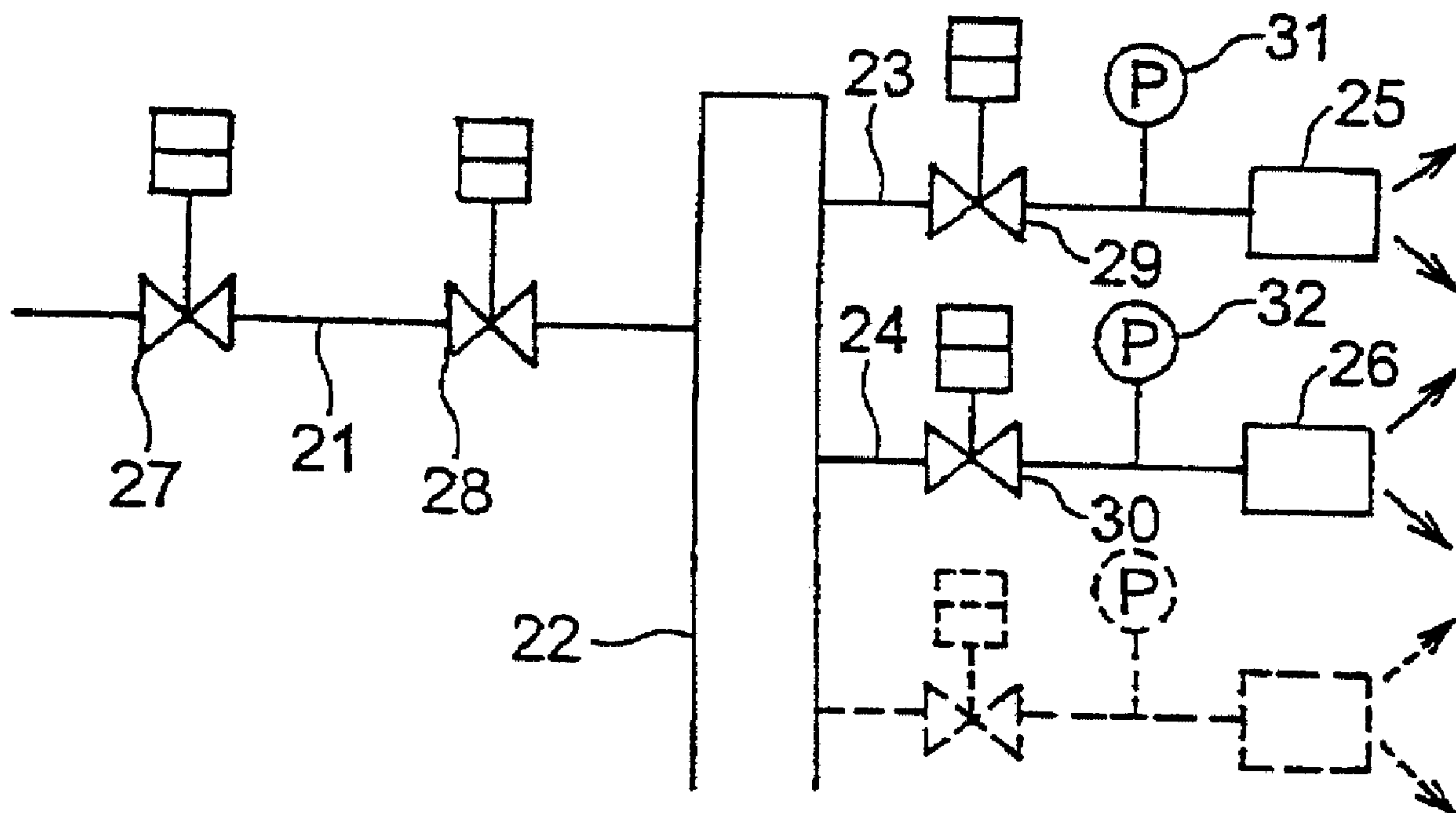




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(54) Titre : CHAMBRES DE COMBUSTION DE TURBINE A GAZ  
 (54) Title: GAS TURBINE COMBUSTOR APPARATUS



(57) Abrégé/Abstract:

A gas turbine combustor apparatus comprising plural combustors and plural fuel supply systems realizes a combustion of a lean and uniform pre-mixture in each of the combustors to thereby enable to reduce NOx generation. Flow regulating valves 29, 30 are provided in fuel supply systems 23, 24, respectively, that supply combustors 25, 26 with fuel. Pressure gauges 31, 32 are provided in the fuel supply systems 23, 24, respectively, in front of inlets of the combustors 25, 26. The flow regulating valves 29, 30 are controlled so that pressures measured by the pressure gauges 31, 32 become the same.

### Abstract of the Disclosure

A gas turbine combustor apparatus comprising plural combustors and plural fuel supply systems realizes a combustion  
5 of a lean and uniform pre-mixture in each of the combustors to thereby enable to reduce NOx generation. Flow regulating valves 29, 30 are provided in fuel supply systems 23, 24, respectively, that supply combustors 25, 26 with fuel. Pressure gauges 31, 32 are provided in the fuel supply systems  
10 23, 24, respectively, in front of inlets of the combustors 25, 26. The flow regulating valves 29, 30 are controlled so that pressures measured by the pressure gauges 31, 32 become the same.

## Title

**GAS TURBINE COMBUSTOR APPARATUS**

## BACKGROUND OF THE INVENTION

## 5           Field of the Invention

The present invention relates generally to a gas turbine combustor apparatus comprising a plurality of combustors and more particularly to a gas turbine combustor apparatus by which a combustion of a lean and uniform pre-mixture is realized in each of the plurality of combustors.

## Description of the Prior art

The gas turbine combustor apparatus comprises therein a plurality of combustors that are arranged along a circumferential direction around a gas turbine rotor. As shown in Fig. 2, each of the combustors 1 is constructed such that a pilot nozzle 8 is centrally arranged and a plurality of pre-mixing nozzle devices 10 are arranged around the pilot nozzle 8. Numeral 11 designates a swirling vane. While fuel is injected from a dual fuel nozzle 2 provided in the pre-mixing nozzle device 10 and is mixed with air to form a pre-mixture, that air is given a swirling force by the swirling vane before it is mixed with the fuel.

While the dual fuel nozzle 2 is provided in plural pieces thereof in the pre-mixing nozzle device 10, one

example of the dual fuel nozzle 2 is shown in Fig. 3. This dual fuel nozzle 2 is constructed such that gas fuel led through a gas fuel flow passage 5 is injected from a gas fuel injection port 7 immediately downstream of the swirling vane 11 and liquid fuel led through a liquid fuel flow passage 4 is injected from a liquid fuel injection port 6 downstream of the gas fuel injection port 7. Incidentally, in Fig. 3, numeral 3 designates a rod member, that constitutes a fuel supply pipe, and numeral 9 designates a cylindrical pre-mixing nozzle member.

In the gas turbine combustor apparatus constructed by comprising such a multiplicity of combustors 1, in order to reduce NOx (nitrogen oxides) generated by combustion, it is necessary to realize a combustion of a lean and uniform pre-mixture in each of the combustors. For this purpose, in manufacturing the combustors, it is necessary to work each of the fuel nozzles of the combustors in a high accuracy so that each of the nozzles may be made in the same dimensions and shapes. However, according to the accuracy of the currently available working technology, it is not always easy, or rather difficult, to obtain a desired uniformity of the accuracy for each of the nozzles and it is a present status that there is accordingly a limitation in the NOx reduction also.

It is therefore an object of the present invention

to provide a gas turbine combustor apparatus in a gas turbine that comprises a plurality of combustors and a plurality of fuel supply systems connected to the plurality of combustors for fuel supply therethrough, wherein the gas turbine combustor apparatus is constructed such that a lean and uniform pre-mixture is formed to be burned in each of the combustors to thereby enable to reduce NOx generation.

In order to solve the mentioned object, the present invention provides:

A gas turbine combustor apparatus, the gas turbine comprising a plurality of combustors and a plurality of fuel supply systems, each of which is connected to each of the plurality of combustors so as to supply fuel therethrough, characterized in that the gas turbine combustor apparatus is constructed such that a flow regulating valve is provided in each of the plurality of fuel supply systems, a pressure gauge is provided in each of the plurality of fuel supply systems in front of a fuel inlet of each of the plurality of combustors and the flow regulating valve is controlled so that pressure measured by the pressure gauge may become the same with respect to all of the plurality of combustors.

In the gas turbine combustor apparatus of the present invention constructed as mentioned above, the flow regulating valves of the respective fuel supply systems are controlled so that the pressures in the respective fuel

supply systems at the position in front of the fuel inlets of the respective combustors may become the same with respect to all of the combustors and thereby a uniform mixture can be formed in each of the combustors.

5           Also, in order to solve the mentioned object, the present invention provides:

          A gas turbine combustor apparatus, the gas turbine comprising a plurality of combustors and a plurality of fuel supply systems, each of which is connected to each of the  
10           plurality of combustors so as to supply fuel therethrough, characterized in that the gas turbine combustor apparatus is constructed such that a flow regulating valve is provided in each of the plurality of fuel supply systems, a flow meter is provided in each of the plurality of fuel supply systems  
15           in front of a fuel inlet of each of the plurality of combustors and the flow regulating valve is controlled so that flow rate measured by the flow meter may become the same with respect to all of the plurality of combustors.

          In the gas turbine combustor apparatus of the present  
20           invention constructed as mentioned above, the flow regulating valves of the respective fuel supply systems are controlled so that the flow rates in the respective fuel supply systems at the position in front of the fuel inlets of the respective combustors may become the same with respect  
25           to all of the combustors and thereby a uniform mixture can

be formed in each of the combustors.

Also, in order to solve the mentioned object, the present invention provides:

A gas turbine combustor apparatus, the gas turbine  
5 comprising a plurality of combustors and a plurality of fuel  
supply systems, each of which is connected to each of the  
plurality of combustors so as to supply fuel therethrough,  
characterized in that the gas turbine combustor apparatus  
is constructed such that a flow regulating valve is provided  
10 in each of the plurality of fuel supply systems, a  
thermometer is provided at a blade passing point downstream  
of each of the plurality of combustors and the flow  
regulating valve is controlled so that temperature measured  
by the thermometer may become the same with respect to all  
15 of the plurality of combustors.

According to the gas turbine combustor apparatus  
constructed as mentioned above, the flow rates of the fuel  
flowing in the respective fuel supply systems are adjusted  
so that the temperatures at the blade passing points  
20 downstream of the respective combustors may become the same  
with respect to all of the combustors and thereby a lean  
pre-mixture formed in each of the combustors can be made  
uniform.

Also, in order to solve the mentioned object, the  
25 present invention provides:

A gas turbine combustor apparatus, the gas turbine comprising a plurality of combustors and a plurality of fuel supply systems, each of which is connected to each of the plurality of combustors so as to supply fuel therethrough, characterized in that the gas turbine combustor apparatus is constructed such that a flow regulating valve is provided in each of the plurality of fuel supply systems, a thermometer for measuring metal temperature is provided on or in a stationary blade downstream of each of the plurality of combustors and the flow regulating valve is controlled so that temperature measured by the thermometer may become the same with respect to all of the plurality of combustors.

According to the gas turbine combustor apparatus constructed as mentioned above, the flow rates of the fuel flowing in the respective fuel supply systems are adjusted so that metal temperatures of the stationary blades positioned downstream of the respective combustors may become the same with respect to all of the combustors and thereby a lean pre-mixture formed in each of the combustors can be made uniform.

Furthermore, in order to solve the mentioned object, the present invention provides:

A gas turbine combustor apparatus, the gas turbine comprising a plurality of combustors and a plurality of fuel supply systems, each of which is connected to each of the

plurality of combustors so as to supply fuel therethrough, characterized in that the gas turbine combustor apparatus is constructed such that a flow regulating valve is provided in each of the plurality of fuel supply systems, a  
5 thermometer for measuring metal temperature is provided on or in each of the plurality of combustors and the flow regulating valve is controlled so that temperature measured by the thermometer may become the same with respect to all of the plurality of combustors.

10           According to the gas turbine combustor apparatus constructed as mentioned above, the flow rates of the fuel flowing in the respective fuel supply systems are adjusted so that metal temperatures of the respective combustors may become the same with respect to all of the combustors and  
15 thereby a lean pre-mixture formed in each of the combustors can be made uniform.

          A gas turbine combustor apparatus of the present invention may be constructed such that a plurality of constructions are taken out of the constructions as  
20 mentioned above, an optimal solution is obtained by the method of least squares and the flow regulating valve is controlled so as to meet the optimal solution. Thereby, uniformity of the pre-mixture formed in each of the combustors can be further enhanced.

25           Also, in order to solve the mentioned object, the

present invention provides:

5 A gas turbine combustor apparatus, the gas turbine  
comprising a plurality of combustors and a plurality of fuel  
supply systems, each of which is connected to each of the  
plurality of combustors so as to supply fuel therethrough,  
characterized in that the gas turbine combustor apparatus  
is constructed such that a flow regulating valve is provided  
in each of the plurality of fuel supply systems, spectrum  
analyses are carried out on measured values of inner pressure  
10 variations in each of the plurality of combustors and the  
flow regulating valve corresponding to the combustor in  
which the inner pressure variations in a specific frequency  
range become a predetermined value or more is controlled  
to be opened or closed.

15 According to the gas turbine combustor apparatus  
constructed as mentioned above, the flow regulating valves  
of the respective fuel supply systems are controlled so that  
frequencies caused by the inner pressure variations in a  
specific frequency range may not become a predetermined  
20 value or more in each of the combustors and thereby a uniform  
pre-mixture can be formed in each of the combustors.

In the gas turbine combustor apparatus as described  
above, such a construction may be employed that a control  
unit is provided and, if an average value of openings of  
25 the respective flow regulating valves exceeds a

predetermined value, the control unit adds a difference between the predetermined value and the average value to the openings of the respective flow regulating valves. This is preferable as the opening and closing control of the flow regulating valve can be stabilized.

Also, in the gas turbine combustor apparatus as described above, such a construction may be employed that a control unit is provided and, if a load shutoff signal is given for the plurality of combustors, the control unit gives signals so that openings of the respective flow regulating valves may be set to a predetermined position. This is preferable as the flow regulating valves in the respective fuel supply systems can be caused to immediately respond to a load shutoff operation.

Further, in the gas turbine combustor apparatus as described above, such a construction may be employed that an alarm circuit is provided and, if the flow regulating valve is opened or closed in excess of a predetermined value, the alarm circuit gives an alarm of such an unusual state of a fuel system. This is preferable as an unusual state of the fuel system is made known and an immediate countermeasure can be taken.

Accordingly, in another aspect, the present invention resides in a gas turbine combustor apparatus, said apparatus comprising a plurality of combustors and a plurality of fuel supply systems, each of which is connected to each of said plurality of combustors so as to supply fuel therethrough, and a controller, wherein said gas turbine combustor apparatus is constructed such that a flow regulating valve is provided in each of said plurality of fuel supply systems, a pressure gauge is provided in each of said plurality of fuel supply systems in a position upstream of a fuel inlet of each of said plurality of combustors and said flow regulating valve is controllable to regulate the fuel supply by said controller so that pressure measured by said pressure gauge is the same with respect to all of said plurality of combustors.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an explanatory view showing a construction

of a gas turbine combustor apparatus of an embodiment according to the present invention.

Fig. 2 is a longitudinal cross sectional view showing one example of a structure of a gas turbine combustor apparatus in the prior art.

Fig. 3 is a longitudinal cross sectional view showing a structure of a dual fuel nozzle used in the gas turbine combustor apparatus of Fig. 2.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

Herebelow, a gas turbine combustor apparatus of the present invention will be described more concretely based on an embodiment shown in Fig. 1. It is to be noted that, while a plurality of fuel supply systems are provided, only two of them will be representatively taken for description. In Fig. 1, numeral 21 designates a fuel supply pipe and construction of the system is made such that fuel led through the fuel supply pipe 21 enters fuel supply systems 23, 24 via a manifold 22 to be supplied into respective combustors 25, 26. A pressure regulating valve 27 and a flow regulating valve 28 are provided in the fuel supply pipe 21. Also, flow regulating valves 29, 30 and pressure gauges 31, 32 are provided in the fuel supply systems 23, 24, respectively, that connect to the combustors 25, 26.

Here, the construction of the entire system is made

such that the flow regulating valves 29, 30 provided in the fuel supply systems 23, 24, respectively, are controlled to be opened or closed so that pressures measured by the pressure gauges 31, 32 provided in the fuel supply systems 5 23, 24, respectively, may become the same. By so effecting the control, pressures in the fuel supply systems 23, 24, through which the respective combustors 25, 26 are supplied with fuel, are maintained to the same value and thereby a uniform pre-mixture can be formed in each of the combustors.

10 In the gas turbine combustor apparatus of Fig. 1 as described above, the construction is made so that the pressures in the fuel supply systems connecting to the respective combustors may become the same. However, if flow meters are provided in the fuel supply systems instead of 15 the pressure gauges and the construction is made such that the flow regulating valves of the respective fuel supply systems are controlled to be opened or closed so that flow rates measured by the flow meters may become the same, then it is also possible to obtain the same effect.

20 Or, instead of the pressure gauges or the flow meters as mentioned above, if thermometers are provided for measuring temperatures at blade passing points downstream of the respective combustors, or metal temperatures of stationary blades downstream of the respective combustors, 25 or metal temperatures of the respective combustors and the

construction is made such that the flow regulating valves  
of the respective fuel supply systems are controlled to be  
opened or closed so that the temperatures so measured may  
become the same, then it is also possible to obtain the same  
5 effect.

In the above, while the description has been made  
on controlling the control systems having respectively the  
single pressure gauge, flow meter or thermometer, the  
construction may be made such that at least two of the  
10 mentioned control systems are provided and an optimal  
solution is obtained by the method of least squares, so that  
the flow regulating valve provided in each of the fuel supply  
systems is optimally controlled. This is preferable for  
forming a uniform pre-mixture in each of the combustors.

15 Furthermore, instead of using the pressure gauges  
or the flow meters for controlling the flow regulating valves  
in the plurality of fuel supply systems, the construction  
may be made such that spectrum analyses are carried out on  
measured values of inner pressure variations in each of the  
20 combustors and the mentioned flow regulating valve  
corresponding to the combustor in which the inner pressure  
variations in a specific frequency range become a  
predetermined value or more is controlled to be opened or  
closed. For example, if the variation includes much of high  
25 frequencies, the flow regulating valve is considered too

much throttled and the control is done so as to open the flow regulating valve. Or, if the variation includes much of low frequencies, it is considered an excess of fuel and the control is done so as to throttle the flow regulating valve. Thus, by controlling the flow regulating valve in each of the fuel supply systems so that the inner pressure variations in a specific frequency range may not become a predetermined value or more in each of the combustors, a uniform pre-mixture can be formed in each of the combustors.

In the above, while the invention has been described based on the gas turbine combustor apparatus of the embodiments, the invention is not limited to the embodiments but may naturally be added with various modifications or alterations as come within the scope of the invention defined by the claims as appended herein.

For example, in the gas turbine combustor apparatus of the embodiments according to the present invention as described above, the construction may be made such that a control unit is provided and, if an average value of openings of the flow regulating valves provided in the respective fuel supply systems exceeds a predetermined value, the control unit adds a difference between the predetermined value and the average value to the openings of the respective flow regulating valves. Then, the opening and closing control of the flow regulating valves can be made a more

stabilized one.

Or, in the gas turbine combustor apparatus of the  
embodiments of the present invention, the construction may  
be made such that a control unit is provided and, if a load  
5 shutoff signal is given for the combustors, the control unit  
gives signals so that openings of the respective flow  
regulating valves may be set to a predetermined position.  
Then, the flow regulating valve in each of the fuel supply  
systems can be immediately set to such an opening position  
10 as corresponds to the load shutoff operation.

Also, in the gas turbine combustor apparatus of the  
embodiments of the present invention, the construction may  
be made such that an alarm circuit is provided and, if the  
flow regulating valve provided in each of the fuel supply  
15 systems is opened or closed in excess of a predetermined  
value, the alarm circuit gives an alarm of the unusual state  
of the fuel systems. Then, the unusual state of the fuel  
systems, such as an irregularity in the openings of the flow  
regulating valves, is made known and an immediate  
20 countermeasure can be taken.

What is claimed is:

1. A gas turbine combustor apparatus, said apparatus comprising a plurality of combustors and a plurality of fuel supply systems, each of which is connected to each of said plurality of combustors so as to supply fuel therethrough, and a controller, wherein said gas turbine combustor apparatus is constructed such that a flow regulating valve is provided in each of said plurality of fuel supply systems, a pressure gauge is provided in each of said plurality of fuel supply systems in a position upstream of a fuel inlet of each of said plurality of combustors and said flow regulating valve is controllable to regulate the fuel supply by said controller so that pressure measured by said pressure gauge is the same with respect to all of said plurality of combustors.

2. A gas turbine combustor apparatus as claimed in claim 1, wherein a control unit is provided and, if an average value of openings of the respective flow regulating valves exceeds a predetermined value, said control unit adds a difference between said predetermined value and said average value to the openings of the respective flow regulating valves.

3. A gas turbine combustor apparatus as claimed in claim 1 wherein a control unit is provided and, if a load

shutoff signal is given for said plurality of combustors, said control unit gives signals so that openings of the respective flow regulating valves may be set to a predetermined position.

4. A gas turbine combustor apparatus as claimed in claim 1 wherein an alarm circuit is provided and, if said flow regulating valve is opened or closed in excess of a predetermined value, said alarm circuit gives an alarm of such an unusual state of a fuel system.

Fig. 1

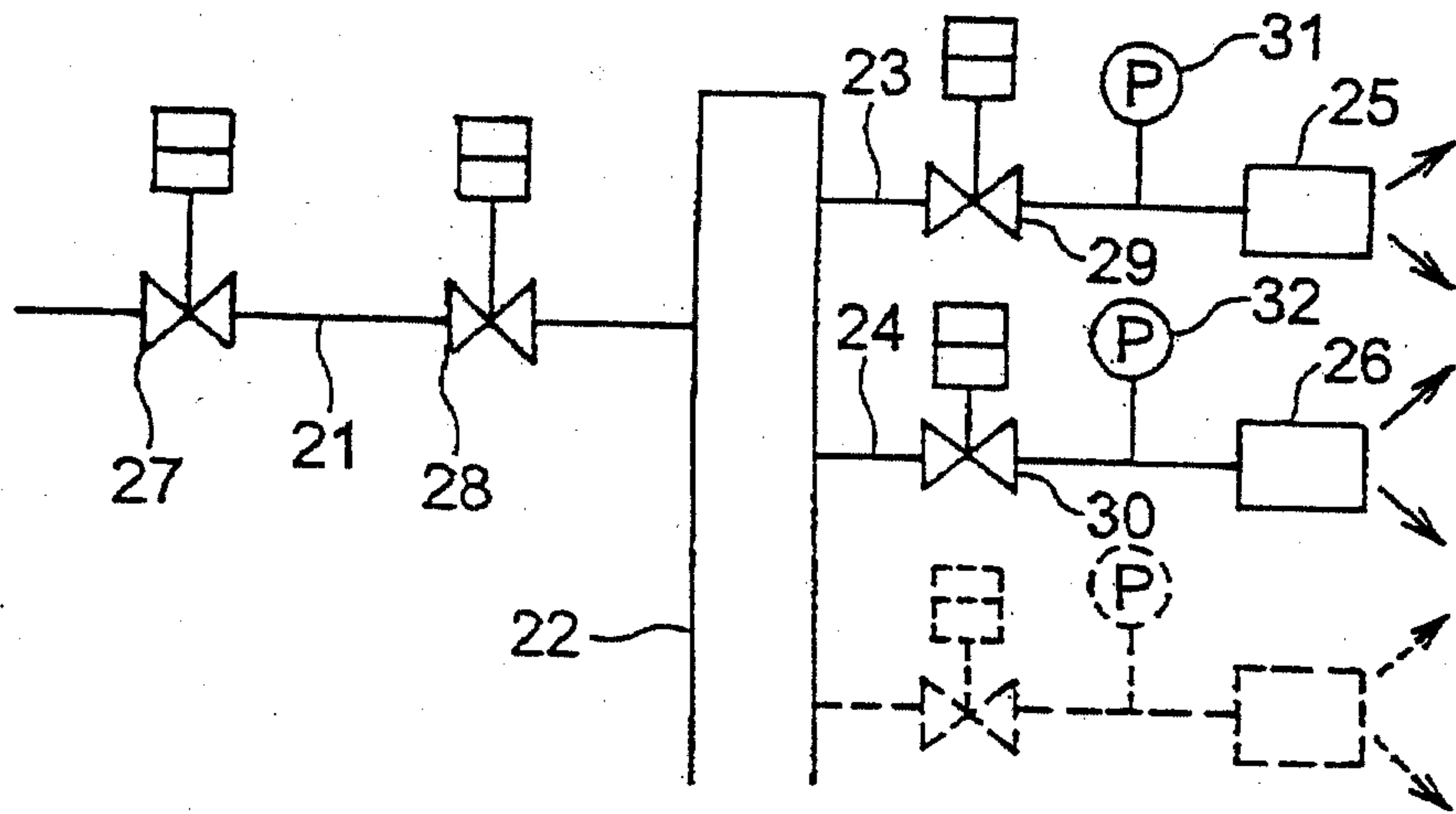


Fig. 2 (Prior art)

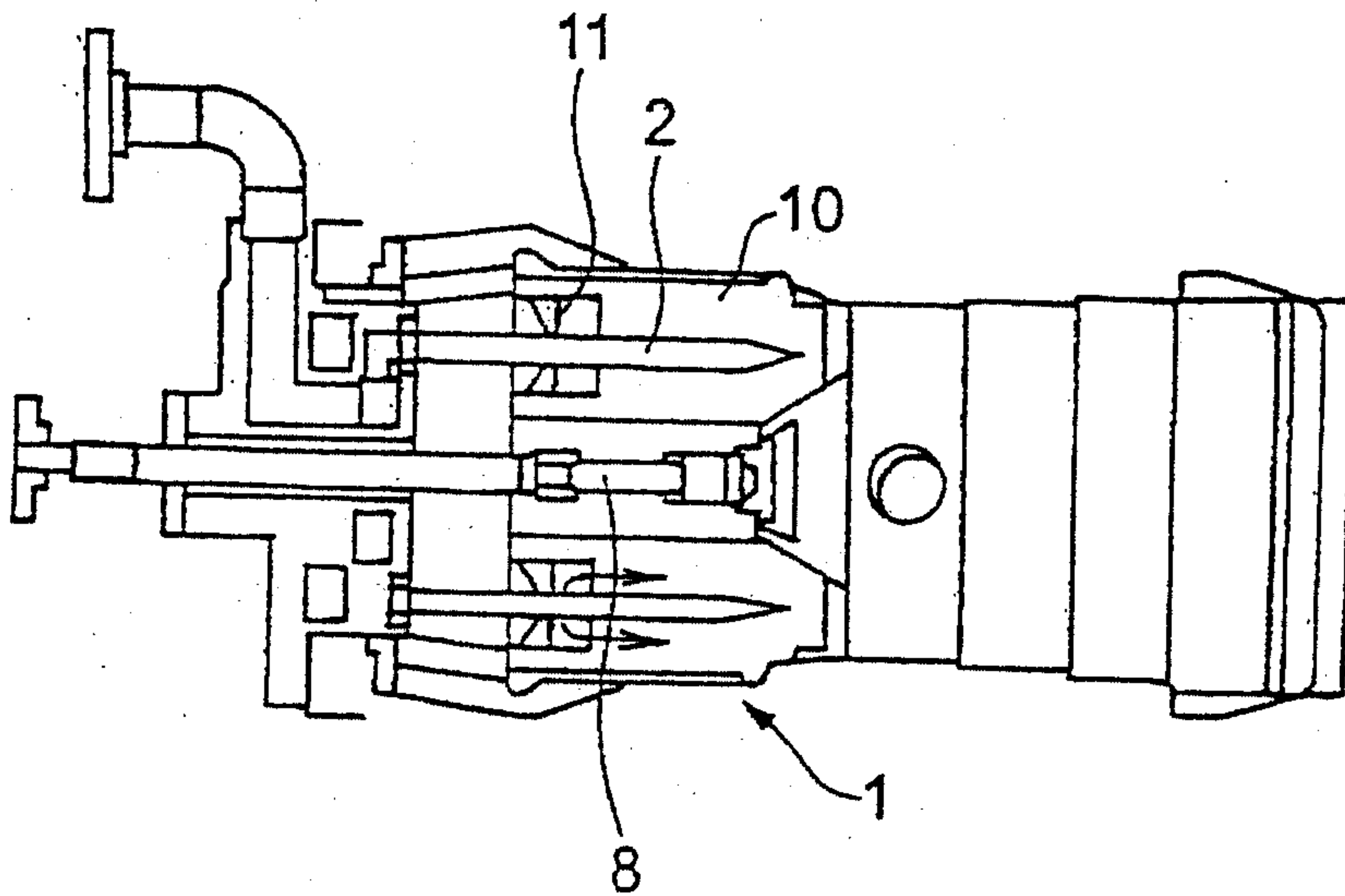


Fig. 3 (Prior art)

