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(54) Toxic gas detection.

(57) Circuit means is disclosed for performing the functions of the self-monitoring and diagnosis of means for the detection of toxic and/or harmful and/or explosive gases, checking the operating condition and efficiency of the various constituent parts, either continuously or at specified intervals, or under manual control.

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It is known that means for detecting the presence of harmful and/or explosive gases which might cause harm to persons and property whenever the quantities present reach critical levels of concentration in air are used in applications in industrial and civil contexts.

It is also known that these devices incorporate means for acoustic and/or visual signalling and can be connected to similar means located in remote positions. These gas detection means generally consist of a sensor element, the sensor itself, of the catalytic or semi-conductor type, which reacts by changing its electrical properties when a gas is present.

The presence of a gas is therefore detected by a circuit, generally of the Wheatstone bridge type, and alarm signals are activated by suitable circuit means.

These circuit means normally make a comparison between the change in the electrical parameters of the sensor and suitable threshold levels, which "reflect" threshold levels of the gas concentrations in an analog electrical form.

The object of this invention is to provide circuit means for the self-monitoring and diagnosis of the abovementioned detection devices which are capable of monitoring the critical parameters for the devices, together with the function of critical components therein, indicating any Faults or abnormalities by suitable means.

This and other objects which will be more apparent below are all accomplished by the circuit according to the invention, which is characterised in that it comprises a microprocessor, suitable interface circuits and alarm signals in combination. The monitoring circuit, in which the microprocessor represents the intelligent portion, is programmed to perform continuous monitoring of the gas sensor (continuous testing over the course of time) and/or monitoring of the detection device as a whole, when specifically commanded to do so (intermittent test).

Performance of the intermittent test may be controlled by means of a switch, or by means of timed puses from the microprocessor at a specified frequency (e.g. : weekly, monthly, half yearly, etc.).

The continuous test provides for measurement of the resistance of the sensor heating element.

If a resistance value which does not lie within the range of rated values is measured, the microprocessor receives one of two RS > MAX, RS < MIN signals. In particular, if the heating element is switched off and the sensor is therefore faulty the RS > MAX signal is activated. This is interpreted by the microprocessor as an alarm signal.

Alarm procedures are then brought into action, i.e. acoustic and/or visual signals are activated, and these obviously have characteristics different from those used for indicating the presence of gas. Performance of the intermittent test to check the functioning of the alarm device as a whole is based on simulation of the detection of a gas and therefore on checking the fact that the components downstream of the sensor (threshold comparison circuits and buzzer) are in a perfect operating condition.

This test procedure is brought into action as described below.

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

– Figure 1 shows the detector as a box diagram.

– Figure 2 shows the power supply for the detector of Figure 1.

– Figure 3 shows the microprocessor connections for the detector of Figure 1,

– Figures 4 and 5 show alternative interfaces required for an electrically compatible connection between the gas sensor, the acoustic indicator and the monitoring circuit in the detector of Figure 1, and

– Figure 6 shows the buzzer interface for the detector of Figure 1.

A monitoring circuit 1 has an alarm LED 2 and a test signal LED 3. Power is supplied by a supply block 4. A gas sensor 6 and an acoustic sensor 7 are connected to the monitoring circuit 1 through an interface 5. A manual test switch 8 is provided; 8′ is the corresponding relay. In Figure 2 an electrical mains connection 10 feeds through a continuous transformer 11 to feeds 9 anti 9′ fitted with a voltage regulator 12.

Figure 3 shows the monitoring circuit microprocessor with its electrical signal inputs and outputs for controlling the timing of the operations which mainly affect user unit 14, alarm 15, sensor 16, input 1/(RS > MAX) or input 18 (RS < MIN), buzzer 19, LEDs 21, 22, test switch 23 and the other circuit components, relay 25, buzzer control 20 and logic input 24 (voltage or current). When under manual or timed control, microprocessor 1 switches off sensors 31 or 31′ (logic signal 16 or 16′) by means of the circuit illustrated in Figure 4 or Figure 5, according to the type of heating elelment operation. Switching off the sensor for a predetermined period (a few seconds) causes it to cool. Subsequent switching on of the sensor provides an opportunity for examination of the thermal transient (through an analysis of the output voltage "V out" from the measuring side of the sensor).

Typically, during the initial seconds of the heating transient "V out" has voltage values in excess of the alarm threshold, and thus logic signal 15 in Figure 3 is activated (ALARM).

When this signal is detected by microprocessor 1 a check is made to ensure that the alarm condition has been generated correctly.

For testing the acoustic signalling device, a manual or timed command in the form of signal 19 (BUZZER 32) is activated and logic signal 20, which represents the functioning of the acoustic indicator from the electrical point of view is detected and checked for correctness..

The acoustic efficiency of the indicator must be checked by the user, who must recognise a particular acoustic message when the test is activated.

Relay 25 is tested by means of a manual or timed control, by activating relay 25′ by microprocessor 1 and subsequently checking logic signal 26 generated by an auxiliary relay contact.

Obviously in the case of automatic timed command, the acoustic and/or visual signals will be of a different type and quality (for example flashing of the test LED 3) so as not to mislead users, giving rise to an unjustified panic situation. Flashing of the LED when the test has a positive outcome (the equipment is functioning correctly) implicitly provides a check on the functioning of the LED itself. If this were not the case a steady light or not light from the LED in the event of a positive test result would not allow any fault in the signalling device to be detected.

Figures 4 and 5 illustrate two possible embodiments of the circuit for measuring the resistance of the heating element.

Figure 4 shows an embodiment in which the heating element is operated at constant current. Circuit 27 (consisting of R1, R2, R3, R4, R5, Q1, Q2, Q3, U1 and D1) forms a current generator which can be switched off by means of logic input 16 and which can provide two different values of current which can be selected through logic input 24 (I1/I2). In this case the resistance is measured by detecting the voltage across the heating element (comparators U2 and U3).

In Figure 5, the embodiment in which the heating element is operated at constant voltage, circuit 27′, consisting of R1, R2, R3, R4, R8, R9, Q1, Q2, Q3 and U1, forms a voltage generator which can be switched off by means of logic input 16′ and which can provide two different voltage values which can be selected by means of logic input 24′ (V1/V2). In this case the resistance is measured by monitoring the current flowing in the heating element (by measuring the voltage at terminals 30 of R7).

Claims

1. Circuit means for the self-monitoring and diagnosis of means for detecting toxic and/or harmful and/or explosive gases, characterised in that it comprises a microprocessor circuit, the input and output signals of which through interface circuits control continuous timed or manual sequences controlling the detection and alarm devices affected by the presence of gas, activating control functions, programming tests and diagnosing circuits.

2. Means according to claim 1, characterised in that the results of diagnosis in a continuous detection system or in an intermittent detection system determined or controlled by manual means provides the microprocessor with a logic signal which is interpreted as an ON/OFF alarm message and may or may not activate acoustic and/or visual signals for diagnosis.

3. Means according to claims 1 and 2, characterised in that diagnosis of correct or incorrect functioning of the sensor is based on measurement of the electrical resistance of the heating element of the sensor itself, and on the emission of a logic signal which the microprocessor at least converts into an alarm activation signal.

4. Means according to the foregoing claims, characterised in that when performing a test the microprocessor causes the gas sensor to be switched off and switched on by means of a constant current or constant voltage circuit so that the thermal transient and emission of the alarm threshold signal can be examined and a comparison can be made with the normal operating state to check that the alarm condition is generated correctly.

5. Means according to the foregoing claims, characterised in that the microprocessor checks that the relay operating any remote devices which may be connected to the gas detector is operating correctly.

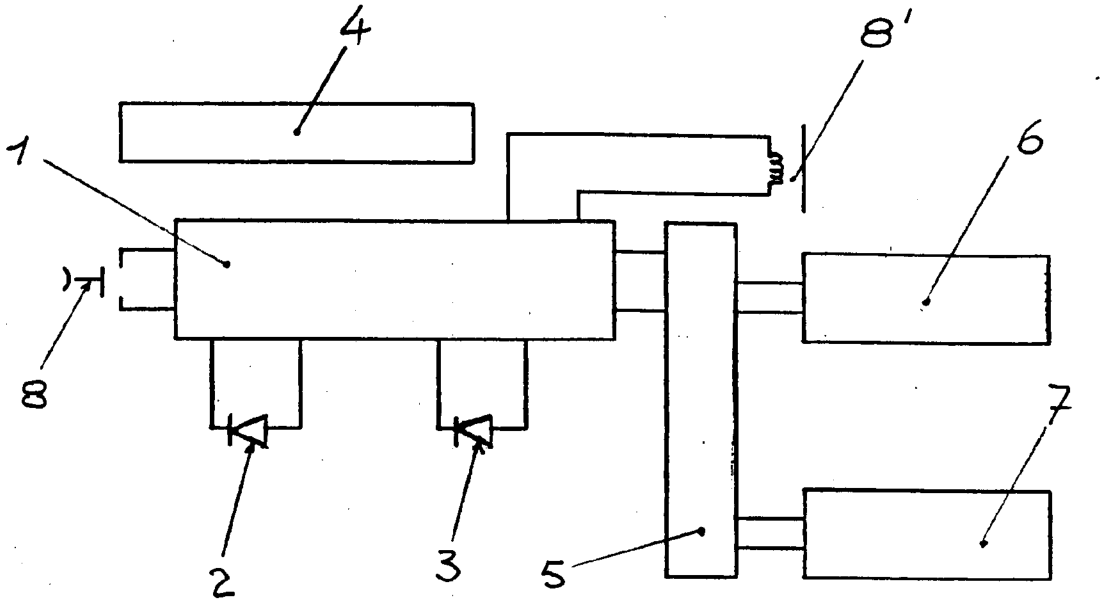


FIG.1

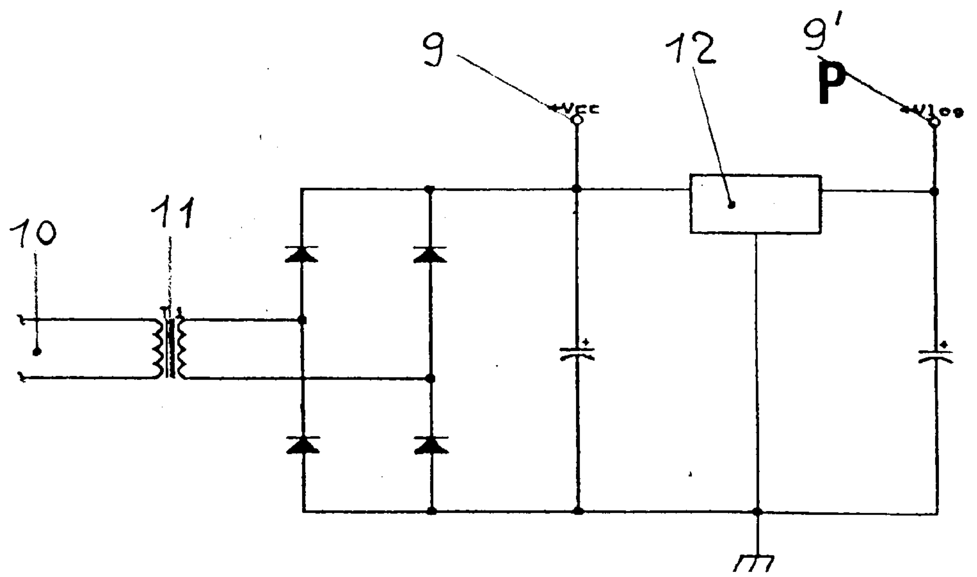
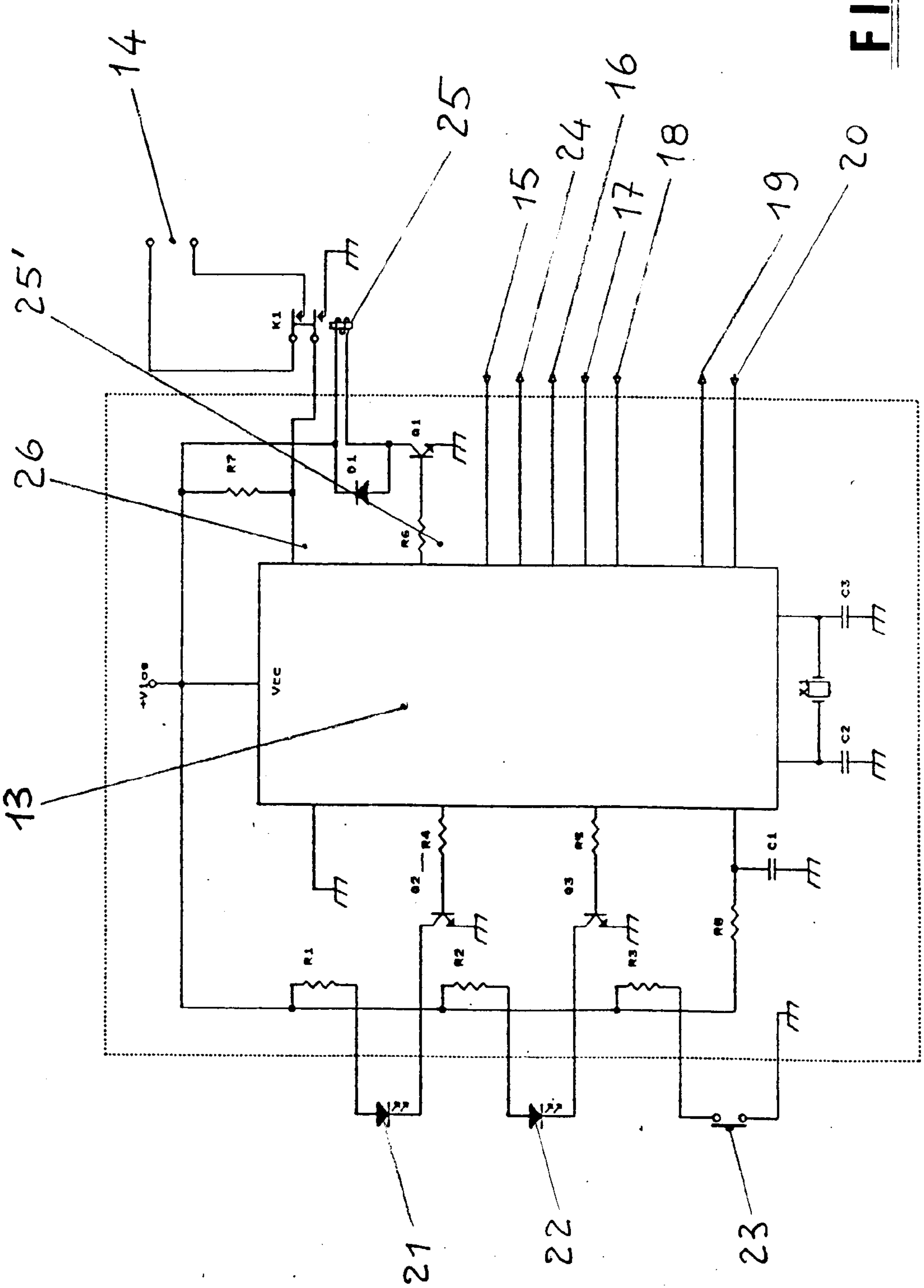


FIG.2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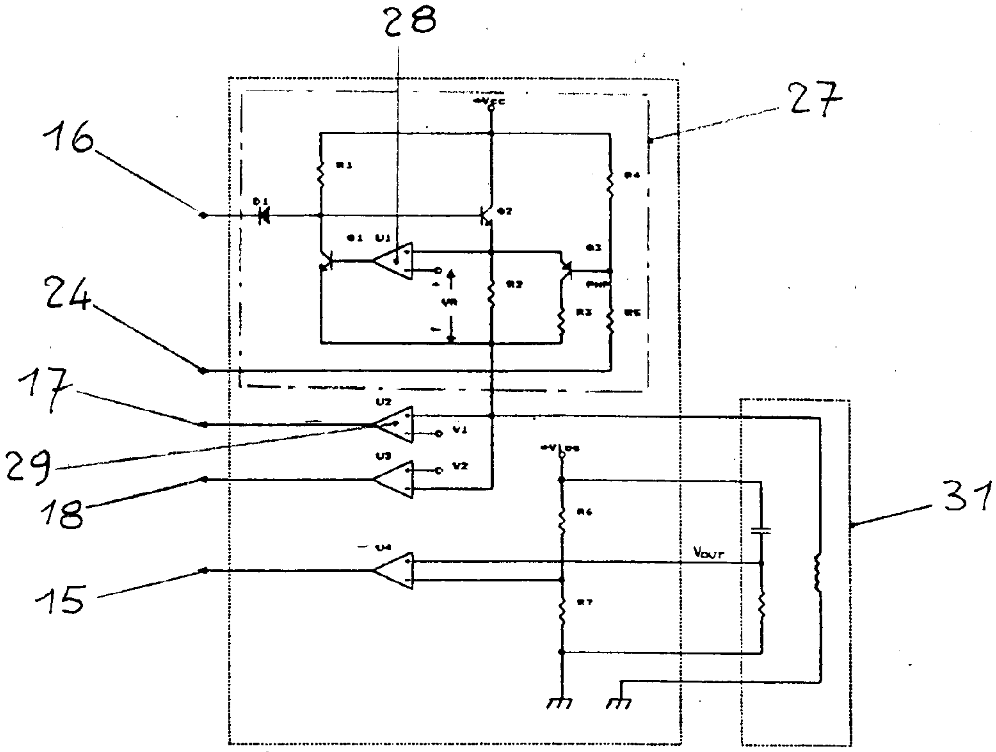
R7
R6
Vcc
C3
C2
C1
X1
R4
Q2
Q3
R5
R8
R1
R2
R3

FIG.3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27
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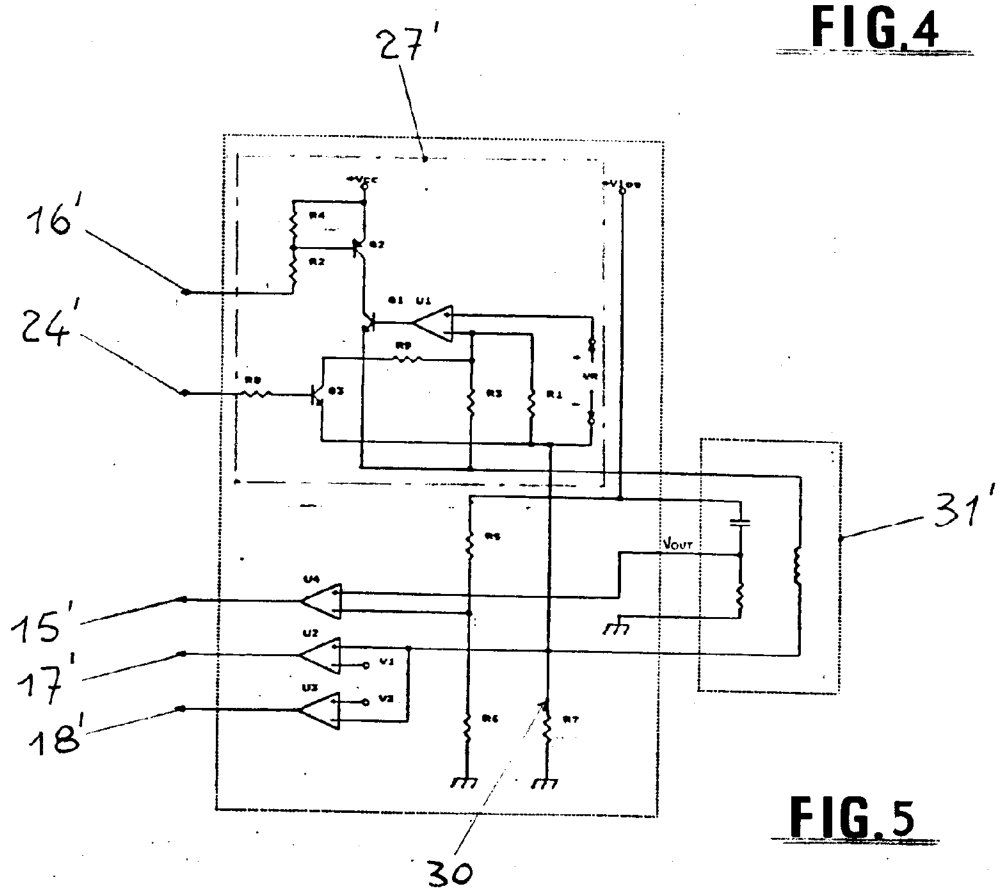
24
17
29
18
15
31
+Vcc
D1
Q2
Q1 U1
Q3
PNP
R1
R2
R3
R4
R5
VR
U2
U3
U4
V1
V2
+Vlos
R6
R7
Vout

FIG.4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R4
R2
Q2
Q1 U1
R9
R8
Q3
R3
R1
VR
R5
R6
R7
Vout
U4
U2
U3
V1
V2

FIG.5

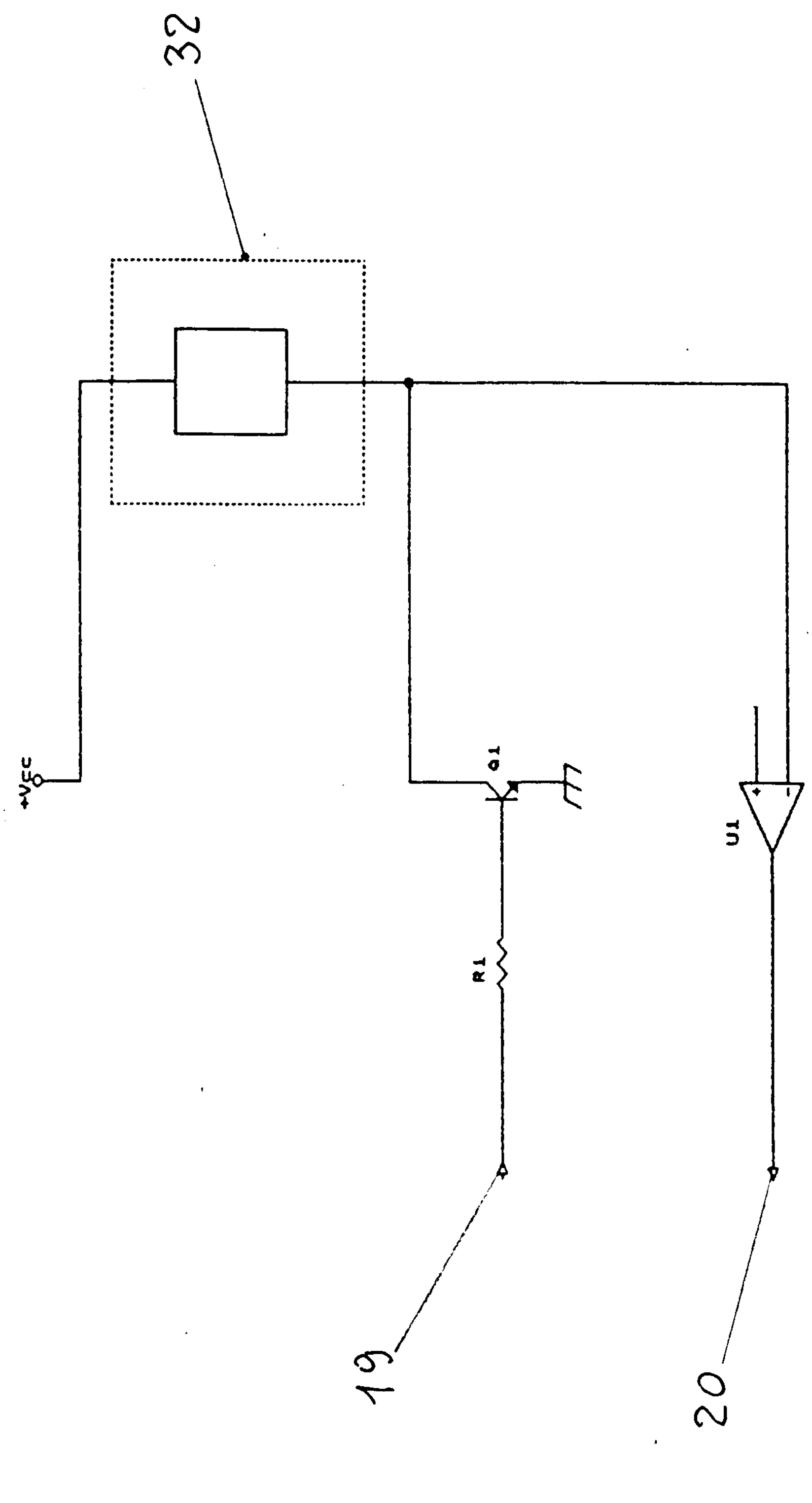

FIG.6