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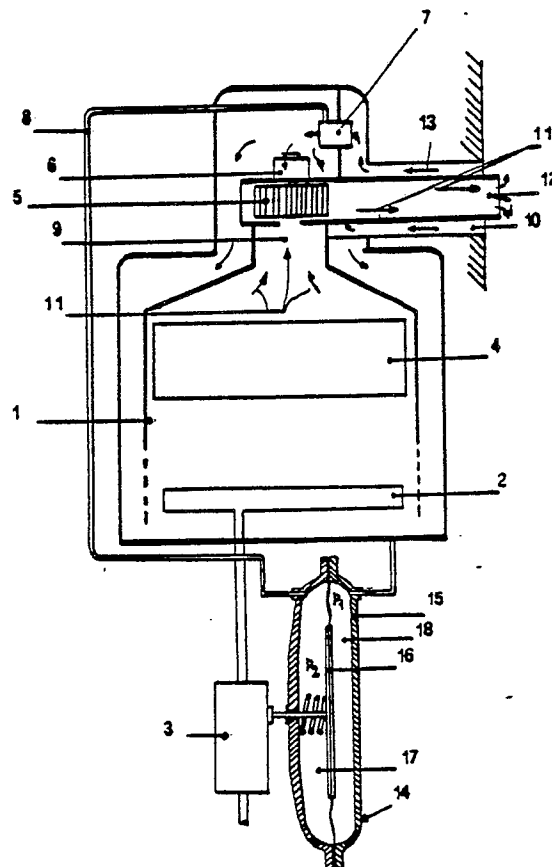
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(54) Automatic device for modulating the flow of combustion air and gas in gas heating apparatus.

(57) The automatic modulator device of the flow combustion air and gas for a gas heating apparatus provided with a suction fan for the suction of burnt gas comprises a control means for controlling the number of revolutions of the suction fan depending on the desired water temperature, a pneumatic circuit connecting the inlet of sucked combustion air to the firebox, a venturi arranged at the inlet of said pneumatic circuit and a transducer controlling the metering of the combustible gas.



EP 0 326 880 A2

## AUTOMATIC DEVICE FOR MODULATING THE FLOW OF COMBUSTION AIR AND GAS IN GAS HEATING APPARATUS

This invention generally relates to gas heating apparatus and more particularly an automatic device for modulating the flow of combustion air and gas in said apparatus so as to optimize the efficiency thereof in any operating conditions.

Since with the term "gas heating apparatus" are preferably, but not exclusively, intended the gas boilers, in the course of the following description reference will be made to the latter for convenience. Such gas boilers are known and employed in the most cases for heating the water which supplies both a heating apparatus with thermal radiators and the various sanitary fittings of which the houses served by these boilers are provided with.

These gas boilers can operate with natural or mechanical draught. In the latter case, they are provided with a suction fan adapted to convey the burnt gas in a stack.

The problem presented by these boilers consists in obtaining a modulation as continuous and regular as possible of the flow rate of the combustible gas to the boiler burners depending on the changes in the thermal demands of the boiler.

In the case of gas boilers provided with a suction fan for exhausting the burnt gas, this suction fan is usually of the type having a fixed revolving speed and this feature does not allow the boiler to be used at the maximum of efficiency in any operating conditions, because the draught generated by this suction fan rotating at a fixed speed is constant and therefore does not change with the change of the thermal demand of the user.

It is therefore the object of the present invention to provide an automatic modulator device which can assure the direct dependence of the combustion air flow on the gas flow in order to maintain the boiler efficiency and the preset temperature of the water conveyed to the user constant in the whole range of thermal power changes of the boiler.

It is another object of the present invention to provide an automatic modulator device capable of changing the flow rate of the combustible gas to the burners by allowing the sanitary and heating water temperature to be maintained constant and equal to the preset value by assuring a high and constant efficiency as well as a hygienic level of the combustion within the limits set by the standards in any operating conditions.

It is still another object of the present invention to provide an automatic modulator device capable of maintaining the efficiency of the boiler high by changing the number of revolutions of the burnt

gas suction fan in order to meter the exact combustion air quantity to be conveyed to the firebox.

These and other objects which will be more apparent in the course of the description are attained according to the invention by an automatic device for modulating the flow of combustion air and gas in a gas heating apparatus provided with a suction fan for the burnt gas, which is characterized in that it comprises:

- a control means for controlling the number of revolutions of the suction fan depending on the desired water temperature,

- a pneumatic circuit connecting the inlet of the sucked combustion air to the bottom of the firebox,

- a venturi arranged in said pneumatic circuit, and

- a transducer for metering the combustible gas, arranged in this pneumatic circuit and controlling the combustible-gas metering valve.

According to a feature of the present invention, said combustible gas metering transducer can be a diaphragm transducer, a piston transducer or a transducer of any other pneumatic type.

According to another feature of the present invention said pneumatic circuit connecting the inlet of the sucked combustion air to the bottom of the firebox can be comprised of a conduct deriving, for example, from the venturi.

According to still another feature of the present invention a probe is provided for measuring the preset temperature of the water in the boiler and supplying a control signal to the means for controlling the number of revolutions of the suction fan in order to change the revolving speed of the latter with the change of the water temperature.

The invention will be now described in more detail in connection to a preferred embodiment thereof, given by way of example only and therefore not intended in a limitative sense, illustrated in the accompanying drawing, wherein the sole Figure diagrammatically shows the pneumatic circuit for controlling the opening of the combustible gas valve depending on the number of revolutions of the fan, with the metering transducer in greater scale.

As can be seen from the drawing, there is diagrammatically shown a gas heating apparatus, in this case a gas boiler, comprising a firebox 1, in the lower portion of which the burner 2 is arranged, which is fed with combustible gas through the

metering valve 3. Above the burner 2 a heat exchanger 4 is provided which is intended to exchange the heat between the burnt gas and the heat carrier fluid. The top wall of the firebox 1 has an outlet 9 in which a centrifugal suction fan 5 is arranged, which sucks the exhausted gas in the firebox 1 following the path indicated by the arrows 11 and conveys them to the outlet 12. The centrifugal suction fan 5 is provided with an electronic control device 6, for example a TRIAC, the function of which is to control the revolving speed of the motor actuating the centrifugal suction fan 5.

A conventional potentiometer for controlling the thermal power and usually employed in the boilers generating warm water of this type has the function to preset the revolving speed of the suction fan 5 and therefore the feeding pressure of the combustible gas to the nozzles of the burner 2 depending on the heating apparatus demand, so as to provide the heating capacity required by the boiler. The number of revolutions of the suction fan 5, when the boiler is heating the sanitary water, is independent from this position.

From the inlet 10 the combustion air is sucked in the direction of the arrows 13 and is forced through a venturi, generally indicated with 7 and then down the firebox in order to feed the burner flame. From the venturi throat a pneumatic circuit is derived, which is formed of the conduct 8 connected to the firebox 1. In the conduct 8 forming the control pneumatic circuit a metering transducer 14 is inserted upstream the inlet in the firebox 1, which acts directly on the metering valve 3 of the combustible gas by opening or closing it depending on the pressure differential acting on both sides of the metering transducer 14.

In the case represented in the drawing, the metering transducer has a diaphragm 16 separating the housing 15 of transducer 14 in a pair of variable volume chambers 17,18, but it could be also a pneumatic transducer of different type, for example a piston transducer or a transducer of any other type. The chamber 18 is subjected to the pressure  $p_1$  in the firebox 1 and the chamber 17 is subjected to the pressure  $p_2$  generated in the venturi 7 and prevailing in the conduct 8. When the pressure  $p_2$  in the conduct 8 is lower than the pressure  $p_1$  in the firebox, the gas valve 3 is closed and *viceversa*, when the pressure  $p_2$  in the conduct 8 is higher than the pressure  $p_1$  in the firebox, the gas valve 3 is opened.

In the boiler an electronic control center unit is provided which usually comprises a temperature selector for the sanitary water and a temperature selector for the heating water which are of a conventional type and therefore not shown in more detail. Also a flame control center unit is provided, which is also of conventional type and therefore not

shown in more detail.

In the heating water circuit a probe is provided, the function of which is to detect the water temperature on the delivery side of the heating apparatus and to supply its signal to the regulator 6 of the number of revolutions of the suction fan 5 through the electronic control center unit.

The operation of the gas boiler provided with the centrifugal suction fan for sucking the burnt gas and the automatic modulator device according to the invention is as follows.

When the boiler is to be started the suction fan 5 causes a suction in the firebox 1 and therefore a vacuum, while at the same time ejecting through the outlet conduct 12 the burnt gas passing through the heat exchanger 4 which heats the water to be conveyed to the thermal radiators of the heating apparatus.

The suction caused by the suction fan 5 in the firebox sucks the combustion air from the outside through the air inlet 10 and conveys it through the venturi 7. The sucked air in the venturi generates a vacuum which, through the conduct 8, acts on the metering transducer 14, the diaphragm 16 of which, depending on the pressure differential between the chambers 17 and 18 of transducer 14, controls the opening degree of the gas valve 3. Therefore, the higher the speed of the suction fan 5 the higher the combustible gas demand and *viceversa*, in the case of low rotation condition of the fan.

It is therefore evident that, by changing the revolving speed of suction fan depending on the thermal loads of the boiler, a control of the sucked combustion air flow rate and of the gas flow rate to the burner will be obtained. The probe in the warm water circuit is intended to measure the water temperature in the boiler and to convey the information about this temperature to the control center unit. As the water is heating, the probe supplies its signal, as already said, to the control center unit which supplies a control signal to the regulator 6 of the revolving speed of suction fan, which reduces its revolving speed so as to conform it to the changed temperature conditions. This procedure is repeated until the water temperature reaches the preset value, i.e. the suction fan decreases its revolving speed with the increase of the water temperature. The sanitary and heating water temperature can be selected and controlled independently from each other. Preferably, there is only a probe which compares the water temperature of the primary circuit or heating circuit with the preset temperature of the water of the sanitary fittings or with the preset temperature for the heating apparatus, depending on the required user. The modulation carried out by the device according to the invention controls the suction fan so as to cause a

change of the number of revolutions thereof and therefore a change of the combustible gas flow rate to the burner 2 in order to allow the water temperature to be maintained to the value preset by the users and therefore, when the temperature decreases, the number of revolutions of fan increases and when the temperature increases, the number of revolutions of fan decreases.

From the foregoing the advantages offered by a gas boiler provided with the device according to the invention can be readily appreciated, which can be summarized as follows.

1) Reliability of the dependence of the combustion air flow on the combustible gas flow in order to maintain the boiler efficiency and the preset temperature of the outlet water for the user constant in the whole range of changes of thermal power provided by the boiler.

2) Maintenance of the boiler efficiency to a value as high as possible by changing on the one hand the revolving speed of the suction fan and by metering on the other hand the exact air quantity by means of the pneumatic modulator device.

3) Inner safety of the system because both flows (air and gas) operate in a strict relationship therebetween.

4) Reliability that the boiler operates at any time with high and constant efficiency depending on the user demands and with a hygienic level of the combustion within the limits set by the standards in any operating conditions.

While the invention as been illustrated and described only in connection to a preferred embodiment thereof, it is understood that all the modifications and changes within reach of those skilled in the art and within the scope of the annexed claims can be made thereto. In particular, the metering transducer of the combustible gas can be of a design different from the diaphragm transducer.

## Claims

1) Automatic device for modulating the flow of combustion air and gas in a gas heating apparatus provided with a suction fan for the burnt gas, characterized in that it comprises:

- a control means for controlling the number of revolutions of the suction fan depending on the desired water temperature,
- a pneumatic circuit connecting the inlet of the sucked combustion air to the bottom of the firebox,
- a venturi arranged in said pneumatic circuit, and
- a transducer for metering the combustible gas, arranged in this pneumatic circuit and controlling the combustible gas metering valve.

2) Automatic modulator device according to claim 1, characterized in that said combustible gas metering transducer is a diaphragm transducer.

3) Automatic modulator device according to claim 1, characterized in that said pneumatic circuit connecting the inlet of the sucked combustion air to the bottom of the firebox is comprised of a conduct deriving from the venturi throat and opening to the bottom of the firebox.

4) Automatic modulator device according to anyone of the preceding claims, characterized in that a probe is provided for measuring the preset temperature of the water in the boiler and supplying a control signal to the means for controlling the number of revolutions of the suction fan in order to change the revolving speed of the latter with the change of the water temperature.

5) Automatic modulator device according to claim 2, characterized in that the diaphragm of the combustible gas metering transducer is connected to the regulator or servoregulator of the combustible gas valve.

