



(51) International Patent Classification:

B29C 45/14 (2006.01) B29C 33/12 (2006.01)

(21) International Application Number:

PCT/FI2020/050490

(22) International Filing Date:

09 July 2020 (09.07.2020)

(25) Filing Language:

English

(26) Publication Language:

English

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

(54) Title: INJECTION MOLDING METHOD WITH A FILM INSERT

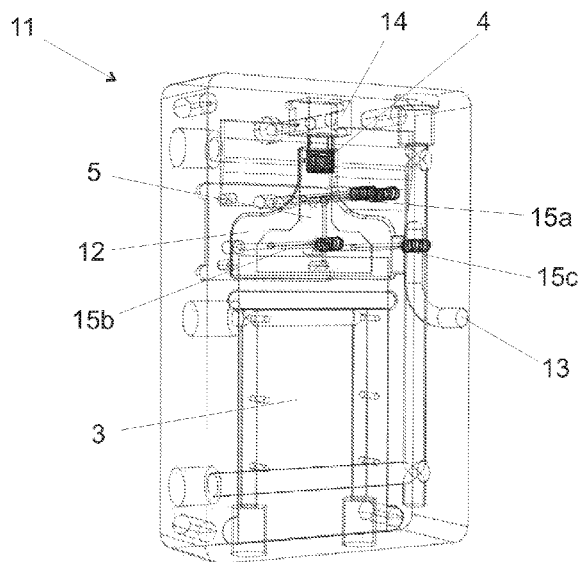


FIG. 2A

(57) Abstract: Injection molding method, in which method an injection mold (11) is prepared, which mold comprises mold space (12) for injection molding of a polymer material, into which mold space a portion of at least one electrical component (3) is inserted before the injection molding in a single molding phase, wherein the mold space (12) is equipped with an electrically conductive film insert (5), which film insert is electrically connected to the at least one electrical component (3), and wherein the side edge of the film insert (5) divides the flow of injected polymer material on both sides of the film insert during the injection molding phase.



Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

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

INJECTION MOLDING METHOD WITH A FILM INSERT

The present invention relates to a plastic injection molding method for manufacturing structures comprising electronic film component.

5 Electronic plastic components comprising electric conductive parts embedded inside the plastic portion of part are typically cast at two casting stages with injection casting. This so called 2K or 'two-shot' injection molding also allows the use of two different polymers for example with different properties, colors or levels of hardness to be processed into one end product in one injection molding process.

10 One of the major advantages of the 2K injection molding is that the polymer to be injected is still hot and has not shrunk yet, which virtually excludes the risk of burrs being formed on the second polymer component. In addition, the surface is still 'virginally' clean, enabling good molecular adhesion between the portions. Another significant advantage of 2K injection molding is the cycle time gained, the constant process and the fact that manual insertion is not required, thus avoiding the risk of
15 damaging the first polymer component.

2K injection molding, however, typically requires two cavities in the mold for the polymer(s), and turning of the mold when changing the polymer to be injection molded. This causes the mold costs to increase and additional process steps in the injection molding. Further, the 2K injection molding method is difficult to implement
20 for components comprising flexible electronics.

The present invention provides a solution for injection molding of a component comprising two sides with embedded conductive film insert and with flexible electronics at least partially embedded in the component with a single injection molding phase or step. This allows for simpler mold structure and faster manufacturing process of
25 the components.

In the present invention the conductive film insert is utilized for dividing the flow of the polymer material in the injection molding to different sides of the film insert in order to obtain full and seamless embedding of the film insert inside the polymer material. This enhances the mechanical durability of the manufactured component
30 especially in relation of flex-to-flex and flex-to-rigid interconnections within the manufactured component.

In the injection molding method of the invention an injection mold is prepared, which mold comprises a mold space for injection molding of a polymer material, into which

mold space a portion of at least one electrical component is inserted before the injection molding in a single molding phase, wherein the mold space is equipped with an electrically conductive film insert, which film insert is electrically connected to the at least one electrical component, and wherein the side edge of the film insert
5 divides the flow of injected polymer material on both sides of the film insert during the injection molding phase.

Suitable polymer material for the injection molding of the present invention include polymer-based thermoplastic and thermoplastic elastomer resins, for example.

10 In an embodiment of the injection molding method of the invention additional support for the film insert is provided within the mold space for keeping the film insert at its place during the injection molding of the polymer material. This additional support is preferably provided with support pins connected to the surfaces of the said mold space and extending through the film insert.

15 In an embodiment of the injection molding method of the invention the injection molding is implemented via cold runner. Another option is to use a hot runner that allows controlling of the temperature of the injected polymer material.

20 In an embodiment of the injection molding method of the invention a connector piece is inserted in the mold space and electrically connected to the film insert before injection molding phase. The connector piece is preferably an USB connector, which is preferably embedded inside the injection molded portion of the component with the exception of its connector surface via which surface a mating USB plug is inserted in the connector. The connector piece may be connected to the conductive film insert with an electrically conductive adhesive, for example.

25 The connector piece may alternatively be any other connector having size that fits inside the piece to be cast, being panel mountable, and having flat surface to be set against the core used for fixing and supporting the connector piece in the mold. The connector piece should preferably also have sufficiently sealed outer surface so that the melt polymer material does not penetrate inside the connector piece during casting or the core used in fixing and supporting the connector piece in the mold must
30 also cover at least the electrical contact surfaces of the connector piece. These alternative connector pieces include FFC connectors (Flat Flexible Cable), all forms of USB connectors, HDMI connectors, any female/male sockets of rectangular connectors, for example.

In an embodiment of the injection molding method of the invention the conductive film insert is plastic film with printed conductive material. For example, the conductive film insert may be formed of a 125 μm thick polyethylene terephthalate (PET) foil with screen printed silver ink.

- 5 In an embodiment of the injection molding method of the invention the electrical component is an OLED display. Alternatively, the electrical component can be a solar module, a thin film battery, a printed circuit board or a sensor node, for example.

- 10 More precisely the features defining an injection molding method in accordance with the present invention are presented in claim 1. Dependent claims present advantageous features and embodiments of the invention.

Exemplifying embodiment of the invention and its advantages are explained in greater detail below in the sense of example and with reference to accompanying drawings, where

- 15 Figures 1A and 1B show schematically an embodiment of an injection molded structure of the invention manufactured with a method of the invention, and

Figures 2A and 2B show schematically an equipped mold for the injection molding method of the invention.

- 20 Figures 1A and 1B show schematically an embodiment of an injection molded structure 1 of the invention, which comprises an injection molded portion 2, an electrical component 3, which in this embodiment is an OLED display, a connector piece 4, which in this embodiment is a USB connector, and an electrically conductive film insert 5.

- 25 The electrically conductive film insert 5 connects electrically the connector piece 4 to the electrical component 3, and is completely embedded inside the injection molded portion 2 of the structure 1. Further, the connector piece 4, with the exception of its connecting surface, and the portion of the electrical component 3 containing the connection area between the electrical component and the film insert 5, are also located inside the injection molded portion 2 of the structure 1.

- 30 The electrically conductive film insert 5 is formed in this embodiment from a 125 μm thick polyethylene terephthalate (PET) foil with screen printed silver ink.

The connector piece 4 is fixed to the film insert 5 with electrically conductive adhesive. The electrical component 3 is fixed to the film insert 5 for example also with electrically conductive adhesive.

5 In this embodiment the injection molded portion 2, which is injection molded in single molding stage, provides enhanced environmental protection and mechanical durability for the connections between the film insert 5 and the electrical component 3, and between the film insert 5 and the connector piece 4.

Figures 2A and 2B show schematically an equipped mold 11 for injection molding of the structure shown in figures 2A and 2B.

10 The mold 11 comprises a mold space 12 for injection molding of the injection molded portion 2 of figures 1A and 1B, to which mold space the polymer is injected via cold runner 13.

Before the injection molding, the electrical component 3 and the connector piece 4 are fixed to the electrically conductive film insert 5, and the thus formed entity is
15 placed in the mold 11. In the mold 11, the connector piece 4 is fixed and supported with connector support core 14 via the contact surface of the connector piece. The connector support core 14 preferably also extends inside the connector piece 4 and fills it or at least covers the electrical contact surfaces of the connector piece, so that the injected melt polymer material cannot penetrate inside the connector piece and
20 cover the electrical contact surfaces during the casting. The film insert 5 is supported in the area of the mold space 12 with pins 15a-15c in order to keep the film insert at its place in the mold during the injection molding phase.

Once these preparatory steps are done, the mold 11 is closed and the injection molding phase is carried out, during which injection molding phase the film insert 5
25 divides the polymer material flow from the cold runner 13 on both sides of the film insert 5 within the mold space 12. The injection molding is carried out until the mold space 12 is filled in order to form the injection molded portion 2 as shown in figures 1A and 1B.

After the injection molding phase, a ready end product is obtained, which in this
30 case is the injection molded structure 1 shown in figures 1A and 1B.

The specific exemplifying embodiment of the invention shown in figures and discussed above should not be construed as limiting. A person skilled in the art can amend and modify the embodiment described in many evident ways within the

scope of the attached claims. Thus, the invention is not limited merely to the embodiment described above.

Claims

1. Injection molding method, in which method an injection mold (11) is pre-pared, which mold comprises mold space (12) for injection molding of a polymer material, into which mold space a portion of at least one electrical component (3) is inserted
5 before the injection molding in a single molding phase, and the mold space (12) is equipped with an electrically conductive film insert (5), which film insert is electrically connected to the at least one electrical component, **characterized** in that the side edge of the film insert (5) divides the flow of injected polymer material on both sides of the film insert during the injection molding phase.
- 10 2. Injection molding method according to claim 1, wherein additional support (15a-15c) for the film insert (5) is provided within the mold space (12) for keeping the film insert at its place during the injection molding of the polymer material.
3. Injection molding method according to claim 1 or 2, wherein the injection molding is implemented via a hot or cold runner.
- 15 4. Injection molding method according to any of claims 1-3, wherein connector piece (4) is inserted in the mold space (12) and electrically connected to the film insert (5) before injection molding phase.
5. Injection molding method according to claim 4, wherein the connector piece (4) is fixed to the mold (11) and supported therein with a connector support core
20 (14), which extends inside the connector piece and covers at least the electrical contact surfaces inside the connector piece.
6. Injection molding method according to claim 4 or 5, wherein the connector piece (4) is an USB connector, a FFC connector or a HDMI connector.
7. Injection molding method according to any of claims 1-6, wherein the conduc-
25 tive film insert (5) is a plastic film with printed conductive material.
8. Injection molding method according to any of claims 1-7, wherein the electrical component (3) is an OLED display, a solar module, a thin film battery, a print-ed circuit board or a sensor node.

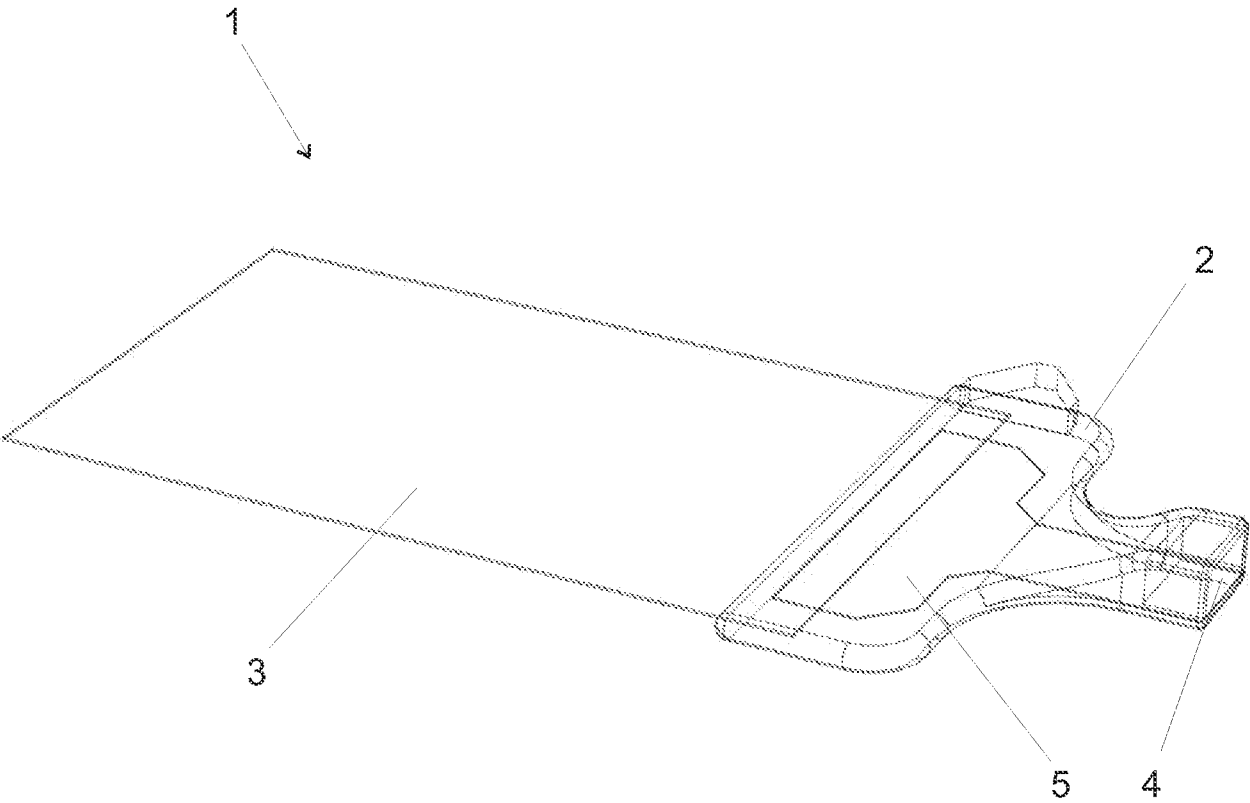


FIG. 1A

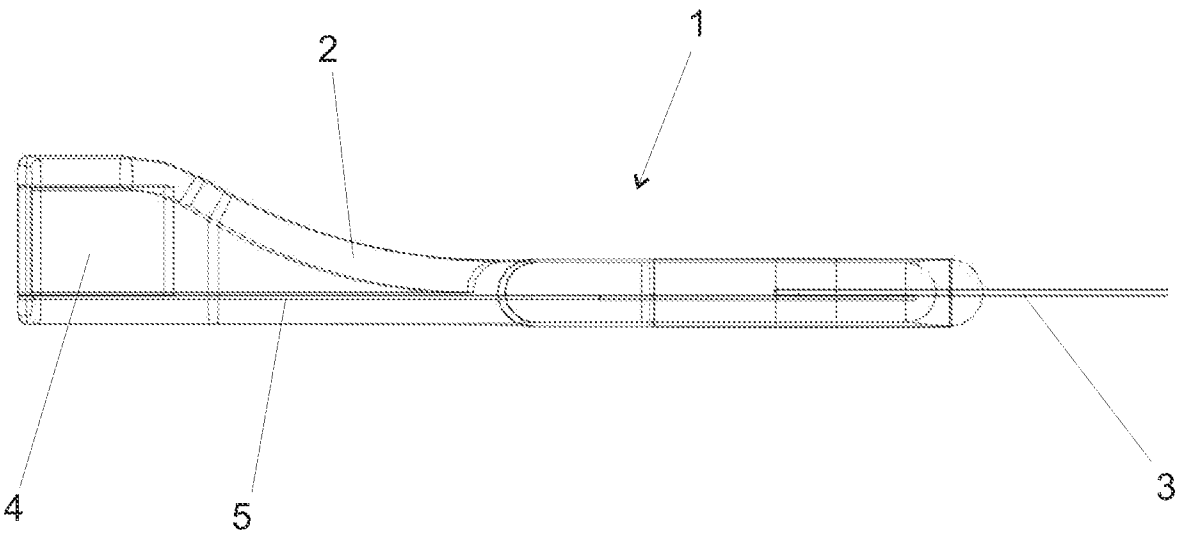


FIG. 1B

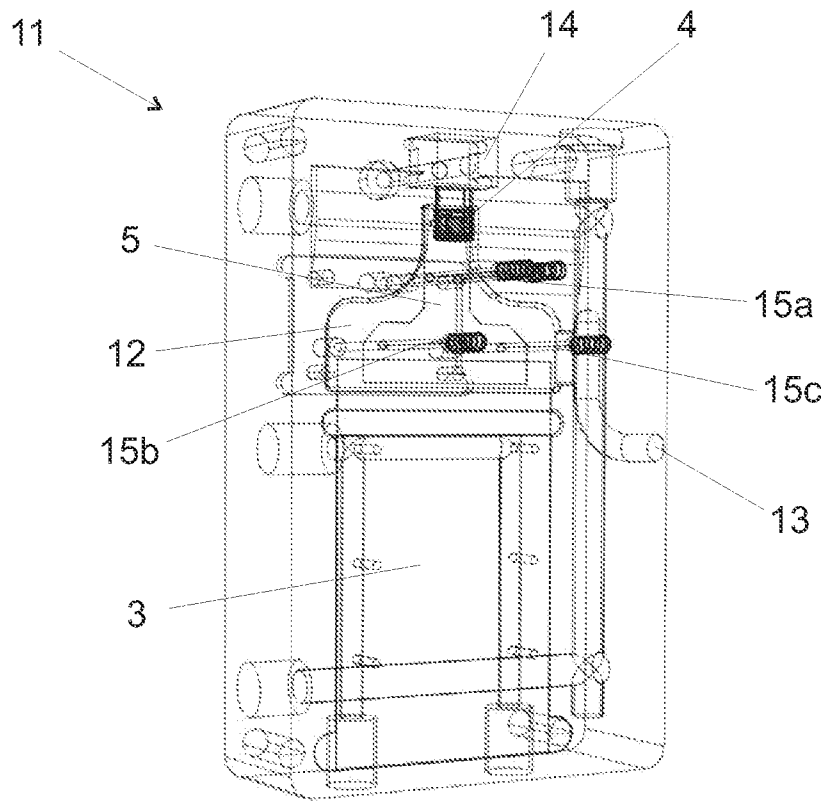


FIG. 2A

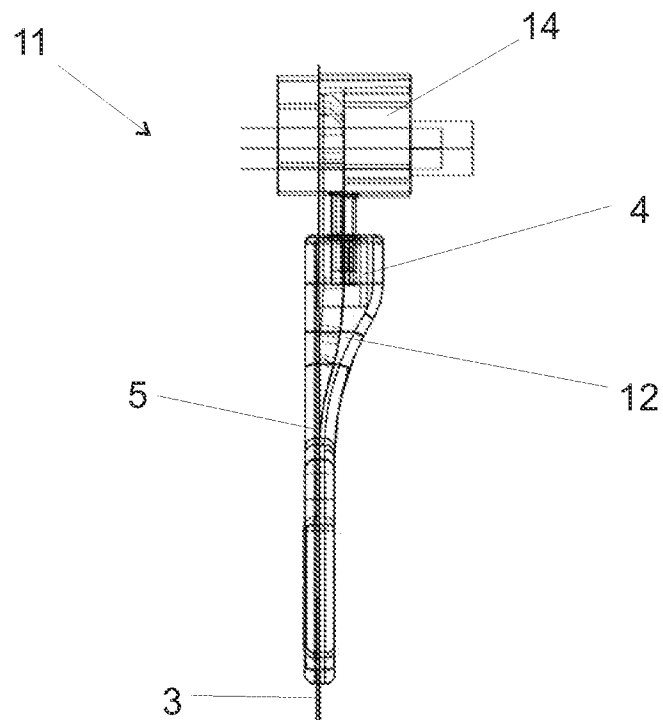


FIG. 2B

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2020/050490

A. CLASSIFICATION OF SUBJECT MATTER
INV. B29C45/14 B29C33/12
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)
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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	JP H05 21492 A (MITSUBISHI CHEM IND) 29 January 1993 (1993-01-29) figures 2-7 -----	1-8
A	JP H11 254476 A (MITSUBISHI ENG PLAST CORP) 21 September 1999 (1999-09-21) figures 4,5 -----	1-8
A	DE 10 2012 208478 A1 (MAGNA EXTERIORS & INTERIORS MAN GMBH [DE]) 21 November 2013 (2013-11-21) paragraph [0021]; figure 6 ----- -/--	1-8



Further documents are listed in the continuation of Box C.



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"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

5 November 2020

Date of mailing of the international search report

19/11/2020

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2020/050490

C(Continuation). 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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Information on patent family members

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