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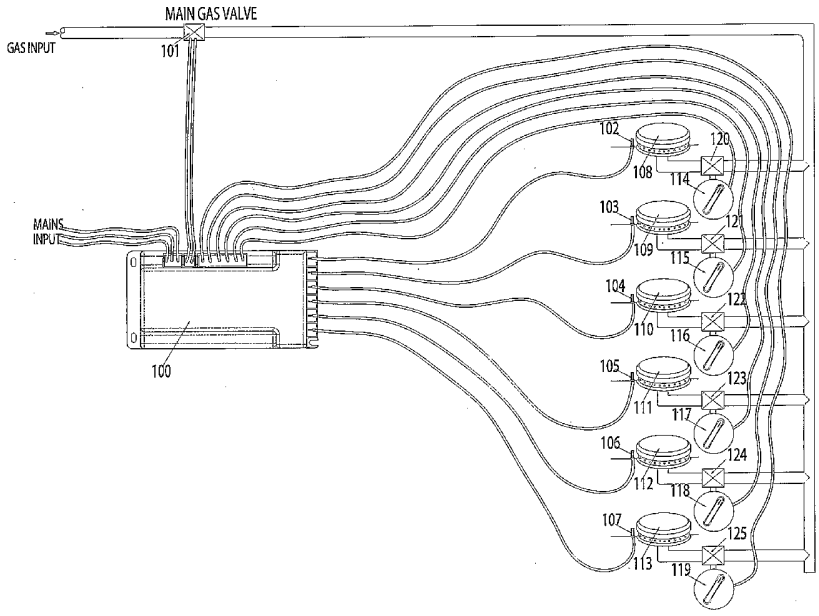
(54) **Title:** HOT SURFACE RE-IGNITER CONTROL



(57) **Abstract:** An electronically activated hot surface re-ignition (HSR) control system adapted for use in gas cooktops, cookers and the like. The HSR system comprises a low voltage control and timing circuit capable of controlling multiple hot surface igniters placed in the path of the gas to effect ignition when operated and to also sense flame independently of each other in such a way that only hot surface igniter of the burner that requires ignition is energised. The control can also be used to energise a gas valve so as to provide fail-safe operation in the event of non-ignition.

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HOT SURFACE RE-IGNITER CONTROL

TECHNICAL FIELD

The present invention relates to heating appliances having gas burners.

BACKGROUND ART

There are two common forms of electronic ignition used in gas cooking appliances.

The first is direct spark ignition, which uses an electronic control unit connected to an electrode placed in the gas path. The control generates a high voltage pulse that is passed through the electrode causing a spark to jump from the electrode tip to the gas burner thus igniting the gas. A further advance in the use of direct spark ignition is a technique known as flame rectification whereby a sinusoidal AC voltage is applied to the electrode. If there is a flame present there is an ionization effect associated with the flame which causes a small current to flow through the electrode to ground. This current can then be used to detect the presence of the flame and thus it is possible to control the ignition cycle so that the unit only sparks when a flame is not detected. This is commonly called auto re-ignition.

Whilst direct spark ignition has proven to be reliable and effective it does have certain drawbacks: it causes electrical interference (EMI), is audibly loud and uses very high voltages to generate sparks. In particular, the audible operation makes it poorly suited to applications utilising low gas flow levels, with the accompanying high probability of the flame being extinguished and operation of the re-igniter being required, such as simmer elements on gas cookers.

An alternative is hot surface ignition, which uses an electrically heated element in the gas path to light the gas. An individual hot surface element is usually provided for each burner. The hot surface igniter is on the whole time the cook top burners are being used, to immediately re-ignite the flame in case of flame failure. The disadvantage is that each hot surface element is a high current device that requires significant power to heat. Further, hot surface igniters often fail in an unacceptably short time. This is due to thermal stress caused by the element being on the whole time the burner is in use.

An object of the present invention is to provide a solution to some of the problems encountered with the current methods of ignition, or at least to provide a useful alternative.

DISCLOSURE OF INVENTION

In one form of the invention, it may be said to reside in a hot surface re-igniter control including detector means adapted to provide a "no flame detected" flame detection signal when no flame at a selected gas burner is detected, and element control means adapted to control an electrical resistance heating element, said element being arranged to ignite a gas burner when a supply of electrical current is applied to the element, said element control means being adapted to apply said supply of electrical current to the element while the detector means continues to effect a "no flame detected" flame detection signal and the control is in an operative mode.

In preference, the detector means is adapted to use flame rectification to detect the presence of a flame.

The use of flame rectification with a hot surface igniter has been found to have the drawback that while the hot surface igniter is hot it emits electrons, due to a thermo-electric diode effect. This provides a carrier for a current between the hot surface igniter and a surrounding earthed protective guard or an earthed burner independently of the ionization effect of the flame. As a result the generation of the "no flame detected" signal is prematurely terminated.

In preference, therefore, the element control means includes means to select and effect a minimum time period for the supply of electrical current to flow to the electrical resistance heating element.

In preference, in the alternative, there are at least two detector means and associated element control means, each associated with and responsive to, a respective gas burner, such that each electrical resistance heating element is heated only when required to ignite the associated gas burner.

In the alternative there is provided independent ignition and sensing (using flame rectification) for each of at least two burners using a hot surface igniter element

associated with each burner as an ignition source, such that each hot surface igniter element is heated only when required.

This has the effect of reducing power requirements for a system during cooking and resolving problems associated with ignition systems described previously.

In a further form the invention may be said to reside in a hot surface re-igniter control including detector means adapted to provide a "flame detected" flame detection signal when a flame at a selected gas burner is detected, and element control means adapted to control an electrical resistance heating element, said element being arranged to ignite a gas burner when a supply of electrical current is applied to the element, said element control means being adapted to interrupt said supply of electrical current to the element while the detector means continues to effect a "flame detected" flame detection signal and the control is in an operative mode.

In a further form the invention may be said to reside in an installation with a hot surface re-igniter control where there is included at least one electrical resistance heating element adapted to ignite a gas burner, detector means adapted to provide a "no flame detected" flame detection signal when a flame at a selected burner is not detected, and element control means arranged to apply a supply of electrical current to the electrical resistance heating element upon the detector means effecting a "no flame detected" flame detection signal while the burner is in an operative mode.

In a yet further form, the invention may be embodied in a method of effecting ignition of gas burners, the method including the steps, when in an operative mode, of detecting the existence of a flame, and effecting an application of a supply of electrical current to the electrical resistance heating element upon detector means detecting absence of flame.

In preference, the detection of the burning status is effected by using flame rectification.

In preference there are provided at least two electrical resistance heating elements with associated detector means as characterised above with common element control means adapted to separately operate each element in response to the signal from the associated detector means.

In a further form the invention can be said to reside in a method of effecting ignition of gas burners the method including the steps, when in an operative mode, of detecting the existence of a flame, and effecting an application of a heating supply of current to the electrical resistance heating element upon detector means detecting absence of flame.

In preference this method is further characterised in that the detection of the burning status is effected by using flame rectification.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG 1 is a layout diagram of a cooktop system made in accordance with the invention, and

FIG 2 is a block diagram of the embodiment of the system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG 1 is a basic layout diagram of a cooktop system made in accordance with this invention.

The cooktop shown in **FIG 1** has six burners **108-113** placed on a panel. Each burner is fitted with a hot surface igniter **102-107** connected to a hot surface re-igniter control unit **100.** There is also one electronically controlled in-line main gas valve **101** which controls the overall supply of gas to the cooktop. Gas line conduits conduct gas from the mains gas supply to the burners **108-113** under the control of the in-line gas cocks **120-125,** that are the user switch controls **114-119** for the cooktop. The unit has six-burners **223-228** cooktop but clearly other number of burners are possible.

FIG2. The unit consists of the following functional blocks:

Main block:

Hot Surface Re-igniter (HSR) **200** controller provides the overall control system containing

Sub-blocks:

- Flame detection circuits **201-206**, provide "flame detected" or "no flame detected" signals to the control means

- Output power switches **207-212**, provides the power distribution control to the hot surface igniter elements **217-222**

- Main power supply **213**, provides necessary voltage and power to all block. It consists of +V and –V low power voltage source for the unit controller, +12Vdc for hot surface igniter, output switches **207-212** and controller switch for the switch mode power supply (SMPS) **214**.

- Switch mode power supply (SMPS) **215** with high frequency transformer output isolating transformer **216**, provides power to hot surface igniters **217-222** and their output switches **207-212.**

- Switch input circuits **231-236** that connect to the gas cock switches **237-242**

Hot surface igniters **207-212**, have electrical resistance heating elements that heat and ignite gas, and also provide the flame sense electrodes.

The HSR controller **200** circuit is permanently powered from a low current power supply. A low current voltage source +V powers the internal logic/micro-control whilst the system is in stand by. In this mode all the gas cock/switches **237-242** are in OFF positions and the hot surface igniters **217-222** are in the OFF state.

As each hot surface igniter **217-222** requires 30 to 40W power to ensure quick and reliable ignition of gas and because all the channels are independent and therefore could be switched on simultaneously the switch mode power supply **215** for the igniters must be capable of providing up to 200-250W power to all the hot surface igniter elements **217-222**. To achieve this a special switch mode power supply (SMPS) **215** is used. This SMPS **215** is controlled by an SMPS switch **214** from the main power unit **213** and is an AC to AC step down high frequency converter that transforms the mains electrical supply, in this case 220/240VAC 50/60Hz into a 24VAC 30/40Khz electrical supply for the igniters. In alternative embodiments, the electrical supply to the igniters may be any suitable voltage, in particular, 12V AC or 12V DC or 24V DC. Low voltages are employed for the igniters because of the risk that, in a fault condition, the igniter supply may become connected to the

cooktop body, causing an electrocution hazard. In an embodiment where this risk is acceptable, or is eliminated by other means, the igniters may be supplied with current at mains voltage. This voltage is provided to each hot surface igniter element **217-222** from an individual galvanic isolated secondary winding of the SMPS transformer output **216**. The control of these high power low voltage outputs is done by relays **207-211** to provide the necessary ON / OFF control for the hot surface igniter heating power distribution. The normally open type relay switches **207-211** are controlled by the main control **200** and only need powering during the ON state so the power consumption during the OFF state is very small. The hot surface igniter being electrically conductive also functions as the flame sense electrode and is electrically connected to the flame sense circuits **201-206**. The flame sense circuit relies on a technique known as flame rectification whereby a sinusoidal AC voltage is applied to the electrode. If there is a flame present there is an ionization effect associated with the flame which allows a small current to flow through the electrode to ground. This flame sense current flows between the igniter and the burner which is earthed.

When a gas cock/switch **237-242** is in the ON position and the unit senses the absence of flame current through any one of the flame sensing circuits **201-206** it switches on the SMPS **214,215** and also engages the appropriate one of the relays **207-211** to drive the power to the corresponding one of the hot surface igniter elements **217-222**. As the hot surface igniter heats it emits electrons, due to the thermo-electric diode effect (much like a hot cathode vacuum valve). This provides a carrier for a current between the hot surface igniter and the surrounding earthed protective guard or the earthed burner independently of the ionization effect of the flame. As a result a false flame detection signal is generated. In order to avoid causing the unit to switch off the current to the hot surface igniter element before the flame has been established the initial flame sense detection is delayed so that the ignition phase is extended to ensure reliable ignition of the gas. Once a flame is established the control unit **200** switches off the SMPS power **215** to the hot surface igniter element **217-222** and switches the channel into flame sensing mode. As an additional safety feature if the unit does not sense flame within a specified time limit the gas valve control **229** will deactivate the main gas valve **230** and shut down gas to all the burners **223-228**.

In an alternative embodiment (not illustrated) the flame sense and flame ignition systems are electrically separate. This avoids the need for the delay of the initial flame sensing operation.

The main control **200** can be realised using standard analogue and digital logic devices or an alternative method is to use a micro controller with software code to perform the same task.

The overall realisation of the invention is a new device called a hot surface re-ignition control (HSR). This invention provides independent ignition and sensing (using flame rectification) of each burner using a hot surface igniter element. It does so in such a manner that it is only heated when required, thus reducing the power requirements for the system during cooking significantly and resolving the problems associated with ignition systems described previously.

CLAIMS

1. A hot surface re-igniter control including detector means adapted to provide a "no flame detected" flame detection signal when no flame at a selected gas burner is detected, and element control means adapted to control an electrical resistance heating element, said element being arranged to ignite a gas burner when a supply of electrical current is applied to the element, said element control means being adapted to apply said supply of electrical current to the element while the detector means continues to effect a "no flame detected" flame detection signal and the control is in an operative mode.

2. A hot surface re-igniter control as in claim 1 wherein the detector means is adapted to use flame rectification to detect the presence of a flame.

3. A hot surface re-igniter control as in claim 1 or claim 2 wherein the element control means includes means to select and effect a minimum time period for the supply of electrical current to flow to the electrical resistance heating element.

4. A hot surface re-igniter control as in any one of the preceding claims including at least two detector means and associated element control means, each associated with and responsive to, a respective gas burner, such that each electrical resistance heating element is heated only when required to ignite the associated gas burner.

5. A hot surface re-igniter control including detector means adapted to provide a "flame detected" flame detection signal when a flame at a selected gas burner is detected, and element control means adapted to control an electrical resistance heating element, said element being arranged to ignite a gas burner when a supply of electrical current is applied to the element, said element control means being adapted to interrupt said supply of electrical current to the element while the detector means continues to effect a "flame detected" flame detection signal and the control is in an operative mode.

6. An installation with a hot surface re-igniter control where there is included at least one electrical resistance heating element adapted to ignite a gas burner, detector means adapted to provide a "no flame detected" flame detection signal when a flame at a selected burner is not detected, and element control

means arranged to apply a supply of electrical current to the electrical resistance heating element upon the detector means effecting a "no flame detected" flame detection signal while the burner is in an operative mode.

7. A method of effecting ignition of gas burners, the method including the steps, when in an operative mode, of detecting the existence of a flame, and effecting an application of a supply of electrical current to the electrical resistance heating element upon detector means detecting absence of flame.

8. The method of the preceding claim further characterised in that the detection of the burning status is effected by using flame rectification.

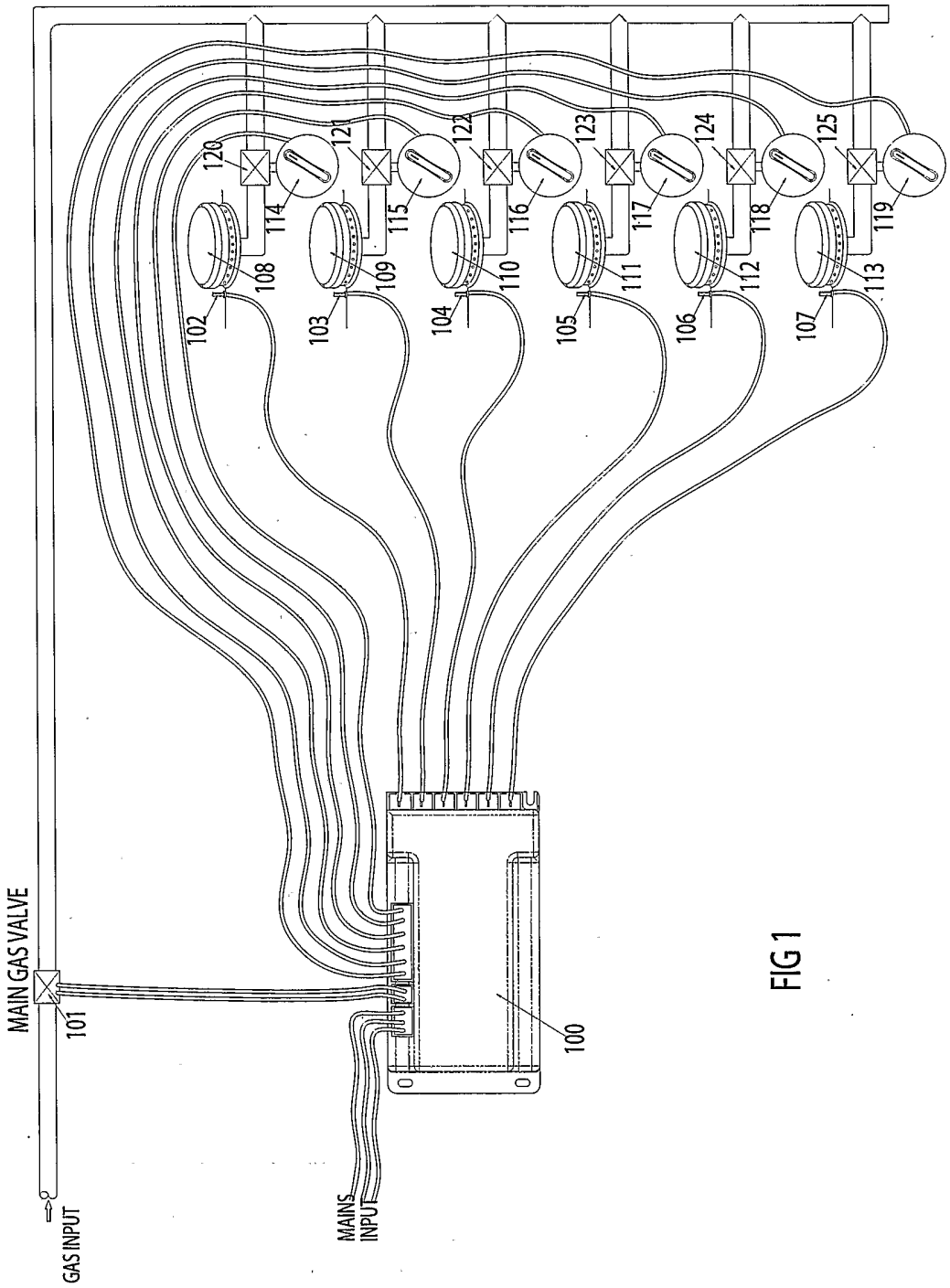
MAIN GAS VALVE
GAS INPUT
MAINS INPUT
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125

FIG 1

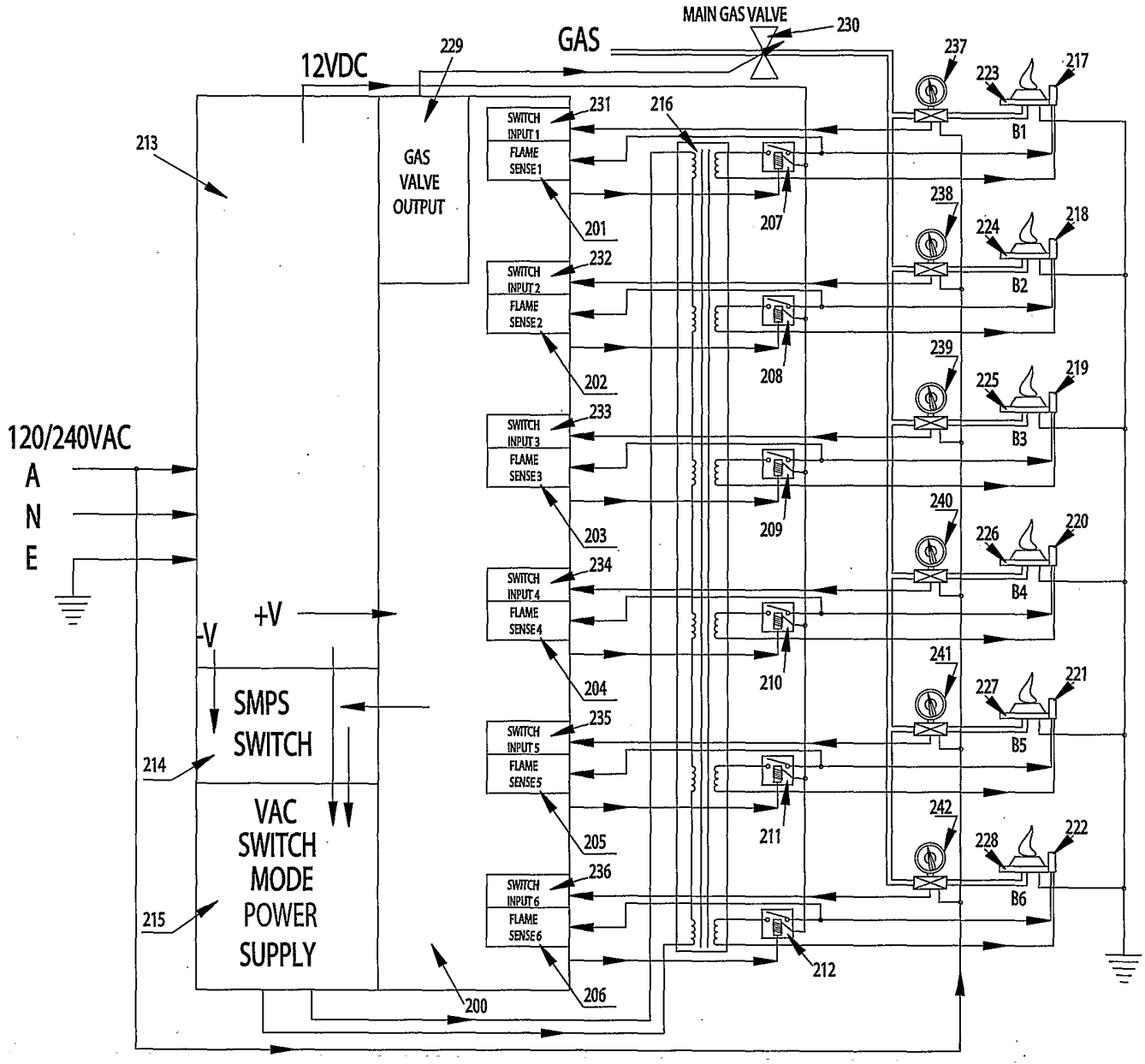
MAIN GAS VALVE
230
GAS
12VDC
229
237
223
217
231
216
SWITCH INPUT 1
FLAME SENSE1
B1
213
GAS VALVE OUTPUT
207
201
238
224
218
232
SWITCH INPUT 2
FLAME SENSE2
B2
208
202
239
225
219
233
SWITCH INPUT 3
FLAME SENSE3
B3
120/240VAC
A
N
E
209
203
240
226
220
234
SWITCH INPUT 4
FLAME SENSE4
B4
+V
-V
210
204
241
227
221
SMPS SWITCH
235
SWITCH INPUT 5
FLAME SENSE5
B5
214
211
205
242
228
222
VAC SWITCH MODE POWER SUPPLY
236
SWITCH INPUT 6
FLAME SENSE6
B6
215
212
206
200

FIGURE 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2004/000351

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: F23Q 7/26, 7/10; F23D 14/72

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F23Q 7/26, 7/10; F23D 14/72

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI: F23Q 7/26, 7/10; F23D 14/72 AND KEYWORDS (RE-IGNIT+ OR REIGNIT+)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4405299 A (SERBER; STEPHEN L.) 20 September 1983 Whole document	1-8
X	US 4432722 A (BOHAN, JR; JOHN E.) 21 February 1984 Whole document	1-8
X	Derwent Abstract Accession No 98-133161/13, Class S03, FR 2752046 A (ISL INSTR SCI LAB SA) 6 February 1998 See abstract	1-8
A	US 5403183 A (ANDERSSON; SVEN-ERIK et al) 4 April 1995 Whole document	

☐ Further documents are listed in the continuation of Box C ☒ See patent family annex

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 May 2004	13 MAY 2004

Name and mailing address of the ISA/AU	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2004/000351

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	4405299	CA	1185164	DE	3278251	EP	0071174
		JP	58024723				
US	4432722	CA	1180789	DE	3261372	EP	0069939
		JP	58018021				
FR	2752046		NONE				
US	5403183	CA	2101925	DE	69219319	EP	0570568
		ES	2100518	SE	9103699	WO	9312378

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

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