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Harboe

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[54] **COMBUSTION CHAMBER FOR GAS TURBINES AND THE LIKE HAVING A FLUIDIZED BURNER BED**

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[52] **U.S. Cl.** .... **60/39.18 C;** 122/4 D

[51] **Int. Cl.** **F02c 1/00**

[58] **Field of Search** .... 60/39.18 C, 39.05, 39.46; 122/4 D; 23/288 S

[56] **References Cited**

UNITED STATES PATENTS

2,482,791	9/1949	Nettel et al.	60/39.18 C
2,842,102	7/1958	Blaskowski	122/4 D
3,446,012	5/1969	Foster-Pegg	60/39.46
3,687,115	8/1972	Bell	122/4 D

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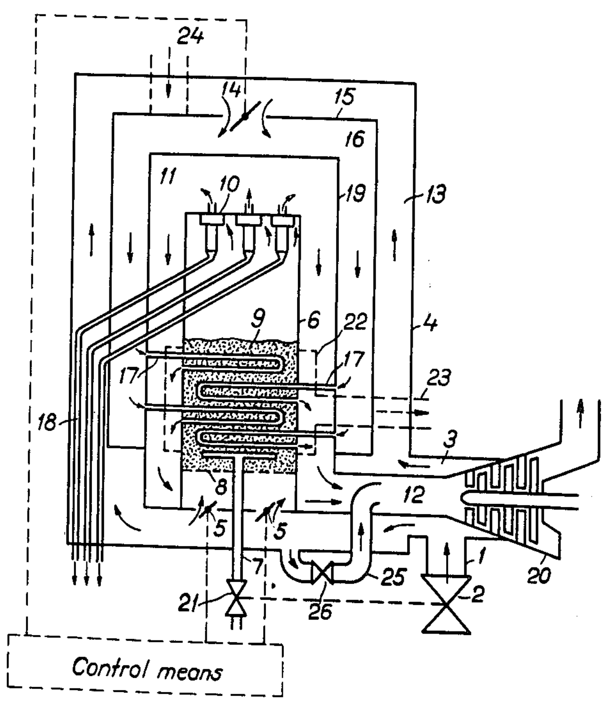
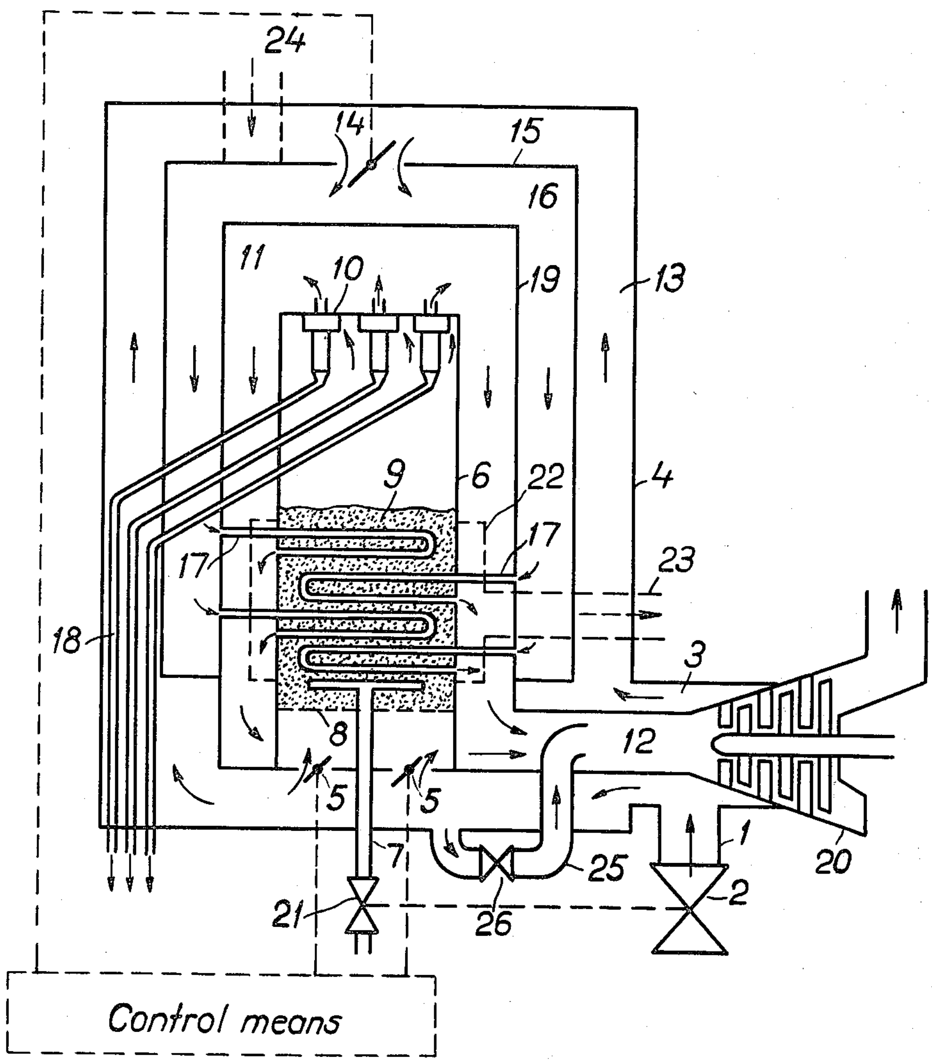
[57] **ABSTRACT**

A combustion chamber with a fluidised burner bed, preferably for gas turbines, comprising means for controlling the supply of fuel, combustion air and a cooling medium for the fluidised bed to maintain a predetermined proportional relationship therebetween constant under varying load conditions.

9 Claims, 1 Drawing Figure

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Control means

COMBUSTION CHAMBER FOR GAS TURBINES AND THE LIKE HAVING A FLUIDIZED BURNER BED

BACKGROUND OF THE INVENTION

In the operation of gas turbines, for example, there has been a frequent demand for any kind of fuels including particulate solid fuel. However, so far, the latter has only reached an experimental stage owing to the difficulties associated with effective purging of the combustion gases. The ashes whirled up or fluidized in and accompanying the combustion gases have caused erosion as well as deposits on the turbine vanes, which, seems to be due among other things to the fact that the combustion temperature in burners heretofore used is so high that the ashes melt and thus acquire a glazed character and a consequently high grinding capacity. Therefore, it has been proposed recently to use combustion chambers with a fluidised bed burner combined with a cooling system.

Combustion chambers with a fluidised bed burner, in which the combustion takes place in a bed of solid cominute or granulated material, which is fluidised in air, produce an advantageously efficient combustion at a moderate temperature and with a moderate amount of excess air. Consequently the ash is not melted down but retains a substantially soft consistency.

Furthermore, this combustion chamber is capable of burning gaseous and liquid full as well as particulate, solid fuel. A disadvantage results from the difficulty of controlling the combustion under varying load conditions. One possibility of controlling the combustion is to divide the chamber into sections which can be selectively connected and disconnected as shown, for example, in U.S. Pat. No. 2,842,102. However, this arrangement results in a discontinuous control. Another possibility is to vary the depth of the fluidised bed so that the bed material is either discharged or recharged with consequent complications.

Another problem is the cooling which is normally effected partly by water and partly by steam, the combustion chamber thus operating as a boiler. This normally means that water in the cooling system must be drained off or blown out when the combustion chamber is temporarily inactivated, so that the fluidised bed will be able to maintain its temperature until reactivated whereupon the cooling system must be recharged. For this reason, this type of combustion chamber is impractical for intermittent operation.

SUMMARY OF THE INVENTION

The present invention eliminates these disadvantages and makes it possible to operate a fluidisation-combustion chamber having a fluidized burner bed of constant temperature and bed depth, while still achieving a high degree of control of the combustion within wide limits and permitting intermittent operation.

The important feature of the combustion chamber according to the invention resides in the fact that its cooling system works with air or some other gaseous medium that a predetermined relation is constantly maintained between the amounts of combustion air and cooling air. THe amount of fuel is thus adjusted to the amount of combustion air under varying load conditions.

The invention contemplates the maintenance of a predetermined proportion between combustion air and cooling air under varying load conditions, which essentially means a constant temperature in the combustion chamber. In practice, however, certain minor variations may be justified.

The proportion between the amounts of combustion air and cooling air should suitably be of the order of 1:2 and the temperature of the combustion chamber with the proper amount of fuel should range between 700°–950°C. Within this temperature range there is no melting of the ash which therefore is retained as a soft, amorphous powder with a low erosion capacity and a low tendency to become sticky and to form deposits.

The cooling air and the combustion gases can be mixed after their passage through the combustion chamber and be supplied, for example, to a gas turbine as a single stream. Another possibility is to keep the two air streams separated and conduct each of them separately to its respective gas turbine, and in this manner the stream of cooling air with its turbine can then be maintained as a purged system. The combustion gases must be separated from ashes and fluidized particles from the burner bed in a dust separator, for example a cyclone, but as mentioned above the combustion gases constitute a minor part of the total air current.

BRIEF DESCRIPTION OF THE DRAWING:

The invention will be further explained with reference to the accompanying drawing which illustrates diagrammatically a combustion chamber embodying the invention.

DESCRIPTION OF A PREFERRED AND A MODIFIED EMBODIMENT

From a compressor or an air storage (not shown) the air enters the conduit **1** through the control valve **2**. If the air should come directly from a compressor, it may be advantageous to supplement the valve **2** with a damper (not shown) the passage from the compressor. The air is passed to a space **3** between an outer and inner turbine casing and from there into the outer casing **4** where the air is divided into combustion air and cooling air.

In the lower part of the casing **4** the combustion air is passed through adjustable dampers or valves **5** into the bottom of the proper combustion chamber **6.** Here the air passes up through a perforated bottom **8** and into the fluidised bed **9** consisting of a particulate, solid material which is whirled up in the form of a suspended fluidised bed by the combustion air flowing therethrough. A fuel pipe **7** with a fuel dispenser head at the upper end supplies said fluidised bed, with the fuel and possibly also with new bed material.

As mentioned herein, the fuel may be gaseous or liquid, but also solid, crushed fuel is feasible. The fluidised bed has the advantage of being capable of burning a somewhat more coarse-grained fuel than that used in burners for pulverized coal such as boilers. By a suitable choice of bed material, it is also possible to obtain a considerable absorption of adventitious substances in the fuel. For example bed material containing limestone is capable of absorbing sulphurous compounds in the fuel, and in this case the sulphur-saturated bed material must be discharged from the upper part of the bed and new material be added to the lower part.

From the bed **9** the flue-gas passes up through the dust separator, suitably cyclone separators **10** with exhaust pipes **18** in the bottom, through which ash and whirled-up bed material are separated. From the separators the purified gas is passed out into the space **11** between the inner combustion chamber **6** and the intermediate casing **19**, from where the flue-gas passes through the pipe **12** to the gas turbine **20**.

The cooling air rises from the bottom of the outer casing **4** through the space **13** between the outer casing **4** and the intermediate casing **15** which is provided at the top with a control damper **14**. From here the cooling air passes through the space **16** between the intermediate casings **15** and **19** and downwards to cooling pipes **17** which conduct the air through the fluidised bed **9** and opens out into the space **11** between the combustion chamber **6** and the intermediate casing **19**. Here the cooling air is mixed with the flue-gas which emanates from the separators **10** and the entire amount of air passes through the pipe **12** to the turbine **20**.

As mentioned earlier, it is most important that the amounts of cooling air and combustion air have a constant proportion relative to each other, which can be achieved by means of an exact, relative adjustment of the regulating dampers **5** and **14**. If, the efficiency of the combustion chamber and consequently that of the turbine, should thereafter be varied by adjusting the regulating valve **2**, said proportion between the amounts of air will remain substantially constant as will also the temperature of the combustion chamber.

The supply of fuel to the fluidised bed through the pipe **7** must be carefully regulated to follow the regulation of the air, which has been indicated purely symbolically in the FIGURE by connecting the fuel valve **21** in the pipe **7** to the air valve **2** in the pipe **1**.

A certain, minor variation of the above-mentioned proportions in the amounts of air under varying load conditions is conceivable which can be done by finely adjusting one of the dampers **5** or **14** in relation to the adjustment of the air valve **2**.

It has been found that a combustion chamber temperature of about 850° and a proportion of 1:2 between the amounts of combustion air and cooling air constitute a suitable adjustment combination.

Also shown on the drawing is a by-pass tube **25** having a valve **26** which connects the outer casing **4** with the outlet pipe **12**. In this manner it is possible, in the event of an emergency stop or a sudden stop, to short-circuit the fluidised bed itself as well as to supply cold air to the turbine **20** by opening the valve **26**, thus rapidly decreasing the power output of the turbine especially if it operates its own compressor. Simultaneously the valves **2** and **21** are throttled.

In the above-mentioned description it has been assumed that cooling air and combustion air emanate both from the same source and proceed to the same consumer, but it is also conceivable to keep the air streams separated, either only at the outlet side or at both the inlet and outlet sides.

For this purpose there may be an additional intermediate casing **22** (dashed line) surrounding the outlets from the tubes **17** and from where the purged, hot cooling air is passed through a pipe **23** to a turbine (not shown) which will thus operate with purged, hot air. The cooling air may be taken from a separate air source through an intake **24** (dashed line), in which case the outer casing **4** becomes substantially unnecessary.

In this manner, the cooling system is capable of working at another, preferably higher, pressure than the combustion chamber, but still the proportional relationship between the two volumes of air is maintained. However, this arrangement makes the control somewhat more complicated.

It is also conceivable to interconnect the regulating valves for the fuel and the two air streams. Another possibility is to control the stream of cooling air in relation to the combustion chamber temperature so that the latter is kept constant, which essentially also means a constant proportional relationship between the volumes of air.

By reason of the separate cooling air system according to the invention other gases than atmospheric air may be used for cooling; even and also water vapour is conceivable. The combustion chamber then acquires the character of a superheater for a steam system, for example a steam turbine.

I claim:

1. A combustion chamber for operating gas turbines and the like; comprising:

a. a burner housing;
b. a fluidized bed of particulate material within said burner housing;
c. means for purging the combustion gas from said burner housing;
d. a chamber surrounding said burner housing for receiving purged combustion gas from said burner;
e. means for injecting fuel into said burner;
f. means for introducing combustion air into said burner;
g. a cooling chamber for receiving a cooling medium surrounding the purged combustion gas chamber;
h. means for introducing a cooling medium into said cooling chamber;
i. means for passing said cooling medium in a confined path through said fluidized bed in heat relationship therewith;
j. means for passing said cooling medium and said purged combustion gas to a power out-put station, and
k. means for maintaining a predetermined proportional relationship between combustion air and said cooling medium constant regardless of varying power out-put demands and to maintain the fluidized bed temperature within a predetermined range.

2. A combustion chamber according to claim **1**, having second control means for simultaneous regulation of the volumes of combustion air and cooling medium on the one hand and the amount of fuel on the other.

3. A combustion chamber according to claim **1**, in which the volume of combustion air and cooling medium are controlled to maintain a combustion temperature ranging between 700°–950°C.

4. A combustion chamber according to claim **1**, in which the volumes of combustion air and cooling medium are controlled to maintain a proportional relationship on the order of 1:2.

5. A combustion chamber according to claim **1**, in which the cooling medium constitutes air emanating from the same source as the combustion air.

6. A combustion chamber according to claim **5**, in which a portion of the air emanating from the same sources is introduced into the cooling chamber as cooling medium and another portion thereof is introduced into the fluidized bed as combustion air; the cooling air upon having passed through the fluidized bed being received in said purged combustion gas chamber and mixed therein with the combustion gas and passed as a combined entity to the power out-put station.

7. A combustion chamber according to claim 6 which is provided with an outer housing surrounding said cooling chamber forming a passage for the air emanating from the common source which is introduced into the fluidized bed and into the cooling chamber respectively at a predetermined controlled rate.

8. A combustion chamber according to claim 7, in which a valved by-pass passage is provided in said outer housing for short-circuiting the fluidized bed and passing the air in the outer housing directly to the power out-put station for rapid reduction of the power out-put thereof.

9. A combustion chamber according to claim 1, in which a separate casing is provided surrounding said burner housing for confining the heated cooling medium and having means for passing it separately to a different power out-put station.

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