Dec. 20, 1966 G. L. WILDE ETAL 3,292,375

COMBUSTION EQUIPMENT, E.G. FOR A GAS TURBINE ENGINE

Filed March 19, 1964 3 Sheets-Sheet 1

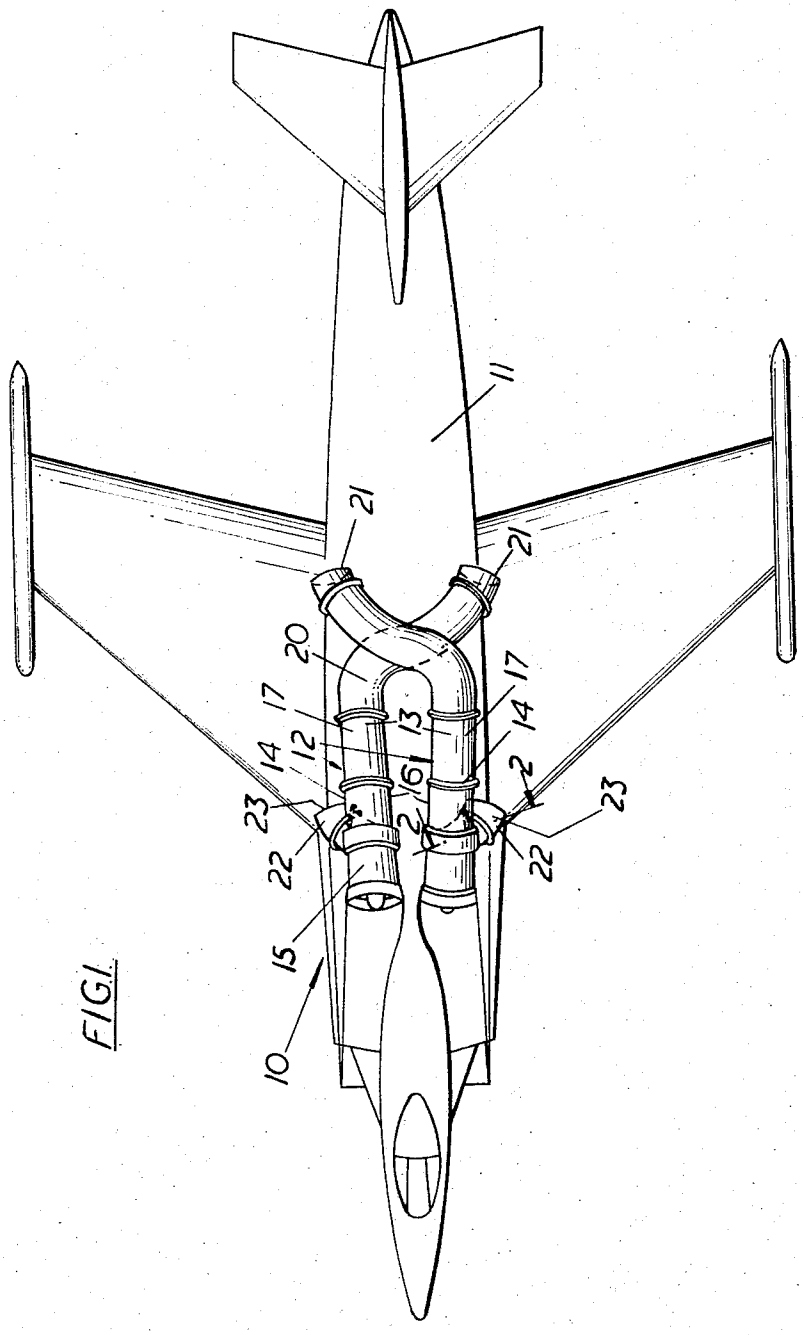


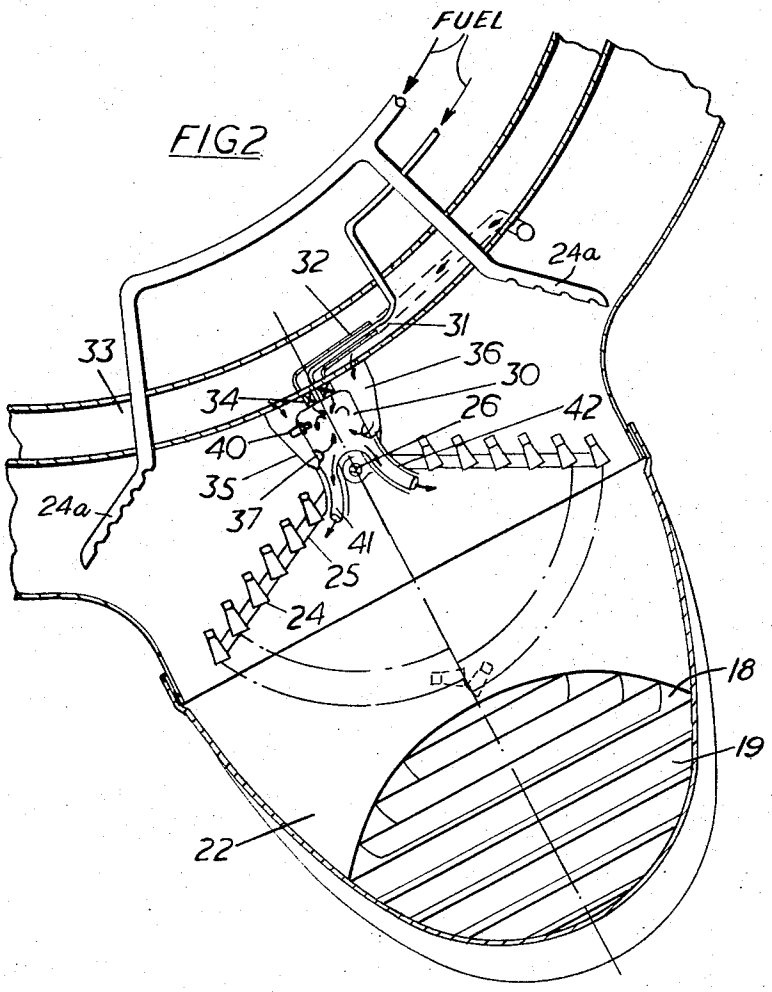
FIG. 1

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COMBUSTION EQUIPMENT, E.G. FOR A GAS TURBINE ENGINE

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FIG2

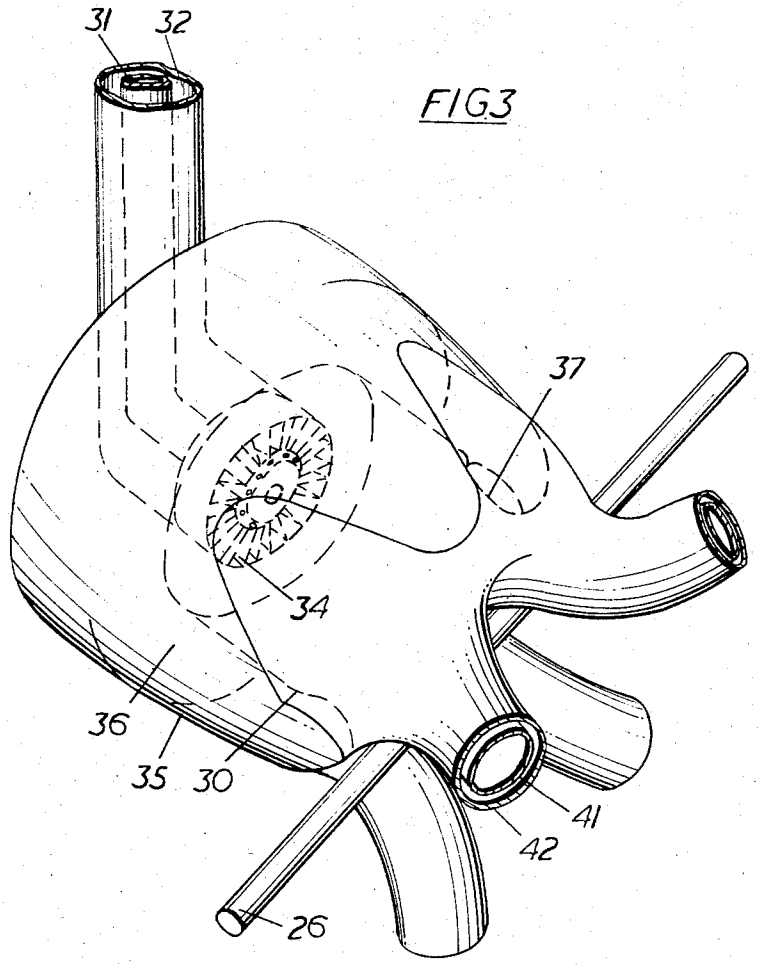


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COMBUSTION EQUIPMENT, E.G. FOR A GAS TURBINE ENGINE

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FIG3



United States Patent Office

3,292,375

Patented Dec. 20, 1966

3,292,375

COMBUSTION EQUIPMENT, E.G. FOR A GAS TURBINE ENGINE

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Filed Mar. 19, 1964, Ser. No. 353,081
Claims priority, application Great Britain, Mar. 29, 1963, 12,678/63
9 Claims. (Cl. 60—224)

This invention concerns combustion equipment, e.g. for a gas turbine engine.

According to one aspect of the present invention, there is provided combustion equipment comprising an air duct, a plurality of combustion stabilizing members arranged in the air duct, means for supplying the combustion stabilizing members with fuel, a chamber mounted in the air duct, means for continuously supplying the interior of the chamber with fuel and air, means for effecting combustion of the fuel and air in the chamber, and means for continuously passing out of the chamber the flame or hot gases arising from the said combustion and for directing the said flame or hot gases past the said combustion stabilizing members so as to ignite fuel supplied thereto.

The said combustion stabilizing members are preferably carried by structure which may be moved between an operative position in which the structure and its combustion stabilizing members extend across the air duct and an inoperative position in which the structure and its combustion stabilizing members present relatively little obstruction to the flow of air through the air duct, the said continuous means directing the said flame or hot gases past the operative position of the said combustion stabilizing members. Thus the said structure may comprise a plurality of pivoted support members each of which carries a plurality of combustion stabilizing members, the said support members being pivotally movable away from and towards each other so as to bring the said structure respectively into its operative and inoperative positions.

The means for continuously passing the flame or hot gases out of the chamber may comprise at least one inner tube which communicates with the chamber, the or each said inner tube being mounted concentrically within an outer tube which is adapted to be applied with cooling air.

According to another aspect of the present invention, a gas turbine engine is provided with combustion equipment as set forth above.

Thus the said air duct is preferably arranged to receive part of the air compressed by the compressor means of the engine and is provided with a jet nozzle additional to a final outlet nozzle arranged at the downstream end of the engine jet pipe.

Each of the said nozzles may be provided with deflector means for varying the direction in which the gases flowing therethrough are directed.

Preferably the said deflector means may be moved so as to direct the said gases forwardly, rearwardly, or downwardly, as desired. Thus the said deflector means may comprise a frame member which is rotatably mounted in the jet pipe or in the air duct and which carries a plurality of jet deflector vanes which extend parallel to each other, means being provided for effecting rotation of the frame member with respect to the jet pipe or air duct.

According to yet another aspect of the present invention, a power plant comprises two gas turbine engines as set forth above, one side of each engine facing the respective side of the other engine and the jet pipes of the

two engines crossing over or through each other, the final outlet nozzle of each engine being disposed on the other side of the other engine, and the additional jet nozzle of each engine being disposed on the other side of the respective engine.

Additionally, the invention comprises an aircraft provided with the said power plant, the engines being disposed on opposite sides of an axis about which the aircraft may pivot.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:

FIGURE 1 is a plan view of an aircraft incorporating the present invention,

FIGURE 2 is a view taken on the line 2—2 of FIGURE 1, and

FIGURE 3 is a diagrammatic perspective view of part of the structure shown in FIGURE 2.

Referring to the drawings, a supersonic aircraft **10** has a fuselage **11** on opposite sides of whose longitudinal axis there are mounted two gas turbine jet propulsion engines **12**. One side **13** of each engine **12** faces the respective side of the other engine, while the other side **14** of each engine faces away from the other engine.

Each of the engines **12** comprises in flow series low and high pressure compressors **15**, main combustion equipment **16**, and high and low pressure turbines **17**. Each engine **12** is provided with a curved jet pipe **20** which crosses over that of the other engine and terminates in a final outlet nozzle **21** which is disposed on the other side **14** of the other engine. Each of the engines **12** also has a duct **22** which is arranged to receive part of the air compressed in the low pressure compressor of the respective engine and which terminates in an additional jet nozzle **23**, each nozzle **23** being disposed on the side **14** of the respective engine.

The nozzles **21**, **23** of each engine are arranged equidistant from the longitudinal axis of the aircraft.

Each of the nozzles **21**, **23** may, as disclosed in U.S. Patent No. 3,130,543 comprise a frame member **18** which is rotatably mounted in its jet pipe or duct and which carries a plurality of jet deflector vanes **19** which extend parallel to each other, means (not shown) being provided for effecting rotation of the frame member with respect to its jet pipe or duct. Such rotation permits the gases passing through the frame member to be forwardly, rearwardly or downwardly directed as desired.

It will be apprecitaed that the nozzles **23** are disposed wholly to the same side of the said longitudinal axis of their respective engines. The jet pipes **20** however, are curved so as to cross the said axis, whereby their final outlet nozzles **21** are disposed on the opposite side of the longitudinal axis to that of their respective engines.

Accordingly, if one of the engines **12** should fail, thrust will still be exerted on opposite sides of the said longitudinal axis and, provided the thrusts of the gases passing through the nozzles **21**, **23** do not greatly differ, there will be relatively little turning moment exerted about the said longitudinal axis.

Mounted in the duct **22** of each engine is a combustion equipment including a plurality of combustion stabilizing gutters **24**. The gutters **24** are carried by support members **25** which are mounted on a common pivot **26**.

The support members **25** may be pivotally moved (by means not shown) away from each other and into an operative position (shown in full lines in FIGURE 2) in which the support members **25** and their gutters **24** extend across the duct **22**. The support members **25** may also be pivotally moved towards each other and into an inoperative position (shown in dotted lines in FIGURE 2) in which the support members **25** and their gutters **24** exert relatively little obstruction to the flow of air through the duct **22**.

Means, indicated diagrammatically at 24*a*, are provided for supplying the gutters 24 with fuel.

Mounted in the duct 22 of each engine is a chamber 30. Fuel may be continuously supplied to the chamber 30 through a fuel pipe 31. The fuel pipe 31 is mounted concentrically within a pipe 32 which is supplied with a stream of air from the duct 22. The pipe 32 is mounted within a passage 33 which receives air from the high pressure compressor of the engine. The air passing through the pipe 32 will thus shield the pipe 31 from the heated air in the passage 33, the air from the pipe 32 passing into the chamber 30 via swirl vanes 34.

The chamber 30 is mounted within a housing 35 from which it is separated by a space 36. The space 36 receives high pressure compressor air from the passage 33, the chamber 30 having dilution air holes 37 through which air from the space 36 may enter the chamber 30 so as to dilute the products of combustion therein.

Ignition of the fuel from the pipe 31 is effected by an igniter 40.

The chamber 30 has four tubes 41 communicating therewith, each tube 41 being adapted to pass the flame or hot gases arising from the combustion within the chamber 30 past the gutters 24 when the latter are in their final position. Since combustion is continuously occurring within the chamber 30, the gutters 24 may be brought into operation as soon as they are moved to their operative position and supplied with fuel.

Each of the tubes 41 is mounted concentrically within a tube 42 which forms part of the housing 35 and communicates with the space 36. Air from the space 36 thus flows past the tubes 41 so as to cool the latter.

We claim:

1. Combustion equipment comprising an air duct, a plurality of combustion stabilizing members arranged in the air duct, means supplying the combustion stabilizing members with fuel, a chamber mounted in the air duct, means for supplying the interior of the chamber with fuel and air, means effecting combustion of the fuel and air in the chamber, structure carrying said combustion stabilizing members and movable between an operative position in which the structure and the combustion stabilizing members extend across the air duct and an inoperative position in which the structure and the combustion stabilizing members present relatively little obstruction to the flow of air through the air duct, at least one inner tube communicating with the chamber for passing out of the chamber the hot gases arising from the said combustion and directing the said hot gases past the operative position of the said combustion stabilizing members so as to ignite fuel supplied thereto, and at least one outer tube, concentric with said at least one inner tube, and adapted to be supplied with cooling air.

2. Combustion equipment as claimed in claim 1 in which the said structure comprises a plurality of support members each of which carries a plurality of combustion stabilizing members and including common pivot means disposed immediately downstream of said chamber, the said support members being pivotably movable away from and towards each other about said pivot means so as to bring the said structure respectively into its said operative and inoperative positions.

3. A gas turbine engine having compressor means, a jet pipe and a final outlet nozzle and including combustion equipment comprising an air duct provided with an additional jet nozzle, a plurality of combustion stabilizing members arranged in the air duct, means supplying the combustion stabilizing members with fuel, a chamber mounted in the air duct, means for supplying the interior of the chamber with fuel and air, means effecting combustion of the fuel and air in the chamber, structure carrying said combustion stabilizing members and movable between an operative position in which the structure and the combustion stabilizing members extend across the air duct and an inoperative position in which the structure and the combustion stabilizing members present relatively little obstruction to the flow of air through the air duct, at least one inner tube communicating with the chamber for passing out of the chamber the hot gases arising from the said combustion and directing the said hot gases past the operative position of the said combustion stabilizing members so as to ignite fuel supplied thereto, and at least one outer tube, concentric with said at least one inner tube, and adapted to be supplied with cooling air.

4. A gas turbine engine as claimed in claim 3 in which the said at least one inner tube is supplied with cooling air from the compressor means.

5. Combustion equipment comprising an air duct, a plurality of combustion stabilizing members arranged in the air duct, means supplying the combustion stabilizing members with fuel, a chamber mounted in the air duct, means for supplying the interior of the chamber with fuel and air, means effecting combustion of the fuel and air in the chamber, structure carrying said combustion stabilizing members and movable between an operative position in which the structure and the combustion stabilizing members extend across the air duct and an inoperative position in which the structure and the combustion stabilizing members present relatively little obstruction to the flow of air through the air duct, a plurality of tubes communicating with the chamber for passing out of the chamber the hot gases arising from the said combustion and for directing the said hot gases past the operative position of said combustion stabilizing members so as to ignite fuel supplied thereto, and pivot means for said combustion stabilizing members disposed upstream of the outlets of said tubes.

6. Combustion equipment as claimed in claim 5 in which said tubes are disposed symmetrically with respect to the pivot axis of the pivot means.

7. A gas turbine engine as claimed in claim 3 in which each of the said final outlet and additional jet nozzles is provided with deflector means for varying the direction in which the gases flowing therethrough are directed.

8. A gas turbine engine as claimed in claim 7 in which the said deflector means may be moved so as to direct the said gases forwardly, rearwardly, or downwardly, as desired.

9. A gas turbine engine as claimed in claim 8 in which the said deflector means comprises a rotatably mounted frame member, a plurality of jet deflector vanes mounted within the frame member and extending parallel to each other, and means effecting rotation of the frame member.

References Cited by the Examiner

UNITED STATES PATENTS

2,552,492	5/1951	Nathan	60—39.72 X
2,659,195	11/1953	Bolanovich	70—39.72 X
2,729,937	1/1956	Hausmann	60—39.72 X
2,800,765	7/1957	French et al.	60—39.72 X
2,872,785	2/1959	Barrett et al.	60—39.72
2,979,899	4/1961	Salmon et al.	60—39.72
3,153,906	10/1964	Marchant	60—35.55
3,164,337	1/1965	Hooper	244—12
3,181,293	5/1965	Orchard et al.	60—35.55
3,206,929	9/1965	Marchant et al.	60—35.55
3,209,535	10/1965	Marchant et al.	60—35.55
3,216,675	11/1965	Snell	244—23

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