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P. W. PILLSBURY ET AL
COMBUSTION AIR CONTROL SHUTTER

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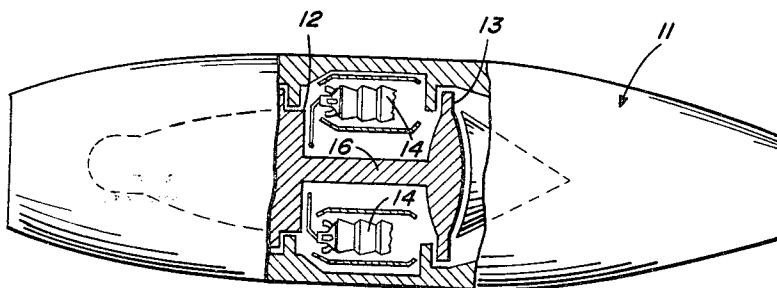


FIG. 1

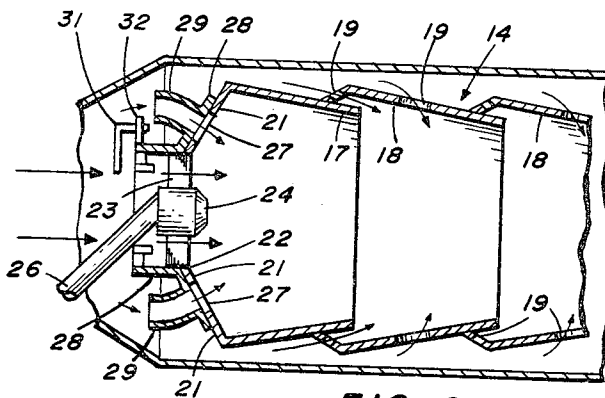


FIG. 2

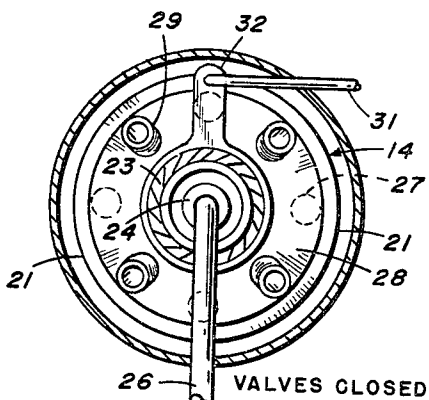
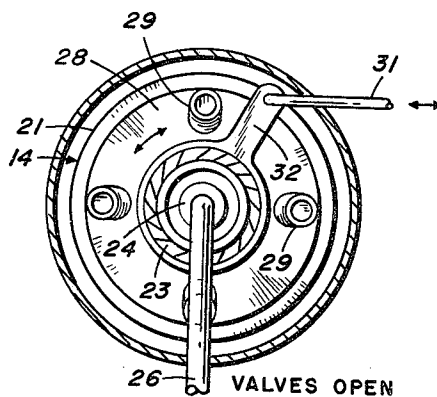


FIG. 3



VALVES OPEN

FIG. 4 INVENTORS
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3,490,230

COMBUSTION AIR CONTROL SHUTTER

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2 Claims

ABSTRACT OF THE DISCLOSURE

A turbojet combustor is provided with scoop ducts mounted on a rotary shutter to control injection of additional air to the burner dome. At low altitude, when smoke is objectionable, the pilot causes rotation of the shutter. The scoop ducts are tilted to produce a swirling air pattern directed at the fuel spray.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION**Field of the invention**

The invention relates to turbojet engines and combustors and, more particularly, to efforts to reduce smoke and resulting pollution of the air produced by such engines.

Description of the prior art

In the turbojet engines known to the prior art, a considerable amount of smoke is produced at the air-fuel ratios which are required for satisfactory operation of the engine, especially at the high throttle settings utilized in low altitude operation for take-off and landing. In order to obtain favorable characteristics of the engine in regard to resistance of the tendency to blow-out the flame of the engine and to enable relighting of the engine at high altitudes after such a blow-out, it has been necessary to provide the engine with a rich mixture. Unfortunately, such a mixture produces a substantial amount of smoke in operation, especially at the lower altitudes. With the increasing concern about air pollution, it has become desirable to limit or reduce the quantities of such contaminants which are released to the atmosphere, particularly at the lower altitudes where such smoke contributes most to air pollution. This is especially true since the number of such engines installed in commercial and military aircraft is steadily increasing. It is known that such smoke could be substantially reduced by operating the engine with higher air-fuel ratio. As discussed above, however, constant use of such a ratio is not practicable due to the adverse effects produced on the altitude relight and blow-out limits characteristics. The present invention solves this dilemma by providing scoop ducts which can be opened or shut by means of a rotary shutter on the burner dome so that additional air may be injected when low smoke characteristics are desired but may be shut-off during normal operation so as to retain favorable altitude relight and blow-out limits.

Other means are known to the prior art for injecting additional air into a turbojet engine, but these means are located in other parts of the engine and perform different functions than that of the present invention. For example, additional air ducts have been provided to mix cool air with combustion products leaving the combustion chamber in order to cool the mixture which will flow over the turbine blades. Also, regulatory means

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have been provided to automatically provide a correct air-fuel ratio. Additional ducts have also been known to provide supplementary air to an after-burner. The distinctions of the present invention over such prior art constructions will be discussed more fully below.

SUMMARY OF THE INVENTION

The present invention involves the modification of the well-known turbojet configuration in which a plurality of combustors are arranged in a circumferential configuration about the turbine shaft between the turbine and the compressor. These combustors are conventionally provided with an upstream fuel nozzle contained in a burner can-dome. Downstream, the burner-can is perforated to allow air to mix with the sprayed fuel. The modification of the present invention involves the provision of additional air ducts in the burner can-dome and the control of passage of air through the ducts by a rotary shutter operable by the pilot. The placement of the additional ducts is such that air exiting from the ducts is directed at or near the base of the fuel spray and the ducts may be arranged so as to produce a swirling air pattern. The combination of the swirling air pattern and the direction of the auxiliary air ducts provides for exceptionally complete combustion of the fuel, which results in a great decrease of smoke products caused by incomplete combustion.

An object of the present invention is to provide means for reducing the amount of smoke in the exhaust of a gas turbine engine.

Another object of the present invention is to provide means for reducing gas turbine exhaust smoke which can be operated at will.

A further object of the present invention is to provide means for selectively effecting a substantial change in the air-fuel ratio in the turbine combustor.

Still another object of the present invention is to provide means for injecting additional air into the burner dome of a turbine combustor and to direct the additional air so as to insure relatively complete combustion of the fuel.

Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side elevation of a turbine engine incorporating the combustor air control shutter of the present invention, with certain parts broken away to better show the relevant interior construction of the engine;

FIG. 2 is a longitudinal section of the upper combustor shown in FIG. 1;

FIG. 3 is an end view of a combustor incorporating a shutter of the present invention, looking from the left in FIG. 2, and showing the air inlet scoops in closed position; and

FIG. 4 is an end view of a combustor as shown in FIG. 3 with the shutter moved so that the air inlet scoops are in open position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIG. 1, which illustrates a preferred embodiment, a turbojet engine 11 comprising a compressor 12 and turbine 13. A plurality of combustors 14 are arranged circumferentially about a shaft 16 which connects the turbine and compressor assemblies. As is shown more particularly in FIG. 2, the

combustor 14 consists of a burner can 17 and a plurality of burner shrouds 18. The burner shrouds are provided with air inlet holes 19. The burner can dome area 21 is provided with a central opening 22 containing an air swirler 23 which surrounds a fuel nozzle 24. Fuel is supplied to the nozzle through fuel line 26. Air coming from the compressor (from the left in FIG. 2) is directed through the air swirler to be thoroughly mixed with fuel from the fuel spray nozzle. Additional air is admitted to the combustor through air inlet holes 19. In the combustor known to the prior art, the amount of air admitted by the air swirler end 23 and the air inlet holes 19 creates the necessarily rich air-fuel ratio required in order to maintain altitude relight and blow-out limits characteristics.

The modification of the present invention enables the normal rich mixture to be temporarily leaned when it is desired to reduce the amount of smoke emanating from the engine. In the present invention, primary air inlet holes 27 are provided in the burner-dome 21. Admission of air through the primary air inlet holes 27 is controlled by a rotary shutter plate 28 which further includes primary air inlet scoops 29 directing air to openings in the shutter plate. The rotary shutter 28 is adapted to be rotated between the position shown in FIG. 4 where the primary air inlet scoops are aligned with the primary air inlet holes in the burner-dome and the position in FIG. 3 where the primary air inlet scoops are not aligned with the primary air inlet holes, thereby cutting-off the flow of air through these holes.

Rotation of the rotary shutter between the positions of FIG. 3 and FIG. 4 is accomplished by the movement of actuator rod 31 attached to lug 32 on the rotary shutter. Rod 31 may be actuated by the pilot through any conventional actuating means such as by hydraulic or pneumatic servo-cylinders or by solenoids, electric motors, etc.

It can be seen from FIG. 2 that the primary air inlet holes 27 perform a function which is different in kind from the prior art air inlet holes 19. The primary function of the latter holes is to mix cool air with the combustion products in the combustor so as to reduce the temperature of the gas mixture flowing over the turbine assembly. The primary air inlet scoops and holes, however, perform the function of providing a radically different air-fuel mixture ratio for the novel purpose of eliminating excessive smoke from the engine exhaust.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings.

What is claimed is:

1. A turbine combustor comprising:

- a burner can including a dome area;
- a fuel injector fixed in the dome area of said burner can and coaxial with said burner can;
- an air swirler formed in said dome area of said burner can and concentrically disposed about said fuel injector;
- a plurality of air inlet openings formed in said dome area arranged in a circular pattern about said air swirler;
- a plate rotatably mounted on the exterior of said dome area and normally positioned to preclude flow of air through said openings;
- a plurality of air scoops fixed on said plate in a circular pattern complementary to the pattern of said air inlet openings; and

means for selectively moving said plate to bring said air scoops into registry with said air inlet openings whereby the additional air admitted to said burner can will vary the air-fuel ratio provided by said fuel injector and said air swirler to lean out the mixture and eliminate excessive smoke from the exhaust.

2. The turbine combustor of claim 1 wherein said air scoops are tilted with respect to the longitudinal axis of the burner can for directing the additional air in a swirling pattern about said axis.

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