 19 is formed as a unitary light alloy casting with the forward part of the vanes 10, including the partition 13, and with three projections 39 spaced intermediately between the vanes 10. As will be seen from Figure 1 each projection 39 forms part of a fin 40 tapering at each end and extending between the island member and the duct. That fin which is seen lowermost in the drawings is, in a manner more particularly described and claimed in the specification of co-pending application No. 692,002, made of stronger construction than the others and is connected to flanges 41 on the outside of the duct, whereby, in association with rear mounting elements 42, the engine is attached to a vehicle which is required to propel. The island member 5 is thus supported from the vehicle, and the casing 1 is supported from the island member by the fins 40 and the vanes 10. The attachment of the duct to the fins 40 is by means of bolts 43, some of which screw into holes tapped in the projections 39, as seen in Figure 2, and others of which screw into holes 44 tapped into a forward part 45 (Figure 1) of each fin which is made as a unitary light alloy casting with a part 46 of the island member. A fuel supply pipe 41a can be attached to the underside of the engine, to connect with passages (not shown) leading into the island member and thence to the fuel conduit 21.

Each projection 39 is connected to the central projection 20 by a part 47 in which is formed a fuel conduit 48 branching from the fuel conduit 21 and leading to a port 49 on each side of the projection 39. Fuel passing through these ports enters conduits formed in each of a pair of laterally projecting brackets 50 arranged one on each side of the projection 39 and secured to it by bolts 51. The conduit in each bracket leads to two co-axially arranged fuel jets 52 and 53 of which 52 projects fuel in an upstream direction into the passage between the island member and the duct between each adjacent pair of vanes 10, and the fuel jet 53 projects fuel into the passage in a downstream direction.

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It will be understood therefore that in addition to the pilot zone jet 22 there are six jets 52 projecting fuel upstream and six jets 53 projecting fuel downstream. The fuel so projected is carried downstream by the airflow and is ignited by the flame held by the radiating and ring-shaped flame holding gutters 17 and 25 so that it burns in the part 54 of the duct downstream of these gutters.

When the invention is applied as an afterburning device in a turbo-jet engine the island member may be the so-called exhaust bullet of the engine.

We claim:

1. A fuel burner comprising a duct, an island member in the duct having a hollow rear end portion constituting a pilot combustion zone open at its downstream end, a plurality of hollow vanes open at each end extending lengthwise along a rear part of the island member and outwardly across the passage between the island member and the duct, each vane comprising two internal partitions dividing the hollow interior into a middle chamber and front and rear end chambers, openings in the wall of the island member connecting the front and rear end chambers with the pilot combustion zone, means in each middle chamber for supporting an igniter of a kind capable of projecting a flame, openings in the wall of the island member through which flame from the igniters may enter the pilot combustion zone, openings in the duct, normally closed by closure members, through which the igniters may be inserted and withdrawn, and means for dispersing fuel into the pilot combustion zone and into the passage between each adjacent pair of hollow three-chamber vanes.

2. A burner according to claim 1 in which at the rear end of the island member there are at least one ring-shaped flame-holding gutter arranged intermediately between the duct and the pilot combustion zone, the ring-shaped gutter opening into the rear chambers of the hollow three-chamber vanes.

3. A burner according to claim 2 in which the dimension of the rear chambers in the lengthwise direction of the duct is two or more times that of the ring-shaped gutter in that direction.

4. A burner according to claim 1 in which the partitions between the said middle and rear end chambers slope outwards and rearwards.

5. A burner according to claim 1 in which the partitions between said middle and front end chambers slope inwards and rearwards.

6. A burner according to claim 1 in which the island member is formed with a manifold chamber surrounding a central rearwardly extending projection provided

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with a fuel conduit and carrying a fuel jet arranged to disperse fuel in the downstream direction into the pilot combustion zone, the manifold chamber being separated from the pilot combustion zone by a ring of swirl-producing blades radiating from the projection, and being connected to the front end chambers of the hollow three-chamber vanes by the openings in the wall of the island member.

7. A burner according to claim 6 in which the part of the island member carrying the rearwardly extending projection is provided with at least as many radiating projections each provided with a fuel conduit as there are hollow three-chamber vanes, these radiating projections extending into the passage between the island member and the duct between each adjacent pair of hollow three-chamber vanes, and carrying fuel jets for dispersing fuel into the passage.

8. A burner according to claim 7 in which one such radiating projection is provided extending into the passage between the island member and the duct between each adjacent pair of hollow-three-chamber vanes, each projection carrying a fuel jet arranged to project fuel in an upstream direction and a fuel jet arranged to project fuel in a downstream direction.

9. A burner according to claim 8 in which each radiating projection forms part of a fin tapering at each end and extending between the island member and the duct, the part of each fin constituted by the radiating projection carrying on each side a lateral projection provided with a fuel conduit, each lateral projection carrying, in axial alignment with one another, a fuel jet arranged to project fuel in an upstream direction and a fuel jet arranged to project fuel in a downstream direction.

10. A burner according to claim 7 in which the parts of the vanes constituting the front end chambers of the vanes are made as a unitary casting with the part of the island member constituting the manifold chamber and the central and radiating projections, and the part of the island member constituting the wall of the pilot combustion zone and the parts of the vanes constituting the middle chambers and the rear end chambers are made of heat-resisting sheet material.

11. A burner according to claim 1 in which there are three three-chamber vanes, and two igniters in the middle chamber of each vane.

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