(12) UK Patent Application (19) GB (11) 2 165 347 A

(43) Application published 9 Apr 1986

(21) Application No 8425021

(22) Date of filing 4 Oct 1984

(51) INT CL⁴
F23D 14/22

(52) Domestic classification
F4T HC S6E2 S6E3 S6E4 S6E5
U1S 1976 F4T

(56) Documents cited
GB A 2018970 GB 1405093 EP A1 0044670
GB 1537239 GB 1057926 EP A2 0015480

(58) Field of search
F4T

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(54) Burner air/gas ratio control

(57) Apparatus for controlling the combustion of gas in a burner (eg for a domestic boiler) comprises a blower 9 for supplying air at one of two rates to combust the gas and a valve 12 for controlling the rate of flow of gas to the burner 3. The valve 12 is controlled by a control unit 15 which receives signals representative of the air pressure of the air delivered by the bloer 9. Depending upon whether the signal represents a high air pressure (high air supply rate) or a low air pressure (low air supply rate) the control unit 15 varies the valve opening so that the volume ratio of air and gas supplied to the burner remains constant.

FIG.1.

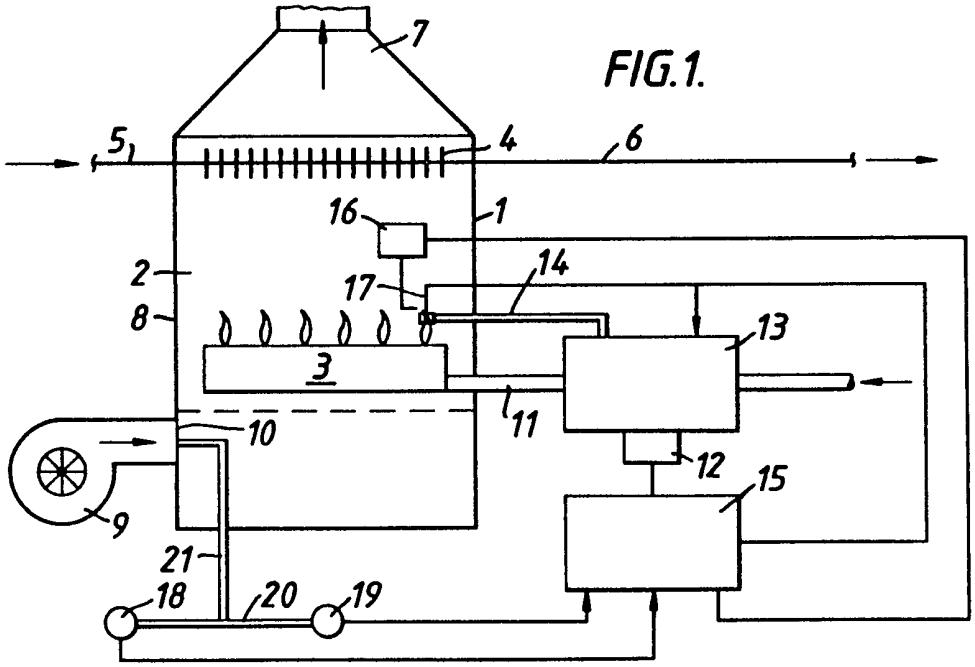

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FIG.1.

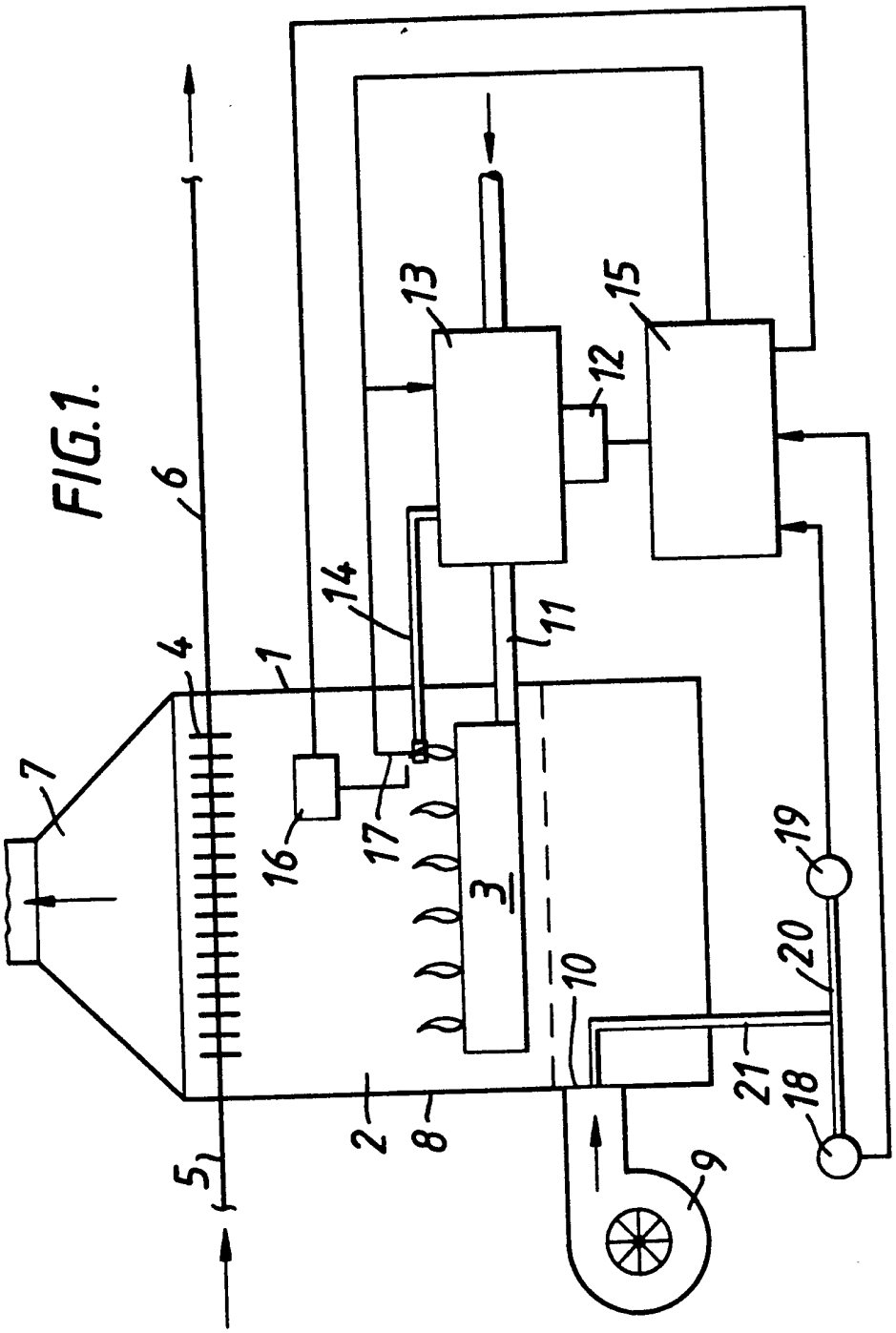
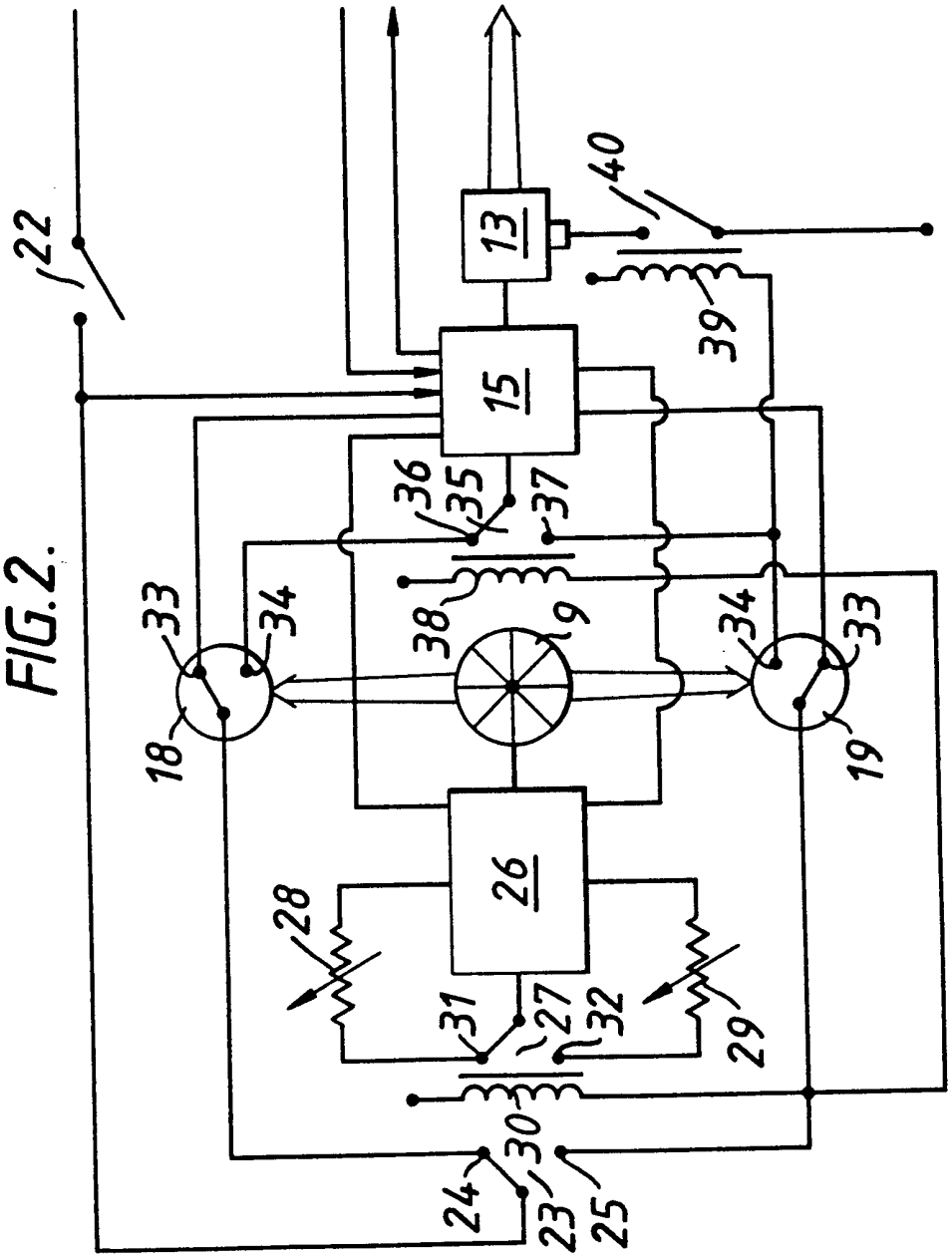


FIG.2.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SPECIFICATION

Developments in air/gas ratio

The present invention relates to apparatus for controlling the combustion of fuel in a burner which is supplied with fuel from a substantially constant pressure source.

The invention is particularly directed to the control of a burner for use in a forced draught domestic gas-fired boiler. This burner, which is usually of the so-called "partially aerated" type, is supplied with gas from the domestic gas supply. This supplies gas at a substantially constant pressure (set by a governor in or near the gas meter). In the type of burner mentioned a jet of gas is injected into the burner inducing the primary combustion air to produce a Bunsen type burner flame. However, because the set gas supply pressure is relatively low (about 20 m bar) only a proportion (40% to 60%) of the air required for complete combustion can be premixed with the gas. The remainder of the combustion air is derived from the surrounding environment. It is therefore necessary by careful appliance design to control the level of excess air such that there is an adequate supply of excess air to complete the combustion process, but in practice it is very difficult to ensure by design that the level of excess air is correct as the fuel supply rate is altered. Failure to control the level of excess air in a forced draught burner can result in incomplete and/or inefficient combustion.

It is therefore an object of the present invention to provide means whereby the excess air can readily be supplied at an adequate level at a number of different fuel rates.

According therefore to the present invention we provide apparatus for controlling the combustion of fuel in a burner which is supplied with fuel from a substantially constant pressure source, the apparatus comprising means for supplying air at a selected one of a number of possible flow rates for the combustion of the fuel in the burner, and valve means for controlling the rate of flow of fuel to the burner from the fuel source such that at the selected air flow rate, the volume ratio of air and fuel remains substantially constant.

The volume ratio of the air to fuel (in this case gas) may be preset at a level which ensures that there is sufficient excess air to provide safe combustion of the gas.

An embodiment of the invention will now be particularly described with reference to the accompanying drawings in which:

Figure 1 shows a schematic view of a domestic gas fired boiler which is controlled by the apparatus of the present invention, and

Figure 2 discloses the control circuitry of the apparatus.

Referring to Fig. 1, the boiler 1 comprises a housing 2 incorporating a partially aerated type burner 3 and a heat exchanger 4 having an inlet 5 and outlet 6 for water to be heated in the heat exchanger 4. The housing 2 terminates upwardly in a chimney or stack 7 for the exhaustion of flue gases produced by the burner 3 when heating water is flowing through the heat exchanger 4.

Secured to one side 8 of the housing 2 is an air blower or fan 9 driven by a motor capable of being speed controlled, which supplies air to the housing 2 through an inlet port 10 in the side 8 of the housing 2. The fan 9 operates at a low or high speed. Low speed operation generates a low air flow rate when the burner 3 is to operate at a low firing rate and consequently a low heat input. In this case of course the flow rate of gas to the burner 3 is also low. High speed operation generates a high air flow rate when the burner 3 is to operate at a high firing rate for a high heat input. In this case the flow rate of gas to the burner 3 is also high.

The burner 3 has an inlet 11 through which gas for combustion reaches the burner 3. The gas is supplied from a constant pressure source such as the governor of a domestic gas meter and reaches the inlet by way of a valve 12 which is of the modulating type, that is, its orifice area is infinitely variable between a fully open and a partially closed position. The valve 12 is part of a multi-functional control unit 13 of known type, this also incorporating a pilot gas supply valve (not shown).

A pilot gas burner 14 extends from the unit 13 for igniting the main gas burner 3, gas for the pilot burner 14 being controlled by the multi-functional control 13.

The unit 13 is itself controlled by an automatic sequence control unit 15 of known type. The unit 15 supplies power to an H.T generator 16 for generating high voltage sparks to ignite the pilot burner 14. Furthermore it is responsive to signals from a flame failure device 17 also of known type. This device 17 senses the presence of the pilot and main burner flame.

The unit 15 also receives signals from two air pressure switches 18 and 19. These switches 18 and 19 terminate at each end of a branch 20 of an air signal tube 21. This tube 21 terminates at the air inlet port 10 of the boiler housing 2 so as to sense the pressure of the air delivered by the fan 9. The operation and function of the air pressure switches will be described in more detail subsequently.

Referring to Fig. 2 components identical to those shown in Fig. 1 bear identical reference numerals. In Fig. 2, power to the circuit is supplied from a 240V AC supply controlled by an on-off switch 22. Power to the automatic sequence control unit is also supplied separately. The selection of the fan speed is determined by the state of the high-low switch 23. When the switch engages terminal 24, the fan 9 runs at a low speed whereas

when the switch engages terminal 25 the fan 9 runs at a high speed. The position of the switch 23 can be set manually depending on whether a low or high speed is required. The switch 23 can of course also be controlled by suitable thermostats (not shown) or other control devices responding to the temperature in the hot water and space heating loops of a central heating system in accordance with the desired thermal requirements in these loops.

The fan speed is controlled by a known type electronic fan speed controller 26. This is operable by a further switch 27 to select one of two variable resistors 28 and 29 depending respectively on whether low speed of high speed is required.

The switch 27 is controlled by a relay 30. When the relay 30 is deactivated the switch 27 engages a terminal 31 to select the low speed variable resistor 28 and when the relay 30 is activated the switch 27 engages a terminal 32 to select the high speed variable resistor 29. The relay 30 itself is controlled by the switch 23, the relay 30 being deactivated when the switch 23 is in position 24 and activated when the switch 23 is in position 25.

The air pressure switches 18 and 19 are of the two position type, each switch being connected to a terminal 33 in the deactivated state and to a terminal 34 in the activated state. Each switch is activated when the pressure of the air delivered by the fan 9 reaches a preset and adjustable level, the level for switch 18 being lower than that for switch 19 so as to provide the two burner firing rates.

When activated each switch 18 or 19 is connected to the unit 15 by a relay switch 35, the low pressure switch 18 being connected via a terminal 36 of the relay switch 35 and the high pressure switch 19 being connected via a terminal 37 of the switch 35. The relay 38 for controlling the relay switchf 35 is itself controlled by the switch 23 such that relay 38 is only activated when terminal 25 is selected. When relay 38 is deactivated, the switch 35 is in contact with terminal 36 and when relay 38 is activated, the switch 35 is in contact with terminal 37.

When the low pressure switch 18 has been activated and is connected to the unit 15 by the relay switch 35, the valve 13 is opened only sufficiently to supply gas at the low flow rate. When the high pressure switch 19 is activated a further relay 39 is activated (by power through the terminal 34 of the switch 19). This causes an on-off switch 40 to close and connect the valve 13 to a further dc voltage supply. This causes the valve 13 to open to an extent sufficient to provide gas at the high flow rate.

The sequence of operations for low and high firing rates are as follows:

(A) *LOW FIRING RATE SELECTED*

(1) Main switch 22 is closed.
(2) Switch 23 is set to position 24.
(3) Pressure Switch 18 is selected.
(4) The automatic sequence control unit 15 checks to see that the switch 18 is de-activated ie. engaging terminal 33.
(5) If th switch is at 33, the next stage at (6) proceeds. If switch is not at 33, the unit 15 opens the main switch 22. This must be reclosed manually to restart the sequence.
(6) Power is supplied to fan 9 via fan controller 26.
(7) Fan 9 increases its speed until it reaches the preset low speed and switch 18 opens to position 34.
(8) The air pressure switch 18 is activated to engage the terminal 34.
(9) The unit 15 opens the pilot valve in the multi-functional control 13 and turns on the spark generator 16.
(10) The pilot 14 ignites and the spark generator 16 is turned off.
(11) The heat of the pilot playing against the flame failure device 17 activates the modulating valve 12 of the multi-functional control 13. Since switch 40 is not closed no electrical signal is applied to the modulating valve 12, hence the low gas rate is supplied.
(12) The main burner 3 ignites from the pilot 14.
(13) The pilot 14 is then extinguished.

The unit 15 will cease operation whenever any of the following events occur:–

(a) The pressure switch 18 moves from position 34 at or after stage (7),
(b) The pilot does not ignite at stage (10),
(c) If the main burner fails during operation at or after stage (13).

Regarding (b) if the pilot does not ignite immediately, the spark generator is operated for a limited period, (eg. 5 seconds) and is then turned off. One more attempt to ignite the pilot is made and then unit 15 ceases operation.

The unit 15 must be reset manually and the sequence of operations proceeds starting from stage 2.

(B) *HIGH FIRING RATE SELECTED.*

The operations are the same as described above except for the following differences at the various stages:–

(2) Switch 23 is set to position 25.
(3) Pressure switch 19 is selected.
(4) The unit 15 checks that switch 19 is at de-activated position 33.
(7) Fan 9 increases speed until it reaches the preset high speed and switch 19 goes to position 34. Switch 40 closes to connect the valve 13 to the DC voltage supply.
(11) Since switch 40 is now closed an electrical signal is supplied to the modulating valve 12 and hence the high gas rate is supplied.

If at or after stage (7) the air pressure switch moves from position 34, the unit 15

ceases operation and must be manually reset. The sequence of operations then proceeds starting from stage (2).

It will be appreciated that the operation of the valve 13 can be closely controlled to ensure that the ratio of the air to gas reaching the burner is constant at each of the selected fan speeds.

Power to the electronic fan speed controller 26 is supplied by the unit 15.

The type of system described can be used in, for example, the low-energy or highly insulated housing where a high input rate eg. 8kW is required for the hot water duty and a much lower rate eg. 4kW is required for the space heating load with controlled levels of excess air at each load.

CLAIMS

1. Apparatus for controlling the combustion of fuel in a burner which is supplied with fuel from a substantially constant pressure source, the apparatus comprising means for supplying air at a selected one of a number of possible flow rates for the combustion of the fuel in the burner, and valve means for controlling the rate of flow of fuel to the burner from the fuel source such that at the selected air flow rate the volume ratio of air and fuel remains substantially constant.

2. Apparatus as claimed in Claim 1 in which the means for supplyingf air is adapted to supply air at a selected one of two possible flow rates.

3. Apparatus as claimed in Claim 1 or Claim 2 in which the air supplying means comprises a variable speed motor driven blower or fan.

4. Apparatus as claimed in any of the preceding claims in which means responsive to the pressure of the air exerted at the selected flow rates is provided to vary the valve opening whereby to control the rate of flow of fuel to the burner in the manner defined.

5. Apparatus substantially as hereinbefore described with reference to the accompanying drawings.

Printed in the United Kingdom for
Her Majesty's Stationery Office, Dd 8818935, 1986, 4235.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.