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(54) Elapsed time indicator.

(57) An apparatus for indicating the lapse of a predetermined time period compises an indicator element (7), which changes from a first state to a second state when an electrical potential difference is applied to it and reverts to the first state when the potential difference falls below a given value, in combination with a circuit with a bleed resistor (9) for controlling as a function of time a potential difference, applied to the indicator element (7). A cell (1) may apply the potential difference. After a certain period of time the cell (1) will be effectively discharged through the bleed resistor (9), the potential difference applied to the indicator element (7) will fall causing it to change state and sign (8) will then be visible. This indicates the end of the time period.

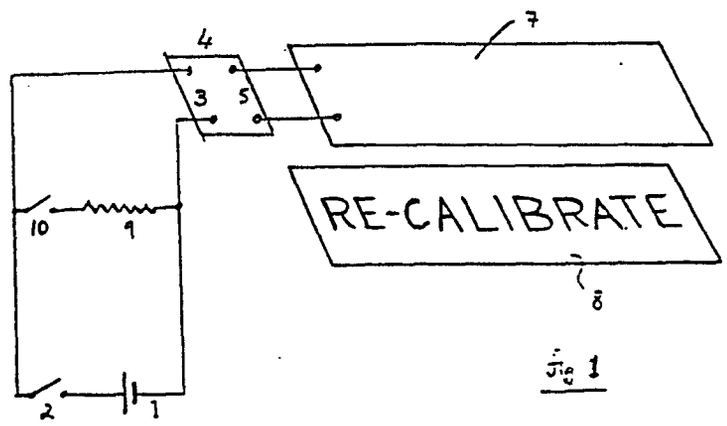

Fig 1

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ELAPSED TIME INDICATOR

This invention relates to electrically operated apparatus for indicating the lapse of a pre-determined time period. This may be a continuous, uninterrupted period or it may be the aggregate of a series of discontinuous time periods of equal or unequal length.

Apparatus according to the invention may be used for indicating the end or the approach of the end of the shelf life of material, such as gold bonding wire, which deteriorates within a relatively short period of its manufacture. It may also be used for indicating when, for example, electronic equipment which is

required to be periodically aligned or adjusted is due for such attention. Apparatus according to the invention is, however, especially well adapted for use in connection with the maintenance of equipment in the quality assurance field.

The invention provides an electrically operated apparatus for indicating the lapse of a predetermined time period the apparatus comprising an indicator element which is changeable from a first state to a second state when an electrical potential difference greater than a specified value is applied thereto and is automatically revertable to the first state when the electrical potential difference applied to the element is equal to or less that the specified value, in combination with a circuit with means for controlling as a function of time a potential difference, applied to the indicator element.

In use a potential difference is applied to the indicator element such that at the beginning of the time period the potential difference is greater than the specified value so that the indicator element changes from the first state to the second state and at the end of the time period the potential difference is less than or equal to the specified value and the element reverts to the first state to indicate the lapse of the period.

Accordingly the present invention provides a method for indicating the lapse of a predetermined time period comprising applying a potential difference to an indicator element which is changeable from a first state to a second state when an electrical potential difference greater than a specified value is applied thereto and is automatically revertable to the first state when the electrical potential difference applied to the element is equal to or less that the specified value, the potential difference being controlled as a function of time.

Preferably the applied potential difference is provided by a source of electric current of known capacity by which may be meant a source of electric current that will supply a known current at a substantially constant potential difference for a known time period, at the end of which period or fairly shortly thereafter the source is discharged or effectively discharged. The source is effectively discharged when its potential difference has been reduced to a value equal to or lower than the specified value as defined above of potential difference referred to in the immediately preceding definition.

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The source of electric current of known current may be any suitable type of electric cell or battery such as one or more silver oxide cells. These cells have a relatively constant voltage during discharge and this voltage falls rapidly when the completely discharged condition is closely approached.

An indicator element is a device having a high electrical resistance, usually not less than 500 kilohm, which changes from a first to a second state when there is applied to it, via, for example, suitable terminals, an electrical potential difference greater than a specified value and which reverts automatically to the said first state upon the reduction of the applied potential difference to a value equal to or less than the specified value.

The indicator element may be any suitable electrically operated device. Particularly suitable is an optical shutter comprising or consisting of an electrochromic device or a sheet of liquid crystal material. In the latter case the material is associated with an oscillator or has an oscillator secured to or embedded in it. In one of its states the optical shutter is transparent and in the other opaque.

Preferably the applied potential difference is controlled as a function of time by the circuit, in which a current flows, with a means for controlling the magnitude of the current.

The means for controlling the magnitude of the current in the circuit may be a bleed resistor connected in parallel with the indicator device, or a current controlling circuit suitably

incorporated in the circuit of the apparatus according to the invention.

In a modification of apparatus according to the invention, so as to enable the apparatus to indicate the lapse of a predetermined time period which is the aggregate of a series of discontinuous time periods, means are provided for reducing the current to a very low if not insignificant value at the end of each time period and then re-establishing it at or effectively at its previous value at the beginning of the next succeeding time period without, in either case, the potential difference applied to the indicator element being materially affected.

When a bleed resistor is provided in parallel with the indicator device as a means for controlling the magnitude of the current in the circuit, this resistor may simply be disconnected at the end of each time period and reconnected at the beginning of the next succeeding time period.

Apparatus according to this invention may also include a sensor and an associated latch circuit. This apparatus will indicate either that a predetermined time period has elapsed or that certain physical conditions have changed to above or below a preset limit so that for example the apparatus will indicate that equipment which has been moved requires recalibration before the predetermined time period has elapsed. Weighing scales used in

shops and in trade should be recalibrated after a certain time period or after the weighing scales have been moved. Apparatus which includes a sensor that detects movement can be fixed onto a weighing scales so that the indicator element will show that the weighing scales need recalibration either after the predetemined time period has elapsed or the scales have been moved.

The sensor is used to measure or detect a physical condition such as movement, acceleration, temperature, pressure, humidity, electro-magnetic radiation, magnetic field, electric field, alpha particles, beta particles, fluid flow or level or the presence of a certain gas or fluid. When movement is the physical condition to be detected the sensor may be a mercury tilt switch which is normally either on or off. When the switch changes from off to on the associated latch circuit will come into operation and the potential difference applied to the indicator element will decrease or cease so that the indicator element will revert to its first state. The latch circuit may be a means of shorting the terminals of the source of electric current in its simplest form.

If the sensor has a continuous output, for example a thermistor, a comparator is included in the apparatus. The comparator compares the output of the sensor with a preset value and when the output of the sensor reaches that value or is above or below it as appropriate the associated latch circuit becomes

operative and the indicator element will revert to its first state.

An apparatus as described as above may be used to indicate the end of the shelf life of a material which deteriorates after a certain period of time. The material may also deteriorate if it is subjected to for example high humidity or high temperature. An apparatus comprising a source of electric current connected by a circuit, which has a means to control the potential difference (a resistor), to an indicator element with a sensor and associated latch circuit can be used to indicate that a material has reached the end of its shelf life. If the sensor is a temperature measuring sensor the apparatus can also indicate that the material should be disposed of if it has been subjected to a temperature above a set limit. Some chemical products and pharmaceutical products are examples of materials which have a certain shelf life as long as they are kept in certain conditions, eg in a refrigerator, but which deteriorate rapidly if the temperature rises.

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

figure 1 is a diagrammatic representation of a first embodiment of a device featuring an optical

shutter and the associated electrical circuit,

figure 2 is a discharge characteristic of a cell suitable for use in the circuit of fig. 1,

figure 3 is a schematic diagram of the embodiment as shown in figure 1,

figure 4 is a schematic diagram of a second embodiment of a device with an optical shutter, associated electrical circuit, a detector with two states and a latch circuit,

figure 5 is a schematic diagram of the second embodiment of the device with a detector with a continuous output and a comparator, and

figure 6 is a circuit diagram of the second embodiment as shown in figure 4.

Referring now to fig. 1, which illustrates apparatus particularly suitable for indicating when measuring equiment, such as a thermocouple, is due for recalibration, a silver oxide cell 1 is connected via a switch 2 to the input terminals 3 of a high input impedance, 30-100 Hz oscillator 4, the output terminals 5 of

which are connected to the input terminals 6 of a sheet 7 of liquid crystal material which acts as an optical shutter. The input resistance of this optical shutter is at least 500 kilohms. In parallel with the input terminals 3 of oscillator 4 are a series-connected resistor 9 and switch 10. Finally, on the underside of the optical shutter is a piece of card 8 or other suitable material bearing the legend "RE-CALIBRATE", preferably in fluorescent ink.

The apparatus is intended to indicate the lapse of a predetermined time period and hence that equipment, such as a thermocouple, for example, is due for re-calibration. In practice, switches 2 and 10 are closed when the equipment is brought into service, whereupon the cell 1 begins to discharge via the resistor 9 which acts as a bleed resistor. It is in part discharged through the input circuit of oscillator 4 but here the current drain is by comparison negligibly small. Oscillator 4 when energised in this way applies a low frequency (30-100 Hz) oscillating (alternating) voltage to the optical shutter 7 from its output terminals 5.

The liquid crystal material of this optical shutter has a 'first state' in which it is transparent and a 'second state' in which it is opaque (or essentially so). Upon the closure of switch 2 (assuming cell 1 is not discharged) the liquid crystal material is converted to its second state and becomes opaque, thus

making it impossible to read the legend RE-CALIBRATE.

Upon the closure of switch 10 (switch 2 also being closed) the cell 1 discharges through the bleed resistor 9 and becomes discharged or effectively discharged after a period which depends upon the value of resistor 9, the type of cell employed and to a lesser extent the ambient temperature.

Cell 1 and resistor 9 are so chosen that the period from 'switch-on', corresponding to the bringing into service of the equipment, to the time when the cell is discharged or effectively discharged, at which point the liquid crystal material of optical shutter 7 reverts to its first (transparent) state and the legend RE-CALIBRATE is visible through the material, corresponds to the "calibration period" of the equipment, upon the expiry of which period the equipment needs to be re-calibrated. The length of this period will depend upon the nature of the equipment and the use to which it is put. It is assumed here that the equipment is either used continuously or is subject to a known and predictable regime of use.

The cell 1 should have a rapid fall-off in voltage as it approaches exhaustion (that is, until it is discharged or effectively discharged) and should preferably have a relatively constant voltage during discharge prior to this. A discharge characteristic of such a cell is shown in fig. 2.

A suitable cell is a DURACELL (Registered Trade Mark) cell, type D350, which has a nominal voltage of 1.5 volts and a nominal capacity of 100 mAh. Its voltage stays substantially constant until very near the end of its life when it falls rapidly to zero as indicated in fig. 2. If it is required that the apparatus of figure 1 should indicate the lapse of, say, 1000 hours, the resistor R would need to have a value of $\frac{1.5 \times 1000}{100}$ =15 kilohms. The period of 1000 hours is, for example, a typical figure for the life of a platinum/platinum-rhodium thermocouple before re-calibration is required, when the thermocouple is used continuously at 1000°C.

If the equipment is subject to discontinuous periods of use, switch 10 should be closed at the beginning of each period of use and opened at the end of it, this process being repeated until the cell 1 is discharged or effectively discharged, whereupon the word RE-CALIBRATE becomes visible through the optical shutter.

If the equipment is in continuous use, then the switch 10 may, of course, be omitted. In addition, switch 2 may also be omitted so as to prevent the accidental switching off of the cell or battery during use. In this case, the cell or battery would simply be connected into the circuit upon the bringing into

service of the equipment with which the apparatus of fig. 1 is to be used.

The first embodiment of the apparatus is also shown as a schematic diagram in figure 3. The device comprises a cell 11 which is connected to input terminals of an oscillator gate 13. The output terminals of the oscillator gate 13 are connected to input terminals of an optical shutter 14. A resistor 12 is connected in parallel with the oscillator.

Referring to figure 4, the device comprises a cell 11, a resistor 12, an oscillator 13, an optical shutter 14, a sensor 15 and a latch circuit 16. The sensor 15 is connected in parallel with the resistor 12 with an output to an input terminal of the oscillator gate 13 via a latch circuit 16. Suitable sensors have two states, on or off, for example a mercury tilt switch. Such a sensor will normally be in the off position until the physical condition which it is measuring, eg movement, causes it to switch to the on postion. Latch circuit 16 will then come into effect and the potential difference supplied to optical shutter 14 will decrease causing optical shutter 14 to revert to its first state.

Referring to figure 5, the device is similar to the second embodiment and enables sensors with a continuous output to be used. A comparator 17 is connected between the sensor and the latch circuit. Comparator 17 enables the output from sensor 15 to

be compared with a preset value such that when the physical condition being measured by sensor 15 results in the output from sensor 15 reaching the preset value latch circuit 16 will come into effect. Sensor 15 may measure temperature, pressure, humidity, electro-magnetic radiation, magnetic fields, electric fields, alpha particles, beta particles, fluid flow or level or it may detect the presence of a particular fluid or compound.

A circuit diagram for the second embodiment of the invention is shown in figure 6. A cell 21 is connected to an oscillator gate 23A, 23B, 23C, 23D, 23E, 23F which is connected to an optical shutter 24. A resistor 22 is connected across the terminals of cell 21. A sensor 25A is connected in parallel with resistor 22. A latch circuit comprises 26A, 26B, 26C and 26D. The values of resistors 25B and 26D are chosen so that the power consumption of latch circuit 26A, 26B, 26C and 26D and sensor 25A is minimal.

Gates 26A and 26B are NOR gates, 1/4 of a quad 2-input device type 4001B. Gates 23A, 23B and 23C are exclusive OR gates, 1/4 of a quad 2-input device type 4070B.

It is not of course essential for apparatus according to the invention to be arranged as just described. A type of optical shutter could for example be used which would be 'open' (transparent) when the equipment is in use and would only close

when the cell is discharged or effectively discharged. In this case, the legend visible when the shutter is open could be IN SERVICE, or SERVICEABLE or something similar.

Yet again, apparatus according to the invention can be used in many fields other than the indication of the expiry of the "calibration period" of equipment. The legend displayed could be, for example, RE-ALIGN, SHELF-LIFE ENDED, REPLACE and so on.

Still further, the indicator element may be one which is not an optical shutter but which has two messages imprinted on it. One message would be visible in the absence of an applied potential difference whilst the other message would become visible upon the application of a potential difference (a.c. or d.c.). The second message could add to or replace the first message.

In general, apparatus according to the invention is particularly useful in the quality assurance field and where any equipment requires periodic attention. It would also be of considerable value in connection with equipment for the armed forces which requires periodic checking and in connection with precision laboratory equipment.

A particular advantage of apparatus according to the invention is that it is fail safe in that failure of the cell or the battery will have the same effect as its being discharged or

effectively discharged at the end of the period being measured. In other words, if the cell or battery fails, the apparatus will (prematurely) read RE-CALIBRATE or RE-ALIGN and so on.

CLAIMS

1. An electrically operated apparatus for indicating the lapse of a predetermined time period, the apparatus comprising an indicator element which is changeable from a first state to a second state when an electrical potential difference greater than a specified value is applied thereto and is automatically revertable to the first state when the electrical potential difference applied to the element is equal to or less that the specified value, in combination with a circuit with means for controlling as a function of time a potential difference, applied to the indicator element.

2. An apparatus according to claim 1 wherein a current flows in the circuit and the applied potential difference is controlled as a function of time by means for controlling the magnitude of the current.

3. An apparatus according to claim 2 wherein the means for controlling the magnitude of the current is a bleed resistor.

4. An apparatus according to any preceding claim wherein the indicator element is an optical shutter.

5. An apparatus according to claim 4 wherein the optical

shutter is an electrochromic device.

6. An apparatus according to claim 4 wherein the optical shutter is a sheet of liquid crystal material.

7. An apparatus according to any preceding claim wherein the circuit further includes a sensor for sensing a physical condition and a latch circuit, such that the latch circuit is operable by the sensor to decrease the potential difference and cause the indicator element to revert to the first state before the end of the predetermined period of time.

8. An apparatus according to any preceding claim wherein the potential difference applied to the indicator element is provided by a source of electric current of known capacity.

9. An apparatus according to claim 7 wherein the source of electric current of known capacity is at least one electric cell.

10. An apparatus according to claim 8 wherein the cell is a silver oxide cell.

11. A method for indicating the lapse of a predetermined time period comprising applying a potential difference to an indicator element which is changeable from a first state to a second state when an electrical potential difference greater than

a specified value is applied thereto and is automatically revertable to the first state when the electrical potential difference applied to the element is equal to or less that the specified value, the potential difference being controlled as a function of time.

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Our ref:
BEA/RR/JTN 899.
Your ref:

EPO Receiving Section, Room 29.
The Patent Office,
London.

1st August 1985.

Dear Sirs,

Re: New European Patent Application [redacted]
Johnson Matthey Public Limited Company.

The application was filed on 23rd July 1985 and we regret that we have noticed an error on page 4 line 13 where "is" should read "may be". Given the priority year has not yet expired we enclose an amended page 4 in triplicate for insertion into the specification as filed.

Yours Respectfully,

R 88

B.E. Arthur
WITHERS & ROGERS.

EPA - EPO - OEB
D G 1
Reçu le
12 AUG 1985

Encl.

THE PATENT OFFICE

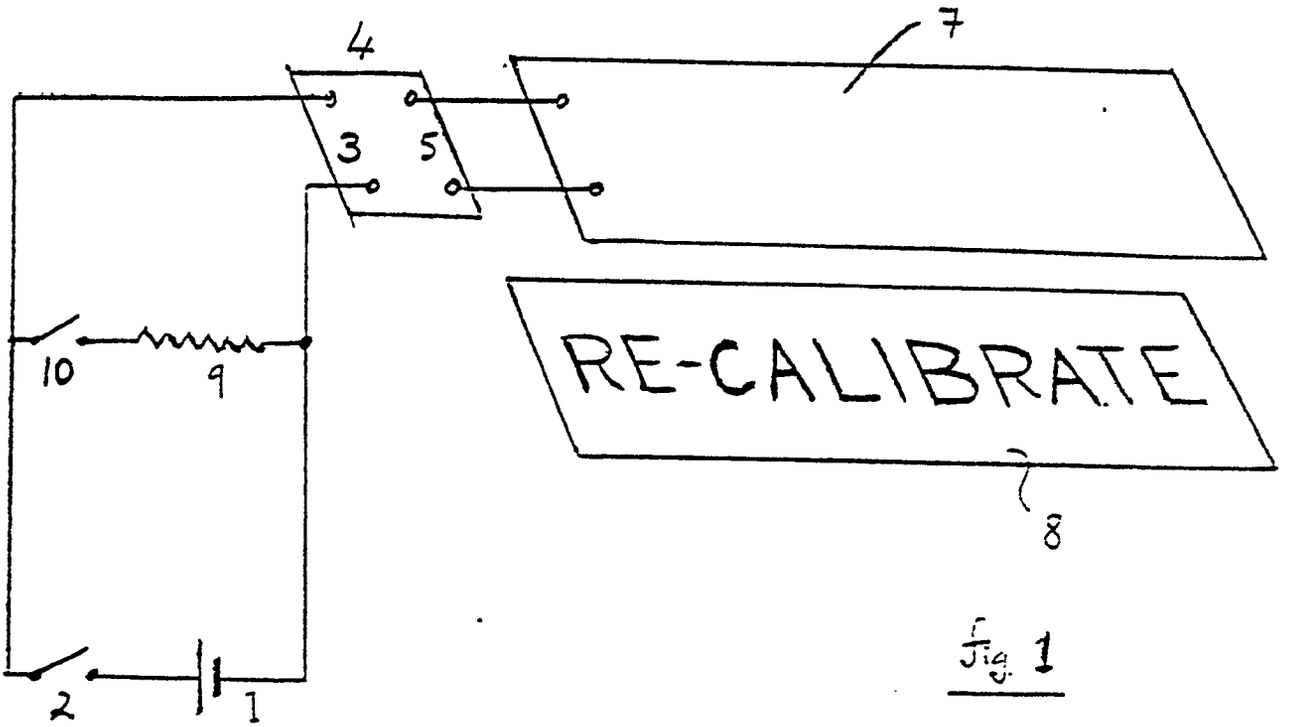

fig. 1

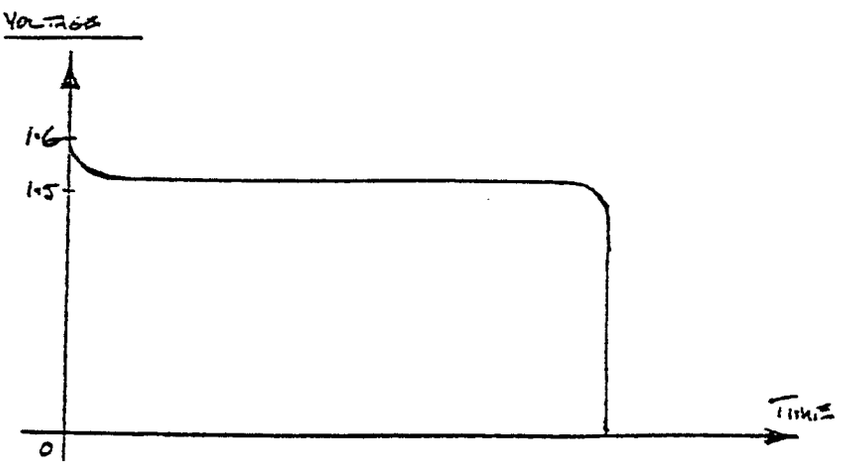

fig. 2

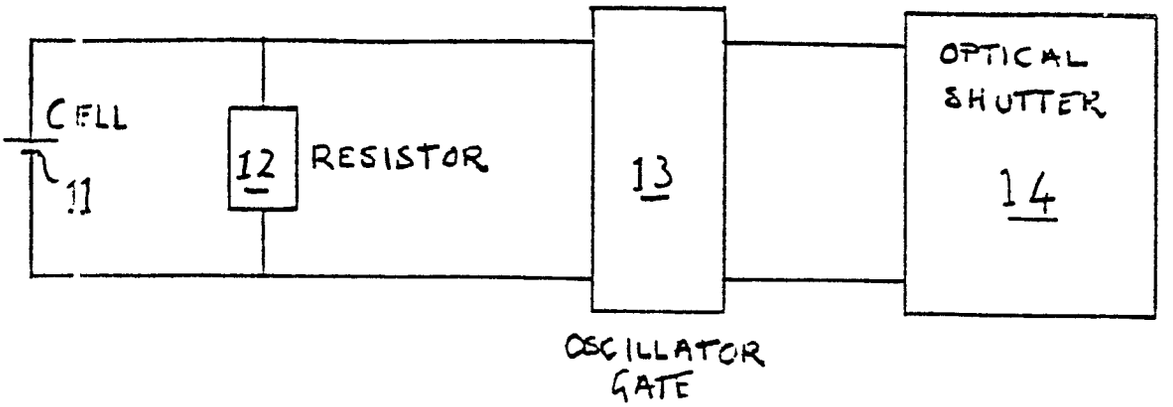

FIGURE 3

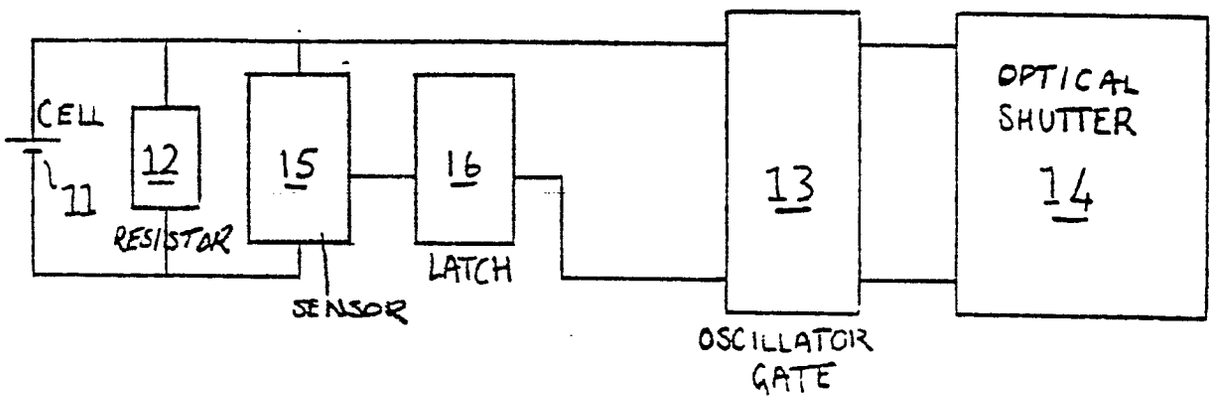

FIGURE 4

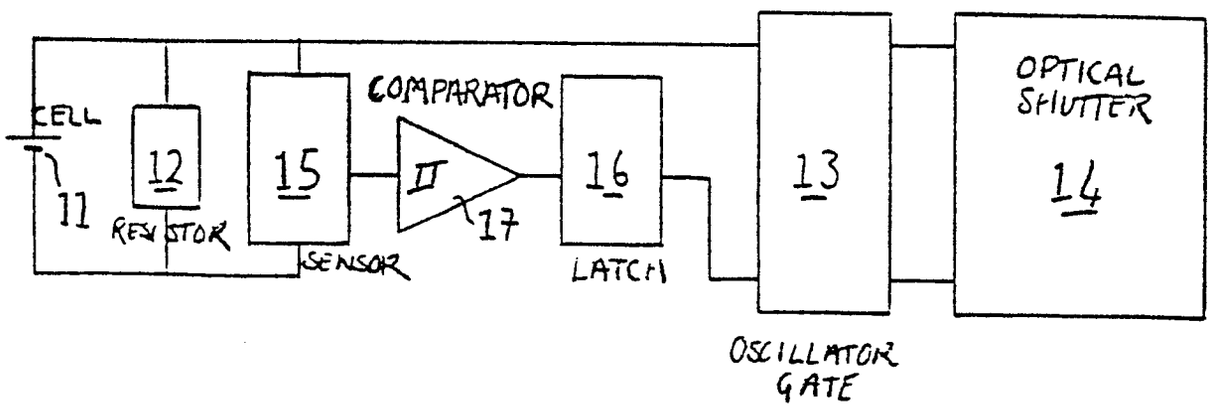

FIGURE 5

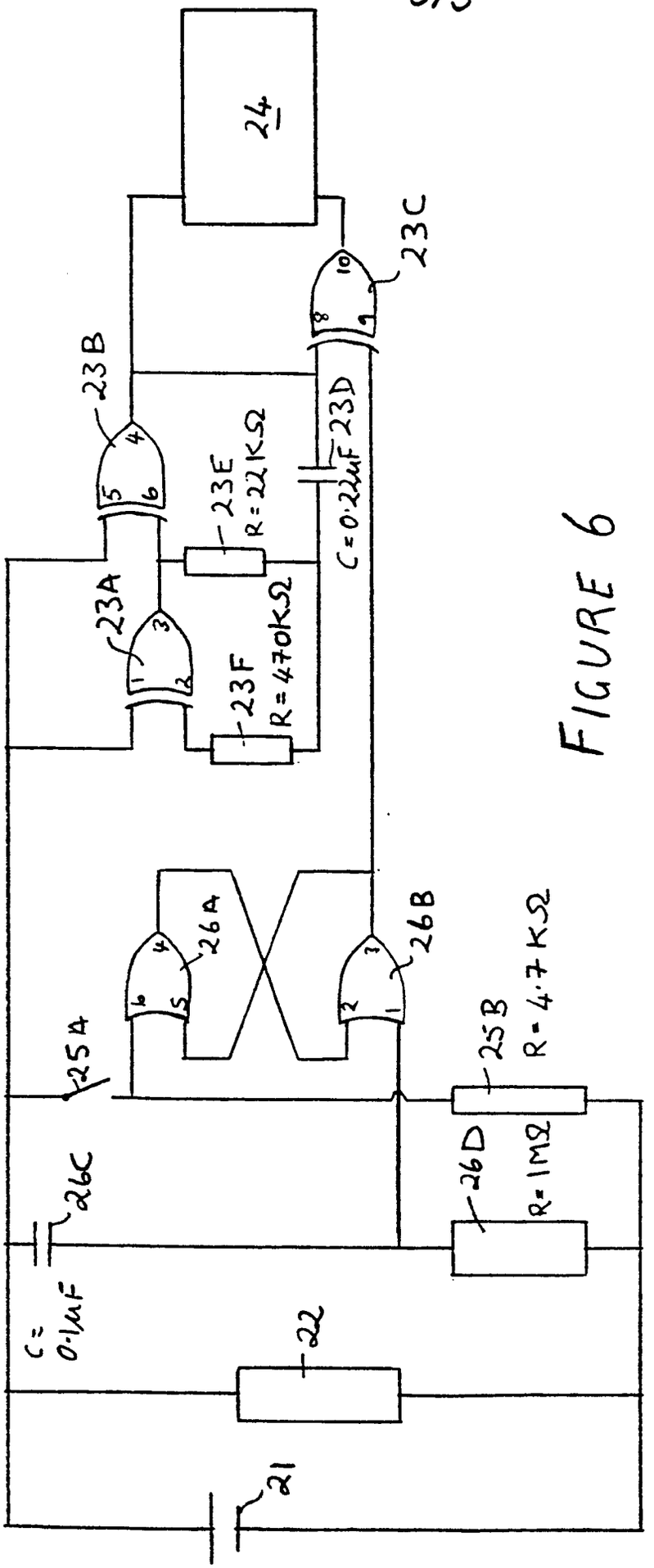
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FIGURE 6