

(12)

EUROPEAN PATENT APPLICATION

(21) Application number: 83830161.2

(51) Int. Cl.³: **F 23 N 5/00**

(22) Date of filing: 03.08.83

(30) Priority: 03.08.82 IT 2272182
12.11.82 IT 2423482

(43) Date of publication of application:
15.02.84 Bulletin 84/7

(84) Designated Contracting States:
AT BE CH DE FR GB LI LU NL SE

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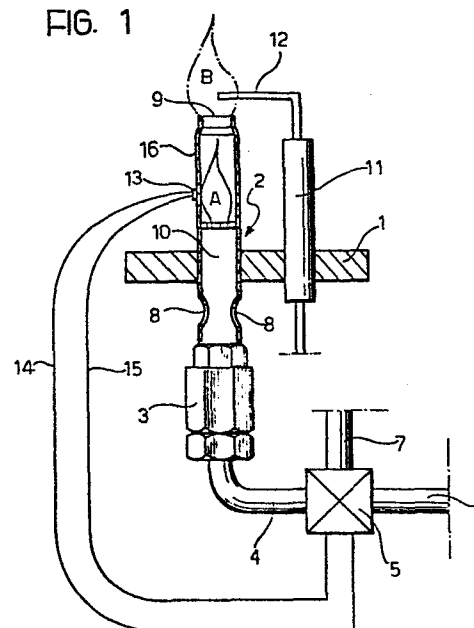
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(54) **A safety device for gas heating apparatus.**

(57) A safety device for gas heating apparatus, is provided which is responsive to a reduction in the oxygen content in the environment in which the apparatus is located, to close a main solenoid valve (3) controlling the gas supply.

The device includes a temperature transducer the temperature sensitive element (13) of which is fixed to the outside of the wall (16) of a pilot burner tube (2) to detect its temperature. In dependence on the detected temperature, the transducer generates a signal which, when the pilot flame burns in a first position (A) in the pilot burner tube (2), corresponding to normal environmental conditions, maintains the gas-supply solenoid valve (5) open and which on the other hand causes the latter to close when the pilot flame burns in a second position (B) as a result of its displacement due to a lowering of the oxygen content in the environment.

FIG. 1



"A safety device for gas heating apparatus"

The present invention relates to a safety device for gas heating apparatus, of the type comprising a pilot burner having a tube for the pilot flame, a main gas supply solenoid valve and means for controlling this solenoid valve to maintain it open when the ambient conditions are normal and to close it upon a reduction in the oxygen content in the environment in which the heating apparatus is located.

As is known, when a gas heating apparatus is installed in an enclosed location and not provided with a fume discharge flue, a progressive reduction in the oxygen content occurs in the environment, together with a progressive increase in the carbon monoxide content.

This happens more quickly when the natural air change with the outside through the doors, windows and fixtures in general takes place more slowly.

Therefore, a situation can arise in which people present in the locality are subject to a serious risk of poisoning, particularly due to the presence of carbon monoxide.

It has been found that the three above-listed phenomena (reduction of oxygen, increase in carbon monoxide, increase in carbon dioxide) are interconnected; in particular it has been found that when the oxygen content falls below a particular value (typically 18.5% by volume in the ambient atmosphere) the carbon monoxide content tends to increase in a potentially dangerous manner (typically more than 100 parts per million is generally considered the threshold not to be exceeded

if the possibility of poisoning for persons present in the locality is to be avoided with certainty).

- Due to the necessity of avoiding the risk of poisoning people, the safety rules generally prescribe that
- 5 "draught free" gas appliances be provided with safety devices operable to securely interrupt the operation of the gas apparatus before the percentage content of oxygen in the local atmosphere falls below a determined threshold value.
- 10 In such devices, according to the known art shown, for example, in US Patent No. 3295585 and French Patent No. 1563239, a hot thermocouple junction, constituted by the cap of a thermocouple of conventional type, detects the position and conformation of the flame which burns
- 15 in the tube of the pilot burner. The electromotive force generated by the thermocouple is used to control the solenoid valve of the main gas inlet to the apparatus. When a variation (reduction) in the oxygen content in the ambient atmosphere causes a variation in the
- 20 conformation or position of the pilot flame, or causes it to become extinguished, this produces a reduction in the electromotive force generated by the thermocouple so that the solenoid valve no longer receives sufficient energy to hold it in an open position, and it therefore
- 25 snaps shut interrupting the passage of gas.

Such safety devices, whilst substantially serving their purpose, do have, however, the recognised disadvantages of being imprecise and not very repeatable.

In fact, the pilot flame in such devices in time causes

30 the formation of deposits and carbonaceous encrustations

on the cap of the thermocouple and on its end part exposed to the flame. Such carbon encrustations become red hot giving rise to so-called hot spots. In this case the temperature detected by the thermocouple junction and the electro-
5 motive force generated by this can fail accurately to reflect the position and conformation of the pilot flame and therefore the oxygen content in the environment.

Because of this, such devices are in practice calibrated in
10 such a way as to conservatively take account of these inaccuracies so that they are prearranged to cut off the flow of gas before an oxygen content is reached which effectively corresponds to the dangerous threshold.

15 In this way the safety of people present in the locality is certainly safeguarded, but at the same time the regular operation of the heating apparatus is hampered.

Moreover, the presence of the thermo couple cap within the
20 pilot burner tube where the pilot flame burns in normal conditions, especially when this cap is asymmetrical with respect to the axis of the tube, induces unpredictable turbulence phenomena which detract from the good reliability and repeatability in the operation of the safety device.

25 The object of the present invention is therefore to obviate the disadvantages met with in safety devices of the prior art in such a way as to arrive at a highly reliable device without prejudicing the correct operation of the pilot
30 burner and therefore the heating apparatus controlled thereby.

The problem underlying the present invention is therefore to be able to detect variations in the
35 oxygen content of the environment in which the apparatus is positioned to operate, by the detection of a thermal condition associated with the pilot burner flame whereby to

acts on the main gas inlet valve to close it when the combustion conditions are dangerous, without causing disturbances to the flow of gas through the pilot burner tube supplying the pilot flame and to maintain the device in
5 conditions of high efficiency.

This problem is resolved, in accordance with the invention, by means of a safety device of the type specified above, which is characterised by the fact that the said solenoid
10 valve control means includes a temperature transducer the temperature sensitive element of which is fixed to the wall of the pilot burner tube in a position lying between the transverse section of the tube at which the pilot flame
15 burns in normal combustion conditions and the section to which this flame is displaced when the normal oxygen content in the environment has fallen below the normal percentage value of the ambient air.

In one embodiment of the invention, the said temperature sensitive element is constituted by the thermo-electric
20 junction of a thermocouple connected to the said main gas supply solenoid valve.

In a variant of this embodiment, one of the elements forming
25 the thermo electric junction is constituted by the wall of the pilot burner tube itself, the other element forming the thermocouple being welded to the outer surface of this wall.

The invention will now be more fully described with reference
30 to a preferred embodiment illustrated in the attached drawings, in which:

- Figure 1 illustrates a schematic vertical section of a pilot burner for gas heating apparatus, provided with a
35 safety device according to the invention including a thermo-

couple;

- Figure 2 illustrates a constructional variant of the end of the pilot burner tube of the preceding figure;

- Figure 3 illustrates the circuit of a safety device according to the invention including a thermistor;

- Figure 4 illustrates a constructional variant of the device of Figure 1 in which one of the elements forming the thermo-electric junction is constituted by the wall of the pilot burner tube.

10 A pilot burner is conventionally constituted by a tube 2 which, by means of a coupling 3, is connected to the gas supply pipe 4 leading from a solenoid valve schematically indicated 5. Gas is supplied to this latter element from a source not indicated via the main pipe 6. From
15 this solenoid valve 5 there also extends a pipe 7 for conveying gas in a conventional way to the main burner of the heating apparatus, not illustrated.

As is conventional, holes 8 are formed at the base of the tube 2 for the admission of combustion air which mixes
20 with the gas coming from the tube 4.

Within the tube 2, in a position located inwardly of the end opening 9, there is provided a transverse metal mesh 10 fixed to the inner walls of the tube itself. In addition, a spark ignition device 11, of conventional
25 type, is provided to the side of the tube 2 on the support panel 1, the electrode 12 of the ignition device 11 being arranged to lie over the tube opening 9 for igniting the pilot flame.

Fixed to the outside of the tube 2 in a position lying
30 between the transverse section at which the mesh 10 is located and the tube opening 9, is a temperature

sensitive element, formed by a thermo-electric junction 13 of a thermo-couple constituted by two metal conductor elements 14 and 15 in themselves conventional in the thermo-couple art. The junction 13 is, for example, welded to the
5 wall 16 of the tube 2.

The thermo-couple 14 and 15 and the associated thermo-electric junction 13 constitutes a temperature transducer according to the invention.

10

Preferably the position in which the junction 13 is fixed to the wall of the tube 2 is nearer the mesh 10 than the opening 9.

15 The conductors 14 and 15 forming the thermo-couple are in turn connected, in a conventional way, to the electro-magnet of the solenoid valve 5 to control its closure in the manner which will become clear from the following description.

20

The operation of the safety device is as follows. When combustion is normal, that is when the environment in which the heating apparatus is put into operation has a normal retained oxygen content, the pilot burner
25 flame forms, conventionally, on the mesh 10 within the tube 2.

In these conditions the pilot flame, indicated A and in solid outline in Figure 1, contacts the inner wall of the
30 tube 2 the temperature of which is therefore significantly raised.

In these conditions the thermo-electric junction 13 generates a corresponding relatively high electromotive force
35 which, via the conductors 14 and 15, maintains the electro-magnet of the solenoid valve excited and therefore maintains this valve in an open condition.

In these conditions, gas is therefore allowed to flow both towards the pilot burner and towards the main burner of the heating apparatus.

When the oxygen content in the environment falls below
5 the normal value (typically 18.5 per cent by volume of the ambient air) the pilot burner flame becomes displaced from the position A to the position indicated B and in broken outline in Figure 1, forming at the opening of the tube 2.

In these conditions the section of the wall 16 of the
10 tube 2 lying between the mesh 10 and opening 9 becomes necessarily subject to a lowering in temperature, which is immediately sensed by the thermo-electric junction 13 of the thermo-couple. The electromotive force generated by this junction 13 therefore falls
15 below the previous value, thereby causing the solenoid valve 5 to close and thus interrupting any supply of gas.

In order to greatly increase the temperature drop in the wall 16 of the tube 2 as a consequence of the displacement of the flame from the mesh 10 to the opening
20 9, and to maintain the greatest possible length of the wall 16 in relatively low temperature conditions, the open end of the tube 2 can be formed in accordance with the variant illustrated in the Figure 2. In this variant, the free end of the tube 2 is provided with a tubular
25 extension 17 constituted by a helically wound metal wire fitted externally over the tube 2.

The mouth of the pilot burner now becomes the end 18 of this tubular extension 17. The heat of the pilot flame, when it forms at this end, is therefore transmitted to
30 the wall 16 of the tube 2 with a significant delay as a

consequence of the helical conformation of the extension. This contributes to maintaining the temperature detected by the thermo-electric junction 13 low during anomalous ambient conditions.

- 5 With reference to Figure 3, the reference numeral 19 generally indicates a thermistor constituting a temperature sensitive element in place of the thermo-electric junction 13 of Figure 1.

10 This thermistor, the resistance of which varies with variations in temperature, is fixed to the outer wall 16 of the tube 2, for example in the same position and manner of connection as the junction 13. It constitutes part of one arm of a conventional electrical bridge, for example a Wheatstone bridge, generally indicated 20. This
15 bridge is constituted by opposing resistors 21 and 22 as well as the resistor 23 connected opposite the thermistor 19. In particular the resistor 23 is of the variable resistance type manually adjustable for the necessary adjustment and calibration operations.

- 20 The bridge 20 is connected across the electrical supply lines 24 and 25 coming from an electrical energy source 26, for example an alternating current source, via a transformer 27 and a rectifier 28.

This bridge is also connected, by terminals 29 and 20,
25 to a signal amplifier 31 connected between the supply lines 24 and 25. This amplifier 31 is in turn connected in a conventional manner to a Schmitt trigger circuit 32 which is also connected between the supply lines 24 and 25 and controls, via a triac 33 the main gas-supply
30 solenoid valve 5.

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As long as the temperature detected by the thermistor 19 is sufficiently high, corresponding to the correct position of the pilot flame within the tube 2, the temperature transducer device sends a signal which, via the amplifier 31, the Schmitt trigger 32 and the triac 33, maintains the solenoid valve 5 open. When the pilot flame becomes displaced, as described in relation to the device of Figure 1, due to a dangerous lowering in the oxygen content of the environment, the temperature reduction in the wall of the tube 2, detected by the thermistor 19, generates in the bridge 20 an electrical condition which causes the closure of the valve 5 whereby to interrupt the flow of gas.

With reference to Figure 4, the device according to the invention comprises a pilot burner 34, a spark ignition device 35 and a thermo-couple 36.

The pilot burner 34 has a tubular body 37 with a vertically disposed axis x - x the lower end of which is connected to a gas inlet tube 38 by means of couplings 39 and 40 and a bi-conical sealing ring 41.

The pilot burner 34 has a tubular sleeve 42 made of material having good thermo-electric properties (for example a nickel-chrome alloy or other material having a sufficiently high Seebeck coefficient) which is fitted coaxially over the upper end of the body 37 and terminates at the top with an outlet section 43 having, in the example illustrated, a restricted section with perimetral slots 44.

The reference numeral 45 indicates a transverse mesh disposed within the tube 37 at a predetermined distance "a" upstream from the outlet mouth 46.

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The reference numeral 48 indicates radial holes provided in the body 37 at its lower end, for the intake of combustion air for the pilot flame.

5 The spark ignition device 35 includes a cylindrical support body 49 made from electrically insulating material, the axis y - y of which extends parallel to the axis x - x and in mutually spaced relationship therewith, as well as an electrically conducting rod-like element 50 which coaxially
10 and rigidly extends through the said support body 49. The rod-like element 50 is connected to a spark generator, not shown because it is conventional, and has a free upper end 51 bent at a right angle and lying over the mouth 46 of the burner.

15 The burner 34 and the ignition device 35 are fixed, in the relative positions described above, to a bracket 52 by means of a yoke 53 screwed to the bracket itself by means of a screw 53a. The bracket 52 is in turn intended to be mounted
20 on the gas heating apparatus not illustrated.

The thermocouple 36 has a hot thermo-electric junction, indicated 54, positioned in correspondence with the tube 42 of the pilot burner 34. More particularly, the thermo-
25 electric junction 54 is formed by one end 55 of a rod-like element 56 made of material having suitable thermo-electric properties (for example constantan), which is welded to the outer surface of the tube 42 which constitutes the other element of the hot junction 54.

30 In particular, the end 55 of the rod-like element 56 is welded externally to the tube 42 at a point along its length at a predetermined distance "b" downstream from the mesh 45.

The junction element, constituted by the tube 42, is electrically connected to earth by means of the pipe 38. The electromotive force generated by the thermocouple is transmitted to a terminal 57 by means of a copper wire 58 which is of suitable length and externally insulated, and has one end 59 soldered to the end 60 of the rod-like element 56 and the other end 61 soldered to the terminal 57.

The terminal 57 is insulated by a bush 62 from a metal support sleeve 63 traversed by the wire 58. A coupling 64 is fitted on the sleeve 63 for fixing the terminal 57 into a gas inlet solenoid valve such as that indicated 5 in Figure 1, having an earthed body.

In this manner, the electromotive force generated by the thermo-couple is presented within the solenoid valve, and in particular between its body and the terminal 57. This electromotive force is utilised to activate the gas inlet solenoid valve in a conventional manner as already described with reference to Figure 1.

The reference numeral 65 indicates a glass fibre sheath extending along the rod-like element 56 from its end 55 soldered to the sleeve 42 to terminate a short distance beyond the copper wire 58.

Reference numeral 66 indicates an electric welding spot effected to rigidly connect together the tube 42 and the body 37 of the pilot burner 34.

During operation, the inlet gas from the tube 38 and the air drawn in by the holes 48 mix within the body 37, traverse the mesh 45 and flow out from the mouth 46 where they are ignited by a spark struck between the end 51 of the ignition

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device and the tube 42. The pilot flame thus ignited forms downstream from the mesh 45, occupying a section of the chamber 47 corresponding to the point where the end 55 of the rod-like element 56 is welded to the tube 42.

5

The device reacts to variations in the composition of the atmosphere in the same way as already described with reference to the devices of Figures 1 and 3.

10 As can be established from what has been described above, in accordance with the invention the advantages of high sensitivity as well as rapidity of operation of the main solenoid valve 5 to cut off the gas, are obtained without disturbing the flow of gas into the pilot burner
15 tube.

Further, because of their position, the thermo-electric junctions 13 and 54 or the thermistor 19 are not in contact with the pilot flame and thus maintain their
20 conditions of maximum efficiency for a long time, since they are not subject to encrustations of a carbonaceous nature or to other deteriorations.

Naturally, the structure of the devices illustrated as
25 preferred can be varied from those expressly indicated above, according to the specific necessities of the installation without by this departing from the scope of the present invention.

CLAIMS

1. A safety device for gas heating apparatus of the type including a pilot burner having a tube (2; 42) for the pilot flame, a main gas supply solenoid valve (5) as well as control means (13;54) for this solenoid valve to maintain it open in normal ambient conditions and to close it as a result of a reduction in the oxygen content in the environment in which the heating apparatus is positioned, characterised in that the said solenoid control means include a temperature transducer in which the element (13; 54) sensitive to temperature is fixed to the wall of the pilot burner tube (2;42) in a position lying between the transverse section of the tube (2; 42) at which the pilot flame (A) burns in normal combustion conditions and the section to which this flame (B) is displaced when the oxygen content in the environment falls below the normal percentage value for the ambient air.

2. A safety device according to Claim 1, characterised in that the said temperature sensitive element is constituted by the thermo-electric junction (13;54) of a thermocouple connected to the said main gas supply solenoid valve (5).

3. A safety device according to Claim 2, characterised in that one of the elements forming the thermo-electric junction (54) is constituted by the wall of the pilot burner tube (42), the other element being constituted by a rod-like member (56) welded at one end to the wall of the said tube (42).

4. A safety device according to Claim 1, characterised in that the said temperature sensitive element is constituted by a thermistor (19) forming part of one arm of an electrical bridge (20) connected between an electrical energy source (26) and the said main gas supply solenoid valve (5).

5. A safety device according to Claims 1 to 4, characterised in that the said temperature sensitive element (13; 54) of the said temperature transducer is fixed to the wall of the pilot burner tube (2;42) in a position closer to the section of the tube in which the pilot flame burns in normal combustion conditions than to the mouth of the said tube.
6. A safety device according to Claims from 1 to 5, characterised in that the said temperature sensitive element (13; 54) of the said temperature transducer is fixed to the outside of the wall of the tube (2;42).

FIG. 1

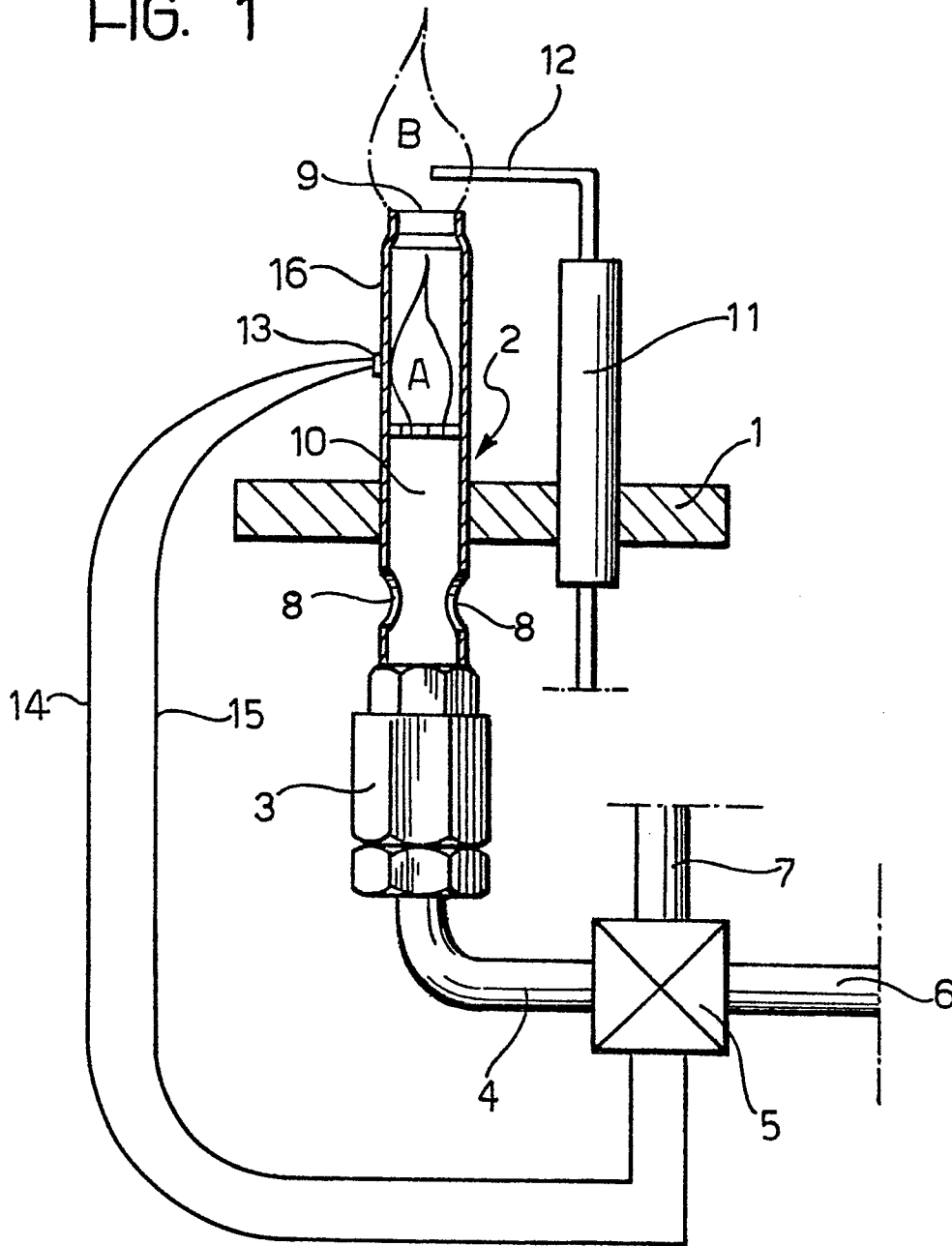


FIG. 2

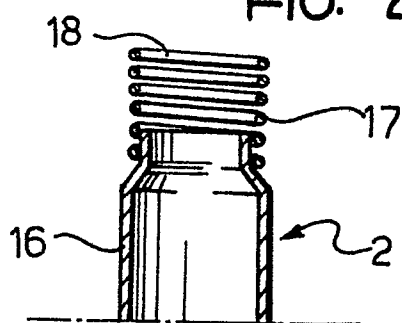
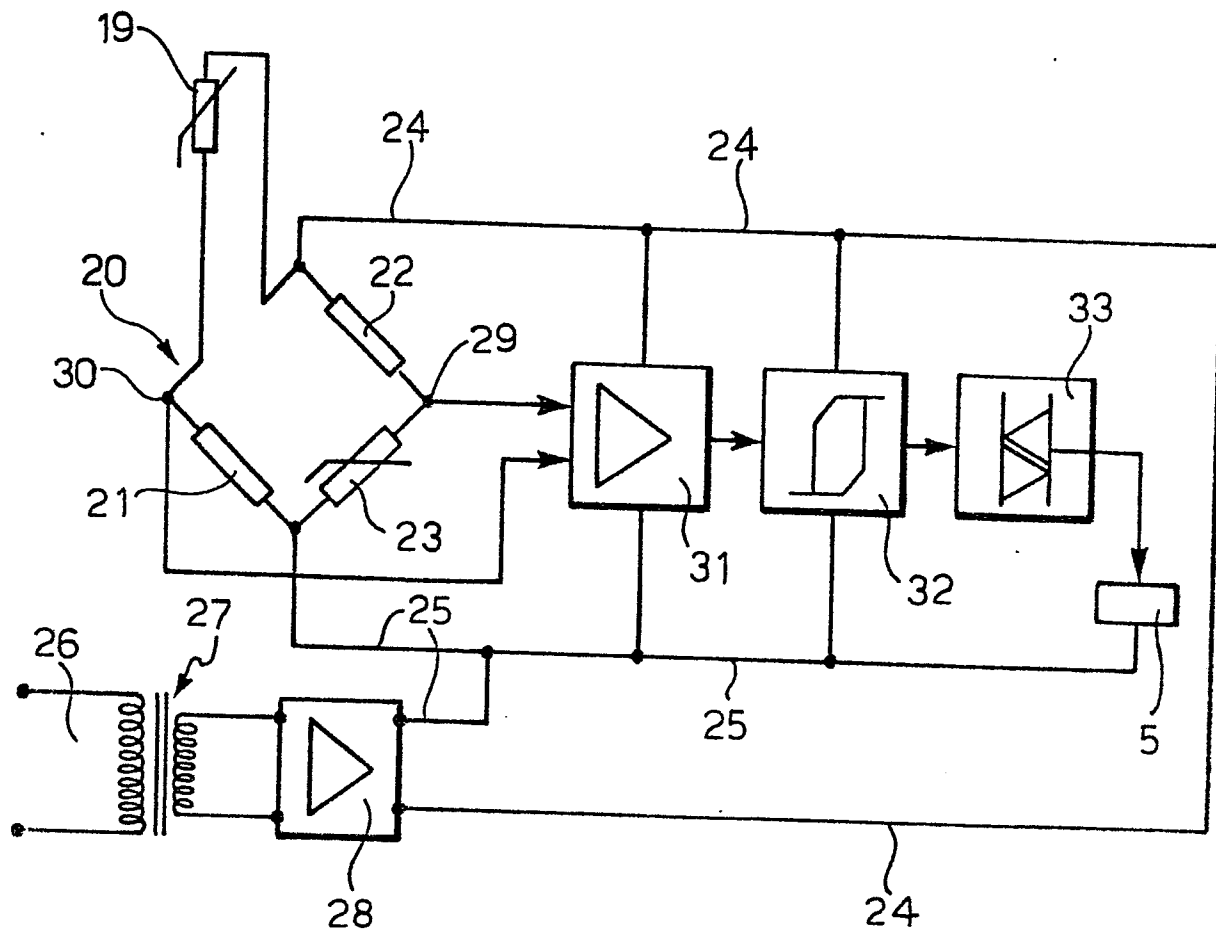


FIG. 3



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FIG. 4

