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FLAME IGNITER FOR GAS TURBINE COMBUSTOR

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FIG. 1.

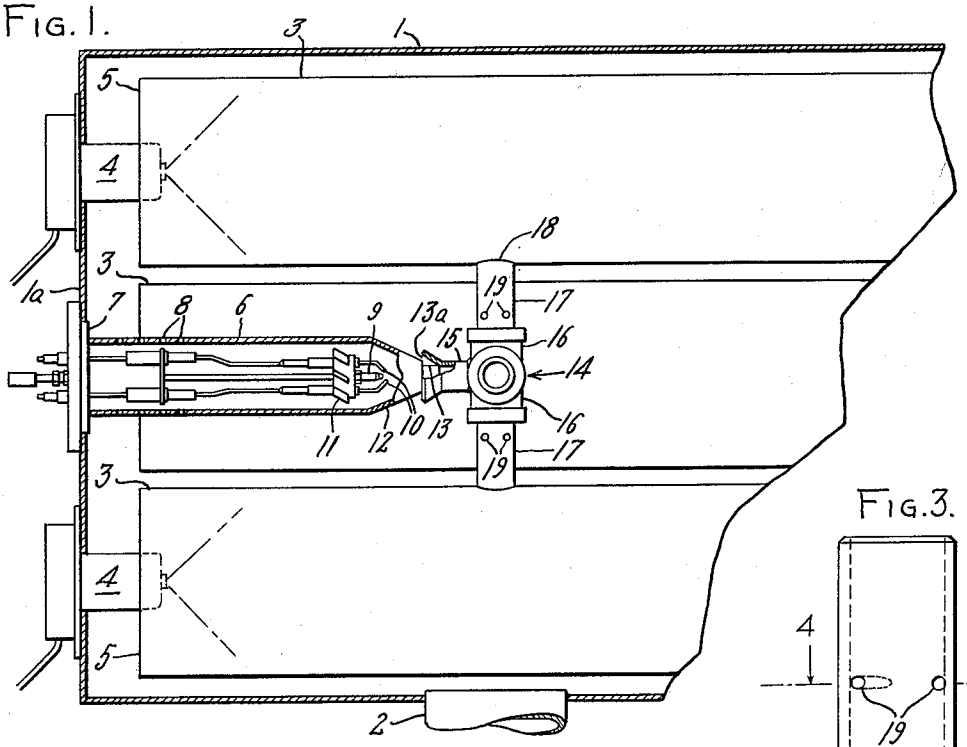


FIG. 3.

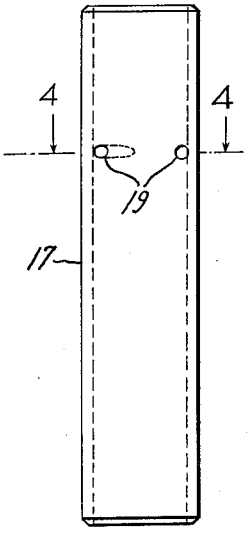


FIG. 2.

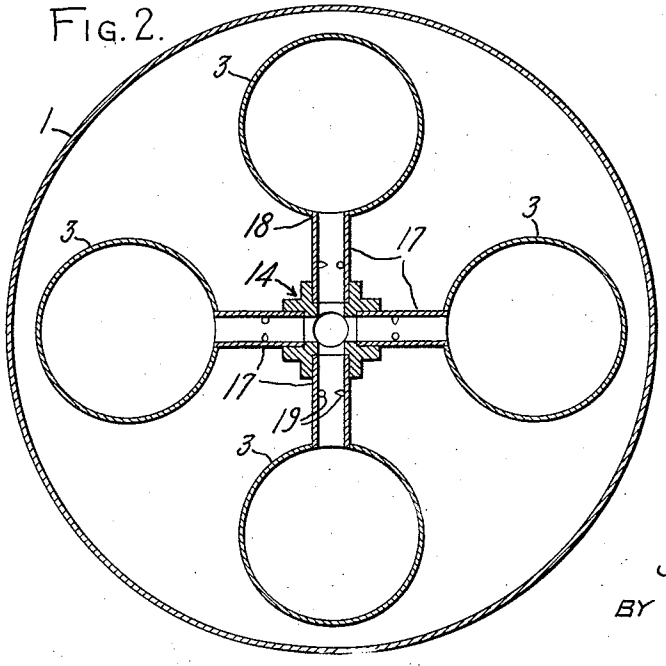
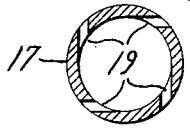


FIG. 4.



INVENTORS
ROBERT G. VAN WIE
JACOB B. GATZEMEYER
BY Kiess
THEIR ATTORNEY

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FLAME IGNITER FOR GAS TURBINE COMBUSTOR

Robert G. Van Wie, Fullerton, Calif., and Jacob B. Gatzemeyer, Schenectady, N.Y., assignors to General Electric Company, a corporation of New York

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8 Claims. (Cl. 60—39.82)

This invention relates to a flame igniter for a gas turbine engine, and more particularly to a flame igniter which is capable of serving more than a single combustion chamber.

In conventional gas turbine design, it has been the practice to provide each combustion chamber with a separate igniter, or to provide an igniter in one or more chambers and then have communication between the various chambers whereby the flame may be carried to the other chambers. Both of these systems have inherent difficulties. To provide a separate igniter in each chamber requires a corresponding increase in initial and maintenance costs, and the use of igniters in only one or more chambers, but not in all of them, may prove unreliable in operation. The igniter of the present invention is specifically designed to overcome difficuties inherent in prior art devices. It is designed so that a high grade fuel, which is easy to ignite, may be used in the igniter to initiate combustion of a relatively lower grade fuel, which is more difficult to ignite, in the combustion chamber. Also, it is designed to communicate directly with all of the combustion chambers that it serves so that it will be reliable in operation; and it has novel means to sustain the flames as they are communicated from the igniter to the combustion chambers.

Accordingly, it is an object of this invention to provide an igniter for a gas turbine which is capable of serving a plurality of combustion chambers.

A further object is to provide such an igniter which communicates directly with the combustion chambers which it serves.

A still further object is to provide means to sustain the igniting flames as they pass from the igniter to the combustion chambers.

Briefly stated, in accordance with one aspect of this invention, an igniter cylinder is mounted within an air plenum chamber which also contains a plurality of combustion chambers defined by suitable liners. The igniter cylinder contains apparatus for initiating a flame, and has associated with it a multiple T connection and a plurality of flame feeding tubes to carry flames from the igniter cylinder to the combustion spaces. Tangential holes are provided in the flame feeding tubes to "revitalize" the flames by admitting additional air to them as they are carried to the combustion chambers.

While it is not intended that this invention be limited to the specific embodiments shown, a better understanding of the device may be had by reference to the following drawings, in which:

Fig. 1 is a side view, partly in section, of a combustion apparatus with a flame igniter in accordance with the present invention;

Fig. 2 is an end view of the combustion chamber assembly of Fig. 1;

Fig. 3 is a side view of one of the flame feeding tubes used with the igniter; and

Fig. 4 is a sectional view of Fig. 3, taken along the line 4—4.

Referring now more particularly to the drawing, Fig. 1 shows an air plenum chamber 1 which receives air through inlet 2 from any suitable source such as a compressor (not shown). Mounted within the plenum chamber are a plurality of combustion chambers, defined by cylindrical liners 3. These combustion chambers are conventionally mounted symmetrically within the plenum chamber as shown in Fig. 2, but such symmetrical mounting is not essential to this invention. A fuel nozzle 4 is mounted in the end dome 5 of each combustion chamber. Any conventional type of fuel nozzle may be used to supply the main fuel to the combustion chambers, and any suitable type of end dome and liner wall construction may be used for admitting primary and secondary air to the combustion chambers. While four combustion chambers have been shown in the drawings, it is to be understood that more or fewer of them could be used without departing from the spirit and scope of this invention.

Centrally located within the plenum chamber is igniter cylinder 6 which is removably mounted to the end dome 1*a* of the air plenum chamber at 7 by any suitable means. The igniter cylinder has a plurality of holes 8 near its fixed end to admit air to the igniter cylinder from the air plenum chamber. Mounted within the igniter cylinder 6 is a fuel nozzle 9 which extends axially through the igniter cylinder. A suitable spark producing means such as a spark plug or a glow plug 10, also is mounted in the igniter cylinder and extends axially therethrough. Swirler vanes 11 are mounted in the igniter cylinder between the air holes 8 which admit air to the igniter cylinder and the end of the fuel nozzle 9, so that the air which enters the igniter cylinder through holes 8 will be given a strong swirl before the fuel from the fuel nozzle 9 is introduced to it. At the outlet end of the igniter cylinder 6 is a contracting conical nozzle portion 12 terminating in a slip joint 13.

To provide communication between the igniter cylinder 6 and the combustion chambers 3, a special multiple T connection 14 is employed. The T connection is connected to slip joint 13 by means of a conduit 15. The slip joint 13 permits the igniter cylinder 6 to be removed from the plenum chamber, leaving the multiple T connection in place, and is also arranged to admit additional air to the burning mixture as it passes through the slip joint. This is conveniently accomplished by providing adequate clearances 13*a* in the slip joint to permit the passage of air. The multiple T connection has a plurality of outwardly extending portions 16, corresponding to the number of combustion chambers employed. The outwardly extending portions 16 receive the flame feeding tube 17. The tubes 17 communicate from the multiple T connection to the combustion chambers, the tubes 17 entering the combustion chambers through holes 18 in the liners 3.

Figs. 3 and 4 are enlarged views of the flame feeding tubes 17, which communicate between the multiple T connection 14 and the combustion chamber liners 3. These tubes 17 contain a plurality of holes 19 which admit additional air to the burning mixture as it is conducted through the tubes to the combustion chambers for the purpose of revitalizing and augmenting the flames as the burning mixture is carried from the multiple T connection to the combustion chambers.

In order to avoid directing cold air toward the central core of the burning gases in the tubes, with a resultant tendency to extinguish the flame, the holes 19, as best shown in Fig. 4, are drilled tangentially of the surface of the tubes. This tangential arrangement of the holes also has the effect of revitalizing and augmenting the flame and of re-establishing its vortex swirl. It will be appreciated by those familiar with fluid flow that a

vortex is an exceedingly stable type of flow. Therefore, the tangential nozzles **19** tend to smooth out and make uniform the turbulent flow resulting from the subdivision of the main stream of burning gases into a number of separate flows through the respective flame feeding tubes **17**. This facilitates the further combustion of unburned fuel due to the injection of the additional combustion air through the nozzles **19**. Thus it will be seen that the nozzles **19** perform the functions of supplying additional oxygen, smoothing out any turbulence which may be present resulting from the subdivision of the vortex flow from the igniter **6** into the separate branch passages **16**, and creating a smooth uniform vortex flow from the tubes **17** into the respective combustion liners **3**.

The operation of the igniter is as follows. Air is introduced to the igniter cylinder **6** through holes **8**, and as it passes axially down the igniter cylinder, it is given a strong tangential vortex swirl by swirler **11** just before fuel is sprayed into the swirling air by fuel nozzle **9**. The amount of fuel introduced by the nozzle **9** is controlled so that an over-rich mixture is formed at that point. This mixture is ignited by the spark-producing means **10**, and the swirling mixture of burning gases then passes down the contracting conical nozzle portion **12**, through the slip joint **13**, where additional air is introduced through the clearances **13***a*, and into the multiple **T** connection **14**. When the vortex swirl of burning gases reaches the multiple **T**, it is divided into a number of separate streams of burning gas, one of which enters each of the tubes **17**.

Each of these separate streams of burning gas necessarily has to turn, 90° in the arrangement shown here, to be directed toward the various combustion chambers through the flame tubes, and this action tends to quench the flame. In order to revitalize and augment the flames before they are introduced into the combustion chambers, the tangential additional air holes **19** are provided. When the burning mixture passes the holes **19**, additional air is introduced to the mixture from the plenum chamber through these holes. Since the fuel-air ratio was "over-rich" in the igniter cylinder, there is still sufficient unburned fuel in the mixture as it passes the holes **19**. The air introduced into the tubes through the tangential holes combines with the unburned fuel and thus tends to revitalize the flames. Since the air is introduced tangentially, it has no objectionable tendency to extinguish the flames, and it also has the effect of re-establishing the stable vortex swirl as discussed above.

When the burning mixture, which has been revitalized by the additional air from the holes **19**, enters the combustion chambers, a combustible mixture exists in the combustion chambers because fuel will have been introduced there through the fuel nozzles **4**. This combustible mixture is ignited by the flame from the flame igniter, thus starting the combustion process in the main combustion chambers of the turbine. Generally a high-grade volatile fuel, such as kerosene or diesel fuel is introduced into the igniter **6** at its nozzle **9**, because such fuel is relatively easy to ignite; and relatively lower grade fuel, for instance a heavy "residual" fuel oil, such as that known to the trade as "Bunker C," is normally used to operate the turbine. Thus the advantage of using fuel which is relatively easy to ignite for starting is derived, and at the same time the turbine can operate normally on the lower grade fuel.

While particular embodiments of this invention have been shown and described, further modifications will appear to those skilled in the art. It is to be understood therefore that this invention is not to be limited to the specific embodiments shown, and it is intended that the appended claims cover all such modifications as fall within the true spirit and scope of the invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In a combustion system having a plurality of parallel combustion chambers mounted in a single air plenum chamber, a flame igniter comprising an igniter cylinder centrally disposed among the combustion chambers having a fuel nozzle and means to admit air from the plenum chamber directly into the cylinder to form an over-rich fuel-air mixture therein and means to ignite the fuel-air mixture, a discharge conduit leading from the igniter cylinder and terminating in a multiple **T** connection, and a plurality of flame feeding tubes communicating between the multiple **T** connection and each of the respective combustion chambers to conduct the burning mixture from the igniter cylinder to the combustion chambers, each of said flame feeding tubes having tangential nozzle means intermediate their ends to inject additional air into the burning mixture in the tubes to supply additional oxygen and re-establish smooth vortex flow in the tubes.

2. In combustion system having a plurality of parallel combustion chambers mounted within a single air plenum chamber, a flame igniter comprising an igniter cylinder centrally mounted within the air plenum chamber and having a plurality of holes to admit air from the plenum chamber, at least one nozzle for introducing a fluid fuel into the igniter cylinder to form an over-rich fuel-air mixture therein, means to ignite the fuel-air mixture, and a plurality of flame feeding tubes constructed and arranged to communicate directly from the igniter cylinder to each of the combustion chambers to conduct burning mixture to each combustion chamber, said flame feeding tubes having tangential nozzle means intermediate their ends to inject additional air into the burning mixture in the tubes to supply additional oxygen and re-establish smooth vortex flow in the tubes.

3. In a combustion system having a plurality of parallel combustion chambers mounted within a single air plenum chamber, a flame igniter comprising an igniter cylinder centrally disposed among the combustion chambers and formed to include a plurality of holes to admit air from the air plenum chamber, at least one fuel nozzle within the igniter cylinder supplying fuel at a rate to form an over-rich fuel-air mixture therein, an igniter to ignite the fuel-air mixture, a conduit leading from the igniter chamber and terminating in a multiple **T**-connection, and a plurality of flame feeding tubes communicating between the multiple **T**-connection and the combustion chambers to conduct the burning mixture to the respective combustion chambers, each of the plurality of flame feeding tubes having supplementary tangential nozzles therein between the **T**-connection and combustion chambers to admit additional air to the tubes to revitalize and augment the flames in the tubes after they pass the multiple **T**-connection and re-establish smooth vortex flow in the tubes.

4. In a combustion system having a plurality of combustion chambers, a flame igniter comprising an igniter cylinder with a plurality of holes to admit air, nozzle means for introducing fuel into the igniter cylinder, igniter means to ignite the fuel-air mixture, a conduit leading from the igniter cylinder and terminating in a multiple **T**-connection, and a plurality of flame feeding tubes communicating between the multiple **T**-connection and the respective combustion chambers, each of the flame feeding tubes having nozzle means formed tangentially of the tube surfaces between the **T**-connection and the combustion chambers to admit additional combustion air to the tubes to promote combustion and re-establish smooth vortex flow in the tubes.

5. In combustion apparatus having a flame-type igniter and at least one combustion chamber, a flame feeding tube having at least one sharp bend therein for conducting burning gases from the igniter to the combustion chamber, the flame feeding tube having a plurality of nozzles disposed tangentially of the tube at a location downstream from said sharp bend to admit additional air to the flame in the tube with a tangential component to

supply additional oxygen and impart additional vortex swirl for stabilizing the flow in the flame feeding tube without substantial tendency to quench the flame.

6. In combustion apparatus having a plurality of parallel combustion chambers disposed within a common air plenum chamber, a flame igniter comprising an igniter cylinder centrally disposed among the combustion chambers, nozzle means for introducing fuel into the cylinder, means to admit combustion air into the cylinder, means to ignite the fuel-air mixture, and a plurality of flame feeding tubes constructed and arranged so that the igniter cylinder communicates directly with each of the combustion chambers to conduct the burning mixture directly to each combustion chamber, the flame feeding tubes having nozzles disposed tangentially to admit additional air to the burning mixture in the tubes.

7. In combustion apparatus having a plurality of separate combustion chambers spaced uniformly about a common axis, the combination of a flame igniter comprising an igniter cylinder disposed coaxial with the axis of the combustion apparatus and having an outlet defined by a contracting nozzle portion, means for creating a rich fuel-air mixture in said igniter cylinder, means for igniting said mixture, and multiple-branched conduit means for communicating flame from the conical outlet end of said igniter cylinder to the respective combustion chambers comprising a plurality of cylindrical flame feeding tubes each communicating with one of the combustion chambers and having its axis disposed generally normal to the axis of the igniter cylinder and communicating with the outlet end thereof, each of said flame feeding tubes having at least one nozzle means disposed to project a supplementary jet of air tangentially into the flame feeding tube to supply additional oxygen and re-establish smooth vortex flow therein.

8. In a combustion system having a single air plenum chamber and a plurality of separate cylindrical liners defining combustion chambers mounted therein and spaced uniformly about the axis of the plenum chamber, each of the cylindrical liners having its axis parallel to that of the plenum chamber, the combination of an igniter cylinder disposed coaxial with the axis of the plenum chamber and having an outlet defined by a contracting nozzle portion, means for creating an over-rich fuel-air mixture in said igniter cylinder, means for igniting said mixture, a multiple T-connection, a flame tube communicating between the multiple T-connection and the contracting nozzle portion of the igniter cylinder and forming with said conical portion a slip-joint with clearance spaces to admit a limited amount of air, and a plurality of flame feeding tubes communicating between the multiple T-connection and the combustion chambers, said flame feeding tubes having their axes generally normal to the axis of the igniter cylinder and including nozzle means disposed to project jets of combustion supporting air tangentially into the flame tube to re-establish smooth vortex flow therein.

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