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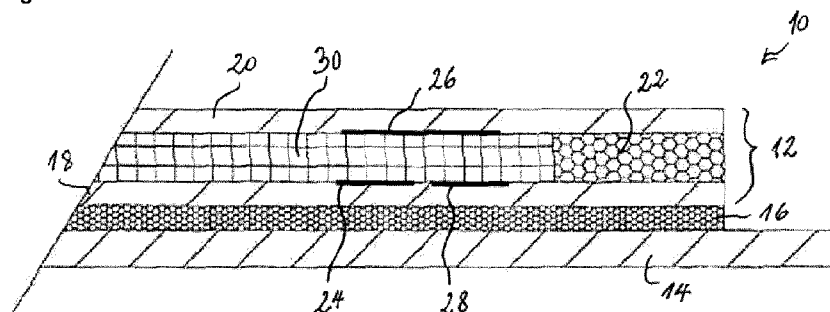
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(54) **Title:** INPUT DEVICE MANUFACTURING PROCESS

Fig. 1



(57) **Abstract:** For the manufacturing of an input device, a sensor assembly (10) comprising a film-type pressure sensor (12) and a cover layer (14) is provided. The pressure sensor includes a first carrier film (18) applied against the cover layer, a second carrier film (20) and a spacer (22) attaching the first and second carrier films to each other. In an opening in the spacer, a first (24) and a second (26) electrode are arranged on the first and the second carrier film, respectively. The electrodes are arranged facing each other so that they may be brought closer together when the pressure sensor is compressed. The sensor assembly is arranged in a mould (32), so that the cover layer lies against a wall thereof. Plastic material (34) is then injected into the mould while a removable insert is injected.

DESCRIPTION

INPUT DEVICE MANUFACTURING PROCESS

Technical field

[0001] The present invention generally relates to the manufacture of an input
5 device, in particular for human-machine interaction.

Background Art

[0002] Input devices are commonly used in conjunction with electronic appliances to enable humans to interact with them. Input devices exist in great variety, e.g. buttons, sliders, keypads, touchpads, touch screens etc.

10 [0003] It is known to construct input devices based upon film-type pressure sensors. A film-type pressure sensor comprises a first and a second carrier film, which are arranged at a certain distance from each another by means of a spacer. The spacer is provided with at least one opening that defines an active zone of the sensor, in which the two carrier films face one another. Inside this active zone, at
15 least two electrodes are arranged on the carrier films, in such a way that the at least two electrodes may be brought closer together, possibly into contact with each other, when the two carrier films are pressed together under the action of compressive force acting on the sensor in the active zone. The activation of the input device is detected by a control circuit connected to the at least two electrode that measures voltage,
20 current, resistance and/or capacitance between the electrodes. In a resistive pressure sensor, the electrodes are brought into electrical contact (directly or via an intermediate resistive or conductive layer) and the resulting drop in electrical resistance is detected by the control circuit. In a capacitive pressure sensor, pressure is detected based upon the change of capacitance between the electrodes when they
25 are brought closer together. In the case of a capacitive pressure sensor, one or more of the electrodes may be covered with an insulating layer that prevents an electrical contact between the electrodes.

[0004] In certain applications, the film-type pressure sensor should not be directly exposed to the environment and thus to the user for aesthetic or haptic reasons, or
30 for protection of the pressure sensor. The film-type pressure sensor may thus be

applied on the backside of a cover layer, which fulfils a decorative as well as a protective purpose. However, it is difficult to integrate the assembly of the film-type pressure sensor and the cover layer with an injection-moulded plastic casing or frame of an electrical or electronical appliance while guaranteeing an appealing appearance and flawless functioning of the input device. This is mainly due to the fact that the film-type pressure sensor has to be backed with a member that can exert the reaction force when the user touches the input device. That member thus has to be arranged at a precisely defined distance from the cover layer. This means that all the parts have to be manufactures with small tolerance and then assembled with one another.

The overall process thus tends to be costly. Manufacturing the cover layer integrally with the injection-moulded plastic casing or frame is currently not a viable alternative, since the thickness of the cover layer would not be sufficiently small for allowing the cover layer to bend, and thereby to activate the pressure sensor, at reasonable pressure. With the thicknesses currently achievable at acceptable costs, the user would have to press too firmly on the cover until the underlying pressure sensor is activated.

Technical problem

[0005] It is an object of the present invention to provide a more cost-efficient input device. This object is achieved by a process as claimed in claim 1.

General Description of the Invention

[0006] For the manufacturing of an input device, a sensor assembly is provided. The sensor assembly comprises a film-type pressure sensor and a cover layer. The film-type pressure sensor includes a first carrier film applied against the cover layer, a second carrier film and a spacer attaching the first and second carrier films to each other. The film-type pressure sensor further includes, in an opening in the spacer, a first electrode arranged on the first carrier film and a second electrode arranged on the second carrier film. The first and second electrodes are arranged in facing relationship with each other in such a way that they may be brought closer together, possibly into contact with each other, when compressive force is exerted on the film-type pressure sensor.

[0007] According to the process, the sensor assembly is arranged in a mould configured for plastic injection moulding in such a way that the cover layer lies

against a wall of the mould. Plastic material (e.g. thermosetting plastic material or thermoplastic material) is then injected into the mould while a removable insert arranged within the opening prevents the second carrier film from collapsing onto the first carrier film under pressure exerted by the injected plastic material. Preferably, the shape of the insert matches the shape of the opening in such a way that the insert completely fills out the opening when arranged therein.

[0008] The plastic material is then preferably caused to harden and to adhere to the sensor assembly. The sensor assembly and the hardened plastic material may thereafter be removed from the mould.

[0009] Once the plastic material has become hard, the insert may be removed from the opening. This may be done while the sensor assembly is still in the mould (but in this case one needs an access to the insert) or thereafter. The insert may be totally removed. Alternatively, it may be removed only partially, i.e. it is retracted a certain length, so that the electrodes may be brought closer together under the action of pressure. The projecting end of the insert may then be cut off and the remaining part may be fixed so as to stay in the retracted position.

[0010] The insert and the spacer preferably have the same thickness and/or the same yield under pressure. They may be made of the same or different materials (e.g. PET, PI, PEI, etc.)

[0011] The insert preferably comprises a tab that protrudes beyond the first and second carrier films for pulling the insert out of the opening.

[0012] The film-type pressure sensor may be a capacitive pressure sensor. In this case, at least one of the first and second electrodes preferably has a permanent insulating layer applied thereon that prevents an electrical contact between the first and second electrodes when compressive force is exerted on the film-type pressure sensor.

[0013] The film-type pressure sensor may also be a resistive pressure sensor. In this case, an electrical contact is established between the electrodes when pressure greater than a certain activation threshold is applied (and when the insert has been removed). The pressure sensor may be a pressure-sensitive switch (being either on or off) or exhibit an electrical response that gradually changes with the amount of pressure applied. In order to achieve a gradual change of resistance between the

electrodes, at least one of the electrodes is made of resistive material or covered with such material.

[0014] It should be noted that a resistive film-type pressure sensor could also be used as a combined capacitive and resistive pressure sensor. The control circuit could measure the capacitance between the electrodes as long as there is no contact between them (i.e. at pressures below the activation threshold) and measure the resistance once the contact has been established (i.e. at pressures above the activation threshold).

[0015] The film-type pressure sensor may comprise a third electrode arranged with the first electrode on the first carrier film in facing relationship with the second electrode in such a way that an electrical property (e.g. capacitance or resistance) between the first and the third electrodes changes via the second electrode when compressive force is exerted on the film-type pressure sensor. Alternatively, the third electrode may be arranged with the second electrode on the second carrier film in facing relationship with the first electrode in such a way that an electrical property (e.g. capacitance or resistance) between the second and the third electrodes changes via the first electrode when compressive force is exerted on the film-type pressure sensor.

[0016] An aspect of the invention concerns an input device manufactured using a process as described hereinabove. The sensor assembly of such an input device is backed with (injection-moulded) plastic material applied against the second carrier film. The opening in the spacer extends to a border of the first and second carrier films so that the insert may be removed. The opening may optionally be closed at the border, e.g. by a plug inserted after removal of the insert.

[0017] Yet another aspect of the invention concerns an electric or electronic appliance comprising an input device as disclosed herein.

Brief Description of the Drawings

[0018] Further details and advantages of the present invention will be apparent from the following detailed description of several not limiting embodiments with reference to the attached drawings, wherein:

Fig. 1 is a schematic cross sectional view of a sensor assembly comprising a film-type pressure sensor and a cover layer;

Fig. 2 is a schematic cross sectional view of the sensor assembly of Fig. 1 placed in a mould for plastic injection moulding;

5 Fig. 3 is a close-up of the sensor assembly in the mould while plastic material is injected;

Fig. 4 is a schematic cross sectional view of the sensor assembly of Fig. 1 after plastic injection moulding;

10 Fig. 5 is a schematic cross sectional view of the sensor assembly in the median plane of the spacer:

Fig. 6 is a schematic cross sectional view of a variant of the sensor assembly of Fig. 1.

Description of Preferred Embodiments

15 [0019] A preferred embodiment of the process of manufacturing an input device according to the invention is illustrated in Figs. 1 to 6. Fig. 1 shows a sensor assembly 10 comprising a film-type pressure sensor 12 firmly attached to a decorative cover 14 by an adhesive layer 16. It should be noted that the drawings are not to scale for the sake of clarity; in particular, the thicknesses of the different layers are exaggerated and not shown in mutually right proportions.

20 [0020] The pressure sensor 12 includes a first carrier film 18 applied against the cover 14, a second carrier film 20 and a spacer 22 (e.g. a double-sided adhesive) attaching the first and second carrier films to each other. An opening in the spacer defines a pressure-sensitive cell of the pressure sensor 12. The pressure-sensitive cell contains an electrode arrangement with at least a first electrode 24 arranged on
25 the first carrier film 18 and a second electrode 26 arranged on the second carrier film 20. In the illustrated embodiment, a third electrode 28 is arranged next to but insulated from the first electrode 24 on the first carrier film 18. The first and third electrodes are arranged in facing relationship with the second electrode, in such a way that they may be brought closer together when compressive force is exerted on
30 the film-type pressure sensor. A control circuit (not shown) connected to the first 24 and third 28 electrodes (and possibly also to the second electrode 26) may detect the

increase of the capacitance as the electrodes get closer and/or the decrease of the resistance as the electrodes get into electrical contact with one another.

[0021] In Fig. 1, the opening in the spacer 22 is totally occupied by a substantially incompressible, removable insert 30, which has to be removed before the pressure sensor 12 can be used as such.

[0022] The cover 14 is intended to become the outer surface of the input device. It has a decorative as well as a protective function. The carrier films 18, 20 are typically made of PET, PEN, PI, PEI or the like. Their respective thickness typically ranges from 50 μm to 200 μm , which would render them quite vulnerable if they were directly exposed to the environment and the user.

[0023] A user will use the pressure sensor 12 by pressing on the cover 14 in the region of the pressure-sensitive cell. The cover 12 and the first carrier film 18 will bend under the exerted pressure, which will move the electrodes 24, 26 and 28 closer together. The capacitance or resistance change detected by the control circuit (e.g. an application-specific integrated circuit, a field-programmable gate array, a micro-controller or the like) may then trigger the desired action. To avoid that the pressure sensor 12 bends as a whole, the second carrier film 20 has to be backed by a substantially rigid support.

[0024] That support is provided by plastic injection moulding. As shown in Figs. 2 and 3, the sensor assembly of Fig. 1 is placed in a mould 32, in such a way that the cover lies against a wall of the mould 32. Plastic material 34 (e.g. ABS) is then injected into the mould 32. The removable insert 30 arranged in the opening of the spacer 22 prevents, during the injection process, the second carrier film 20 from collapsing onto the first carrier film 18. In the absence of the incompressible insert, the injected plastic material 34 would permanently press the second carrier film 20 against the first carrier film 18.

[0025] When the plastic material 34 has hardened and adhered to the sensor assembly, so as to form what we will hereinafter call the input device, the mould is opened and the input device is withdrawn. As shown in Fig. 4, the incompressible insert 30 is then removed from the opening in the spacer 22 along the direction of the arrow. Once the insert 30 has freed the opening, the cover 14 and the first carrier film 18 may bend into the opening when pressure is applied on the cover 14.

[0026] Fig. 5 is a cross sectional view of the median plane of the spacer 22 and the insert 30. One observes that the opening extends to the border of the pressure sensor 12 and that it widens in the direction of removal of the insert 30. Such widening is considered advantageous, since it may facilitate the removal of the insert.

5 Nevertheless, the opening may also have a constant width along the direction of removal. The shape of the insert 30 matches the shape of the opening of the spacer 22. The insert 30 also comprises a tab 36 that protrudes beyond the border of the pressure sensor 12. The tab 36 may be seized in order to pull on the insert 30 for removing it from the opening.

10 [0027] Fig. 6 shows a variant of the sensor assembly of Fig. 1. The only difference is that the second electrode 26 is coated with an insulating layer 38 that prevents a direct contact between the second electrode 26 and the first 24 and the third 28 electrode. In all other regards, the sensor assembly of Fig. 6 is identical to that of Fig. 1 and it is used in the same way in the input device manufacturing process.

15 [0028] The electrodes 24, 26 and 28 are preferably printed electrodes. Conductive parts thereof are preferably made of silver ink whereas resistive parts are preferably made of carbon ink. The insulating layer 38 of Fig. 6 is preferably also a printed layer.

[0029] While specific embodiments have been described in detail, those with ordinary skill in the art will appreciate that various modifications and alternatives to those details could be developed in light of the overall teachings of the disclosure. Accordingly, the particular arrangements disclosed are meant to be illustrative only and not limiting as to the scope of the invention, which is to be given the full breadth of the appended claims and any and all equivalents thereof.

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Legend:

- 10 Sensor assembly
- 12 Film-type pressure sensor
- 14 Cover
- 16 Adhesive layer
- 18 First carrier film
- 20 Second carrier film
- 22 Spacer
- 24 First electrode
- 26 Second electrode
- 28 Third electrode
- 30 Removable insert
- 32 Mould
- 34 Plastic material
- 36 Tab
- 38 Insulating layer

Claims

1. Process of manufacturing an input device, comprising
providing a sensor assembly (10), said sensor assembly (10) comprising a film-
type pressure sensor (12) and a cover layer (14), said film-type pressure sensor
5 (12) including a first carrier film (18) applied against said cover layer (14), a
second carrier film (20) and a spacer (22) attaching said first and second carrier
films (18, 20) to each other, said spacer (22) having an opening therein, said film-
type pressure sensor (12) further including a first electrode (24) arranged on said
first carrier film (18) and a second electrode (26) arranged on said second carrier
10 film (20), said first and second electrodes (24, 26) being arranged in facing
relationship with each other in said opening in such a way that said first and
second electrodes (24, 26) may be brought closer together, possibly into contact
with each other, when compressive force is exerted on said film-type pressure
sensor (12),
15 arranging said sensor assembly (10) in a mould (32) in such a way that said
cover layer (14) lies against a wall of said mould (32);
injecting plastic material (34) into said mould (32) while preventing said second
carrier film (20) from collapsing onto said first carrier film (18) under pressure
exerted by said injected plastic material (34) with a removable insert (30)
20 arranged within said opening.
2. The process according to claim 1, comprising causing said plastic material (34) to
harden and to adhere to said sensor assembly (10).
3. The process according to claim 2, comprising removing said sensor assembly
(10) and said hardened plastic material (34) from said mould (32).
- 25 4. The process according to any one of claims 1 to 3, comprising removing said
insert (30) from said opening.
5. The process according to any one of claims 1 to 4, wherein said plastic material
(34) is a thermosetting plastic material or a thermoplastic material.
6. The process according to any one of claims 1 to 5, wherein said insert (30) and
30 said spacer (22) have the same thickness.

7. The process according to any one of claims 1 to 6, wherein said insert (30) comprises a tab (36) that protrudes beyond said first and second carrier films (18, 20) for pulling said insert (30) out of said opening.
8. The process according to any one of claims 1 to 7, wherein said film-type pressure sensor (12) is a capacitive pressure sensor.
9. The process according to claim 8, wherein at least one of said first and second electrodes (24, 26) has a permanent insulating layer (38) applied thereon that prevents an electrical contact between said first and second electrodes (24, 26) when compressive force is exerted on said film-type pressure sensor (12).
10. The process according to any one of claims 1 to 7, wherein said film-type pressure sensor (12) is a resistive pressure sensor.
11. The process according to any one of claims 1 to 10, wherein said film-type pressure sensor (12) comprises a third electrode (28) arranged with said first electrode (24) on said first carrier film (18) in facing relationship with said second electrode (26) in such a way that an electrical property between said first and said third electrodes (24, 28) changes via said second electrode (26) when compressive force is exerted on said film-type pressure sensor (12) or wherein said third electrode (28) is arranged with said second electrode (26) on said second carrier film (20) in facing relationship with said first electrode (24) in such a way that an electrical property between said second and said third electrodes (26, 28) changes via said first electrode (24) when compressive force is exerted on said film-type pressure sensor (12).
12. Input device (10, 34) manufactured using a process as claimed in any one of claims 1 to 11.
13. Input device (10, 34) comprising a sensor assembly (10), said sensor assembly (10) comprising a film-type pressure sensor (12) and a cover layer (14), said film-type pressure sensor (12) including a first carrier film (18) applied against said cover layer (14), a second carrier film (20) and a spacer (22) attaching said first and second carrier films (18, 20) to each other, said spacer (22) having an opening therein, said film-type pressure sensor (12) further including a first electrode (24) arranged on said first carrier film (18) and a second electrode (26) arranged on said second carrier film (20), said first and second electrodes (24,

- 26) being arranged in facing relationship with each other in said opening in such a way that said first and second electrodes (24, 26) may be brought closer together, possibly into contact with each other, when a compressive force is exerted on said film-type pressure sensor (12), said sensor assembly (10) being
5 backed with plastic material (34) applied against said second carrier film (20), said opening extending to a border of said first and second carrier films (18, 20), said opening optionally being closed at said border.
14. Electric or electronic appliance comprising an input device (10, 34) according to claim 13.

Fig. 4

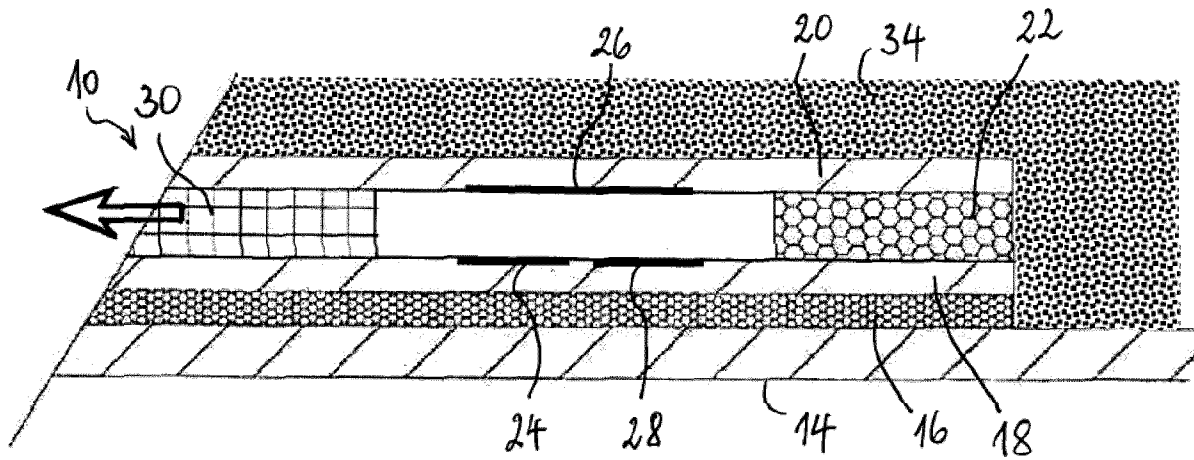


Fig. 5

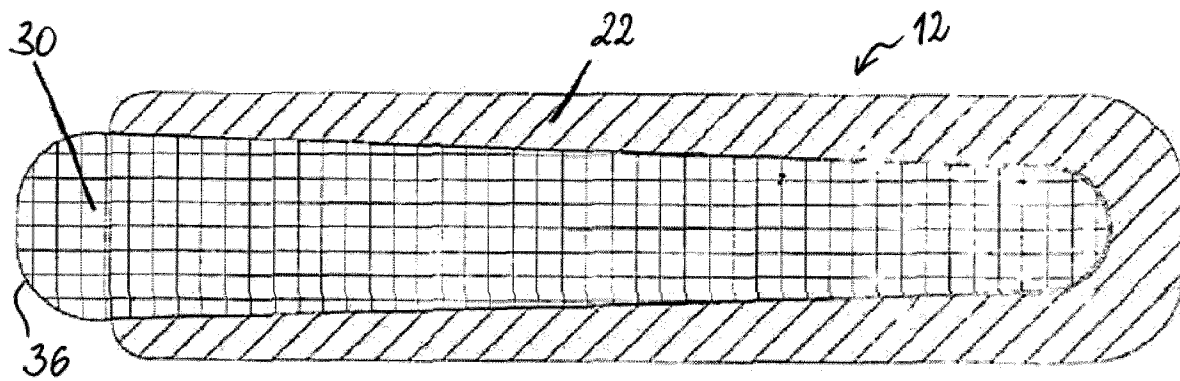
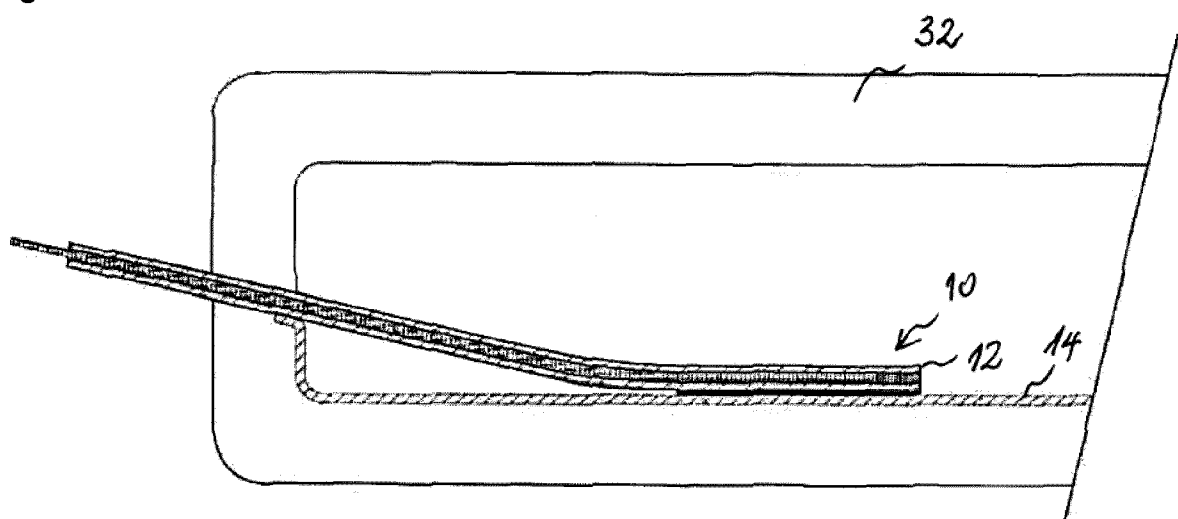


Fig. 6



INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. H01H13/88 B29C45/00 B29C45/14
ADD.

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)
H01H B29C

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

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	the whole document	1-12
X	JP 2009 146354 A (NISSHA PRINTING) 2 July 2009 (2009-07-02)	13,14
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X	JP 61 201228 U (-) 17 December 1986 (1986-12-17)	13,14
A	the whole document	1-12
X	EP 1 641 009 A1 (IEE SARL [LU]) 29 March 2006 (2006-03-29)	13,14
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Further documents are listed in the continuation of Box C.



See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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