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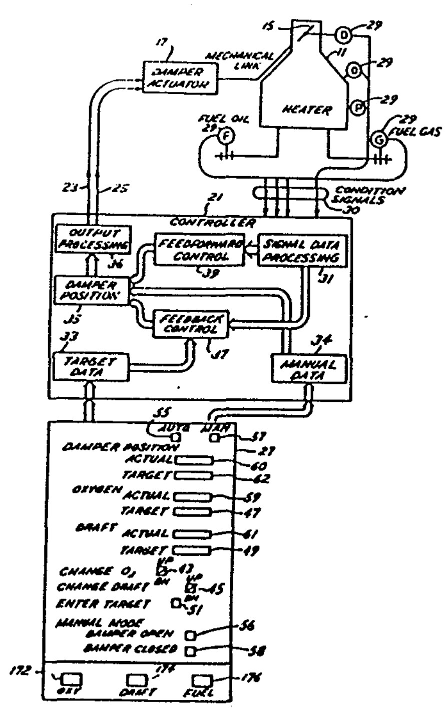
(54) **Damper controller for natural draft heater.**

(57) A stack damper controller for receiving operator input of a targetted combustion variable and for adjusting the position of the stack damper according to the target value. The controller may include a control logic module for each barrel of the heater, each module including several control loops. The apparatus for controlling at least one stack damper for maintaining stack oxygen content at an optimal level for minimising fuel consumption of a plurality of associated heater barrels in view of system conditions, comprises at least one fuel feed means for feeding fuel to at least one barrel; monitoring means (D.O.P.G.F.) for providing condition signals representative of a plurality of combustion system variables, the monitoring means measuring the excess stack oxygen level for each of the plurality of associated heater barrels and generating an excess stack oxygen signal for each of the barrels and also measuring fuel feed for each fuel feed means and generating a fuel entry signal associated with a fuel feed means; at least one damper control means responsive to a damper control signal for positioning a damper; and control means (21) including a logic module for each barrel.



EP 0 083 479 A1

"Damper Controller for Natural Draft Heater"

The invention relates to apparatus for minimising fuel consumption in a refinery furnace by maintaining the oxygen content at a low level under operating constraints, and more particularly relates to apparatus for controlling stack oxygen content and heater draft in relation to operator input of targetted excess stack oxygen and targetted heater draft. More, particularly, the present invention relates to a controller having standardised elements and to a controller which is easy to implement, operate and maintain for natural draft heaters having complicated arrangements of heater barrels and dampers.

The air supply rate within a natural draft process heater is controlled by adjusting the position of a stack damper. Earlier, dampers were set by hand. In recent years, automatic controls for dampers have been suggested and applied.

With respect to combustion processes in process furnaces, and the like, apparatus has been provided for controlling the air supplied to the furnace, close to the requirement for combustion in order to minimise heat loss to flue gas. Such apparatus have included large scale analog or digital calculating machines which utilise values of measured variables for automatically adjusting the air supplied to the furnace. The automatic control of the damper was based on flue gas oxygen content or was based on heater draft measurement, but not on both.

All such large scale computer systems of this type, however, involve very expensive equipment. The related application, above-identified, provides a highly welcomed simplified system. This system adds a feedforward feature to the control to respond to fuel changes. However, the simplified system utilises a single heater barrel having a single damper. The system herein described improves upon the system of the related application by providing a simplified system for a process heater having complicated arrangements of plural heater barrels. Moreover, the improved system is constructed to permit the heater to remain in operation even when one or more of the critical instruments measuring a combustion variable is out of service. Further, the system makes use of control by both excess oxygen and heater draft measurement.

An object of the invention is to provide a simplified controller for controlling the oxygen level in a combustion furnace in order to improve combustion efficiency.

A further object of this invention is to provide a controller which satisfies draft requirements and responds to fuel changes promptly to avoid fuel rich conditions.

A further object of the invention is to provide a controller which is applicable to a multi-barrel heater as well as a single barrel heater.

A further object of the invention is to provide a controller that can stay on control even if one of its critical input measurement instruments is out of service.

These and other objects are achieved in a stack damper controller for receiving operator input of a targetted combustion variable and for adjusting the position of the stack damper according to the target value. In one aspect of the invention, the controller includes a control logic module for each barrel of the heater. Each module includes several control loops.

The invention will now be described by way of example with reference to the accompanying drawings, in which:-

FIGURE 1 is a block diagram of the controller of the preferred embodiment of the invention, shown in relation to associated apparatus;

FIGURES 2A, 2B and 2C are diagram representations of different heater arrangements;

FIGURE 3 is a diagram representation of the heater arrangement of Figure 2C, together with its companion control circuitry;

FIGURE 4 is a logic block diagram of a control module used in each of the heaters of Figures 2A-2C;

FIGURE 5 is a logic diagram of the controller of the heater of Figure 2B;

FIGURE 6 is a logic diagram of an adapter of the logic of Figure 5;

FIGURE 7 is a logic diagram of the controller of the heater of Figure 2C; and

FIGURE 8 is a logic diagram of an adapter of the logic of Figure 7.

Referring to Figure 1, a refinery furnace or heater 11 receives fuel and control signals for performing a refinery heating process in which combustion is performed in the heater. The oxygen level necessary to perform the combustion is controlled according to the position of a stack damper 15 which is arranged in the top of the stack of the heater and is rotatable for changing air passage through the stack. Damper 15 is rotated under control of a damper positioner or actuator 17 which mechanically controls the position of damper 15.

A controller 21 is responsive to the operating conditions of heater 11 and to manual instructions of the operator, for controlling actuator 17 to change the position of damper 15. The position of damper 15 is automatically regulated by controller 21 for (1) controlling the oxygen supply in the stack close to the oxygen requirement for combustion, in order to achieve a minimum fuel consumption level in the heater and (2) controlling the heater draft at a level required by heater operation. Controller 21 generates a control output signal to actuator 17 to control the damper position.

An operator input device 27 permits the operator to transmit to controller 21 an oxygen target level indicative of a desired excess oxygen level above the oxygen combustion requirement, to be maintained in the stack. Device 27 also permits the operator to provide a draft target level to controller 21. The draft target level is of a desired draft through the heater combustion chamber. Controller 21 receives the target data and responsively controls the damper in order to establish the stack oxygen content and draft in conformance with the target values.

Monitoring transducers, indicated by diagram circles 29, are located within the heater and associated fuel and combustion control apparatus, for generating electrical analog signals indicative of the value of individual condition variables. The analog signals are transmitted to controller 21 along a plurality of leads 30. Controller 21 responds to signals developed along leads 30 and responsively controls the damper position.

In the preferred embodiment, controller 21 is constructed from a micro-computer which controls the overall system processing and management of controller 21. The microcomputer based controller performs a number of tasks which may be summarised as follows:

(1) analog condition signals are retrieved from leads 30 and processed to form signal data which are a measure of the condition variables, illustrated by control block 31;

(2) operator input data is received from input device 27 and target data indicative of a target excess oxygen level and of a draft level is stored in memory, illustrated by control block 33; manual operator input data of a desired damper position is received from input device 27 and is stored in memory as illustrated by control block 34;

(3) the signal data at 31 and operator input data at 33 are manipulated in order to formulate a damper position value at 35; also, data at 34 is manipulated in order to formulate a damper position value at 35; and

(4) a control output signal is generated by an output processing control 36 in view of the damper position value at 35 for controlling damper actuator 17, and other output signals are sent to input device 27 for displaying visual output information to the operator.

In general, controller 21 controls the position of damper 15 by two sources of control: (1) a feedback control, represented by a control block 37, and (2) a feedforward control, represented by a control block 39. The controller utilises feedback control 37 when positioning the damper responsive to the target data at 33. A conventional oxygen analyser (not shown) is located in the stack and monitors the excess oxygen level in the flue gas resulting from the combustion. When the measured excess oxygen level deviates from the target data, a damper position value at 35 may be generated by the controller and an output signal is responsively transmitted to actuator 17 to compensate for the deviation.

Similarly, a conventional draft monitoring device is located in the combustion chamber and monitors the draft in the heater. The heater draft is a negative pressure. When measured draft deviates from the target data, a damper position value at 35 may be generated by the controller.

A consolidated damper position is determined from the values generated from the draft control and oxygen control. The value representing the more open position of the damper is chosen. The output processing block 36 then generates the output signal representing the chosen damper position.

The controller utilises feedforward control 39 when positioning the damper in anticipation of an increased need for combustion air, responsive to detecting a demand for increased combustion. The analog signals on leads 30 will carry information of an increased demand in combustion, and controller 21 will respond accordingly, generating an anticipated damper position at 35, for appropriately adjusting the damper.

The effect of the feedforward control 39 and feedback control 37 are summed in order to generate a desired damper position, as described hereinafter. The preferred embodiment is described with five analog signals received along leads 30, representing the conditions of the following variables:

Damper Position	(D)
Stack Oxygen	(O)
Heater Draft	(P)
Fuel Gas Flow	(G)
Fuel Oil Flow	(F)

Each of the analog signals appearing along leads 30 are converted to digital data for storage in memory by controller 21, as represented by control block 31. As understood, transducers 29 which monitor the system variables may include conventional flow transmitters which monitor flow rate and generate signals related thereto, conventional position sensors for monitoring the positions of damper 15, a conventional excess oxygen analyser for monitoring excess oxygen level, a conventional draft sensor for monitoring heater draft.

Signal processing control 31 processes the signals developed along leads 30 for generating signal data in a form usable by controller 21. Initially the analog signals developed along leads 30 are converted to a digital signal by an analog-to-digital converter (not shown). After the analog signals are converted to digital signals, the digital signals are stored in memory in the form of digital data.

Operator input device 27 effectively inputs target values to the controller via manually operable switches 43, 45. Operation of switches 43, 45 respectively increment or decrement a number visually displayed on visual displays 47, 49 of the input device. As the operator moves either of switches 43, 45 to an upward mode or to a downward mode, the displayed value in respective displays 47, 49 increments or decrements according to the mode to which the switch is moved. When a display reaches a number desired by the operator, the operator discontinues actuation of the switch. Input device 27 then develops binary data signals representative of the values displayed on displays 47, 49 for transmission to controller 21.

Preferably, an Enter Target button 51 located on input device 27 is manually actuable by the operator for effectively entering the values displayed on displays 47, 49 into controller 21. The Enter Target button generates an interrupt signal to controller 21 for signalling the controller that the binary data signals representative of the values displayed in displays 47, 49 should be read from input device 27 and stored in memory at 33 as new target values.

Input device 27 includes an AUTOMATIC pushbutton switch 55 and a MANUAL pushbutton switch 57 for placing the system in an automatic or a manual mode. Controller 21 monitors the status of switches 55, 57. With switch 55 actuated, the controller performs its automatic function of controlling the damper position using feedforward control 39 and feedback control 37; with switch 57 actuated, the controller discontinues controlling the damper by the feedforward and feedback controls and instead controls the damper by manual data at 34 entered by the operator via input device 27. Switches 55, 57 may be lighted when pressed, for displaying whether the controller is in its manual or automatic mode.

Input device 27 includes a pair of manually operable pushbuttons 56,58. When actuated, pushbuttons 56,58 change the manual data at 34 in order to open or close the damper. The operator views visual display devices 60,62 during operation of pushbuttons 56,58. Display device 60 is controlled by controller 21 in order to display to the operator a visual indication of the monitored position of damper 15. Display device 62 displays the target damper position as input by the pushbuttons 56,58.

Three examples of different heaters are illustrated in Figures 2A,2B and 2C. Figure 2A illustrates a single barrel, single stack damper heater 63. As shown, fuel oil and fuel gas feed the single barrel and the combustion chamber draft and oxygen content of the stack are monitored.

Figure 2B illustrates a dual barrel, single stack damper heater 65. As shown, the same fuel oil line 67 and fuel gas line 68 feed both barrels 69,71 of the heater. Draft for each barrel is monitored at 73,75, as well as oxygen content for each barrel at 77,79. A single stack damper 81 is positioned for controlling combustion efficiency.

Figure 2C illustrates a triple barrel, triple stack damper heater 83 having three barrels 85,87,89. As shown, the same fuel oil line 91 feeds two of the three barrels, 85,89. Fuel oil line 93 feeds barrel 87. Also, the same fuel gas line 95 feeds barrels 85,89, a fuel gas line 97 feeds barrel 87. Draft for each barrel is monitored at 99,101,103, as well as oxygen for each barrel at 105,107,109. Three dampers 111,113,115 are positioned for controlling combustion efficiency.

The three heater arrangements of Figure 2 are given by way of example. As will suggest itself, other arrangements of multiple barrels and dampers may be controlled in accordance with the present invention.

The single barrel, single damper heater of Figure 2A is the same as that of Figure 1 and is controlled by a single controller as shown in Figure 1. The dual barrel, single stack damper heater of Figure 2B may be controlled by two controllers; however, the control output signals from the two controllers are consolidated into a single output signal to control the common damper. As will suggest itself, the number of separate microprocessors used may be one or two.

The triple barrel, triple damper heater 83 of Figure 2C utilises three (3) controllers as shown in Figure 3. Controllers 117,118 and 119 are utilised instead of a single controller. Controllers 118,119 monitor the combustion conditions associated with barrels 85, 89 and responsively position dampers 111,115. Controller 117 monitors the combustion conditions associated with barrel 87 and responsively controls damper 113. As illustrated, three damper actuators S are utilised for the three dampers.

As previously explained with respect to Figure 1, controller 21 includes a feedforward control and a feedback control. Also, a damper position control responds to the feedforward and feedback control for positioning the damper. These controlling functions are developed by a set of control logic utilised to do the following:

a. Maintain oxygen content in flue gas of a process heater closest to but not lower than target.

b. Maintain draft closest to but not less negative than target.

c. Respond to fuel increase promptly, but not to fuel decreases, to achieve the purpose of air to lead for fuel increase and air to lag for fuel decrease.

In order to provide the same basic logic design to various heater arrangements, a logic module is utilised for each barrel within the heater arrangement and an adapter logic block is utilised to handle the interaction between barrels.

Referring to Figure 4, a logic module is shown as having four (4) control loops: a fuel loop 121, an oxygen loop 123, a draft loop 125 and a damper loop 127. Fuel loop 121 forms the feedforward control 39 (Figure 1); whereas oxygen loop 123 and draft loop 125 form the feedback control 37. Damper loop 127 forms the damper position control 35.

Fuel loop 121 receives the monitored fuel oil rate at 129 and the monitored fuel gas rate at 131, which have been retrieved by the signal data processing section 31 (Figure 1) as previously described. A pair of multiplication logic blocks 133, 135 multiply the rate inputs by a fuel oil heating value and a fuel gas heating value. The oil heating value is received at input 137 of multiplier 133 and the gas heating value is received at input 139 of multiplier 135. Instruments are available which will monitor such heating values with time. Such monitoring devices transmit condition signals to signal data processing block 31 (Figure 1). On the other hand, fixed constants could be used where the fuel oil heating value and fuel gas heating value do not vary with time.

The heating values are in terms of BTU content per unit volume of fuel. Thus, the output data at nodes 141,143 of multipliers

133,135 is BTU. An adder block 145 receives the respective outputs from multipliers 133,135 in order to generate a total BTU value along output 147. A logic block 149 monitors the total BTU output to determine whether an increase in BTU is occurring. Block 149 compares the present BTU value with a previously monitored BTU.

If block 149 determines that there is not an increase in BTU, no change in damper position is requested from the fuel loop. Exit is made at 151 for repeating the fuel loop to monitor when an increase in BTU occurs.

If a BTU increase is occurring, a ratio block 152 determines the amount of change to be made to the damper. Ratio block 152 uses a ratio factor of the change of damper required for each unit of change of BTU. The amount of change in BTU (which is calculated at logic block 149) is multiplied by the ratio factor at ratio block 152. The resultant calculated change in damper position is sent to the damper loop at 153. This value is the feedforward request which asks the damper for more oxygen based on anticipated need due to increase in fuel.

Oxygen loop 123 includes an arithmetic logic block 154 which receives an input at 155 of the oxygen set point. The oxygen set point is entered by the operator from device 27 (Figure 1) and then is stored in target data block 33, as previously described. Stack oxygen is received at input 157 of logic block 154. Logic block 154 performs an algorithm using the oxygen set point and stack oxygen data in order to generate an output at 159 of a change in damper position. The algorithm determines how much of a change in the damper position is necessary in order to bring the stack oxygen equal to the oxygen set point. The algorithm is a conventional proportional-integral 2-mode formula.

Draft loop 125 includes an arithmetic block 161 which receives an input at 162 of the draft set point. The draft set point is entered by the operator from device 27 (Figure 1) and then is stored in target data block 33, as previously described. Draft is received at input 163 of logic block 161. Logic block 161 performs an algorithm using the draft set point and stack draft data in order to generate an output at 164 of a change in damper position. The algorithm determines how much of a change in the damper position is necessary in order to bring the draft equal to the draft set point. The algorithm is a conventional, 2-mode (proportional-integral) formula.

The change in damper position at the outputs 159,164 of logic blocks 154,161 are received by a selector block 165. Block 165 selects the one of the two outputs 159,164 which requires a more open position of the damper. The passage of the more open damper position is sent to the damper loop at 167. This value is the feedback request which asks the damper for more or less damper opening in order to meet the draft or oxygen set point requested by the operator.

Damper loop 127 receives the feedforward input of damper position from fuel loop 121 and the feedback input of damper position from oxygen loop 123. The two inputs are summed at logic block 169, generating a change in damper position which is utilised to generate a control output signal to actuator 17, as described above. Any one of or combination of the three loops (fuel, draft and oxygen) can be withdrawn from control by putting it on manual mode. This capability of graceful degrading provides maximum service under instrument failure condition, and is useful in isolating problem areas.

As shown in Figure 1, input device 27 includes a manual mode selector having three pushbutton switches 172,174 and 176 associated with oxygen loop 123, draft loop 125 and fuel loop 121, respectively. The switches 172,174 and 176 are represented in Figure 4. When a switch 172-176 is open (pushbutton depressed), the associated control loop drops out. For example, with switch 172 open, selector 165 passes the draft request to the damper loop.

The logic module of Figure 4 is utilised for each heater barrel of various heater arrangements. For example, the dual barrel heater of Figure 2B requires two logic modules and therefore, two controllers.

As shown in Figure 5, a pair of logic modules 171,173 are utilised for the dual barrel heater. Module 171 includes a fuel loop 175, an oxygen loop 177, a draft loop 179 and a damper loop 181. Module 173 also includes a fuel loop 189, an oxygen loop 183, a draft loop 185 and a damper loop 187. Each module responds to each barrel as if they have separate identities. This modular concept allows a standardised logic to be used repeatedly for various heater arrangements. Since there is only one damper in the dual barrel heater of Figure 2B, an adapter loop 191 receives the two damper position signals from the two modules and forms a single damper position signal.

Adapter 191 is shown in more detail in Figure 6 as including a select logic 193. Logic 193 receives the two damper position signals from the damper loops 181, 187, and outputs the one damper position signal which requests the more open damper position.

The triple barrel heater of Figure 2C requires three logic modules. As shown in Figure 7, three modules 195,197,199 are utilised. As shown, each module includes the four different loops: fuel, oxygen, draft and damper. In the triple barrel heater, the movement of central damper 113 affects the oxygen level at the other two dampers 111,115. In order to supervise this effect, an adapter loop 201 is utilised. The adapter loop compensates for the influence of damper 113 onto barrels 85,89 by moving dampers 111,115 in an opposite direction of the movement of damper 113.

As shown in Figure 8, adapter loop 201 generates a compensation signal at 211 to the damper loops of barrels 85,89. The compensation signal is generated in accordance with the changing position of the central damper of barrel 113.

The changing position of the central damper 113 is inverted by an inverter 203. The damper position of the central barrel is then multiplied by a ratio K_p at multiplier 205. Ratio K_p is the degree of change on damper 113 affecting dampers 111,115. The output at 207 then is the change in dampers 111,115 which is required due to the change made in the position of damper 113. This compensating change signal at 207 is sent to the damper loops of barrels 85,89 and is received by logic block 169 (Figure 4). The compensating change signal is added to the change in the dampers 111,115 required by the draft, oxygen and fuel loop of its respective module. The resultant outputs control the two dampers 111,115.

It should be understood, of course, that the foregoing disclosure relates to preferred embodiments of the invention and that other modifications or alterations may be made therein without departing from the spirit or scope of the invention as set forth in the appended claims.

Claims

1. Apparatus for controlling at least one stack damper for maintaining stack oxygen content at an optimal level for minimising fuel consumption of a plurality of associated heater barrels in view of system conditions, comprising:

at least one fuel feed means for feeding fuel to at least one barrel;

monitoring means for providing condition signals representative of a plurality of combustion system variables, said monitoring means measuring the excess stack oxygen level for each of said plurality of associated heater barrels and generating an excess stack oxygen signal for each of said barrels;

said monitoring means measuring fuel feed for each fuel feed means and generating a fuel entry signal associated with a fuel feed means;

at least one damper control means responsive to a damper control signal for positioning a damper; and

control means including a logic module for each barrel, said module comprising:

i. feedforward control responsive to a said fuel entry signal for generating a feedforward signal for positioning a damper at a position for substantially providing an oxygen level anticipated for combustion;

ii. feedback control responsive to a said excess stack oxygen signal for generating a feedback signal for positioning the damper at a position for substantially providing a target oxygen level; and

iii. damper control responsive to said feedforward signal and said feedback signal for generating a said damper control signal.

2. Apparatus for controlling at least one stack damper for maintaining stack oxygen content at an optimal level for minimising fuel consumption of a plurality of associated heater barrels in view of system conditions, comprising:

at least one fuel feed means for feeding fuel to at least one barrel;

monitoring means for providing condition signals representative of a plurality of combustion system variables, said monitoring means measuring the stack oxygen level for each of said plurality of associated heater barrels and generating a stack oxygen signal for each of said barrels;

said monitoring means measuring fuel feed for each fuel feed means and generating a fuel entry signal associated with a fuel feed means;

at least one damper control means responsive to a damper control signal for positioning a damper;

control means including:

a fuel monitoring loop for each fuel feed means, said fuel monitoring loop generating a feedforward signal indicative of a damper position change;

an oxygen monitoring loop for each barrel, said oxygen monitoring loop comparing the monitored stack oxygen with a target stack oxygen value and generating a feedback signal indicative of a damper position change; and

a damper control loop for each damper, said damper control loop responsive to a said feedforward signal associated with the fuel feed means feeding the barrel associated with the damper and responsive to a said feedback signal associated with the stack oxygen of the barrel associated with the damper, for generating a said damper control signal.

3. Apparatus according to Claim 2, wherein said monitoring means measures the heater draft level for each barrel, and generates a heater draft signal for each barrel; and wherein said control means includes a draft monitoring loop for each barrel, said draft monitoring loop compares the monitored heater draft level with a target heater draft value and generates a feedback signal; and wherein said damper control loop is responsive to said feedback signal associated with heater draft of the barrel associated with the damper.

4. Apparatus according to Claim 2, wherein said control means includes an adapter means for receiving a said damper control signal

and generating a modified damper control signal in accordance with the arrangement of dampers and barrels.

5. Apparatus according to Claim 4, wherein said control means includes an adapter means for receiving a plurality of damper control signals and generating a consolidated damper position signal to control the position of a single stack damper.

6. Apparatus according to Claim 4, wherein said adapter means receives a said damper control signal for generating a modified damper position signal which modifies another said damper control signal.

7. Apparatus according to Claim 2, wherein said damper control includes damper positioning means for generating said damper control signal.

8. Apparatus according to Claim 3 and further including operator input means manually operable for permitting the operator to generate target data representative of a stack oxygen target value and a draft target value.

9. Apparatus according to Claim 8, wherein said operator input means includes first visual display means for displaying said target value; and second visual display means for displaying said stack oxygen level and said heater draft level.

10. Apparatus according to Claim 9, wherein said operator input means includes manually actuable switch means for changing said target values.

11. Apparatus according to Claim 10, wherein said feedback control loop is responsive to the difference between said stack oxygen level and said target value and the difference between said draft level and said target heater draft value for generating a feedback signal.

12. Apparatus according to Claim 11, wherein said feedback control loop generates said feedback signal according to only one of said differences.

13. Apparatus according to Claim 12, wherein said feedback signal is generated from said difference which requests the more open damper position

14. Apparatus for controlling a stack damper for maintaining combustion oxygen at an optimal level for minimising fuel consumption

of an associated heater barrel, comprising:

oxygen monitoring means measuring the excess stack oxygen level for the associated heater barrel and generating an oxygen level signal;

draft monitoring means measuring the heater draft level for the associated heater barrel and generating a draft level signal;

damper control means responsive to a damper control signal for positioning the damper;

means for providing a target excess stack oxygen and a target heater draft; and

control means responsive to said oxygen monitoring means and said draft monitoring means for generating a damper control signal, said control means determining the change in damper position necessary in order for the excess stack oxygen level to substantially equal the target excess stack oxygen and determining the change in damper position necessary in order for the heater draft level to substantially equal the target draft level and selecting the one of said last named changes which requires a more open damper position and formulating a said damper control signal according to said more open damper position.

15. Apparatus for controlling a stack damper for maintaining stack oxygen content at an optimal level for minimising fuel consumption of an associated heater barrel in view of system conditions, comprising:

fuel feed means for feeding fuel to the heater barrel;

monitoring means for providing condition signals representative of a plurality of combustion system variables, said monitoring means measuring the stack oxygen level for the associated heater barrel and generating a stack oxygen signal, said monitoring means measuring fuel feed of said fuel feed means and generating a fuel entry signal, said monitoring means measuring the heater draft device for the associated heater barrel;

a damper control means responsive to a damper control signal for positioning a stack damper;

control means including:

a fuel monitoring loop for said fuel feed means, said fuel monitoring loop generating a feedforward signal indicative of a damper position change;

an oxygen monitoring loop for comparing the monitored stack oxygen with a target stack oxygen value and generating a feedback signal indicative of a damper position change;

a draft monitoring loop for comparing the monitored heater draft level with a target heater draft value and generating a feedback signal indicative of a damper position change;

a damper control loop responsive to a said feedforward signal and responsive to a said feedback signal for generating a said damper control signal; and

loop selection means for selectively disengaging from said control means any of said fuel monitoring loop, said oxygen monitoring loop or said draft monitoring loop, said control means generating said damper control signal according to the engaged loops.

16. Apparatus according to Claim 15, wherein said loop selection means is manually operable by the operator.

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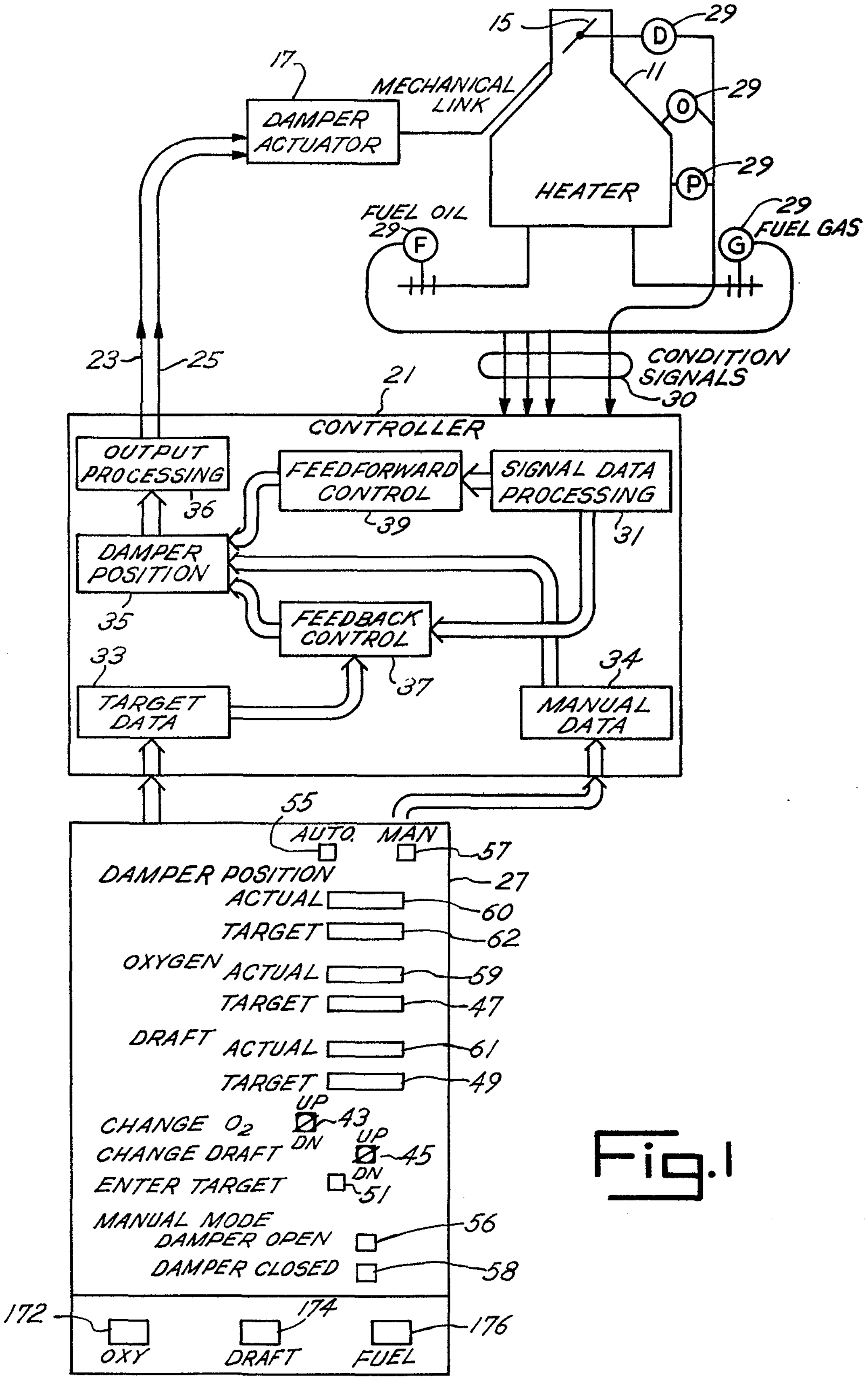
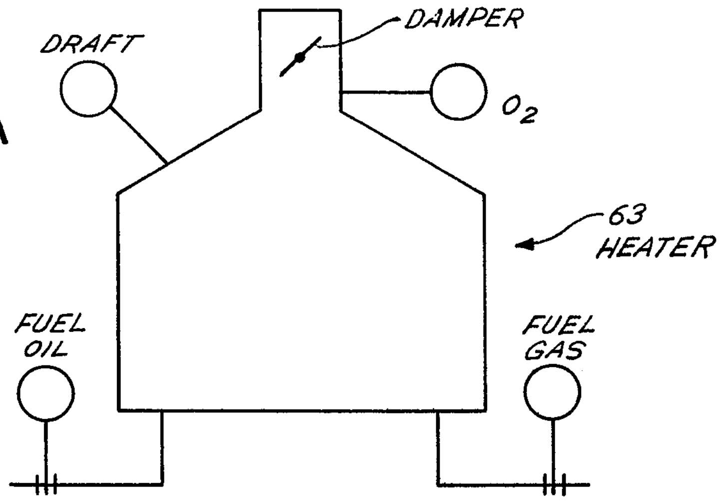


Fig.1

Fig. 2A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HEATER
FUEL OIL
FUEL GAS

Fig. 2B

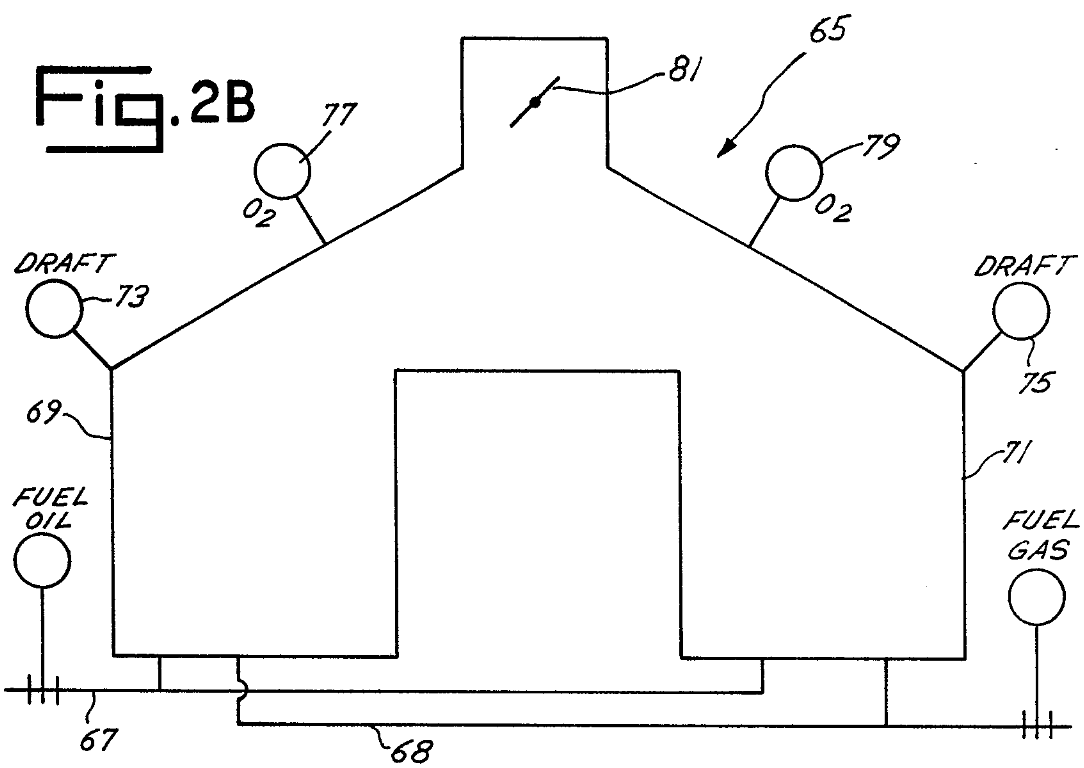
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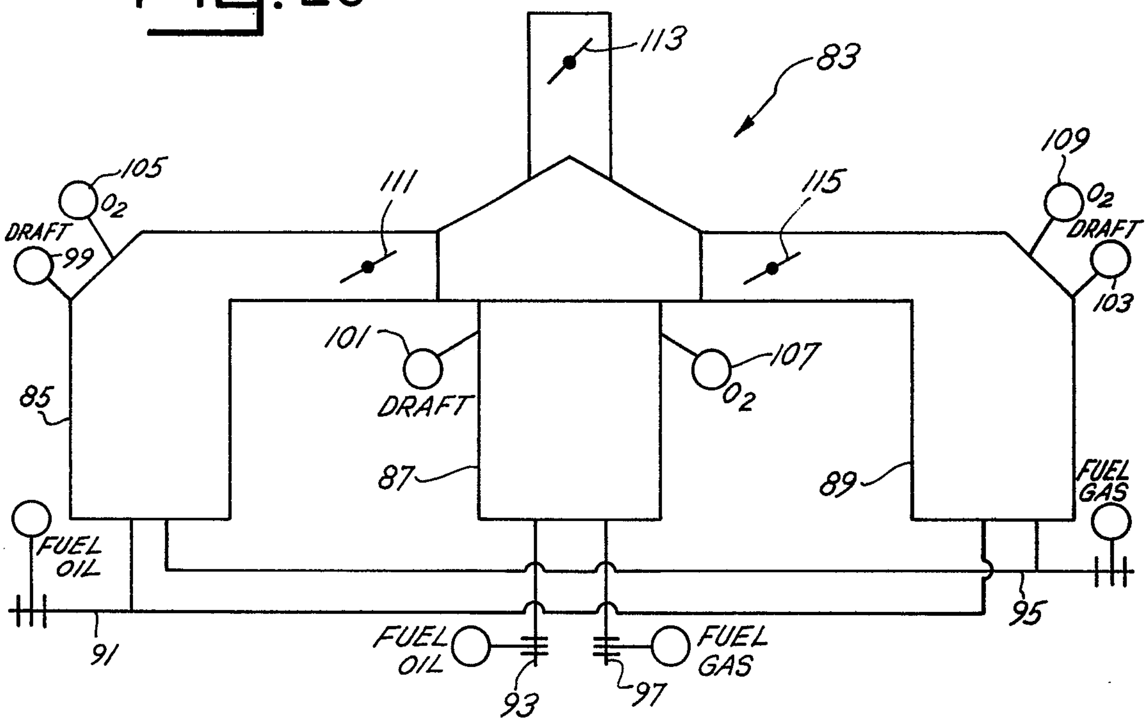
Fig. 2C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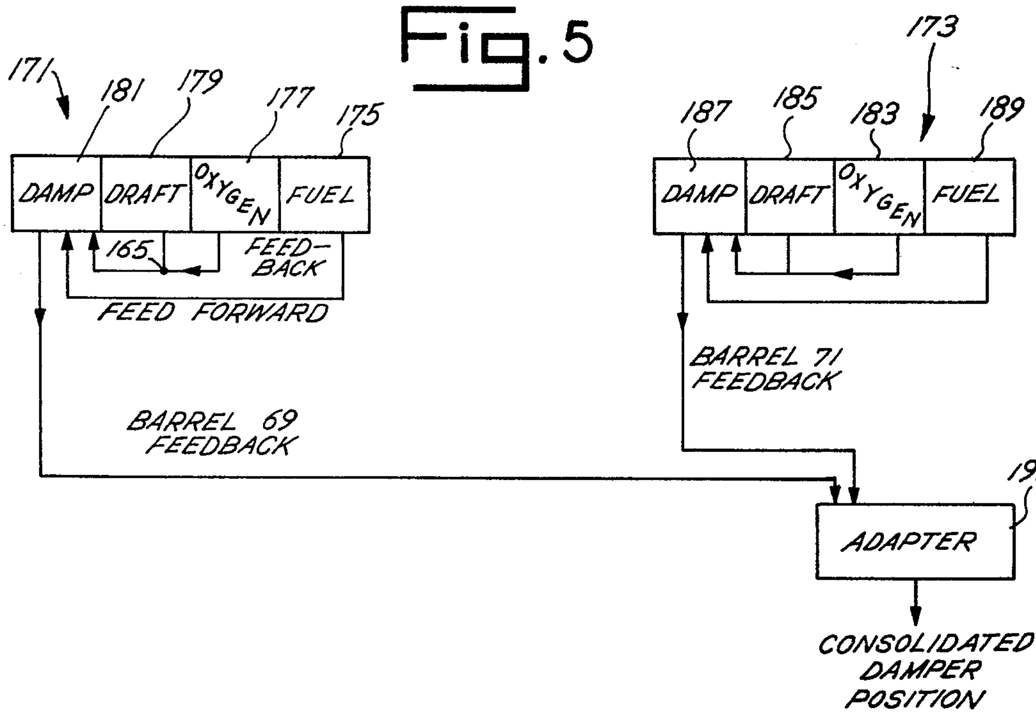
FUEL GAS
93
97

Fig. 5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OXYGEN
FUEL
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FEED-BACK
FEED FORWARD
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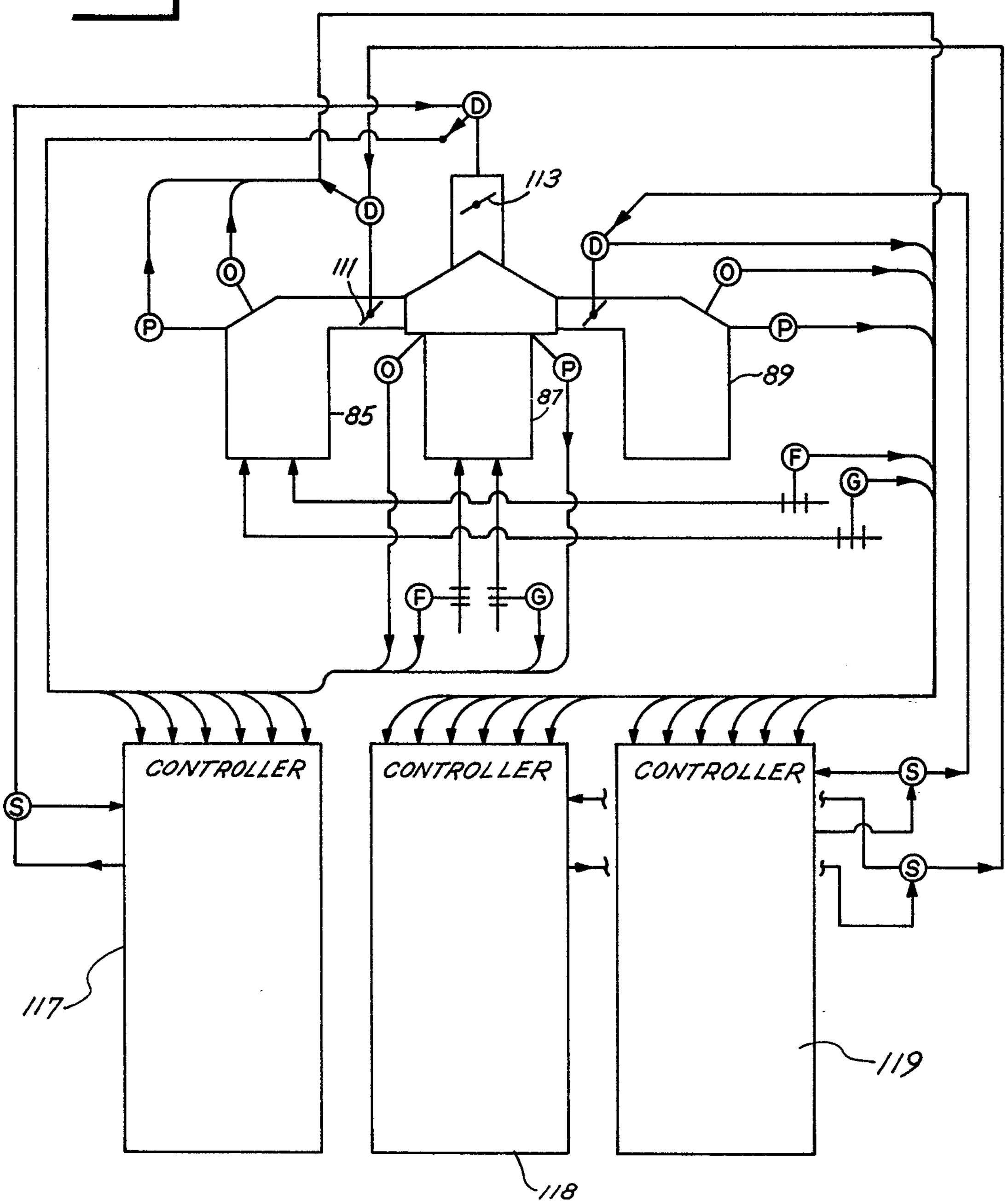
OXYGEN
FUEL
BARREL 71 FEEDBACK
BARREL 69 FEEDBACK
191
ADAPTER
CONSOLIDATED DAMPER POSITION

Fig. 3


113
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89
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D
D
O
O
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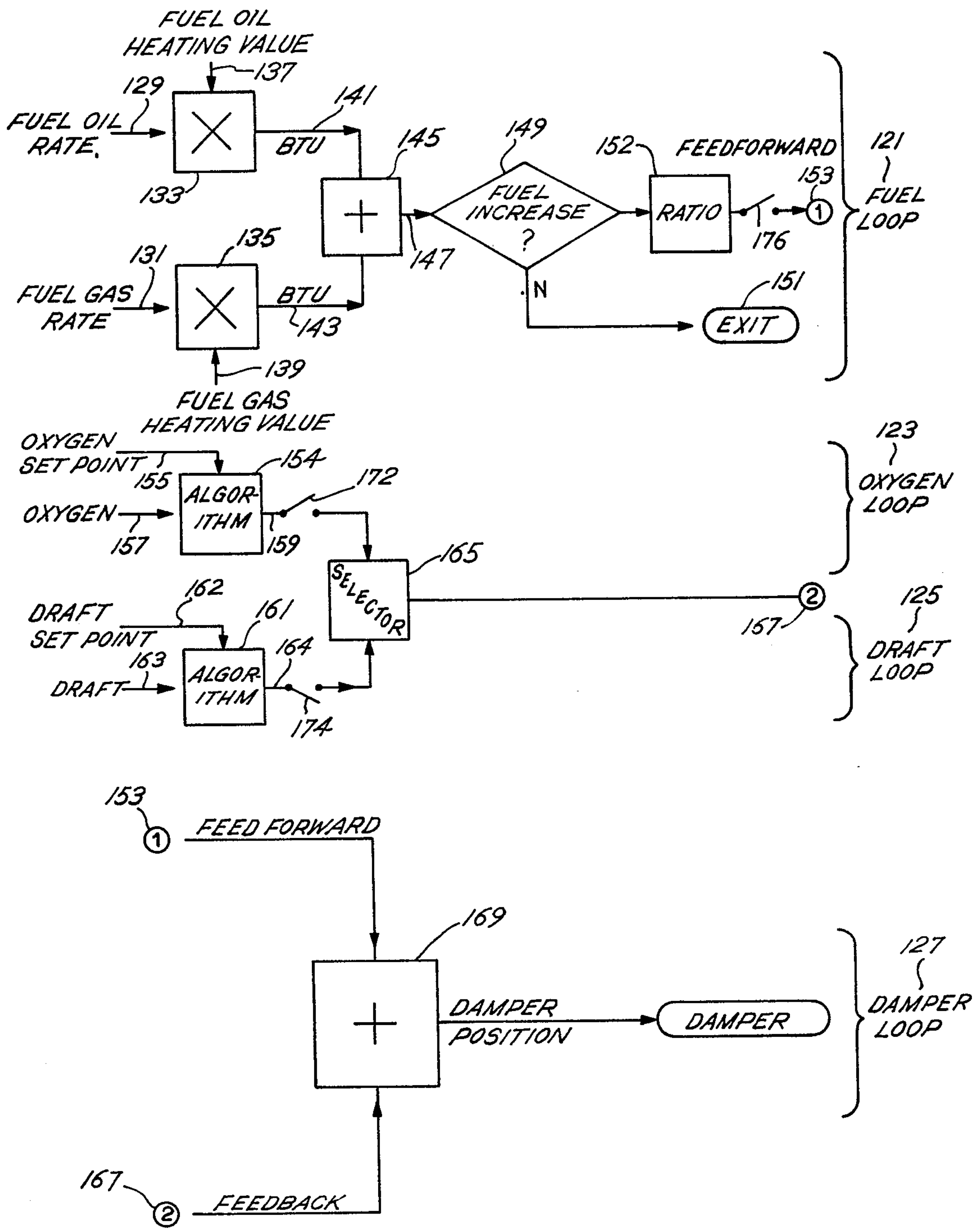
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153
176
121
FUEL LOOP
131
FUEL GAS RATE
135
BTU
143
147
N
151
EXIT
139
FUEL GAS
HEATING VALUE
OXYGEN SET POINT
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154
172
123
OXYGEN LOOP
OXYGEN
157
ALGORITHM
159
165
SELECTOR
167
DRAFT SET POINT
162
161
163
DRAFT
ALGORITHM
164
174
125
DRAFT LOOP
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FEED FORWARD
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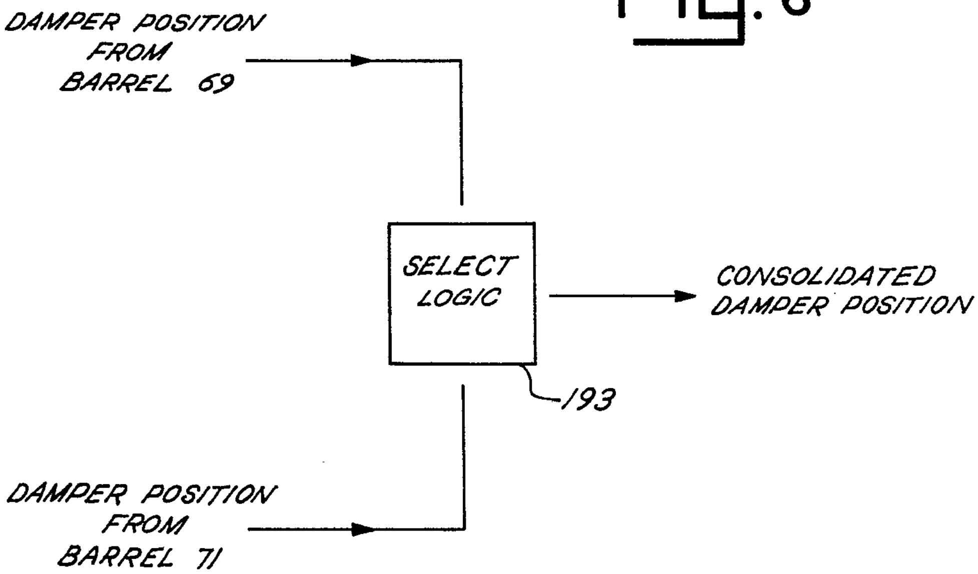
DAMPER POSITION
DAMPER
127
DAMPER LOOP
167
FEEDBACK

Fig.4

Fig. 6


DAMPER POSITION FROM BARREL 69
SELECT LOGIC
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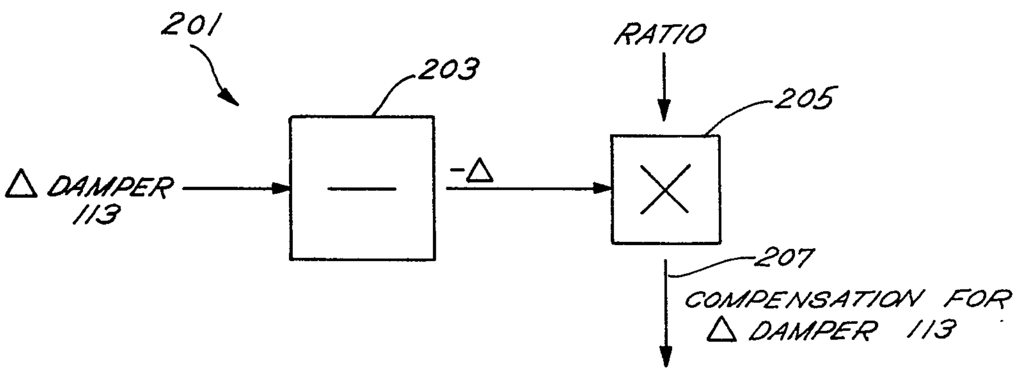
DAMPER POSITION FROM BARREL 71

Fig. 8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RATIO
205
△ DAMPER 113
-△
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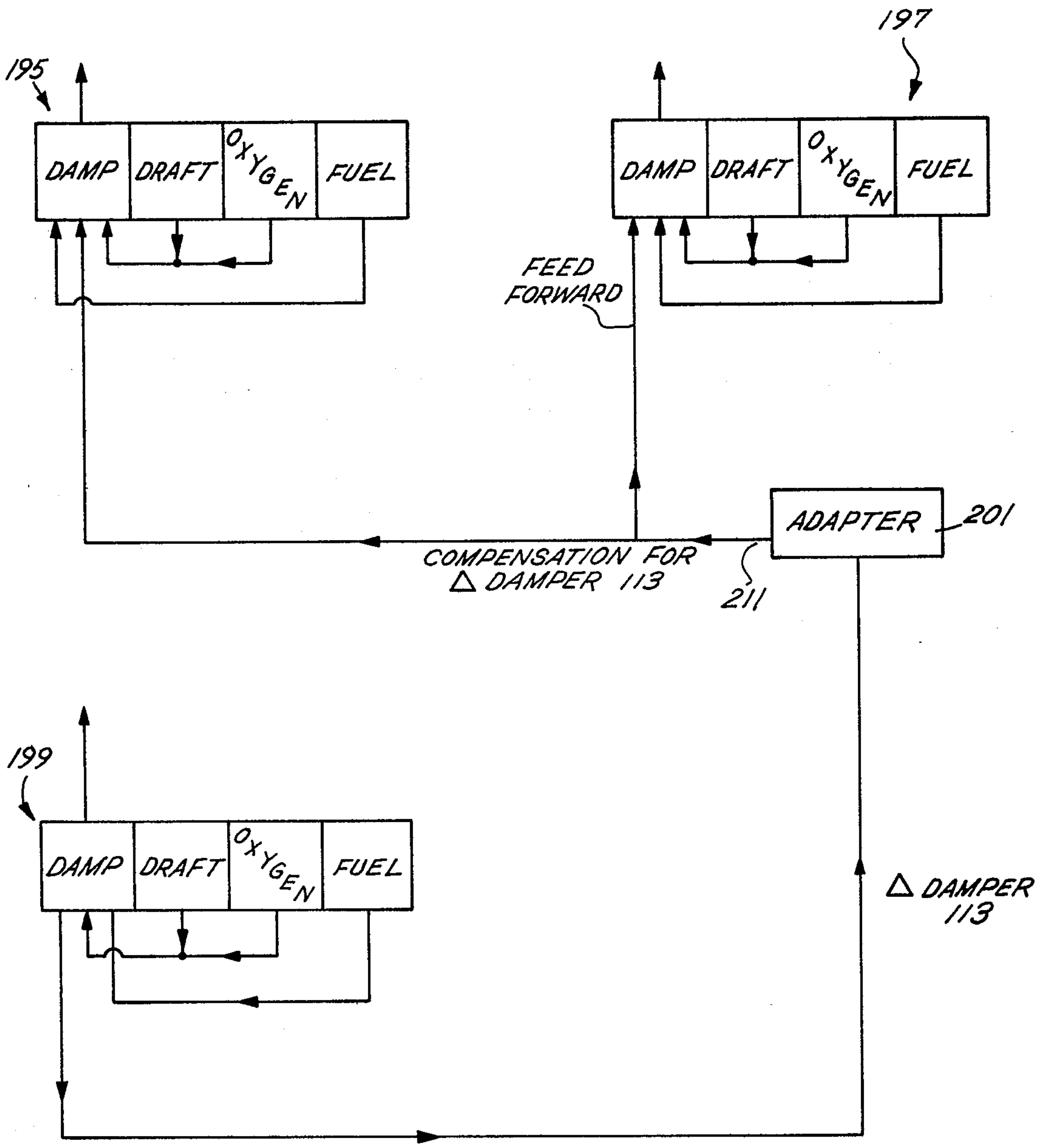
COMPENSATION FOR △ DAMPER 113

Fig. 7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△ DAMPER 113
211
199
DAMP
DRAFT
OXYGEN
FUEL
△ DAMPER
113

8326

0083479
Application number

European Patent Office

EUROPEAN SEARCH REPORT

EP 82 30 6586

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
X	OIL & GAS JOURNAL, vol. 79, no. 38, September 1981, pages 134-138, Tulsa, Oklahoma (USA); D.J.LEONARD et al.: "Automatic control ups heater combustion". *Page 135, left-hand column, paragraph: "The technique" - page 136, left-hand column; figure 5* ---	1-3,8-15	F 23 N 5/00
P,X	US-A-4 330 261 (J.H.SUN) *The whole document* ---	1-3,8-15	
A	ADVANCES IN INSTRUMENTATION, vol. 35, part 2, 1980, pages 63-73, Research Triangle Park, North Carolina (USA); M.SCHEWE et al.: "Advanced boiler control - A proven strategy - ". *Page 65, paragraph: "Excess Air Optimization Strategy"; figures 4,10* ---	1-3,14,15	TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
A	US-A-3 369 749 (C.W.SIEGMUND et al.) *Figures* --- -/-	2	F 23 N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	30-03-1983	THIBO F.

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
A	CONTROL AND INSTRUMENTATION, vol. 10, no. 9, October 1978, pages 71-72, London (GB); E.D.NEUBERGER et al.: "Closed loop O2control is key to efficient combustion control". *The whole document* ---	1,2,14,15	
A	EP-A-0 030 736 (SERVO INSTRUMENT) ---		
A	US-A-4 097 218 (J.W.WOMACK) ---		
A	DE-A-2 745 459 (MEASUREX CORP.) -----		
			TECHNICAL FIELDS SEARCHED (Int. Cl. 3)

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