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(71) Applicant *(for all designated States except US)*: **BERTELLI & PARTNERS S.R.L.** [IT/IT]; Viale Europa, 188/270, I-37050 Angiari (Verona) (IT).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **BERTELLI, Pierluigi** [IT/IT]; Viale dei Caduti, 67, I-37045 Legnago (Verona) (IT).

(74) Agents: **RIPAMONTI, Enrico** et al.; C/o Giambrocono & C. S.p.a., Via Rosolino Pilo, 19/B, I-20129 Milano (IT).

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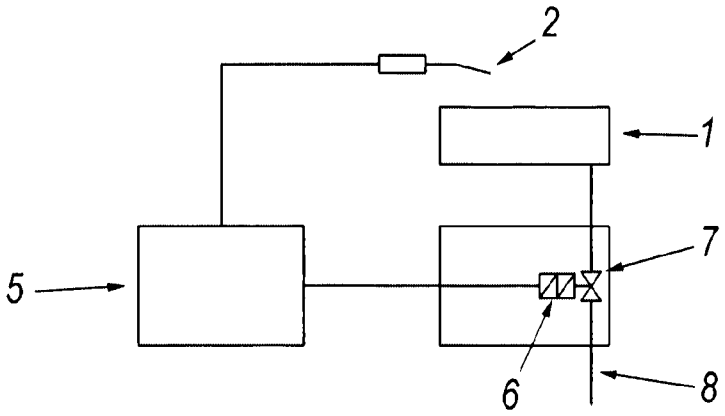

Fig. 1

(57) Abstract: A method for controlling a gas appliance or boiler to reduce the number of orifices positioned in corresponding gas feed lines to a burner (1), said gas being fed by a conduit in which a shut-off and/or turndown valve (7) is positioned, a flame sensing member (2) being provided in proximity to the burner, a control unit (5) being provided to command and control the correct operation of the appliance. This unit is connected to and controls the shut-off valve on the basis of the characteristics of the gas combustion in the burner and modifies the flow of this gas by intervening on the valve to achieve a combustion within predefined parameters independently of the type of gas fed, such orifices being at least partially replaced by a calibrated hole.

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IMPROVED CONTROL METHOD FOR A GAS APPLIANCE OR BOILER

The present invention relates to a method in accordance with the introduction to the main claim. The invention also relates to a gas appliance in accordance with the introduction to the corresponding independent claim.

In gas appliances the gas is fed to the burner/burners via calibrated holes or orifices which, in combination with the value of the pressure at the outlet of the gas valve, define the correct gas flow rate corresponding to the appliance working power. The calibrated hole or orifice is normally an independent component which is added to the gas feed line or directly to the burner, such that it can be replaced if the appliance is to be adapted to a different fuel gas type.

The need for the orifice or calibrated hole arises mainly because of the need to adapt the gas outlet pressures (from the burner feed lines) to the normal operating ranges of commercially available gas valves, because of the normal presence of a pressure regulation downstream of the cylinder in the case of LPG gas, because of the need to obtain correct gas-air mixing (by virtue of a predefined gas exit velocity from each individual orifice) and because of the impossibility of traditional systems to assess the respective situation.

For example, if there is a boiler set to operate on methane, its conversion to LPG requires replacement of the orifices with orifices of smaller diameter to be able to work with higher gas valve outlet pressures. This conversion also requires the gas valve to be calibrated, whether provided with mechanical calibration (mechanical stops) or electronic calibration (solenoid or motor operated actuators for regulating the gas flow). If the methane orifices were not replaced by specific LPG orifices, there would be an increase in gas flow (and hence in burnt power) indicatively of about 50-70%.

The result of all this would be combustion falling outside the "clean" parameters permitted by regulations (hence combustion dangerous to the environment and potentially to man, and the risk of damage to the burner and/or heat exchanger of the gas appliance, with potential danger to persons or things (for example danger of fire).

The need for replaceable orifices or calibrated holes on the gas feed line to the burner (also positioned at this latter) involves a substantial additional cost for the manufacturer of such gas appliances in that, for example on atmospheric ramp burners, it is normal for 5-20 orifices to be present, having to be prepared and inserted manually by the manufacturer during boiler construction and by the installer during conversion to a different gas type. A similar situation exists on premixed burners in which although only one orifice is present, it is normal to have to change the orifice on conversion to the gas family used (for example from natural gas to LPG gas, i.e. from 2nd family to 3rd family).

Conversion to a different gas type by replacing the orifices is also often required to be carried out by the installer, a whole case history of damage to things and persons being known because of errors in appliance conversion.

An object of the present invention is to provide a method and an appliance in which this method is implemented, which represent improvements on corresponding known methods and appliances.

A particular object of the invention is to provide a method for controlling a gas appliance which enables this latter to be used with any type of gas, without it being necessary to "mechanically" modify or adapt said appliance (or boiler) to a particular gas or gas family.

Another object is to provide a method of the stated type by which the boiler can operate in accordance with optimal combustion parameters for every type of gas and enables combustion situations with parameters not accepted by

regulations to be avoided, but always with parameters such as to achieve a non-pollutant combustion.

A further object is to provide a method of the stated type which enables the boiler to operate correctly and safely.

Another object is to provide a gas appliance or boiler in which the aforeindicated method is implemented and which has low production and installation costs.

These and other objects which will be apparent to the expert of the art are attained by a method and a gas appliance in accordance with the accompanying claims.

The present invention will be better understood from the accompanying drawings, which are provided by way of non-limiting example and in which:

Figure 1 shows a block diagram of the gas boiler or appliance in which a method according to the invention is implemented; and

Figure 2 shows a flow diagram of a method according to the invention.

With reference to said figures, Figure 1 shows a simplified block diagram of some elements (useful for understanding the present invention) of a gas boiler or appliance formed in accordance with the invention. The boiler comprises a burner 1 in proximity to which an electrode (or equivalent member) 2 is positioned to sense the flame level of the burner 1. This sensing electrode or member 2 is associated with its own known electronic circuitry (not shown), and operates by generating an electrical signal corresponding to the combustion "quality", i.e. by sensing if it takes place without generating pollution and is within regulation limits.

The electrode 2 is connected to a preferably microprocessor unit 5 adapted to control the correct operation of the boiler. More specifically, this control by the unit 5 takes place via the flame signal (originating from the electrode) used as feedback for a control loop which also comprises an actuator 6 for a modulating

valve 7 (i.e. for shut-off and/or turndown) for the gas flow towards the burner and positioned in a gas feed line 8 to the burner. This feed line 8 is connected to one or more gas feed conduits (not shown) associated with the burner.

Each gas feed line is without orifices specifically arranged for a particular gas type with which the boiler can operate. If the burner is provided with a plurality of gas feed lines, at least part of these lines (if not all) are not provided with specific gas orifices, but instead comprise a simple calibrated hole usable with any gas fed to the burner.

After a start step (block 10) in which the burner is activated by opening the valve 7, the method of the invention comprises activating a combustion control algorithm (block 11). This control can be implemented, in known manner, on the basis of monitoring the flame via the electrode 2 or by the possible use of other sensors (of known type, such as a CO sensor, lambda probe, etc.) measuring the combustion.

The control can also be carried out in accordance with PCT application No. PCT/IT2010/000126 in the name of the same Applicant, according to which the control unit 5 cooperates with a memory unit (not shown) in which a plurality of optimum boiler working conditions are store, conditions which are functions of characteristics related to the flame, to the thermal power and to the lambda value, and are represented on operating curves. According to this control method, the boiler operating point is determined on one of these curves, the combustion air/gas ratio is modified starting from a current operating value, displacing this operating point along the curve, checking if that ratio variation arrives at a predefined value, and if this is the case then restoring a preceding air-gas ratio of correct operation, whereas if this is not the case the gas flow is modified to achieve an optimal combustion ratio.

The subsequent block 12 evaluates whether combustion has started and is

within the parameters and is non-polluting or whether it is found to be outside these parameters.

If the response is negative (combustion within regulation parameters), the gas flow to the burner is increased by acting via the unit 5 on the valve 7 (block 13) to at most a predetermined maximum value, and the process then terminates (block 14).

If the response is positive (combustion outside regulation parameters), the gas flow is decreased (block 15) and it evaluates whether a minimum flow value has been reached (block 16). If it is in this condition, possibly after a succession of flow modifications, the burner is halted (block 17), because a malfunction condition is sensed such as to make it opportune to block or halt the appliance to avoid potential damage or danger, and maintenance is requested. If it is not in this condition and the gas flow reduction by the actuator 6 of the valve 7 brings the boiler into an operating condition within accepted limits, the achieved situation is maintained as operation is taking place correctly. The procedure hence terminates (block 14).

The control unit 5 maintains the valve 7 in the attained position as long as the gas within the system or appliance remains at a flow rate such as to enable correct combustion with the passage of time.

Consequently, by using combustion control based on commanding the gas valve by electronic control (for example by feedback deriving from the flame signal), a bad combustion condition (which can be due to the presence of the wrong type of gas) can be sensed, and action be taken in the following manner:

- reducing the gas flow (by acting on the actuator of the gas valve 7) until shutdown is achieved if correct combustion operation is not achieved;
- ensuring emergency operation where possible and indicating the irregularity to the installer, who will then set the pressure of the exit gas to adapt it to the gas

type in use, so restoring correct working conditions;

- automatically intervening on the pressure setting (in the case of a gas valve without mechanical calibration).

In any event, correct and safe boiler operation is guaranteed under any condition.

Hence by using correct combustion control (such as the aforestated procedure based on operating curves or another method based on flame monitoring or with the addition of other combustion sensors), where the burner type and form ensure correct air/gas mixing, the requirement for interchangeable orifices associated with the gas feed lines disappears.

By virtue of the invention the same boiler model or a defined power of a gas appliance can be used for all gas types, without the need to modify the orifices on the basis of the gas fed to the appliance. This simplifies the installation by the installer/maintenance personnel who, to adapt the boiler to the particular gas have merely to act on a parameter of configuration of the control unit (or rather on its control algorithm) on the basis of the combustion datum (flame) determined.

Hence the interchangeable orifices can be totally replaced by substituting them with a simple calibrated hole on the gas feed side to obtain maximum cost advantage during boiler production. Moreover, on premixed burners controlled by an automatic combustion control system (controlling the air/gas ratio) adapting to the gas type, the presence of a different gas type during installation can be indicated by monitoring the gas valve control parameters or the flame signal dynamics, based on a definite working power or combustion value (greater or lesser gas valve opening to obtain the same combustion datum or greater or lesser flame signal dynamics for equal working conditions), so warning the installer of the need to modify the gas family configuration

parameter.

A particular embodiment of the invention has been described. Others are however possible while remaining within the scope of the accompanying claims.

CLAIMS

1. A method for controlling a gas boiler provided with a burner (1) and comprising a control valve (7) for the gas fed to the burner (1), means (2) for sensing the flame present in this latter and means (5) for controlling functional members of the boiler such as said gas valve (7), this latter being positioned in a conduit (8) feeding gas to at least one gas feed line connected to the burner, characterised by controlling the gas combustion in the burner (1) and intervening on the gas valve (7) on the basis of the combustion datum to modify the gas flow to the burner (1) whenever the combustion datum indicates incorrect combustion, and to return said datum to within predefined parameters, said control being implemented independently of the gas fed to the burner and of the particular setting of the burner to operate with a particular gas type.

2. A method as claimed in claim 1, characterised by replacing at least one orifice of a corresponding gas feed line connected to the burner with a calibrated hole, said hole being independent of the gas type fed to the burner.

3. A method as claimed in claim 1, characterised in that the combustion control comprises monitoring the burner flame by the flame sensing means (2).

4. A method as claimed in claim 1, characterised in that combustion control takes place by determining the boiler operating point on an operating curve thereof when under operating conditions, and modifying the combustion air/gas ratio starting from a current or actual operating value, such as to displace this operating point along the curve, then checking if this ratio variation reaches a predefined value, and in that case considering the combustion at said operating point to be correct and restoring the preceding air-gas operating ratio or, in the opposite case modifying the gas flow to achieve an operating point of non-pollutant combustion, or proceeding with halting the appliance.

5. A method as claimed in claim 1, characterised in that the intervention on

the gas valve (7) takes place by acting on an actuator (6) of said valve.

6. A method as claimed in claim 1, characterised by verifying the operating parameters of the gas valve (7) and/or of the variation in a combustion control datum such as a signal originating from the flame sensing means (2), and identifying the feed gas type then, as a result of this, intervening automatically or manually on the burner operating parameters.

7. A device for controlling a gas boiler provided with a burner (1) and comprising a control valve (7) for the gas fed to the burner (1), means (2) for sensing the flame present in this latter and means (5) for controlling functional members of the boiler such as said gas valve (7), this latter being positioned in a conduit (8) feeding gas to at least one gas feed line connected to the burner, characterised by comprising in said feed line a calibrated hole usable for any feed gas.

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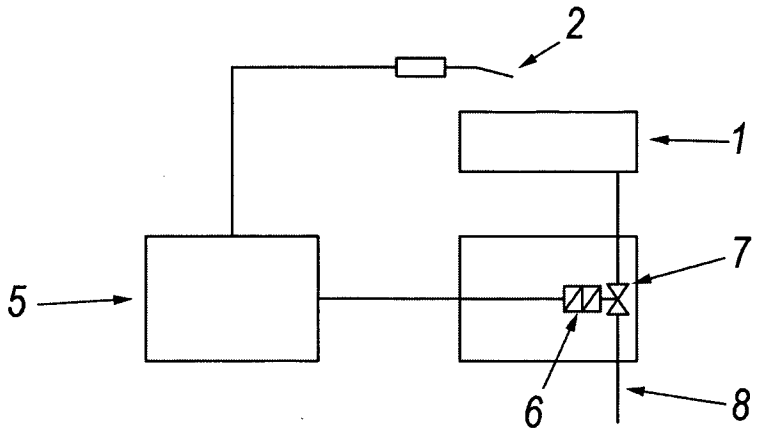

Fig. 1

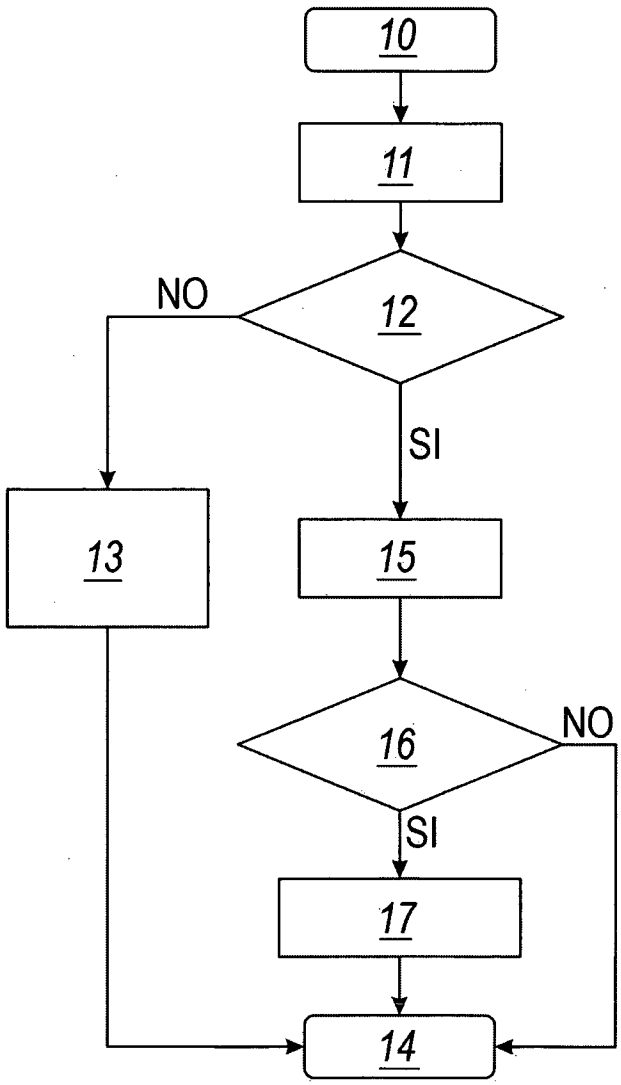

Fig. 2