

[54] **CONTROL OF BURNERS**

[75] Inventors: **Joshua Swithenbank**, Hathersage, near Sheffield; **David Shaw Taylor**, Sheffield, S11 9AU, both of England

[73] Assignee: **Land Pyrometers Limited**, England

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236/15

[56]

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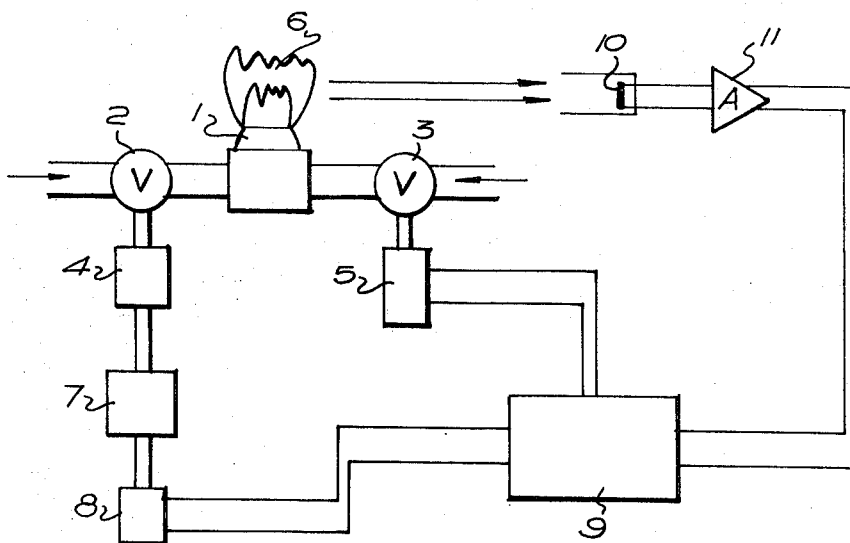
Primary Examiner—Edward G. Favors
Attorney—Lowe & King

[57]

ABSTRACT

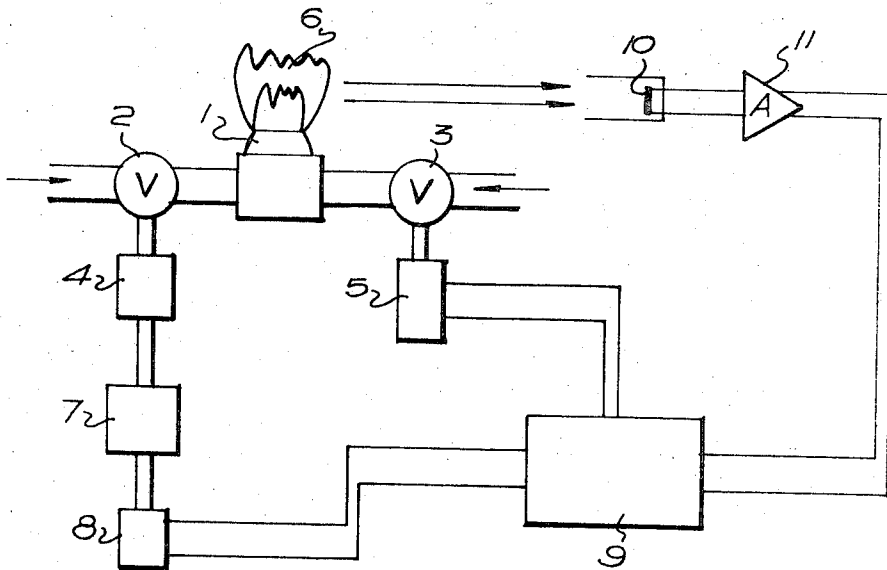
The control of the reactant flow ratio to a burner is effected by applying determined fluctuations to the flow of one reactant to the burner, detecting radiation from the flame from the burner, correlating the fluctuations in the radiation with the applied fluctuations, and utilizing the polarity of the correlation to effect the appropriate adjustment of the reactant flow ratio to the burner.

9 Claims, 1 Drawing Figure



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INVENTORS,
JOSHUA SWITHENBANK
DAVID SHAW TAYLOR
BY *Lowe & King* ATTORNEYS

CONTROL OF BURNERS

This invention relates to the control of burners, e.g., for boilers or furnaces, and has for its object the provision of control means for automatically ensuring stoichiometric combustion or other desired combustion conditions (i.e., nearly stoichiometric) of one or more burners.

According to the present invention, control means for the reactant flow ratio for at least one burner comprises at least one valve for controlling the general level of flow of a reactant to the burner, a variator for applying to the flow periodic fluctuations of small amplitude and low frequency as compared with the natural frequency of flame flicker, a detector for radiation from the flame from the burner, and for emitting a signal corresponding to the radiation, phase-sensitive detector means for assessing the polarity of any correlation between the applied fluctuations and the signal for the radiation detector, and an adjuster responsive to the polarity of the correlation assessed by the phase-sensitive detector means for adjusting the reactant flow ratio at the burner.

The relative phase (i.e., the polarity of the correlation) of the applied fluctuations and the determined fluctuations of the detected radiation will vary as the mixture at the burner varies on either side of the stoichiometric ratio. For example, lean and rich mixtures of fuel (whether gaseous, liquid or solid, (e.g., pulverized fuel) and oxidant (e.g., air) will result in equal signal frequencies, respectively inphase and anti-phase, or vice versa depending on which is caused to fluctuate, while a stoichiometric mixture will result in the frequency of the signal from the detector being twice that of the applied fluctuations.

The adjustment of the reactant flow ratio at the burner may be applied to the flow to which the fluctuations are applied (and clearly must be if only the fuel supply is valve-controlled, the oxidant flow being induced by the fuel flow or by the draught), or the adjustment may be applied to the flow of another reactant (e.g., oxidant) to the burner.

The or each valve may be provided with an electrical actuator for setting the general level of flow, and the variator may be an electrical (or electronic) oscillator the input frequency of which is compared with the frequency of the detected signal. Alternatively, the or each valve may be provided with a mechanical, or a hydraulic or pneumatic actuator, the variator being a corresponding vibrator, and a transducer being provided to produce from the vibrator an input signal for the phase-sensitive detector means to correlate with the output signal from the radiation detector. In each case the actuator may serve as an adjuster for the valve member if that valve is to be used to effect the adjustment of the reactant flow ratio at the burner.

Again, the variator may be the valve member controlling the flow to which fluctuations are to be applied (or a component associated therewith), the valve member having a natural frequency under conditions of gas flow, a transducer being provided to produce from the valve member an input signal for the phase-sensitive detector means to correlate with the output signal from the radiation detector, and again, an actuator for setting the general level of flow of the valve may also serve as an adjuster for the valve member if that valve is to

be used to effect the adjustment of the reactant flow ratio at the burner.

For an installation utilizing a number of burners, individual valves are provided for controlling the general level of flow of reactant to the burners, individual variators are provided for applying fluctuations to the flows to the different burners and individual adjusters (which again may be actuators for the valve members) are provided for adjustment of the reactant flow rates at the different burners, sufficient differences being provided between the fluctuations applied to each (e.g., non-harmonically related frequencies) to enable the phase-sensitive detector means to differentiate between the fluctuations of the radiation from the flames from the different burners, for the adjuster of the appropriate burner to be operative, and individual radiation detectors are provided for the different burners, or a single radiation detector serves for all the burners by switching the phase-sensitive detector means sequentially to examine and adjust the flame from each burner. Alternatively, a single radiation detector may serve for all the burners by applying the fluctuations to one burner at a time, and switching the appropriate adjuster to the phase-sensitive detector means.

Control means according to the invention may be adapted for the detection of failure of a burner or any one or more of a number of burners (and even the extinction of the flame in a single-burner installation may be difficult to detect by conventional means for some time after extinction has occurred) as is described by a co-pending application Ser. No. 137,804.

The radiation detected may be the electromagnetic radiation emitted by the flame in the ultra violet, visible or infra-red region of the spectrum, or any other radiation from the flame which exhibits variations in magnitude which bear a positive relation to the combustion intensity of the flame and which is capable of translation into an electrical effect by suitable detector.

The invention will now be described further with reference to the accompanying drawing, which shows, by way of example only, in diagrammatic form, an arrangement for one burner only, but reference will be made as to how this can be modified for use with a multi-burner installation.

The flows of gaseous fuel and air to a burner 1 are controlled by valves 2, 3 respectively, the positions of which are set and adjusted by actuators 4, 5 and the mean position of the valve 2 is set to give the flow necessary for the desired size of flame 6. Periodic fluctuations are applied to the valve member (not visible) of the valve 2, through the actuator 4, by a mechanical (or hydraulic or pneumatic vibrator 7, so that (for example) a one per cent oscillatory change of flow through the valve 2 takes place at a frequency of (say) 10 cycles per second. A transducer 8 coupled to the vibrator 7 gives a signal proportional to the applied fluctuations, which signal is fed into a phase sensitive detector 9 for correlation with a signal from a radiation detector 10 and amplified by an amplifier 11. Any component of the signal from the radiation detector 10 that is at the same frequency as the applied fluctuations is caused to operate the actuator 5 of the air control valve 3. An in-phase signal (the result of a lean fuel/air mixture) will cause the valve 3 to close a little, while an anti-phase signal (the result of a rich fuel/air mixture) will cause the valve 3 to open a little more, and the adjustment ef-

ected by the actuator 5 until no signal exists at the applied frequency.

For a multi-burner system controlled by basically the same arrangement, each burner will be provided with the items covered by reference numerals 2 to 8 and the items 5 and 8 will be connected to the phase-sensitive detector 9 through a multi-pole switch (not shown), whereby sequential switching to each burner arrangement can be effected in turn, the one radiation detector 10 serving for all the burners by arranging that the frequencies of the fluctuations applied by the respective vibrators 7 are non-harmonically related. Alternatively the fluctuations could be applied to one burner at a time so that the radiation detector 10 can create only one signal for correlation with the applied fluctuations. Yet again, individual radiation detectors may be provided for the different burners, the frequencies of the fluctuations applied by the respective vibrators 7 again being non-harmonically related. In each case the appropriate actuator 5 is operated to effect the necessary adjustment of its valve.

What we claim is:

1. Control means for the reactant flow ratio for at least one burner comprising at least one valve for controlling the general level of flow of a reactant to the burner, a variator for applying to the flow periodic fluctuations of small amplitude and low frequency as compared with the natural frequency of flame flicker, a detector for radiation from the flame from the burner and for emitting a signal corresponding to the radiation, phase-sensitive detector means for assessing the polarity of any correlation between the applied fluctuations and the signal from the radiation detector, and an adjuster responsive to the polarity of the correlation assessed by the phase-sensitive detector means for adjusting the reactant flow ratio at the burner.

2. Burner control means as in claim 1 wherein the valve is provided with an electrical actuator connected to the valve member for setting the general level of flow, and the variator is an electrical oscillator the input frequency of which is compared with the frequency of the detected signal.

3. Burner control means as in claim 1 wherein the valve is provided with a mechanical actuator connected to the valve member for setting the general level of flow, and the variator is a corresponding vibrator, a transducer being provided to produce from the vibrator an input signal for the phase-sensitive detector means to correlate with the output signal from the radiation detector.

4. Burner control means as in claim 1 wherein the variator is the valve member controlling the flow to which fluctuations are to be applied, the valve member having a natural frequency under conditions of gas

flow, and a transducer is provided to produce from the valve member an input signal for the phase-sensitive detector means comparator to correlate with the output signal from the radiation detector.

5. Burner control means as in claim 1 wherein the valve is provided with an actuator for setting the position of its valve member.

6. Burner control means as in claim 5, wherein the actuator of the valve also serves as the adjuster.

7. Burner control means as in claim 1 for an installation utilizing a number of burners, wherein individual valves are provided for controlling the general level of flow of reactant to the burners, individual variators are provided for applying fluctuations to the valve members of the different valves, and individual adjusters are provided for adjustment of the reactant flow rates at the different burners, sufficient differences being provided between the fluctuations applied to each to enable the phase-sensitive detector means to differentiate between the fluctuations of the radiation from the flames from the different burners, for the adjuster of the appropriate burner to be operative, and individual radiation detectors are provided for the different burners.

8. Burner control means as in claim 1 for an installation utilizing a number of burners, wherein individual valves are provided for controlling the general level of flow of reactant to the burners, individual variators are provided for applying fluctuations to the valve members of the different valves, and individual adjusters are provided for adjustment of the reactant flow rates at the different burners, sufficient differences being provided between the fluctuations applied to each to enable the phase-sensitive detector means to differentiate between the fluctuations of the radiation from the flames from the different burners, for the adjuster of the appropriate burner to be operative, and a single radiation detector serves for all the burners, and means for switching the phase-sensitive detector means to be sequentially responsive to the single radiation detector to examine and adjust the flame from each burner.

9. Burner control means as in claim 1 for an installation utilizing a number of burners, wherein individual valves are provided for controlling the general level of flow of reactant to the burners, individual variators are provided for applying fluctuations to the valve members of the different valves, and individual adjusters are provided for adjustment of the reactant flow rates at the different burners, and a single radiation detector serves for all the burners by applying the fluctuations to one burner at a time, and means for switching the appropriate adjuster to the phase-sensitive detector means.

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