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If this document is being filed together with a new application, the execution date of the application is:

A. Patent Application No.(s)

B. Patent No.(s) 5,869,972

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5. Name and address of party to whom correspondence concerning document should be mailed:

Name: Marina T. Larson, Ph.D.

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Street Address: P.O. Box 5068

City: Dillon State: CO Zip: 80435-5068

6. Total number of applications and patents involved: 1

7. Total fee (37 CFR 3.41).....$ 40.00

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01 FC:581 40.00 OP

THIS ASSIGNMENT is effective the 23rd day of February 1996,
BETWEEN
(1) NICHOLAS ANDREW MORRIS of 71 Spring Road, Kempston, Bedford MK42 8LT, England (hereinafter called "the Inventor" which expression where the context so admits shall include his executor and administrator);

(2) UNILEVER UK CENTRAL RESOURCES LIMITED of Unilever House, Blackfriars, London EC4P 4BQ, England (hereinafter called "the Company", which expression where the context so admits shall include its successors and assigns);

(3) UNILEVER PLC of Unilever House, Blackfriars, London EC4P 4BQ (hereinafter called "Unilever", which expression where the context so admits shall include its successors and assigns).

WHEREAS
(A) The Inventor claims to be a true and first inventor of an Invention concerning a Voltage Tester Strip (Easy Read-Out System) which Invention is described in the specification attached hereto and is known by Unilever as case T3067.

(B) The Invention was made pursuant to an agreement between the Inventor and the Company, and the Inventor has agreed to assign to the Company all its right, title and interest in and to the Invention upon the terms and conditions herein.

(C) The Company is a subsidiary of Unilever and for the better regulation of the affairs of Unilever and the Company, has agreed to assign to Unilever all its right, title and interest in and to the Invention.

(D) Unilever has requested the Inventor and the Company (to the extent of any right, title and interest vested respectively in them) to convey to it the Invention and all patent and other intellectual property rights pertaining thereto upon the terms and conditions herein.

AND IT IS HEREBY AGREED that

(1) In the premises and in consideration of £1 in hand paid, the Inventor and the Company at the request of Unilever HEREBY ASSIGN AND HAVE ASSIGNED to Unilever (to the extent only of the right, title and interest vested respectively in them):

(i) the right, title and interest throughout the world to and in the Invention and the exclusive benefit thereof,

(ii) the full right to apply for and obtain patent or other similar forms of protection in respect of the Invention throughout the world.

TO HOLD the same unto Unilever absolutely.

(2) The Inventor and the Company HEREBY COVENANT jointly and severally with Unilever that for the whole world they will each at all times hereafter at the request and cost of Unilever sign, execute and do all such documents, acts or things as may be necessary to enable Unilever or its nominee to enjoy the full benefit of the property rights hereby assigned and to apply for patents or other similar protection in respect of the Invention and fully and effectively to vest the same in Unilever or as it shall direct.

IN WITNESS whereof the Inventor, the Company and Unilever have caused these presents to be executed and effective the day and year first above written.

SIGNED by the Inventor
N A Morris .....

.....
Witnessed .....

SIGNED for and on behalf of
The Company .....

.....
Authorised Signatory

SIGNED for and on behalf of
Unilever .....

.....
Authorised Signatory

Title: Determination of the Characteristics of Fluids

Field of the invention

This invention relates generally to determination of the characteristics of fluids (liquids or gases) and more specifically to a qualitative or quantitative method of testing for such a characteristic and to a portable (hand-held) tester for use in determination of the characteristic.

The term "characteristic" is used herein in its most general sense to refer to any qualitative or quantitative physical or chemical property of a fluid which may require to be determined, including for example the presence or absence of a particular constituent in the fluid or the concentration of a particular constituent in the fluid.

The invention

According to one aspect of the invention there is provided a method of testing a fluid for a particular characteristic thereof according to which a hand-held testing device is contacted with the fluid to cause a powered sensing element to produce a response indicative of the characteristic to be determined, any response is processed to produce an electrical signal, the magnitude of which is indicative of the characteristic, in close proximity to means which responds to a change in electric field or in temperature resultant from the electrical signal to produce a visible indication of the magnitude of the electrical signal.

According to a second aspect of the invention, there is provided a portable tester for use in determination of a particular characteristic of a fluid, comprising a hand-held device for contact with the fluid, the device comprising a source of electrical power,

a sensing element which when powered has a response to the said characteristic if present in the fluid to produce a response, electronic means for processing the response to produce an electrical signal of magnitude indicative of the characteristic, and in close proximity to the electronic means an indicator which responds to a change in electric field or temperature resultant from the electrical signal in a visually discernable manner.

The sensing element may take various forms. In one example, it has electrodes the surfaces of which give rise to a change in potential or current flow as a result of an electrochemical reaction taking place at the said surfaces in the presence of one or more particular constituents in the fluid. The sensing element may carry an enzyme or other substance which promotes the electrochemical reaction. Again, the test element may carry a miniature light source and detector which qualitatively or quantitatively senses the presence of a constituent of the fluid by optical detection.

The source of electrical power may be a small battery, for example a lithium cell or an air cell such as a zinc-air cell, or a solar cell, for example based on amorphous or crystalline silicon and used in conjunction with an electrical storage device such as a capacitor.

The electronic response-processing means may also take various forms, such as a simple integrated circuit, or an amplifier circuit, practised as conventional electrical circuitry or as thick film hybrid technology.

This electronic means, whatever its form, in use receives the signal from the sensing element and converts it into a form compatible with the manner of operation of the display.

The display itself may also take various forms, such as a thermochromic strip, a strip which otherwise changes its appearance, eg, colour or reflectance, with temperature change or in the presence of an electric field, a conductive strip of continuous or

stepped variable resistance, discretely variable resistances, light emitting polymers, or possibly LCDs and LEDs.

The thermochromic or other strip, when employed, may be of the irreversible kind, so as to provide a record of the result of the test which can be retained.

Thus, the complete portable tester may be practised in various ways. In one embodiment, the tester is wholly disposable; in another, the sensing element and display are separable and disposable (or retainable as a record); and in another, the test strip only is disposable (or retainable as a record).

In all these embodiments, the sensing element may comprise a test strip in the form of a base layer, conductive tracks laid over the base layer, e.g. to form electrodes, a thermochromic layer deposited over the conductive tracks, i.e. to respond, after amplification, to current flow in the conductive tracks, and a covering layer over the thermochromic layer.

Description of embodiments

The invention is further described with reference to the accompanying drawings, in which:-

Figure 1 diagrammatically indicates three possible designs of the portable tester, when incorporating a solid state display;

Figure 2 shows one possible embodiment of test strip;

Figure 3 shows one possible form of the display when the tester is employed to quantitatively detect the concentration of an analyte in a fluid;

Figure 4 is an explanatory diagram;

Figure 5 shows another possible form of the display, when this takes the form of a thermochromic strip; and

Figure 6 is a simplified circuit diagram.

Figure 1(a) shows an integral design of portable tester 10 which is disposable in its entirety after use. Reference 12 indicates the display.

In the split design of Figure 1(b), the test strip 14 is disposable after use of the tester, whilst the main body 16 comprising the power cell, electronics and display is retained for re-use, typically for only a limited number of times.

The split design of Figure 1(c) has re-usable main body 18 comprising the power cell and electronics, whilst the test strip and display, conveniently combined into a single element 20, are disposable.

The design of Figure 1(c), which is possibly the preferred design, may conveniently employ a composite test strip 22 of the kind shown in Figure 2. This test strip comprises a base layer 24 bearing conductive tracks 26, a thermochromic layer 28 deposited over the conductive tracks, and a transparent covering layer 30. When current passes in the conductive tracks 26, a portion of the thermochromic layer changes colour, the dimensions of the changed colour portion being dependent on the magnitude of the current, which is suitably processed and/or amplified by the electronics in the main body of the tester.

Figure 3 indicates one possible form of display. If the tester is used quantitatively to sense the concentration of analyte in a solution, the number of bars which are revealed, as by change of colour for example, is proportional to the analyte concentration.

Figure 4 is a diagram for use in understanding the functions of the tester.

At the test strip 30, the current i (or charge q) generated is dependent on, for example, the concentration of the analyte in a solution. The current (or charge) signal (the response) is processed in electronics 32, conveniently including a capacitor in which the current or charge is integrated. A predefined decay is determined by the magnitude of a resistor in an RC circuit of which the capacitor forms part. The electronics provides an output in a form acceptable to the display 34. In the drawing, the graph 36 shows three possible current curves which may be received at the display 34, which in this case provides a continuous bar output 38 of length dependent on the concentration of the analyte. The actual display could be digital, i.e. in discrete steps, instead of analogue, i.e. continuous.

If the test strip accumulates charge q, the electronics may be designed to produce a constant current output the magnitude of which is proportional to the magnitude of stored charge.

Figure 5 again shows one possible form of display 40 in the form of a thermochromic strip. As the current increases in the conductive track 42, so the area 44 of the thermochromic layer which changes in colour is increased, and this moves to the right as depicted.

Finally, Figure 6 is a simplified circuit diagram of the test strip 46, power cell 48, signal-processing electronics 50 and display 52.

Functionally, the electronics 50 provides a constant potential 54 to the test strip 46, for example to generate an electrode surface at which an electrochemical reaction can take place. The signal 56 (current or charge) developed at the test strip 46 is fed back to the electronics 50, which provides an amplified or otherwise processed signal 58 to the display.

The tester may be employed for a variety of purposes, such as sensing oxido-reductase reactions which result in current flow or changes in chemical potential at electrode

surfaces. Examples are GODFAD/FADH2, or enzymes which employ NAD/NADH2 or NADP/NADPH2 systems. In potentiometry, it is possible qualitatively or quantitatively to sense any chemical reaction which changes the chemical potential at the surface of an electrode in a manner proportional to the concentration of the analyte. It is possible for the test strip to carry a substance which promotes the reaction (when the test strip is disposable). The electro-chemical reaction may be associated with antibody-antigen reactions (Ab-Ag) for electrochemical linked immuno assays.

Moreover, the tester can be applied to optical assay systems, such as in any of the foregoing examples, but with optical detection and transduction.

Claims

1. A method of testing a fluid for a particular characteristic thereof according to which a hand-held testing device is contacted with the fluid to cause a powered sensing element to produce a response indicative of the characteristic to be determined, any response is processed to produce an electrical signal, the magnitude of which is indicative of the characteristic, in close proximity to means which responds to a change in electric field or in temperature resultant from the electrical signal to produce a visible indication of the magnitude of the electrical signal.

2. A method according to claim 1, applied to test the concentration of an analyte in a solution by sensing an electrochemical reaction at the surface of an electrode on the test strip.

3. A method according to claim 1, applied to test the concentration of an analyte in a solution by optical detection and transduction.

4. A portable tester for use in determination of a particular characteristic of a fluid, comprising a hand-held device for contact with the fluid, the device comprising a source of electrical power, a sensing element which when powered has a response to the said characteristic if present in the fluid to produce a response, electronic means for processing the response to produce an electrical signal of magnitude indicative of the characteristic, and in close proximity to the electronic means an indicator which responds to a change in electric field or in temperature resultant from the electrical signal in a visually discernable manner.

5. A tester according to claim 4, wherein the power source generates an electrode surface on the sensing element.

6. A tester according to claim 4, wherein the power source powers a miniature light source at the sensing element.

7. A tester according to any of claims 4 to 6, wherein the display is a thermochromic layer an area of which is caused to change colour in dependence on the magnitude of an anlyte in a solution.

8. A tester according to any of claims 4 to 7, wherein at least the sensing element is separable from the tester and is disposable.

9. A tester according to any of claims 4 to 8, wherein the sensing element carries a promoter for stimulating an electrochemical reaction at the surface of the test strip.

10. A tester according to any of claims 4 to 9, wherein the sensing element and the display are combined in the form of a composite test strip.

C263.1/U

Abstract

Determination of the Characteristics of Fluids

A portable tester for qualitatively or quantitatively sensing an electrochemical or analogous reaction at the surface of a test strip (46), the current flowing or charge accumulated at the test strip being processed by electronics (50) to generate a current signal suitable for activating a display (52) typically in the form of a thermochromic layer. (Figure 6)

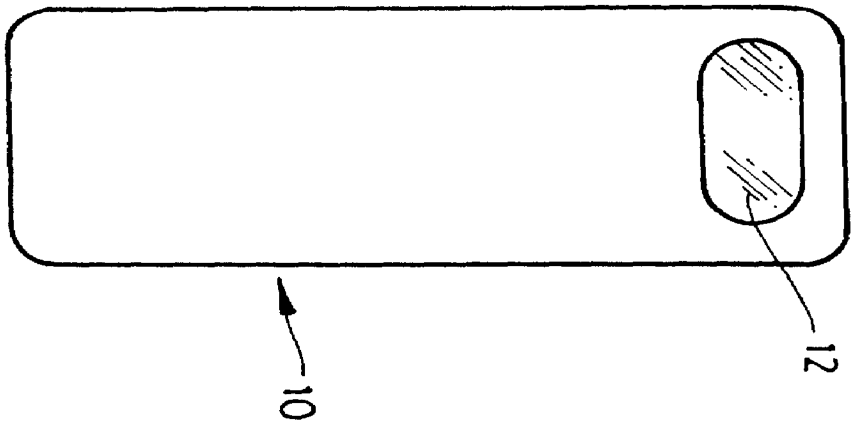


Fig. 1(a)

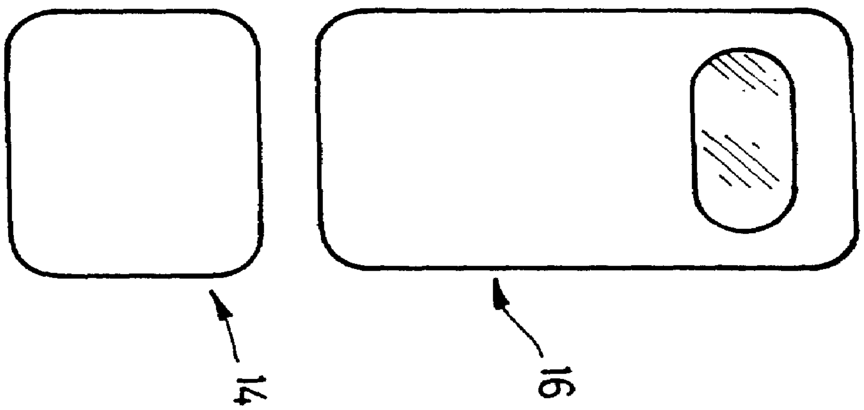


Fig. 1(b)

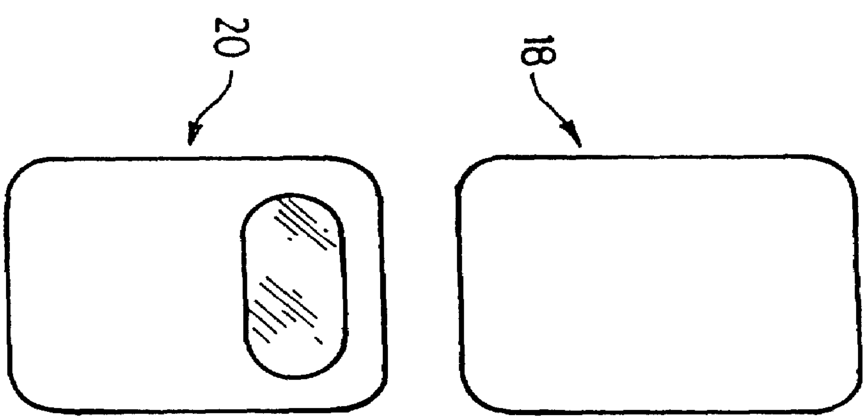
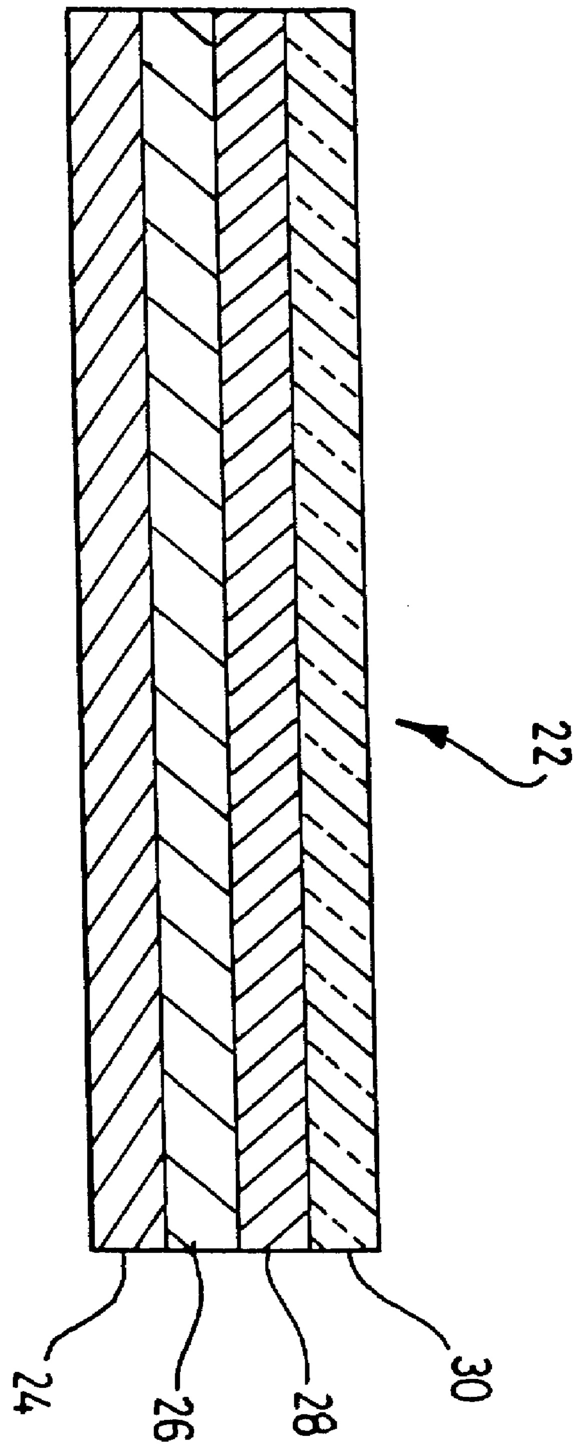


Fig. 1(c)

Fig. 2



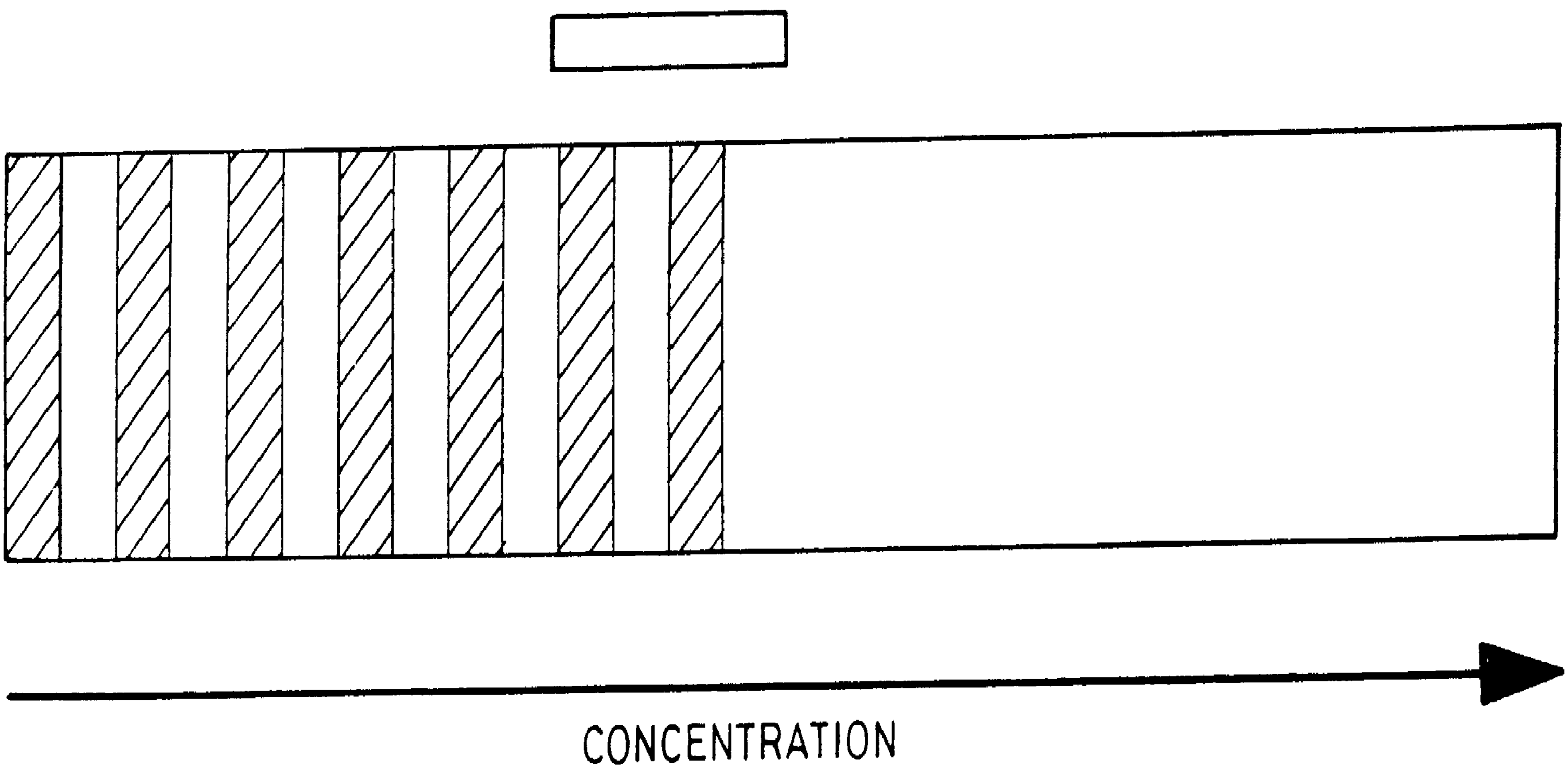


Fig. 3

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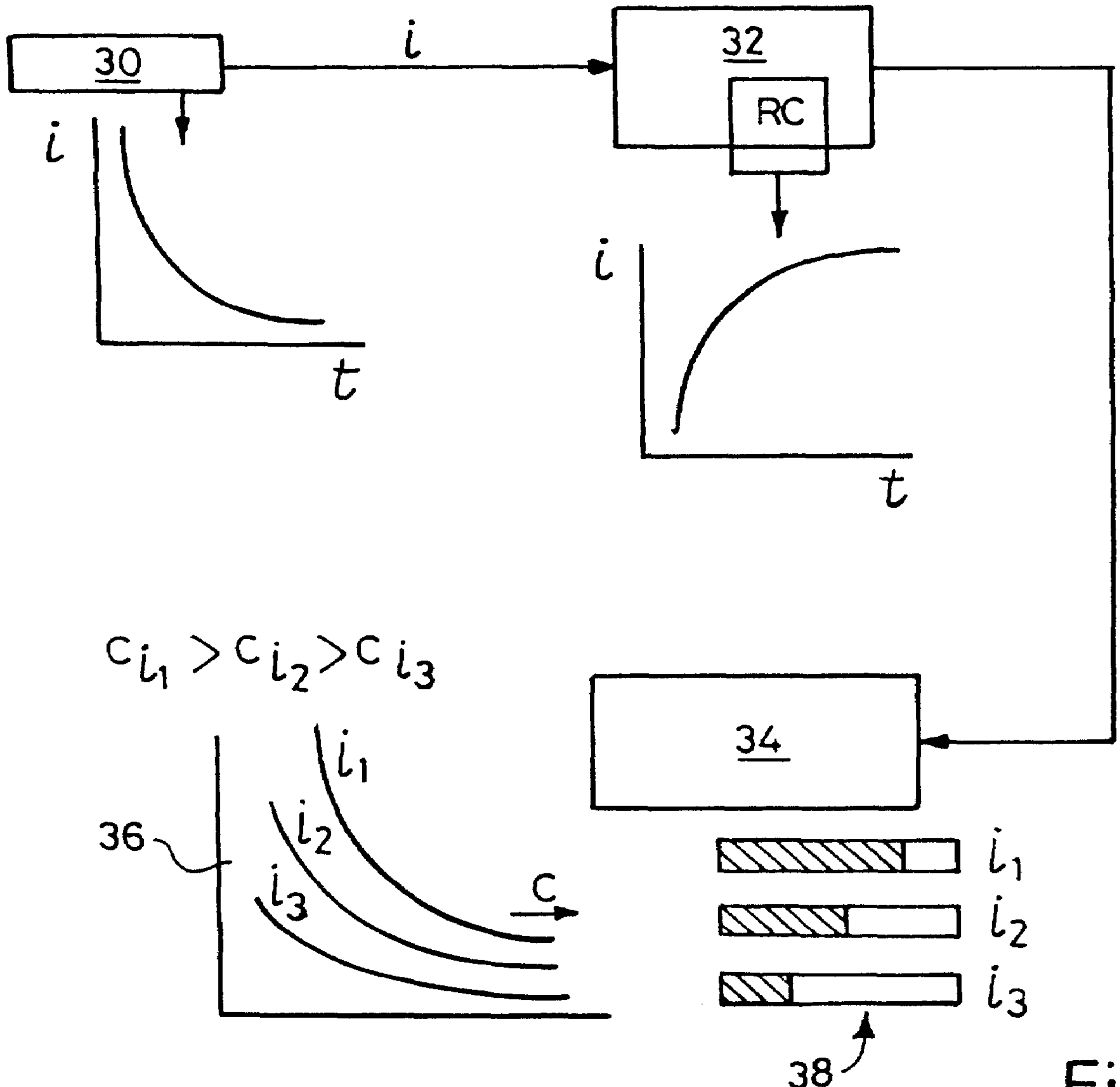
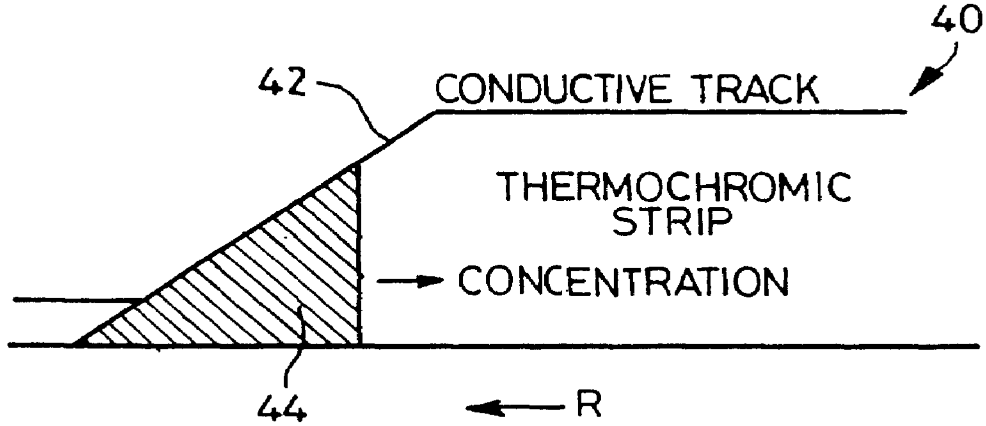

30
i
32
RC
i
t
i
t
O/P
34
$c_{i_1} > c_{i_2} > c_{i_3}$
36
i_1
i_2
i_3
C
i_1
i_2
i_3
38

Fig. 4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42
CONDUCTIVE TRACK
THERMOCHROMIC STRIP
CONCENTRATION
44
R

Fig. 5

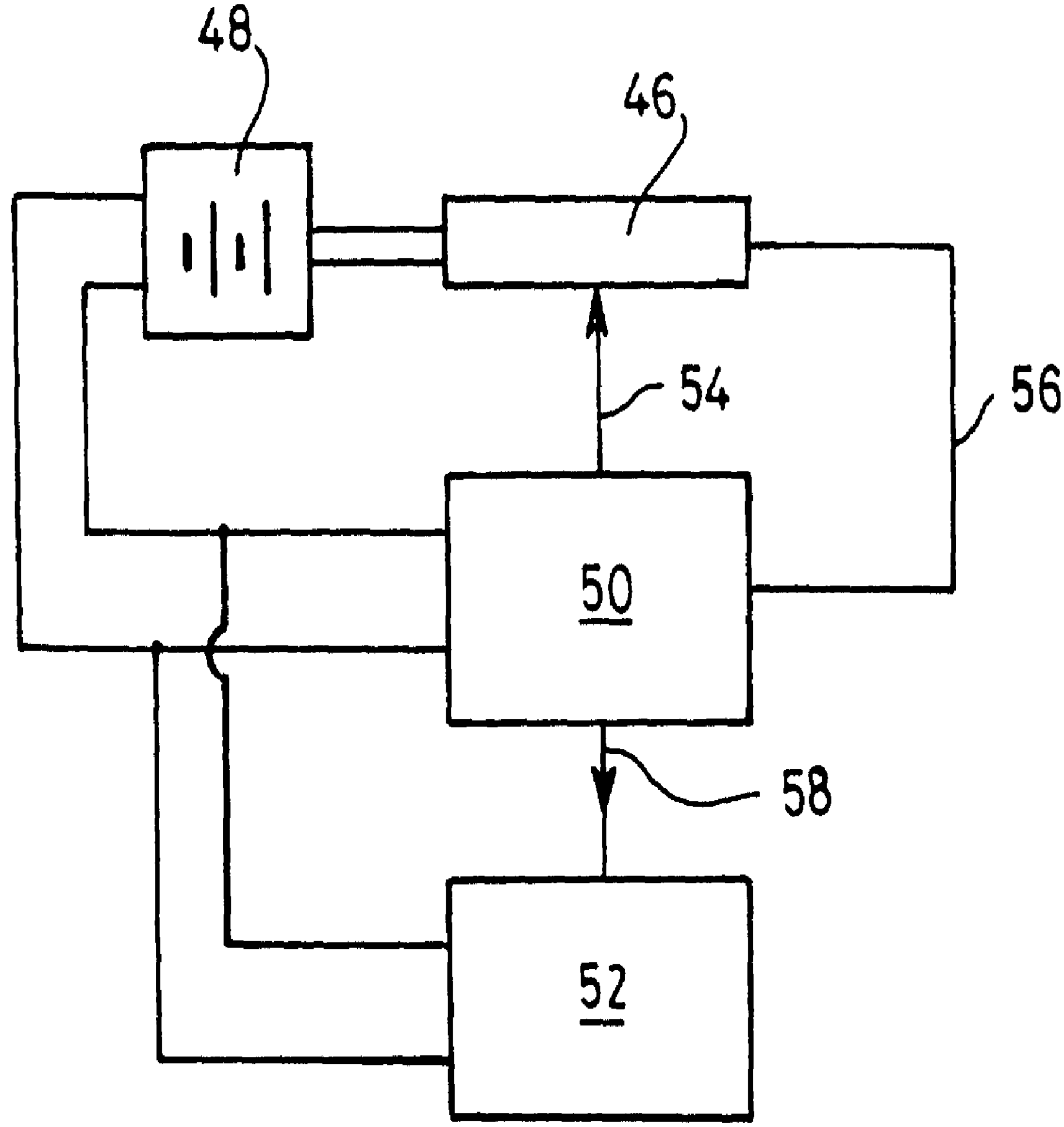

Fig. 6

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