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R. J. JACKSON
COMBUSTION CHAMBER

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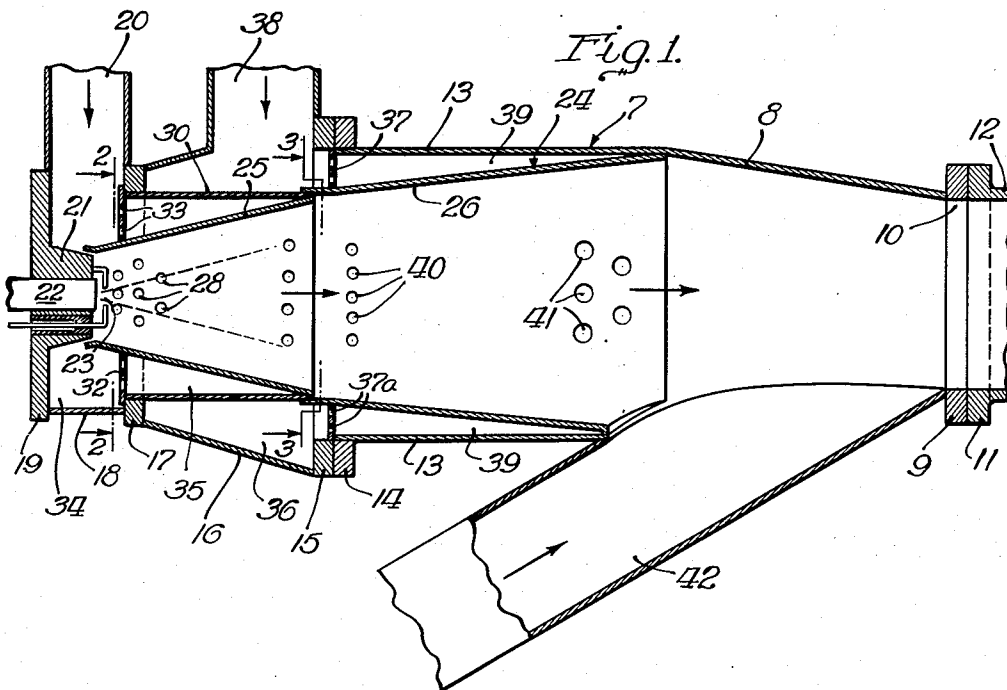
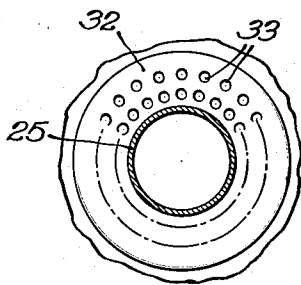


Fig. 2.

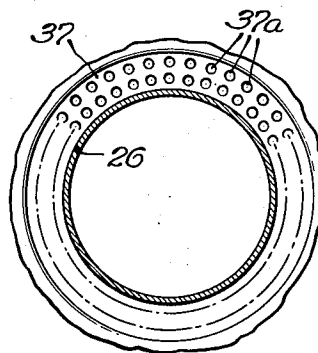


Fig. 3.

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COMBUSTION CHAMBER

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1 Claim. (Cl. 60-13)

1

This invention relates to combustion chambers, and has to do with combustion chambers for use in driving gas turbines and for analogous purposes.

Combustion chambers for use in driving gas turbines are known. The present combustion chambers are, in general, lacking in flexibility in respect to varying conditions encountered in the use thereof and control of the temperature of the gases delivered to the turbine, and do not provide adequate cooling of the parts of the combustion chamber to guard against injury by the high temperatures encountered, when operated in parallel with a second source of combustion products which varies widely in both temperature and quantity.

My invention is directed to a combustion chamber which avoids the above noted objections to the present combustion chambers. To that end, I provide a combustion chamber in which great flexibility is possible to suit various operating conditions encountered and adequate cooling of the parts is assured. In the combustion chamber of my invention combustion occurs within a flame tube spaced from an enclosing housing to which air is admitted under pressure for supporting combustion and for cooling the housing and the flame tube as well as the combustion gases, whereby the temperature of the gases discharged from the combustion chamber may be readily and accurately controlled. The combustion chamber of my invention is particularly suitable for use in a system comprising an air compressor driven by a turbine, the compressor being available for supplying air to both the combustion chamber and an internal combustion engine, the exhaust from the engine being utilized in driving the turbine either with or without combustion gases from the combustion chamber, as conditions may require. The exhaust gases from the engine are delivered to the combustion chamber outwardly beyond the primary combustion space therein so as to avoid risk of extinguishment of the flame by the engine exhaust gases which, in conjunction with the arrangement of the flame tube and associated elements, constitutes an important feature of my invention. While the combustion chamber of my invention is particularly suitable for use in a system of the character stated, it is not limited to that particular use and may be used for any other purpose to which it is suited. Further objects and advantages of my invention will appear from the detail description.

In the drawings:

Figure 1 is a lengthwise central sectional view of the combustion chamber embodying my invention, certain parts being broken away;

2

Figure 2 is a sectional view taken substantially on line 2-2 of Figure 1, the adjacent portion of the housing being broken away;

Figure 3 is a sectional view similar to Figure 2 but taken on line 3-3 of Figure 1;

Figure 4 is a view similar to Figure 1 but showing a modified form of combustion chamber embodying my invention; and

Figure 5 is a diagrammatic view of a system embodying the combustion chamber of my invention.

In the form of combustion chamber shown in Figures 1 to 3, inclusive, I provide a housing 7 of generally cylindrical form having an end portion or extension 8 of substantially frusto-conical form, to the outer end of which is secured a bolting ring 9 defining a discharge opening 10. This ring 9 is adapted for bolting to a bolting flange 11 of an inlet stack or conduit 12 of a gas turbine as will appear more fully later.

Body portion 13 of housing 7 is provided, at its inner end, with a bolting ring 14 suitably secured, conveniently by bolting, to a ring 15 of a frusto-conical section 16 flaring toward body section 13 and secured at its inner end, by a ring 17, to a substantially cylindrical section 18 closed at its other end by a head 19. The parts of the assembly may be secured together in any suitable manner, as by welding, bolting, or the like, as will be understood. An air supply conduit 20 opens into section 18, as shown. The head 19 is provided with an inwardly extending boss 21 in which is suitably mounted a fuel spray nozzle 22 of suitable known type. Ignition means 23, which may be of suitable known type, is provided adjacent the inner end of nozzle 22 for igniting the injected fuel.

A flame tube 24 is disposed within housing 7 and extends lengthwise thereof from the end at which the head 19 is located, which may be defined as the fuel supply end of the housing. The flame tube 24 is of substantially conical shape and flares from the fuel supply end of the housing toward the discharge end thereof. This flame tube 24 comprises an inner section 25 and an outer section 26. The inner section 25 extends outward from boss 21, as shown, and is provided with perforations 28 throughout its extent, of adequate total area to assure supply of air to the primary combustion space defined by section 25 in amount to support rapid and substantially complete combustion of the injected fuel. A cylindrical casing 30, which is imperforate, surrounds section 25 of flame tube 24 and fits snugly thereabout at its outer end so as to provide a closure therewith, as shown. The outer end of casing 30 fits snugly within the inner of section

3

26 of flame tube 24, also providing a closure therewith, and the inner end of casing 30 fits snugly within ring 17 to which it may be welded or otherwise suitably secured. An air flow straightener 32, in the form of an annulus or ring, fits snugly about section 25 of flame tube 24, adjacent the inner end thereof, and extends therefrom outward radially beyond the casing 30. This straightener 32 (Figure 2) is provided with perforations 33 of adequate total area not to objectionably impede free flow of air from space 34, between head 19 and straightener 32, into the space 35 extending about flame tube section 25 between the latter and casing 30. It will be clear, from what has been said, that the space 34 is closed off from space 36 extending about casing 30 between the latter and section 16 of the housing 7.

A perforated annular air flow straightener 37 fits snugly about section 26 of the flame tube 24, adjacent the inner end thereof, and extends radially outward to the inner end of body section 13 of housing 7. An air supply conduit 38 opens into space 36, from which air flows through the straightener 37 (Figure 3) into space 39 between section 26 of the flame tube 24 and the surrounding wall of body section 13 of housing 7. The total area of perforations 37a of air flow straightener 37 is adequate to guard against objectionably impeding free flow of air therethrough into space 39. Section 26 of flame tube 24 defines a secondary combustion space extending outward from the primary combustion space within section 25. Section 26 is provided, for the major portion of its length, with perforations 40 the total area of which is adequate to assure free flow of air therethrough in sufficient quantity to maintain the flame within section 26 while also serving as a diluent, as circumstances may require, for cooling the hot products of combustion. The outer portion of section 26 of the flame tube 24 is provided with perforations 41 of greater diameter than the perforations 40, for admission to that portion of section 26 of cooling air. A conduit 42 opens into housing 7 outwardly beyond the primary combustion space within the flame tube 24. This conduit 42 may be connected to a suitable source of combustion gases. In the system of the character above referred to, the conduit 42 is connected to the exhaust of an internal combustion engine for delivering to housing 7 the exhaust gases from the engine for mixing with the combustion gases issuing from the flame tube 24. It is of importance that complete combustion of the fuel supplied to the flame tube be assured, in order that the volume, temperature and pressure of the combustion gases issuing therefrom be maintained at the optimum values for most efficient operation. It is important, therefore, that the conduit 42 be so disposed that the entering engine exhaust gases will not quench the flame or retard combustion in the primary combustion space. Preferably, the conduit opens into housing 7 adjacent the outer or outlet end of flame tube 24, between the latter and the discharge end of housing 7, as shown. That arrangement of the conduit 42 is also of importance in that it is conducive to flexibility of control of the temperature of the gases delivered to the gas turbine, as will appear more fully later.

The modified form of combustion chamber, shown in Figure 4, is similar to that shown in Figure 1, but is somewhat different in respect to structural features. It comprises the housing 43

4

to the discharge end of which is secured a ring 46 defining a discharge opening 47. The ring 46 is suitably secured, conveniently by bolting, to flange 41 of the inlet stack or conduit 48 of a gas turbine. A cylindrical section 50 is secured to the inner end of body section 44, conveniently by means of rings 51 and 52 on the adjacent ends of sections 44 and 50, respectively, bolted or otherwise suitably secured together. The end of section 50 remote from section 44 is closed by a head 53 provided with a boss 54 carrying a fuel injection nozzle 55 and ignition means 56. A flame tube 57, perforated and of conical shape, extends lengthwise within the housing 43 from boss 54 to extension 45, the outlet end of this tube fitting within housing 43 so as to form therewith a closure about the flame tube. The tube 57 is provided for a major portion of its length with perforations 58 and, at its outer portion, with perforations 59 of materially greater diameter than the perforations 58. As will be understood from what has been said, the tube 57 defines an inner primary combustion space and an outer secondary combustion space.

A perforated air flow straightener 60 fits about flame tube 57 a short distance from the inner end thereof and extends radially outward therefrom to the section 50, providing an inner perforated end wall therefor. An air supply conduit 61 opens into section 50 and a conduit 62 opens into extension 45 of housing 43 for supplying thereto combustion gases, such as the exhaust gases from an internal combustion engine.

In Figure 5 I have shown the combustion chamber, designated 65, of Figures 1 to 3, inclusive, embodied in a system of the character above referred to comprising a gas turbine T, a compressor C driven by turbine T and an internal combustion engine E. Atmospheric air enters the compressor C through conduit 66 and air under pressure is delivered from the compressor C through conduit 67 to intake manifold I of engine E. Air under pressure is also delivered from compressor C, through conduit 68, to the air supply conduits 20 and 38 of combustion chamber 65, each of the conduits 20 and 38 being provided with a control valve 69 of suitable known type. Fuel is supplied to the injector nozzle 22 of combustion chamber 65 through a conduit 70 controlled by a valve 71. The exhaust manifold X of engine E is connected by a conduit 72 to the exhaust gas supply conduit 42 of combustion chamber 65, and the discharge end of combustion chamber 65 is connected to the intake stack or conduit 12 of turbine T, the exhaust from which is discharged through conduit 74.

Fuel and air are introduced into the flame tube in proper proportion to assure complete combustion of the fuel in the primary combustion space. In that connection, uniform distribution of the primary air is of importance and the air flow straightener 32 is of assistance in that respect. The primary air enters through the air supply conduit 20 and may be regulated in amount by the valve 69 therein, as will be understood. The secondary air enters through the air supply conduit 38 and flows through the air flow straightener 37 substantially lengthwise of the housing so as to be distributed substantially uniformly along the flame tube, this secondary air passing through the perforations 40 and 41 of the flame tube into the interior thereof for maintaining combustion. This secondary air serves to cool the housing and the flame tube, and also serves as a diluent of the combustion gases and to cool the

5

latter as may be required. The combustion gases ejected from the flame tube mix with the engine exhaust gases entering the housing of the combustion chamber through the conduit 42, and the resultant gas mixture is delivered to the turbine T at appropriate temperature and pressure to assure most efficient operation thereof. The secondary air entering through supply conduit 38 also serves to maintain the proper volume or mass flow of gases to the turbine to assure maximum efficiency in operation of the latter.

When the engine is operating under light load, the exhaust gases delivered therefrom to the combustion chamber will be relatively cool. In such case the quantity of secondary air delivered to the combustion chamber will be reduced in amount sufficient to assure that the gas mixture discharged from the combustion chamber to the turbine will be at the optimum operating temperature. As the operating load of the engine increases the temperature of the exhaust gases also increases with a corresponding reduction in the amount of heat which should be added to the combustion chamber. Accordingly, as the engine load increases the amount of secondary air supplied to the combustion chamber may be increased and the fuel supply decreased to maintain the optimum operating temperature of the gas mixture discharged from the combustion chamber while guarding against injury thereto by excessively high temperatures. When the engine is operating under full load conditions the temperature of the exhaust gases may be above the optimum operating temperature. In such cases the supply of fuel and primary air to the combustion chamber may be cut off and the amount of secondary air delivered to the combustion chamber may be increased sufficiently to assure adequate cooling of the combustion chamber, the secondary air then also serving to dilute the exhaust gases from the engine and to maintain the gas mixture delivered to the turbine at the optimum operating temperature. It will be seen that the combustion chamber of my invention is highly flexible to meet the varying conditions encountered in the operation of a system of the character referred to, and may be utilized either as a source of combustion gases, or as means for mixing air with the exhaust gases delivered from the internal combustion engine, as conditions may require for most efficient operation of the system.

The operation of the modified form of combustion chamber shown in Figure 4 is, in general, similar to that of the combustion chamber of Figure 1. In Figure 4 the primary air and the secondary air are both supplied to the single conduit 61, as will be understood. While the provision of two air supply conduits, one of primary air and the other for secondary air, as in Figure 1, is conducive to increased flexibility of the combustion chamber, that is not essential to the broader aspects of my invention many of the benefits of which are realized in the combustion chamber shown in Figure 4. As will be understood, any suitable fuel supply and ignition means may be provided, the injection nozzle and the ignition means shown being by way of example only.

It will be understood that changes in detail may be resorted to without departing from the field and scope of my invention, and I intend to include

6

all such variations, as fall within the appended claim, in this application in which the preferred forms only of my invention have been disclosed.

I claim:

5 In a combustion chamber for use in driving a gas turbine, a substantially cylindrical housing having a discharge end for connection to a gas turbine and a fuel supply end, a substantially conical perforated flame tube within said housing extending lengthwise thereof having a fuel inlet end adjacent said fuel supply end and an open outlet end spaced from said discharge end, said tube comprising an inner section defining a primary combustion space and an outer section defining a secondary combustion space and spaced for substantially its full length from the surrounding wall of said housing defining there-
10 with an unobstructed annular space about said tube decreasing uniformly in cross section toward the outlet end of said tube, the outlet end of said outer section fitting the interior of said housing providing therewith a closure about said tube, means for supplying fuel to said primary combustion space, a substantially cylindrical casing
15 extending about said inner section of said tube with its outer end in interfitting relation to the outer end of said inner section and the inner end of said outer section providing therewith closures thereabout, said casing defining with said inner section an unobstructed annular space about the latter uniformly decreasing in cross section toward said secondary combustion space, said casing being spaced from the surrounding wall of said housing and having its inner end spaced
20 from said fuel supply end of said housing and closed to the space between said housing and casing, a perforated air flow straightener at the inner end of said casing fitting about said inner section of said tube, a second perforated air flow straightener fitting between said housing and said second section of said tube adjacent the inner end thereof, air supply conduits respectively opening into said housing between said fuel supply end thereof and said first flow straightener and between the inner end of said casing and said second flow straightener, and a conduit opening into said housing between the discharge end thereof and the outlet end of said tube for supplying to said housing exhaust gases from an internal combustion engine.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,159,758	Diedrich	May 23, 1939
2,216,494	Kurtz et al.	Oct. 1, 1940
2,227,666	Noack	Jan. 7, 1941
2,446,059	Peterson et al.	July 27, 1948
2,448,561	Way	Sept. 7, 1948
2,457,157	King, Jr.	Dec. 28, 1948
2,458,497	Bailey	Jan. 11, 1949
2,525,206	Clarke	Oct. 10, 1950
2,545,495	Sforzini	Mar. 20, 1951
2,585,968	Schneider	Feb. 19, 1952
2,605,611	Wosika	Aug. 5, 1952

FOREIGN PATENTS

Number	Country	Date
597,205	Great Britain	Jan. 20, 1948