



(11) Publication number : **0 573 223 A1**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number : **93304163.4**

(51) Int. Cl.⁵ : **F23N 5/20**

(22) Date of filing : **28.05.93**

(30) Priority : **30.05.92 GB 9211829**

(43) Date of publication of application :
08.12.93 Bulletin 93/49

(84) Designated Contracting States :
DE FR GB IT NL

(71) Applicant : **BLUE CIRCLE HEATING LIMITED**
Myson House, Railway Terrace
Rugby, Warwickshire CV21 3JH (GB)

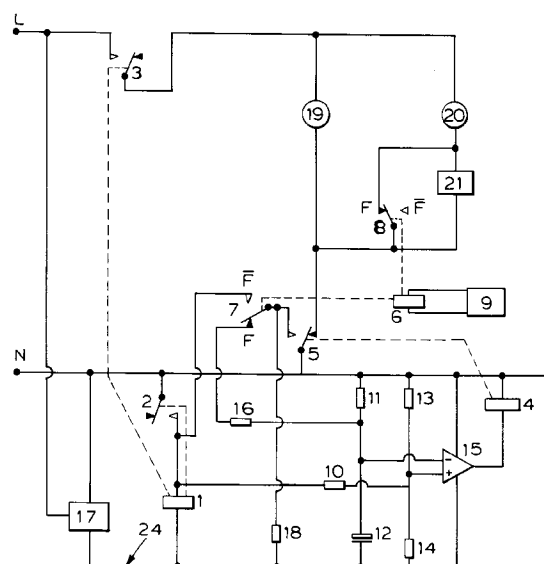
(72) Inventor : **Kinge, Richard Arthur George**
12 Parsonage Close, Bishops Tachbrook
Leamington Spa, Warwickshire, CV33 9SD
(GB)

(74) Representative : **Lawrence, Brian Richard**
59 Shenfield Place
Shenfield Brentwood Essex CM15 9AH (GB)

(54) **Heating appliances.**

(57) A heating appliance typically for a gas hot water boiler or a gas central heating system comprises a pilot gas valve 19 for supplying gas to a pilot gas burner (not shown), a main gas valve 20 for supplying gas to a main gas burner (not shown), an ignition device 21 for igniting the gas of the pilot gas burner, a flame detector circuit 9 for detecting the presence of a flame on the pilot gas burner, and a control circuit for controlling the operation thereof, the control circuit including a resistive/capacitive timing circuit (11,12 etc.) which operates in conjunction with a comparator 15 and a reference signal to afford a pre-ignition timing function for self-checking purposes and which operates in conjunction with the comparator 15 and a changed reference signal for affording an ignition period for igniting the pilot gas burner 19 which, if exceeded, causes a system lockout to occur which prevents gas flow to the pilot gas burner 19 and main gas burner 20.

FIG 1



This invention relates to heating appliances, and more specifically to gas fired heating appliances such as hot water boilers for gas central heating systems. It is especially concerned with control systems for use in such heating appliances.

To automatically light a gas fired heating appliance from complete shut-down in response to a command from an external "call for heat" control such as a room thermostat or time switch, it is necessary to ensure that safe conditions exist prior to the commencement of the lighting process and that in the event of failure to ignite, the appliance is left in a safe shutdown state. Thus, a heating appliance control system needs to provide that the safety of such an appliance is not compromised by the failure of any single component. All single component faults should result in a failure of the appliance to light so that it is impossible for any failed part to go unnoticed in a state which could be hazardous. Note that in this regard, certain failure modes of components are generally accepted as being impossible such as the short circuit condition for spiral wound resistors and the welding of relay contacts which do not SWITCH current.

It is an object of the present system to provide a gas heating appliance having an improved form of control system.

According to the present invention there is provided a heating appliance comprising gas burner means, ignition means for lighting said gas burner means, flame detector means for detecting the presence of flame on said gas burner means, and a control system for controlling the operation thereof, said control system comprising a resistive/capacitive timing circuit which is responsive to a demand for said appliance to be operated for causing a varying voltage signal to be generated, comparator means for comparing said varying voltage signal with a reference signal and for affording a comparator signal effective for causing gas to be supplied to said gas burner means and for causing said ignition means to be energised, said comparator means also being effective for causing the reference signal applied thereto to be changed, and is effective for comparing said varying voltage signal with said changed reference signal whereby, if a flame is detected by said flame detector means before said comparator means again operates, the gas supply to said gas burner means is maintained and the energisation of said ignition means is terminated, and if a flame is not detected by said flame detector means, said comparator means is again operated and said gas supply to said gas burner means and the energisation of said ignition means are terminated.

In carrying out the invention it may be arranged that said gas burner means comprises a main gas burner and a pilot gas burner, said ignition means being effective for lighting said pilot gas burner and said flame detection means being effective for detecting a

flame on said pilot gas burner, it being arranged that said main gas burner is supplied with gas when said pilot burner is supplied with gas and when said ignition means is de-energised.

Conveniently, a main gas valve may be provided for supplying gas to said main gas burner, and a pilot gas valve may be provided for supplying gas to said pilot gas burner.

It may be arranged that said demand for said appliance to be operated is constituted by an electrical mains signal applied to said control system, and power supply means may be provided responsive to the electrical mains signal for affording a d.c. electrical supply for energising said control system.

In a preferred arrangement according to the invention, it is arranged that said resistive/capacitive timing circuit is connected to said d.c. electrical supply for causing capacitor means thereof to be charged in response to said demand being received, said comparator means being effective for comparing the voltage of said capacitor means with said reference signal afforded by potential divider means, and for causing a first relay to be energised, said first relay causing a second relay to be energised, for connecting one line of said electrical mains signal to said pilot gas valve and said main gas valve, and for causing said second relay to be latched in its energised condition.

It may be arranged that the operation of said second relay causes said reference signal afforded by said potential divider means to be changed whereby said comparator means causes said first relay to be de-energised, said first relay in its de-energised condition being effective for causing said pilot gas valve to be energised to supply gas to said pilot gas burner, and for causing said ignition means to be energised for causing said pilot gas burner to be lit.

It may also be arranged that an output from said flame detection means indicating the presence of a flame on said pilot gas burner is effective for causing the main gas valve to be energised for supplying gas to said main gas burner, for causing said ignition means to be de-energised, and for causing said capacitor means to be discharged whereby said comparator means maintains said first relay in its de-energised condition to maintain energisation of said main gas valve and said pilot gas valve.

Alternatively, it may be arranged that said comparator means, in response to a comparison of said varying signal and said changed reference signal, and in the absence of an output from said flame detector means indicative of no flame being present on said pilot gas burner, causes said first relay to be energised to cause said pilot gas valve and said main gas valve to be de-energised to prevent gas flow to the pilot gas burner and the main gas burner.

Advantageously, a heating appliance in accordance with the present invention may comprise a fan for providing combustion air to said gas burner

means, in which case said control circuit may comprise an air proving switch responsive to air from said fan for controlling the operation of said gas burner means.

In another preferred arrangement according to the invention, it may be arranged that said resistive/capacitive timing circuit is connected to said d.c. supply for causing an initially charged capacitor means thereof to be discharged in response to said demand being received, and to be further discharged when said reference signal is changed.

In yet another preferred arrangement according to the invention, it may be arranged that said resistive/capacitive timing circuit is connected to said d.c. supply for causing capacitor means thereof to be charged or discharged in response to said demand being received, the charge or discharge, as the case may be, being reversed when said reference signal is changed.

Essentially, a heating appliance in accordance with the present invention includes a control system which employs a self checking lockout timer circuit which utilises its components in a timing function prior to commencement of the ignition process so that it is established that its operation is healthy before there is any subsequent need to lockout due to ignition failure. The timing function is preferably obtained by charging a capacitor via a resistor until a defined reference voltage is reached. Upon satisfactorily reaching this first "time-out", the reference is changed so that the same timing components are re-used as the capacitor charges towards a new voltage.

As an additional feature, the time taken for this self checking may be made long enough to act as a "rapid cycle limiter" to prevent instances where this type of operation could be a nuisance to the user.

Some exemplary embodiments of the invention will now be described reference being made to the accompanying drawings, in which:

Fig. 1 is a block schematic circuit diagram of a control system for use in a heating appliance in accordance with the present invention; and

Fig. 2 is a block schematic circuit diagram of a modified form of the control system of Fig. 1 for use in a heating appliance incorporating a forced air supply.

In Fig. 1 of the drawings there is depicted a control system for a gas heating appliance, the appliance having a main gas burner (not shown) which is supplied with gas via a main gas valve solenoid 20, a pilot gas burner (not shown) which is supplied with gas via a pilot gas valve solenoid 19, a flame detector 9 for detecting the presence of a flame at the pilot gas burner (not shown), and a spark generator 21 which, when energised, causes one or more sparks to be generated in the vicinity of the pilot gas burner (not shown) to cause it to light.

The control system to be described with refer-

ence to Fig. 1 includes a number of relay coils, as will be described, and it should be appreciated that the relay contact positions are shown in the conventional de-energised state, and dotted lines are used to indicate which relay contacts are influenced by each relay coil.

The control system shown in Fig. 1 comprises a NEUTRAL supply line N and, when there is a "call for heat", e.g. from a room thermostat or time switch, a switched live mains supply is applied to supply line L.

Upon application of the switched live mains supply to the supply line L, an auxiliary d.c. supply rail 24 is energised by a d.c. power supply 17. The power supply circuit 17 could, for example, take the form of a mains transformer and rectifier or a capacitor dropper circuit. In this position, the main gas valve solenoid 20 and the pilot gas valve solenoid 19 are both isolated from the supply line L by means of relay contacts 3 so that no gas is supplied to either the main gas burner (not shown) or the pilot gas burner (not shown). Accordingly, there will be no flame present at the pilot gas burner (not shown), and it is arranged that in the no-flame condition the flame detector circuit 9 energises relay coil 6, causing its contacts 7 and 8 to move to the "no-flame" (F) position.

When the auxiliary supply line 24 is energised, current flowing through resistor 11 slowly charges capacitor 12 and accordingly, as will hereinafter become apparent, provides a limit to the rate of successive ignition attempts. The voltage developed across the capacitor 12 is connected to the inverting input of a comparator 15, to the non-inverting input of which is applied a reference voltage which is largely defined by resistors 13, 14 and 10 and the resistance of a relay coil 1. The output from the comparator 15 energises relay coil 4 thus operating relay contacts 5. The operation of relay contacts 5 completes the circuit via the already operated contacts 7 to energise relay coil 1, the contacts 2 of which latch relay 1 and maintain its energisation.

The energisation of relay coil 1 causes the voltage on the non-inverting input of comparator 15, defined by resistors 13, 14 etc., to be pulled up to a new voltage by the current flow through resistor 10 thus de-energising relay coil 4. This change to the timer reference voltage on the non-inverting input of comparator 15, resets its output state but leaves the timing capacitor 12 charging so that satisfactory operation of the timer at this point signals its certain subsequent operation when the capacitor 12 voltage reaches the new reference voltage. The contacts 3 on relay coil 1 and the now released contacts 5 of relay coil 4 provide energisation of the pilot gas valve solenoid 19. Energisation of the spark generator circuit 21 is also provided by the small current which flows via the main gas valve solenoid 20, which current is insufficient to operate solenoid 20.

During this "ignition" period, capacitor 12 contin-

ues its charge towards the neutral rail N via resistor 11.

If the spark generator 21 is successful at lighting the gas from the pilot gas valve solenoid 19 before capacitor 12 charges to the new voltage on the non-inverting input of comparator 15 then the flame detector 9 will detect the flame and will de-energise relay 6 causing the relay contacts 8 to operate and causing the spark generator 21 to be short circuited to halt the sparks, the short circuiting of the spark generator 21 causing full current to be applied to the main gas valve solenoid 20 to provide full rate gas to the main gas burner (not shown) which will then be lit from the pilot burner. Normal operation of the appliance can now continue since contacts 7, also on relay coil 6, prevent lockout by holding capacitor 12 discharged via resistors 16 and 18.

If flame is not detected by the flame detector 9 before capacitor 12 charges to the new reference voltage on the non-inverting input of comparator 15 then relay coil 4 will be energised thus causing relay contacts 5 to halt the generation of sparks and the supply of gas. The appliance will now remain in this lockout condition until the "call for heat" is interrupted and restored to reattempt light-up. If the flame detector 9 subsequently indicates flame (due to perhaps an intermittent fault on the flame detector 9) then resistor 16 pulls capacitor 12 rapidly up to the neutral rail N, via relay contacts 5, to prevent the release of the relay coil 4 which would allow the system to restore gas and ignition etc.

The system so far described is advantageous in that should a malfunction occur, the control system locks out to prevent the generation of sparks and the supply of gas to the gas burners.

The system so far described would be employed on non-fanned combustion systems where the air supply is provided by natural draught, etc. The invention can equally well be applied to systems which provide a fan together with an air proving device, such as an air pressure switch, to provide the combustion air. In such cases the basic arrangement of Fig. 1 would be modified to the circuit shown in Fig. 2 where the air pressure switch is indicated by 23 and the fan by 22. When using this arrangement it is necessary to slug or delay the operation of the air pressure switch 23, usually by using a restricting orifice in one of its feed pipes, so that it does not indicate air flow until the timer circuit has passed its first threshold point. The inclusion of diode 25 halts the charge of the capacitor 12 at the timer proving voltage, so that the ignition period is not shortened by excessive delay in the operation of the air pressure switch 23. The operation of the arrangement of Fig. 2 is in other respects the same as that of Fig. 1.

The arrangements of Figs. 1 and 2 which have been described, operate satisfactorily, but in some situations degradation of the capacitor 12 can occur e.g.

due to leakage with age, and can result in the timing periods being increased with possible adverse affects. This may be overcome by reconnecting the capacitor 12 between the neutral rail N and the inverting input of the comparator 15 and by arranging that the capacitor 12 is precharged prior to the normal operation of the system so that it discharges during the timing periods. This provides the benefit that if the capacitor 12 degrades and becomes leaky with age, the timing periods before lockout will safely be reduced. A "low cost" variation in the arrangement of Fig. 2 is produced if capacitor 12 is connected between the neutral rail N and the inverting input of comparator 15 without any additional precharging circuitry added. The capacitor 12 voltage will move towards the initial "reference" on the non-inverting input of comparator 15 due to the current flow through diode 25. Once air flow is proved by the air pressure switch 23, the capacitor 12 will discharge towards the neutral rail N to provide the fail safe ignition timing. It is necessary, in this compromise arrangement, to form resistor 11 from at least two parallel components so that any failure will not jeopardise a controlled safety lockout.

A further example of a possible variation of the arrangements which have been described, is the reversal of the capacitor 12 charge/discharge at the point of satisfactorily proving the first "time-out" period. This charge then discharge of the capacitor 12 will also ensure that capacitor degradation does not extend the time to lockout.

It will be appreciated that the control systems which have been described in relation to Figs. 1 and 2 have been given by way of example only and may be modified to suit any particular application.

Claims

1. A heating appliance comprising gas burner means, ignition means for lighting said gas burner means, flame detector means for detecting the presence of flame on said gas burner means, and a control system for controlling the operation thereof, said control system comprising a resistive/capacitive timing circuit which is responsive to a demand for said appliance to be operated for causing a varying voltage signal to be generated, comparator means for comparing said varying voltage signal with a reference signal and for affording a comparator signal effective for causing gas to be supplied to said gas burner means and for causing said ignition means to be energised, said comparator means also being effective for causing the reference signal applied thereto to be changed, and is effective for comparing said varying voltage signal with said changed reference signal whereby, if a flame is detected by said flame detector means before said compara-

tor means again operates, the gas supply to said gas burner means is maintained and the energisation of said ignition means is terminated, and if a flame is not detected by said flame detector means, said comparator means is again operated and said gas supply to said gas burner means and the energisation of said ignition means are terminated.

2. A heating appliance as claimed in claim 1, in which said gas burner means comprises a main gas burner and a pilot gas burner, said ignition means being effective for lighting said pilot gas burner and said flame detection means being effective for detecting a flame on said pilot gas burner, it being arranged that said main gas burner is supplied with gas when said pilot burner is supplied with gas and when said ignition means is de-energised.

3. A heating appliance as claimed in claim 1 or claim 2, comprising a main gas valve for supplying gas to said main gas burner, and a pilot gas valve for supplying gas to said pilot gas burner.

4. A heating appliance as claimed in any preceding claim, in which said demand for said appliance to be operated is constituted by an electrical mains signal applied to said control system.

5. A heating appliance as claimed in claim 4, comprising power supply means responsive to the electrical mains signal for affording a d.c. electrical supply for energising said control system.

6. A heating device as claimed in claim 5, in which said resistive/capacitive timing circuit is connected to said d.c. electrical supply for causing capacitor means thereof to be charged in response to said demand being received, said comparator means being effective for comparing the voltage of said capacitor means with said reference signal afforded by potential divider means, and for causing a first relay to be energised, said first relay causing a second relay to be energised for connecting one line of said electrical mains signal to said pilot gas valve and said main gas valve, and for causing said second relay to be latched in its energised condition.

7. A heating appliance as claimed in claim 6, in which the operation of said second relay causes said reference signal afforded by said potential divider means to be changed whereby said comparator means causes said first relay to be de-energised, said first relay in its de-energised condition being effective for causing said pilot gas valve to be energised to supply gas to said pilot

gas burner and for causing said ignition means to be energised for causing said pilot gas burner to be lit.

8. A heating appliance as claimed in claim 7, wherein an output from said flame detection means indicating the presence of a flame on said pilot gas burner is effective for causing the main gas valve to be energised for supplying gas to said main gas burner, for causing said ignition means to be de-energised, and for causing said capacitor means to be discharged whereby said comparator means maintains said first relay in its de-energised condition to maintain energisation of said main gas valve and said pilot gas valve.

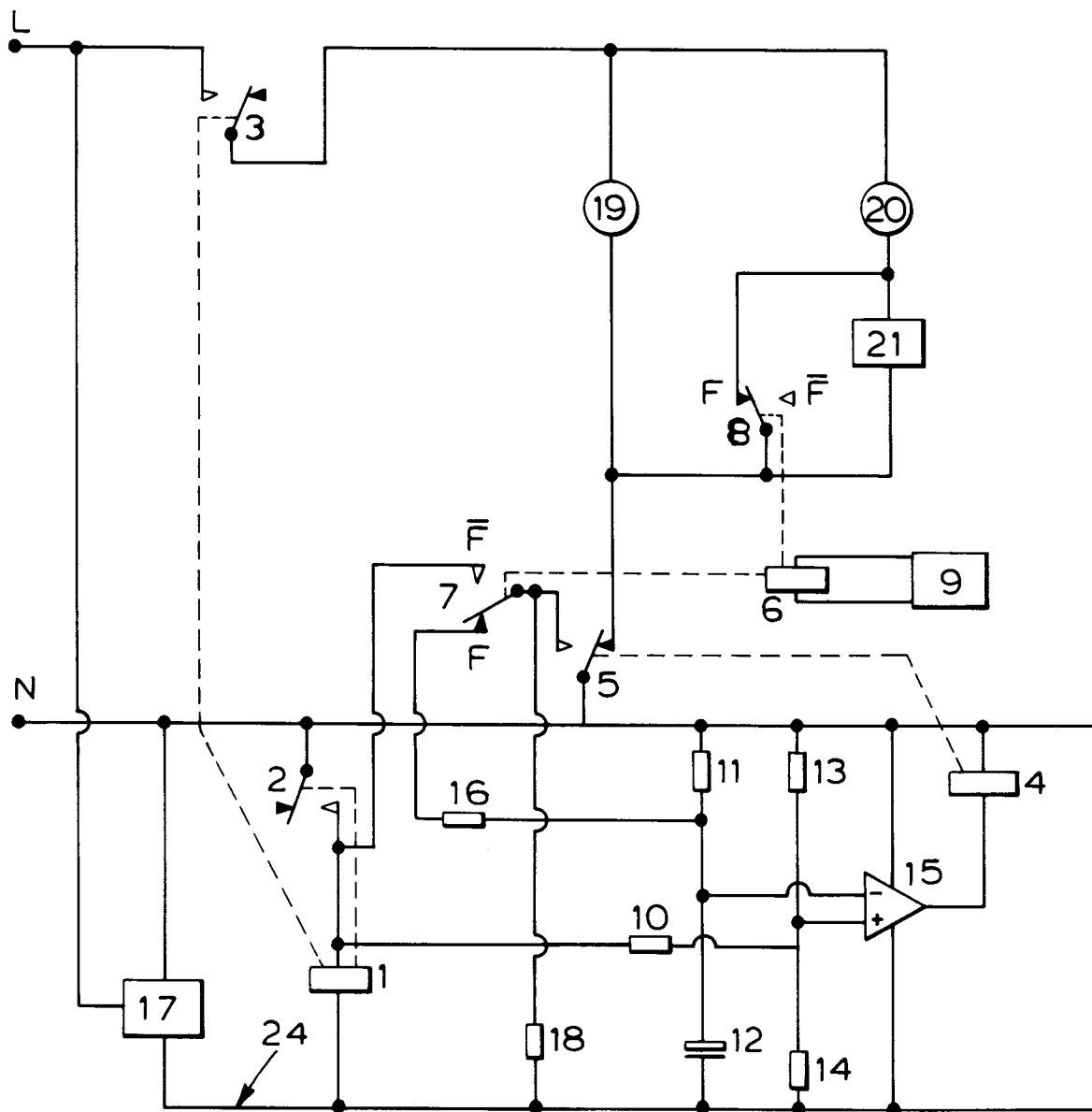
9. A heating appliance as claimed in claim 7, wherein said comparator means, in response to a comparison of said varying signal and said changed reference signal, and in the absence of an output from said flame detector means indicative of no flame being present on said pilot gas burner, causes said first relay to be energised to cause said pilot gas valve and said main gas valve to be de-energised to prevent gas flow to the pilot gas burner and the main gas burner.

10. A heating appliance as claimed in any preceding claim, comprising a fan for providing combustion air to said gas burner means, said control circuit comprising an air proving switch responsive to air from said fan for controlling the operation of said gas burner means.

11. A heating appliance as claimed in claim 5, in which said resistive/ capacitive timing circuit is connected to said d.c. supply for causing an initially charged capacitor means thereof to be discharged in response to said demand being received, and to be further discharged when said reference signal is changed.

12. A heating appliance as claimed in claim 5, in which said resistive/ capacitive timing circuit is connected to said d.c. supply for causing capacitor means thereof to be charged or discharged in response to said demand being received, the charge or discharge being reversed when said reference signal is changed.

FIG 1



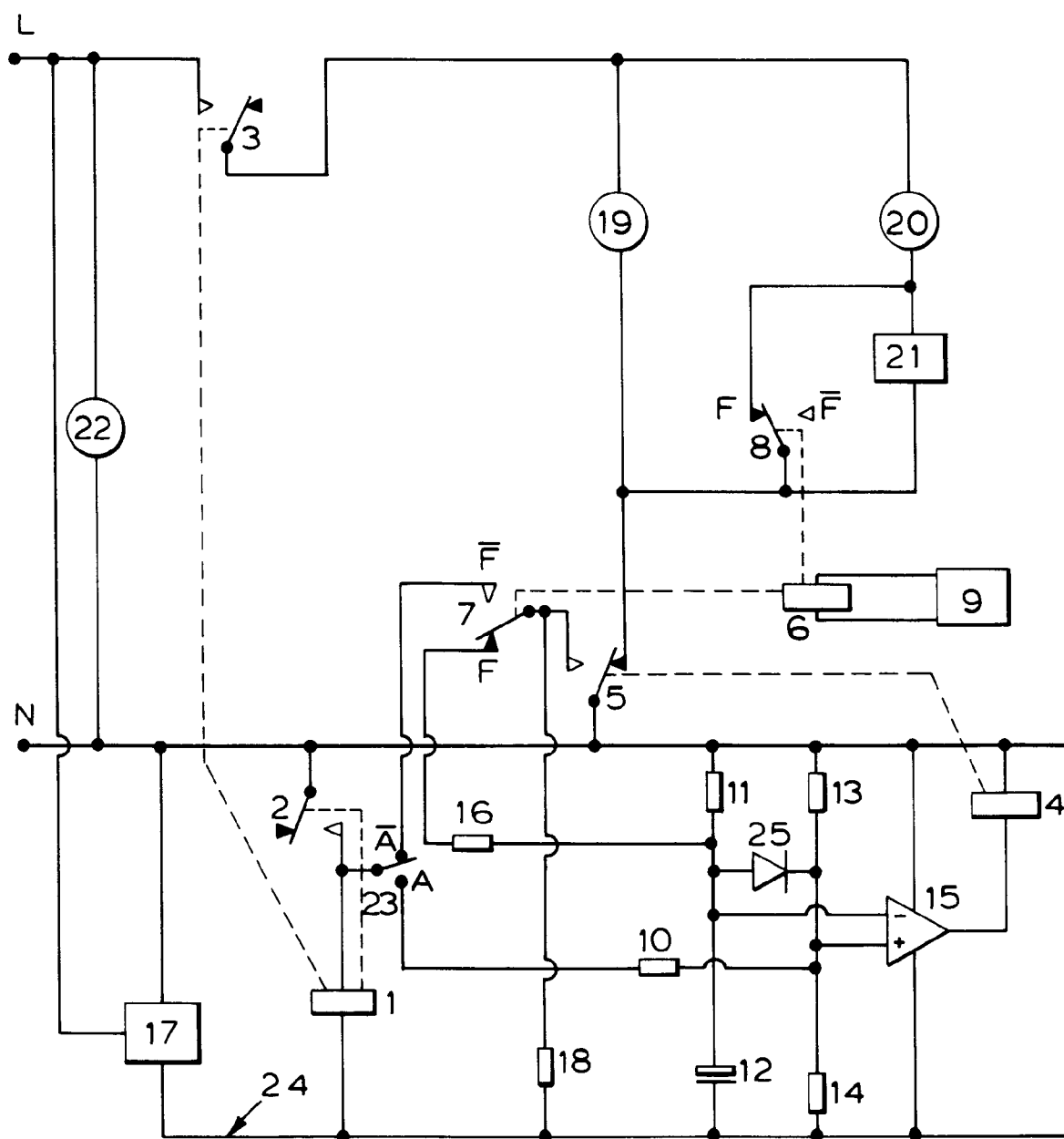


FIG 2



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 30 4163

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.5)
A	GB-A-2 078 398 (DANFOSS) * claim 1; figures *	1	F23N5/20
A	--- PATENT ABSTRACTS OF JAPAN vol. 7, no. 257 (M-256)16 November 1983 & JP-A-58 140 517 (NORITSU) 20 August 1983 * abstract * * figure *	1	
A	--- PATENT ABSTRACTS OF JAPAN vol. 6, no. 74 (M-127)11 May 1982 & JP-A-57 012 219 (TOSHIBA) 22 January 1982 * abstract * * figure *	1	
A	--- PATENT ABSTRACTS OF JAPAN vol. 7, no. 1 (M-183)6 January 1983 & JP-A-57 161 421 (MATSUSHITA DENKI SANGYO) 5 October 1982 * abstract * * figure *	1	
A	--- EP-A-0 482 857 (HONEYWELL) * abstract; figures *	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F23N
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 23 AUGUST 1993	Examiner KOOIJMAN F.G.M.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application I : document cited for other reasons & : member of the same patent family, corresponding document			

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