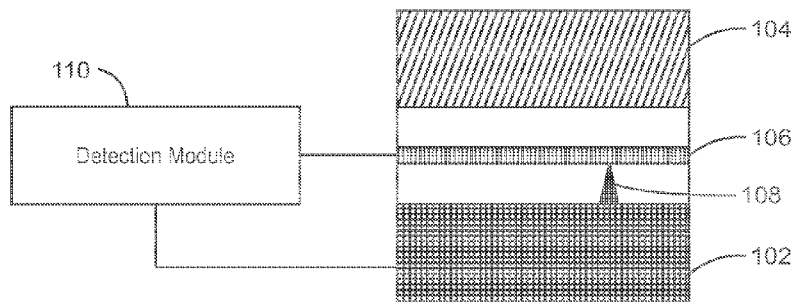




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[Continued on next page]

(54) Title: DETECTION MECHANISM



100
FIG. 1

(57) Abstract: A detection mechanism is described herein. The detection mechanism may include a detection grid to be disposed between a cathode and an anode of a battery.



TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG). **Published:**

— with international search report (Art. 21(3))

DETECTION MECHANISM

Background Art

Various electronic devices such as portable computing devices include batteries. A battery
5 is a power storage device that includes one or more electrochemical cells that convert stored
chemical energy into electrical energy. Batteries have two electrodes, a cathode and an anode.
By definition, in electrochemical cells, positively charged ions flow from the anode to the
cathode, while electrons flow through an external circuit from the anode to the cathode.
Although the definition of the anode and cathode are reversed during the recharge cycle, as used
10 herein, the terms anode and cathode will refer to the electrodes in the discharge cycle.

In some cases, batteries may malfunction due to dendrite formation. A dendrite is a
deposit, for example, of metal formed at the anode during charging of the battery. When a
dendrite that has formed on the anode comes in contact with the cathode, the battery may short
circuit, leading to very high current flows through the dendrite.
15

Brief Description of the Drawings

Fig. 1 is a diagram illustrating a cross sectional side view of a battery including a detection
mechanism.

Fig. 2 is a diagram illustrating a peripheral view of a plurality of detection grids to be
20 disposed in the dielectric of the battery.

Fig. 3 is a diagram illustrating a cross sectional side view of a battery including a plurality
of detection grids.

Fig. 4 is a block diagram illustrating a method of forming a detection grid.

The same numbers are used throughout the disclosure and the figures to reference like
25 components and features. Numbers in the 100 series refer to features originally found in Fig. 1;
numbers in the 200 series refer to features originally found in Fig. 2; and so on.

Description of the Embodiments

The present disclosure relates generally to a detection mechanism to detect dendrite
30 formation in a battery. The detection mechanism may include a detection grid. The grid may be
disposed between a cathode and an anode of the battery. The detection grid may be composed of
conductive material and communicatively coupled to the anode such that when a dendrite is
formed on the anode and contacts the detection grid an impedance may be detected.

Fig. 1 is a diagram illustrating a cross sectional side view of a battery including a detection mechanism. The battery 100 may include an anode 102 and a cathode 104. The battery 100 includes a detection grid 106 configured to detect a formation 108, such as a dendrite. The formation 108 may be formed during a charge, or recharge, cycle of the battery 100.

5 The battery 100 is an electrochemical cell battery. In embodiments, the battery 100 is a rechargeable battery including various electrically conductive materials for the cathode 104 and the anode 102. In a lithium ion-battery, for example, the anode 104 may be composed, for example, of lithium metal, a composite of lithium and carbon, or other materials. The cathode 104 may be composed of, for example, lithium iron phosphate, lithium cobalt oxide, or other
10 similar materials. The battery 100 may include other rechargeable battery types such as lead-acid batteries, nickel cadmium batteries, nickel metal hydride batteries, lithium polymer batteries, and the like. In these rechargeable battery types, the anode 102 and cathode 104 will, of course, have different compositions.

During recharge, dendrites may form at the anode 102 as illustrated by the dendrite 108 of
15 Fig. 1. Dendrites are deposits of conductive material, such as lithium metal, that may form on the surface of the anode 102 during recharge of the battery 100. As noted herein, the definitions of the anode and cathode during the discharge cycle will be used consistently. Dendrite formation may become problematic if the dendrite 108 communicatively couples the anode 102 to the cathode 104.

20 The detection mechanism of the battery 100 includes a detection grid 106 and a detection module 110. As illustrated in Fig. 1, the dendrite 108 may form at the anode 102. As the dendrite 108 forms, the dendrite 108 may communicatively couple the detection grid 106 to the anode 102. The detection module 110 may be configured to monitor an impedance value between the anode 102 and the detection grid 104. When the dendrite 108 is communicatively
25 coupled to the detection grid 106, the detection module 110 may detect a change, for example, a decrease, in the impedance value due to the coupling between the dendrite 108 and the detection grid 106. The detection module 110 may be configured to reduce or mitigate the formation of the dendrite by reducing recharge of the battery 100.

In embodiments, the detection grid 106 has an opening to enable ion flow between the
30 anode 102 and the cathode 104. The opening, described in more detail below, may be defined by a grid pattern of the detection grid 106. While the opening may be large enough to enable ion flow, the opening may be small enough to prevent a dendrite from passing through the opening undetected by the detection module 110.

Although Fig. 1 illustrates various components of the battery 100, additional components may be used. Further, the battery 100 may be communicatively coupled to an electronic device, and the battery 100 may include components configured to provide electrical charge to the electronic device. Additionally, the battery 100 may be configured to receive electrical charge
5 from a charging device that may plug into a wall outlet, for example.

Fig. 2 is a diagram illustrating a peripheral view of a plurality of detection grids to be disposed in the dielectric of the battery. Like numbered items are as described in Fig. 1. In some embodiments, the detection grid 106 is a first detection grid and the battery may include a second detection grid 202. The detection grids 106, 202 may be disposed within dielectric
10 material 204. The dielectric material 204 may be electrolyte mixture such as ethylene carbonate or diethyl carbonate containing complexes of lithium ions in the case of a lithium ion battery. In some embodiments, the dielectric material may include an absorbent material that is saturated with the electrolyte mixture. In some embodiments, the dielectric material may be solid-state electrolyte which conducts lithium ions.

As illustrated in Fig. 2, the detection grids 106, 202 may include an opening, or a number of openings configured to enable ions to flow between a cathode and an anode of a battery, such as the battery 100 of Fig. 1. The openings may be small enough to prevent dendrites from passing through the grid without detection. In some embodiments, the detection grids 106, 202 may be laterally offset with respect to each other in order to reduce the ability of a dendrite from
15 passing through the detection grids 106, 202 undetected.

Fig. 3 is a diagram illustrating a cross sectional side view of a battery including a plurality of detection grids. Like numbered items are as described in Figs. 1 and 2. The detection grids 106, 202, are indicated by the dashed boxes in Fig. 3. As illustrated in Fig. 3, the first detection grid 106 is laterally offset with respect to the second detection grid 202. By providing two
25 detection grids 106, 202, and by disposing each detection grid as laterally offset with respect to each other, a dendrite 302 may be substantially prevented from passing through the second detection grid 202 without being detected by the first detection grid 106. The first and the second detection grids 106, 202 may be communicatively coupled to the detection module 110 and to the anode 102. As discussed above, the detection module 110 may be configured to
30 measure the impedance between the anode and the detection grids 106, 202. If a dendrite, such as the dendrite 302 shown in Fig. 3, communicatively couples to either detection grid 106, 202, the impedance value may be relatively less than if the dendrite was not coupled to either detection grid 106, 202. In embodiments, the detection module 110 may be configured to take action if a dendrite is detected, for example, by reducing or stopping any charging processes of

the battery 100 in order to significantly reduce further dendrite formation or growth, or by applying high voltage pulses to break down the dendrite, among others..

Fig. 4 is a block diagram illustrating a method of forming a detection mechanism. The method 400 may include forming, at block 402, a detection grid defining an opening to enable ion flow. The detection grid may be formed between an anode and a cathode of a battery. The detection grid may detect when a deposit, such as a dendrite, formed at the anode. The method 400 may include forming, at block 404, an interface to communicatively couple the detection grid to the anode of the battery. The interface may be a mechanism to enable the communicative coupling via a two-wire interface for example.

In embodiments, the interface includes detection circuitry configured to reduce charging activity of the battery when the deposit contacts the detection grid. For example, the detection grid is composed of conductive material. The detection circuitry may be configured to monitor the impedance value between the anode and the detection grid. Once the deposit formed on the surface of the anode approaches or contacts the detection grid, the impedance value may drop, and the detection circuitry may reduce charging activity of the battery.

In embodiments, the detection grid is a first detection grid. The method 400 may include forming a second detection grid. The first and the second detection grid may be configured to be laterally offset from each other to enable electron flow between the cathode and the anode, and to prevent a dendrite to pass through either detection grid undetected.

An embodiment is an implementation or example. Reference in the specification to "an embodiment," "one embodiment," "some embodiments," "various embodiments," or "other embodiments" means that a particular feature, structure, or characteristic described in connection with the embodiments is included in at least some embodiments, but not necessarily all embodiments, of the present techniques. The various appearances of "an embodiment," "one embodiment," or "some embodiments" are not necessarily all referring to the same embodiments.

Not all components, features, structures, characteristics, etc. described and illustrated herein need be included in a particular embodiment or embodiments. If the specification states a component, feature, structure, or characteristic "may", "might", "can" or "could" be included, for example, that particular component, feature, structure, or characteristic is not required to be included. If the specification or claim refers to "a" or "an" element, that does not mean there is only one of the element. If the specification or claims refer to "an additional" element, that does not preclude there being more than one of the additional element.

It is to be noted that, although some embodiments have been described in reference to particular implementations, other implementations are possible according to some embodiments. Additionally, the arrangement and/or order of circuit elements or other features illustrated in the drawings and/or described herein need not be arranged in the particular way illustrated and
5 described. Many other arrangements are possible according to some embodiments.

In each system shown in a figure, the elements in some cases may each have a same reference number or a different reference number to suggest that the elements represented could be different and/or similar. However, an element may be flexible enough to have different implementations and work with some or all of the systems shown or described herein. The
10 various elements shown in the figures may be the same or different. Which one is referred to as a first element and which is called a second element is arbitrary.

It is to be understood that specifics in the aforementioned examples may be used anywhere in one or more embodiments. For instance, all optional features of the computing device described above may also be implemented with respect to either of the methods or the computer-
15 readable medium described herein.

Furthermore, although flow diagrams and/or state diagrams may have been used herein to describe embodiments, the techniques are not limited to those diagrams or to corresponding descriptions herein. For example, flow need not move through each illustrated box or state or in exactly the same order as illustrated and described herein.

20 The present techniques are not restricted to the particular details listed herein. Indeed, those skilled in the art having the benefit of this disclosure will appreciate that many other variations from the foregoing description and drawings may be made within the scope of the present techniques. Accordingly, it is the following claims including any amendments thereto that define the scope of the present techniques.

25

CLAIMS

What is claimed is:

1. A detection mechanism, comprising a detection means to be disposed in a dielectric material between a cathode and an anode of a battery.

5

2. The detection mechanism of claim 1, wherein the detection means comprises an opening to enable ion flow between the cathode and the anode; and wherein the detection means is to detect when a deposit formed at the anode contacts the detection means.

10

3. The detection mechanism of claim 2, wherein a deposit formed at the anode comprises a dendrite.

15

4. The detection mechanism of claim 1, comprising detection circuitry means communicatively coupling the detection means to the anode, wherein the detection circuitry means is to reduce charging activity of the battery when a deposit contacts the detection means.

5. The detection mechanism of claim 1, wherein the detection means is composed of a conductive material.

20

6. The detection mechanism of claim 1, comprising a second detection means to be disposed between the cathode and the anode of the battery.

7. The detection mechanism of claim 6, wherein the second detection means is laterally offset with respect to the first detection means.

25

8. A detection mechanism, comprising a detection grid to be disposed in a dielectric material between a cathode and an anode of a battery.

30

9. The detection mechanism of claim 8, wherein the detection grid comprises an opening to enable ion flow between the cathode and the anode; and wherein the detection grid is configured to detect when a deposit formed at the anode contacts the detection grid.

10. The detection mechanism of claim 9, wherein a deposit formed at the anode comprises a dendrite.

11. The detection mechanism of any of claims 8, 9, or 10, comprising detection circuitry communicatively coupling the detection grid to the anode, wherein the detection circuitry is to reduce charging activity of the battery when a deposit contacts the detection grid.

5

12. The detection mechanism of any of claims 8, 9, 10, or 11, wherein the detection grid is composed of a conductive material.

13. The detection mechanism of any of claims 8, 9, 10, 11, or 12, comprising a second detection grid to be disposed between the cathode and the anode of the battery.

10

14. The detection mechanism of any of claims 8, 9, 10, 11, 12, or 13, wherein the second detection grid is laterally offset with respect to the detection grid.

15. A detection mechanism, comprising a detection grid to be disposed in a dielectric material between a cathode and an anode of a battery.

15

16. A method for forming a detection mechanism, comprising:
forming a detection grid to be disposed between a cathode and an anode of a battery; and
forming an interface to communicatively couple the detection grid to the anode.

20

17. The method of claim 16, wherein the detection grid defines an opening to enable ion flow between the cathode and the anode.

18. The method of any of claims 16 or 17, wherein the detection grid is to detect when a deposit formed at the anode contacts the detection grid.

25

19. The method of any of claims 16, 17, or 18, wherein the detection grid is formed to be communicatively coupled to the anode via detection circuitry via the interface, wherein the detection circuitry is to reduce charging activity of the battery when a deposit contacts the detection grid.

30

20. The method of any of claims 16, 17, 18, or 19, wherein the detection grid is composed of a conductive material.

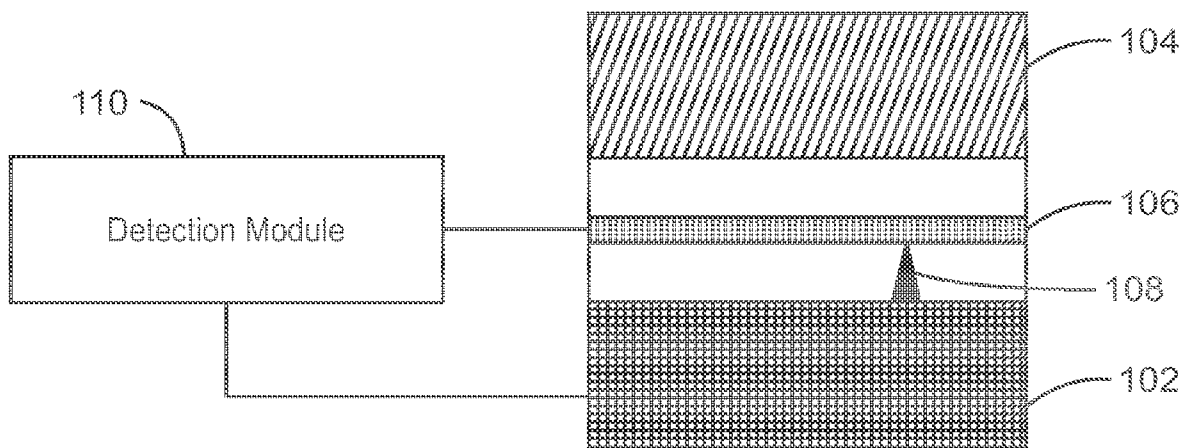
21. The method of any of claims 16, 17, 18, 19, or 20, wherein the detection grid is a first detection grid, the method comprising forming a second detection grid to be disposed between the cathode and the anode of the battery.

5

22. The method of any of claims 16, 17, 18, 19, 20, or 21, wherein the second detection grid is to be disposed laterally offset with respect to the first detection grid.

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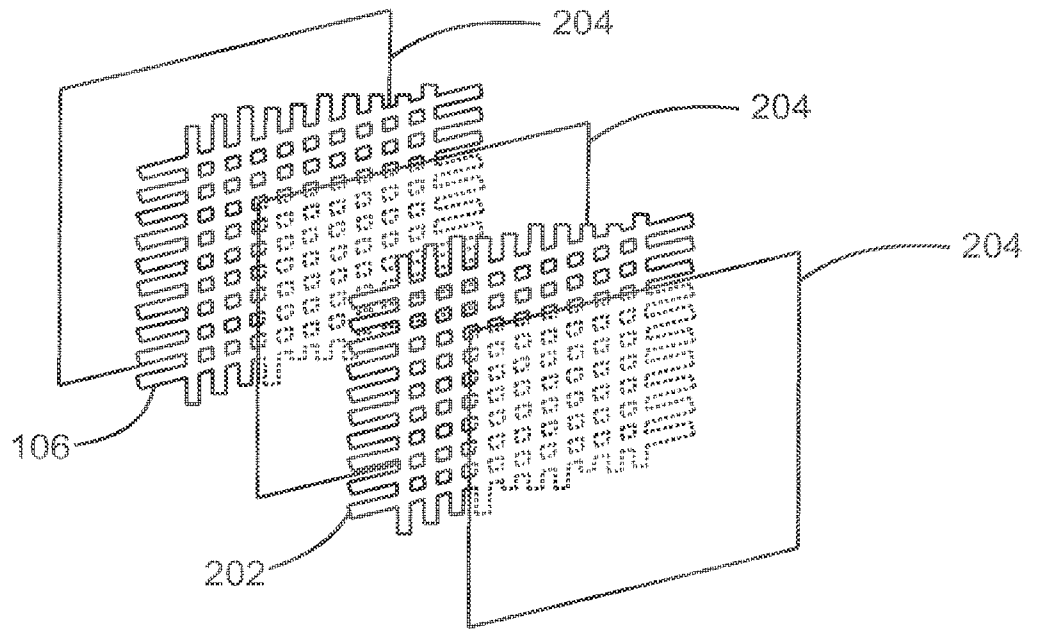


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FIG. 1

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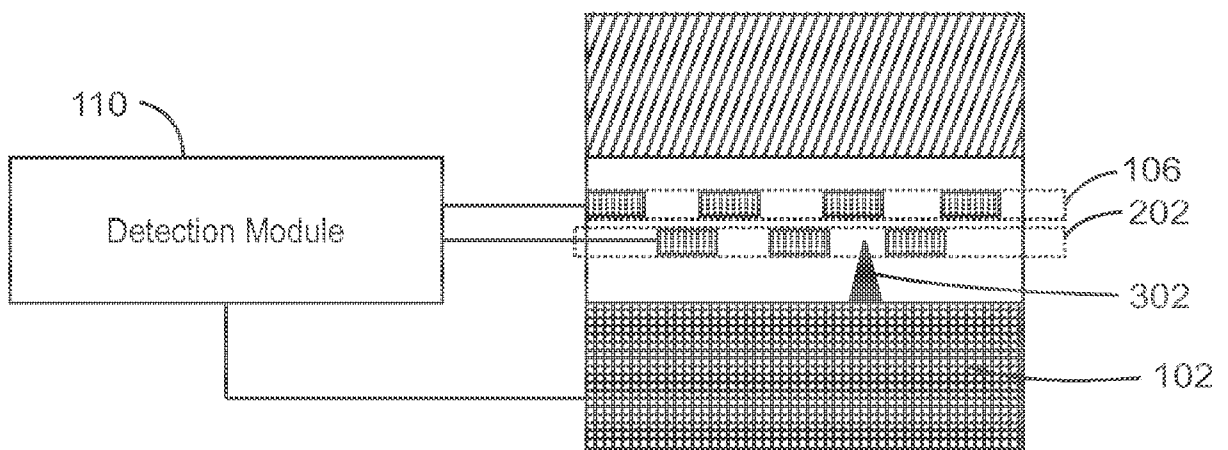


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FIG. 2

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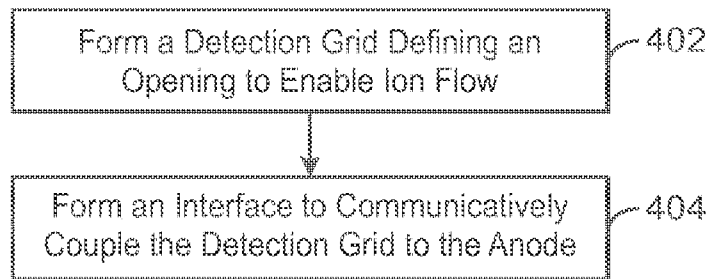


300
FIG. 3

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400
FIG. 4

⤵

A. CLASSIFICATION OF SUBJECT MATTER**H01M 10/48(2006.01)i, H01M 10/04(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01M 10/48; H01M 2/16; H01M 10/058; H01M 2/30; H01M 4/64; H01M 10/0566; H01M 10/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: detection, dielectric, grid, disposing, battery

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2011-124104 A (HITACHI, LTD.) 23 June 2011 See abstract; paragraphs [0007], [0017]-[0038]; claims 1-10; and figures 1, 3-6.	1-5
Y		8-11, 15-18
A		6-7
Y	JP 2010-157449 A (NISSAN MOTOR CO., LTD.) 15 July 2010 See abstract; paragraphs [0001], [0009], [0032]-[0041], [0068]-[0086]; claims 1-2, 5; and figures 2-9.	8-11, 15-18
X	JP 2011-034952 A (TOYOTA MOTOR CORPORATION) 17 February 2011 See abstract; paragraphs [0022]-[0032], [0038], [0048], [0066]; claims 1-3; and figures 3-4, 9, 12.	1-5
X	JP 2010-073558 A (NISSAN MOTOR CO., LTD.) 2 April 2010 See abstract; paragraphs [0015]-[0037], [0053]-[0054]; claims 1-11; and figures 1-2, 5, 8-9.	1-5
A	JP 08-180853 A (MITSUBISHI CABLE IND., LTD.) 12 July 1996 See abstract; paragraphs [0010]-[0036]; claims 1-3; and figures 1-2.	1-11, 15-18

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

10 October 2014 (10.10.2014)

Date of mailing of the international search report

10 October 2014 (10.10.2014)

Name and mailing address of the ISA/KR

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Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.: 12-14,19-22
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fees.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2014/043856

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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