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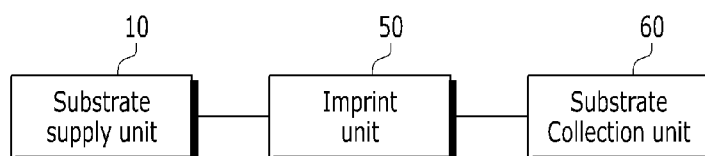
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(54) **Title:** IMPACT PRINT TYPE HOT EMBOSsing APPARATUS

[Fig. 3]



(57) **Abstract:** The present invention relates to an impact print type hot embossing apparatus performing an imprint process on a continuously supplied substrate. The impact print type hot embossing apparatus includes a substrate supply unit that continuously supplies the substrate and an imprint unit that heats the substrate and applies an impact to the heated substrate in a dot type or a line type to perform an imprint process. As described above, the present invention is the hot embossing apparatus adopting a print type in the existing dot printer and line printer and forms patterns on the substrate using a fine probe or a mechanism of a print head type on which a fine shape is imprinted.



Description

Title of Invention: IMPACT PRINT TYPE HOT EMBOSSING APPARATUS

Technical Field

- [1] The present invention relates to a hot embossing apparatus, and more particularly, to an impact print type hot embossing apparatus using a print head adopting a print type of the existing dot printer and line printer to form patterns on a substrate.

Background Art

- [2] As parts used in electron and display industries are small, highly defined, and thinned, a need exists for a process of more precisely manufacturing fine patterns. Further, precision, high productivity, and a low cost are essential elements even in part manufacturing equipments. In particular, it is more urgently required to develop a continuous manufacturing system capable of coping with a huge market to be formed in the future by making inexpensive home appliances and printed electronics having a precision of several to several tens of μm on a flexible substrate (paper, plastic, or the like) by using a patterning/printing process and develop a fine patterning technology for a curved surface of a roll, a cylinder, or the like, used for the continuous manufacturing system.
- [3] In order to implement high function and high integration for next-generation semiconductor, display devices, bio devices, optical communication parts, and high energy parts, ultrafine shape processing of several hundreds of nm to several tens of μm is essential. However, the existing LIGA process or fine mechanical processing method has economical and technical limitations. Thus, a need exists for a new technology and equipment capable of manufacturing an ultrafine shape of several tens of μm or less.
- [4] A hot embossing is a technology of heating a polymer at a glass transition temperature or more, stamping a fine structure using a stamp in a state in which the polymer is soft, and cooling and hardening the stamped fine structure. This technology is a new technology capable of processing the ultrafine patterns in a unit of a micron or less.
- [5] Meanwhile, high-temperature embossing may be difficult to apply uniform temperature and pressure to the overall working surface, as compared with intermediate-temperature embossing capable of processing a 300 mm wafer. However, the high-temperature embossing may be applied to only a 100 mm wafer due to technical difficulty. Therefore, development competition of a high-temperature embossing equipment depends on acquisition of a technology capable of making an area large.
- [6] The press type high-temperature embossing is easy to apply uniform temperature or

pressure to a small working area but has a limitation in continuously increasing an area (see FIG. 1).

- [7] Meanwhile, a roll type process used in a large-area print process has been reviewed as a new method for making an area large (see FIG. 2). For example, when using a roll having the stamp mounted on the surface thereof, the ultrafine shape may be continuously manufactured and the working area may be increased to correspond to the size of the roll. This roll type is a new technology capable of remarkably improving productivity. Further, this roll type is a manufacturing type capable of directly stamping the ultrafine shape on a polymer film wound around the roll in a flexible display that has been in the limelight as the next-generation display device.
- [8] As compared with the press type having relatively static process characteristics, a roll type thermal nanoimprint lithography (TH-NIL) having strong dynamic characteristics includes various variables and the process thereof has not been yet standardized. A working process and an equipment concept for various roll types of TH-NIL are being established around the world and thus, it can be said that the roll type TH-NIL is in a development initial stage.
- [9] The roll type high-temperature embossing technology is a technology directly transferring the ultrafine shape on the flexible polymer film by using the rotating roll, unlike the press type imprinting the stamp on a flat substrate. The roll type high-temperature embossing production equipment capable of manufacturing ultrafine shape parts has not been yet released in the market, but a conceptual idea on equipment may be acquired from a heat treatment process of textile or an embossing process imprinting a micro-sized shape.
- [10] However, there are problems in that in the roll type high-temperature embossing technology, it is necessary to replace the manufactured stamp roll every time a pattern to be imprinted on the substrate is changed and thus, the production delay due to the replacement is expected and costs increase.
- [11] Reference numerals that are not explained in FIG. 2 are as follows: 200: substrate, 400: print roll; 401: pattern, 500: press roll.
- [12] The above information disclosed in this Background section is only for enhancement of understanding of the background of the invention and therefore it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

Disclosure of Invention

Technical Problem

- [13] The present invention has been made in an effort to provide a hot embossing apparatus capable of improving productivity and reducing costs by applying a print

head in a program control type capable of immediately coping with a change in patterns to be imprinted on a substrate to a roll type high-temperature embossing technology.

Solution to Problem

- [14] An exemplary embodiment of the present invention provides an impact print type hot embossing apparatus, including: a substrate supply unit 10 that supplies a substrate 200; and an imprint unit 50 that performs an imprint process on the substrate 200, wherein the imprint unit 50 includes a print head 30 that applies an impact to the substrate 200.
- [15] The imprint unit 50 may heat the substrate 200 and may perform the heating by an electromagnetic induction heating method.
- [16] The print head 30 may apply the impact to the substrate 200 in a dot type or a line type.
- [17] The print head 30 may include several pins 31 that moves vertically and may vertically move at least one pin 31 to apply the impact to the substrate 200.
- [18] The print head 30 may include several fine pattern pins 34 and may vertically move at least one pattern pin to apply the impact to the substrate 200.
- [19] The print head 30 may include a line printer 30 that is rotatable by connecting to at least two pattern lines 35 corresponding to the width of the substrate 200 and may vertically move the pattern line 35 to apply the impact to the substrate.
- [20] The imprint unit 50 may include a heating support 21 that supports and heats one surface of the substrate 200 and the print head 30 may be provided at an opposite side of the heating support 21, having the substrate 200 therebetween.
- [21] The imprint unit 50 may further include a first rotating roll 71 that changes a moving angle of the substrate 200 supplied from the substrate supply part 10 and a second rotating roll 72 that changes the moving angle of the substrate 200 passing through the heating support 21 and the print head 30.
- [22] The imprint unit 50 may include a roll type heater 22 that changes the moving angle of the substrate 200 supplied from the substrate supply unit 10 and heats the substrate 200.
- [23] The print head 30 may be provided at a position facing a curved portion of the roll type heater 22 contacting the substrate 200.
- [24] The imprint unit 50 may further include the second rotating roll 72 that changes the moving angle of the substrate 200 passing through the roll type heater 22.
- [25] The pin 31 may be formed in at least any one of a circular shape, a rectangular shape, a probe shape, and a square shape.
- [26] A size of a front end of the pin 31 may be 100 nm to 90 μm .

[27] The imprint unit 50 may further include a controller.

Advantageous Effects of Invention

[28] According to exemplary embodiments of the present invention, even though the pattern forms to be imprinted on the substrate are changed, the immediately changed pattern forms can be imprinted through the print head controlled by the set program. Therefore, the stamp roll on which various pattern forms are imprinted is not needed, such that costs can be reduced and the time consumed to replace the stamp roll can be reduced, thereby improving the productivity.

Brief Description of Drawings

[29] FIG. 1 is a diagram schematically showing a hot press type high-temperature embossing process according to the related art.

[30] FIG. 2 is a diagram schematically showing a hot roll type high-temperature embossing process according to the related art.

[31] FIG. 3 is a conceptual diagram of an impact print type hot embossing apparatus according to an exemplary embodiment of the present invention.

[32] FIGS. 4 to 7 are diagrams showing an imprint unit according to another exemplary embodiment of the present invention.

[33] FIGS. 8 and 9 are diagrams showing a configuration and an operation of a print head according to an exemplary embodiment of the present invention.

[34] FIG. 10 is a diagram schematically showing a configuration of a print head according to another exemplary embodiment of the present invention.

[35] FIG. 11 is a diagram schematically showing a configuration and an operation of a print head according to yet another exemplary embodiment of the present invention.

[36] FIG. 12 is a diagram showing a substrate on which patterns are imprinted by using the impact print type hot embossing apparatus according to the exemplary embodiment of the present invention.

Mode for the Invention

[37] The present invention will be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the present invention. The drawings and description are to be regarded as illustrative in nature and not restrictive. Like reference numerals designate like elements throughout the specification.

[38] Referring to FIGS. 3 and 4, an impact print type hot embossing apparatus according to an exemplary embodiment of the present invention is an apparatus for performing an imprint process on a continuously supplied substrate 200.

- [39] That is, the impact print type hot embossing apparatus according to the exemplary embodiment of the present invention adopts a fine probe or a print head on which a fine shape is imprinted, unlike the existing roll to roll method. That is, the impact print type hot embossing apparatus according to the exemplary embodiment of the present invention is a method of collecting dot type patterns on a substrate 200 to form the desired patterns as a whole or forming patterns in a fine pattern line 35 corresponding to a width of the substrate 200 (see FIG. 11).
- [40] In detail, the impact print type hot embossing apparatus according to the exemplary embodiment of the present invention includes a substrate supply unit 10, an imprint unit 50, a substrate collection unit 60.
- [41] In this configuration, the substrate supply unit 10 consecutively supplies the substrate 200 to the imprint unit 50. That is, the substrate 200 wound in a roll type is supplied to the imprint unit 50 through the substrate supply unit 10. The substrate collection unit 60 may collect in the roll type the substrate 200 on which the patterns are imprinted by the imprint unit 50. However, the substrate supply unit 10 and the substrate collection unit 60 may be manufactured in several forms by a person with ordinary skill in the art and therefore, the more detailed description thereof will be omitted.
- [42] The imprint unit 50 heats the substrate 200 and applies the impact the heated substrate 200 in a dot type or a line type, thereby performing the imprint process. A method of heating the substrate 200 may be an electromagnetic induction heating method. Meanwhile, the imprint unit 50 may further include the controller that controls a heating operation of the substrate 200 and an operation of applying the impact to the substrate 200 in the dot type or the line type and may be configured as in the exemplary embodiment shown in FIGS. 4 to 7.
- [43] Hereinafter, a first exemplary embodiment to a fourth exemplary embodiment of the imprint unit 50 will be described.
- [44] < First Exemplary Embodiment of Imprint Unit 50 >
- [45] The imprint unit 50 shown in FIG. 4 includes a heating support 21 that supports and heats a bottom surface of the substrate 200 supplied from the substrate supply unit 10 and a print head 30 that performs an imprint process by applying the impact to the heated substrate 200 in the dot type or the line type.
- [46] The heating support 21 heats the bottom surface of the substrate 200 while flatly supporting the bottom surface of the substrate 200. That is, the heating support 21 heats the substrate 200 at a glass transition temperature or more while supporting the bottom surface of the substrate 200 passing through between the substrate supply unit 10 and the substrate collection unit 60.
- [47] The print head 30 applies in the dot type or the line type the impact to a top surface of the substrate 200 heated at the glass transition temperature or more through the

heating support 21 to perform the imprint process.

[48] <Second Exemplary Embodiment of Imprint Unit 50>

[49] The imprint unit 50 shown in FIG. 5 further includes a first rotating roll 71 and a second rotating roll 72 in addition to the components as described in the first exemplary embodiment.

[50] The first rotating roll 71 changes a moving angle of the substrate 200 supplied from the substrate supply unit 10 to the heating support 21. The second rotating roll 72 is a component to change the moving angle of the substrate 200 passing through the heating support 21 and the print head 30.

[51] The first rotating roll 71 and the second rotating roll 72 may apply a tension force to the substrate 200 between the first rotating roll 71 and the second rotating roll 72.

[52] <Third Exemplary Embodiment of Imprint Unit 50>

[53] The imprint unit 50 shown in FIG. 6 includes a roll type heater 22 and the print head 30.

[54] The roll type heater 22 changes the moving angle of the substrate 200 supplied from the substrate supply unit 10 and heats the substrate 200.

[55] The print head 30 is provided at a position facing a curved portion of the roll type heater 22 contacting the substrate 200.

[56] The print head 30 applies in the dot type or the line type the impact to the substrate 200 heated by the roll type heater 22 to perform the imprint process.

[57] <Fourth Exemplary Embodiment of Imprint Unit 50>

[58] The imprint unit 50 shown in FIG. 7 further includes the second rotating roll 72 in addition to the components as described in the third exemplary embodiment. The second rotating roll 72 changes the moving angle of the substrate 200 passing through the roll type heater 22.

[59] That is, the fourth exemplary embodiment adds the second rotating roll 72, such that the tension force applied to the substrate 200 is more improved than the third exemplary embodiment.

[60] Hereinafter, the first exemplary embodiment to the third exemplary embodiment of the print head 30 will be described.

[61] <First Exemplary Embodiment of Print Head 30>

[62] The print head 30 shown in FIGS. 8 and 9 includes several pins 31 that moves vertically and vertically moves at least one pin 31 to apply the impact to the substrate 200, thereby performing the imprint process.

[63] The shape of the pin 31 may be formed in at least any one or two of a circular shape, a rectangular shape, a probe shape, and a square shape.

[64] A size of a front end (front tip) of the pin 31 may be within the range of 100 nm to 90 μ m so as to perform the ultrafine shape processing of several hundreds of nm to several

tens of μm on the substrate 200.

[65] The print head 30 configured as described above transfers the fine dot forms on the top surface of the substrate 200 several times and the dot forms are collected, thereby forming the overall pattern shape.

[66] Meanwhile, several pins 31 may be arranged on the print head 30 in the rectangular shape.

[67] Meanwhile, when the first exemplary embodiment includes the controller, the controller controls the pin 31 according to a set program on whether the pin 31 at any position moves vertically or at least two pins 31 at any position move vertically.

[68] Reference numeral 207 that is not explained in FIG. 9 is a dot formed by the pin 31. When the dot 207 is collected, the patterns such as A of FIG. 12 are formed.

[69] <Second Exemplary Embodiment of Print Head 30>

[70] The print head 30 shown in FIG. 10 includes several fine pattern pins 34 and vertically moves at least one fine pattern pin 34 to apply the impact to the substrate 200, thereby performing the imprint process. As shown in FIG. 10, the pattern pin 34 may be formed in various types TYPE1, TYPE2, ..., TYPE n and may be formed by a combination thereof.

[71] The case of the first exemplary embodiment, has the front end shape of the print head of the geometrically simplest type (dot, circle) and performs a stamping by combining more complex shape (for example, $\sqcap$ -letter shape, $\sqsubset$ -letter shape, or the like) using the same.

[72] On the other hand, in the case of the second exemplary embodiment, the complex shape may be more rapidly formed by previously imprinting the desired complex shape on the print head.

[73] As a result, using the print head 30 according to the second exemplary embodiment more improves the working speed than using the print head 30 according to the first exemplary embodiment.

[74] Meanwhile, when the second exemplary embodiment includes the controller, the controller controls the pin 34 according to a set program on whether the pattern pin 34 at any position moves vertically or at least two pattern pins 34 at any position move vertically.

[75] <Third Exemplary Embodiment of Print Head 30>

[76] The print head 30 shown in FIG. 11 includes a line printer 30 that is rotatable by continuously connecting at least two fine pattern lines 35 corresponding to the width of the substrate 200 and vertically moves the fine pattern line 35 to apply the impact to the substrate, thereby performing the imprint process. As a result, the fine patterns may be transferred to a predetermined width of the substrate 200 at a time.

[77] As described above, several line printers 39 of the print head 30 may be provided as

needed when the patterns are formed on the substrate 200.

- [78] In this case, the print head 30 according to the third exemplary embodiment may remarkably improve the working speed as compared to the print head 30 according to the second exemplary embodiment.
- [79] A length L1 of the pattern line 35 may be equal to or shorter than a width L2 of the substrate 200.
- [80] Meanwhile, when the third exemplary embodiment includes the controller, the controller controls the line printer 30 according to the set program on whether any pattern line 35 moves vertically.
- [81] When each exemplary embodiment described above includes the controller, the controller controls the heating temperature of the heating support 21 or the roll type heater 22.
- [82] While this invention has been described in connection with what is presently considered to be practical exemplary embodiments, those skilled in the art can easily practice various changes and modifications without departing from the substantial features of the present invention. Therefore, it is to be construed that the exemplary embodiments disclosed herein are to be considered as descriptive aspects rather than restrictive aspects and the true scope of the present invention is defined in claims rather than in the above description and all differences in the scope equivalent thereto are included in the present invention.

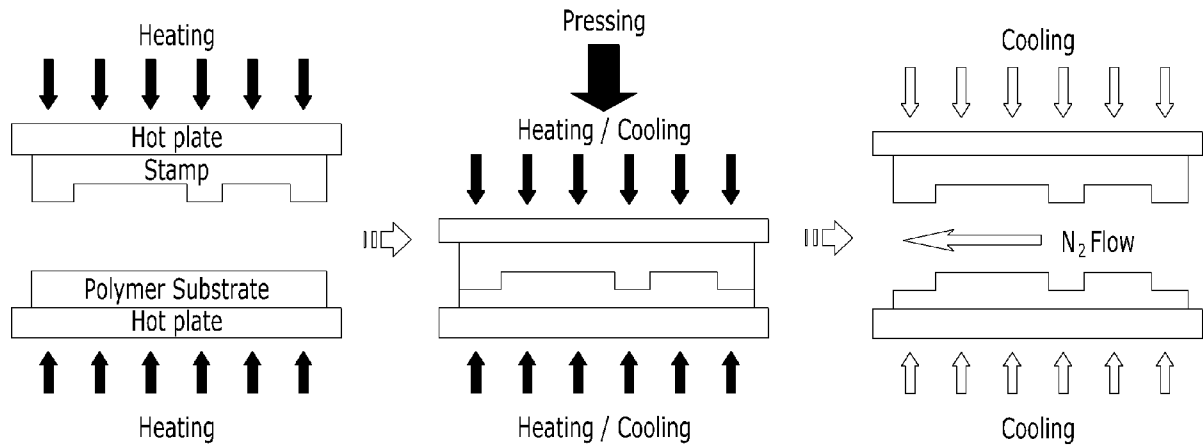
Claims

- [Claim 1] An impact print type hot embossing apparatus, comprising:
a substrate supply unit 10 that supplies a substrate 200; and
an imprint unit 50 that performs an imprint process on the substrate 200,
wherein the imprint unit 50 includes a print head 30 that applies an impact to the substrate 200.
- [Claim 2] The impact print type hot embossing apparatus of claim 1, wherein:
the imprint unit 50 heats the substrate 200.
- [Claim 3] The impact print type hot embossing apparatus of claim 2, wherein:
the imprint unit heats the substrate 200 by an electromagnetic induction heating method.
- [Claim 4] The impact print type hot embossing apparatus of claim 1, wherein:
the print head 30 applies the impact to the substrate 200 in a dot type or a line type.
- [Claim 5] The impact print type hot embossing apparatus of any one of claim 1 to claim 4, wherein:
the print head 30 includes
several pins 31 that moves vertically and
vertically moves at least one pin 31 to apply the impact to the substrate 200.
- [Claim 6] The impact print type hot embossing apparatus of any one of claim 1 to claim 4, wherein:
the print head 30 includes
several fine pattern pins 34 and
vertically moves at least one pattern pin 34 to apply the impact to the substrate 200.
- [Claim 7] The impact print type hot embossing apparatus of any one of claim 1 to claim 4, wherein:
the print head 30 includes
a line printer 30 that is rotatable by connecting at least two pattern lines 35 corresponding to the width of the substrate 200 and
vertically moves the pattern line 35 to apply the impact to the substrate.
- [Claim 8] The impact print type hot embossing apparatus of claim 1, wherein:
the imprint unit 50 includes a heating support 21 that supports and heats one surface of the substrate 200 and
the print head 30 is provided at an opposite side of the heating support

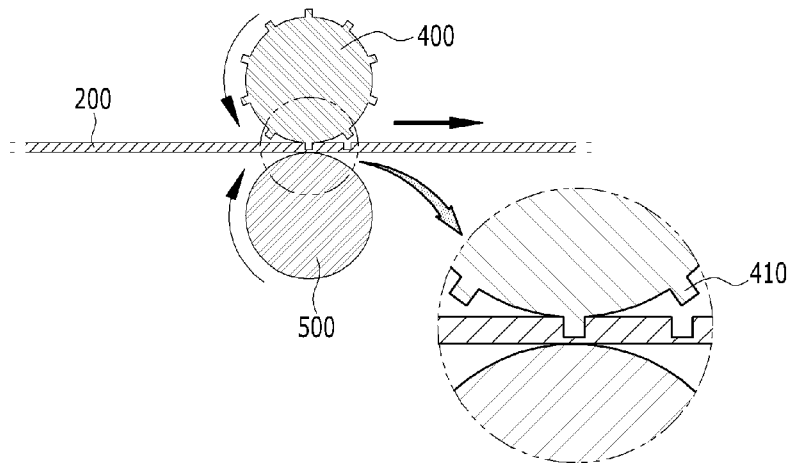
21, having the substrate 200 therebetween.

- [Claim 9] The impact print type hot embossing apparatus of claim 8, wherein:
the imprint unit 50 further includes
a first rotating roll 71 that changes a moving angle of the substrate 200
supplied from the substrate supply part 10 and
a second rotating roll 72 that changes the moving angle of the substrate
200 passing through the heating support 21 and the print head 30.
- [Claim 10] The impact print type hot embossing apparatus of claim 1, wherein:
the imprint unit 50 includes
a roll type heater 22 that changes the moving angle of the substrate 200
supplied from the substrate supply unit 10 and heats the substrate 200.
- [Claim 11] The impact print type hot embossing apparatus of claim 10, wherein:
the print head 30 is provided at a position facing a curved portion of the
roll type heater 22 contacting the substrate 200.
- [Claim 12] The impact print type hot embossing apparatus of claim 10, wherein:
the imprint unit 50 further includes
the second rotating roll 72 that changes the moving angle of the
substrate 200 passing through the roll type heater 22.
- [Claim 13] The impact print type hot embossing apparatus of claim 5, wherein:
the pin 31 is formed in at least any one of a circular shape, a
rectangular shape, a probe shape, and a square shape.
- [Claim 14] The impact print type hot embossing apparatus of claim 13, wherein:
a size of a front end of the pin 31 is in the range of 100 nm to 90 μm .
- [Claim 15] The impact print type hot embossing apparatus of claim 1, wherein:
the imprint unit 50 further includes
a controller.

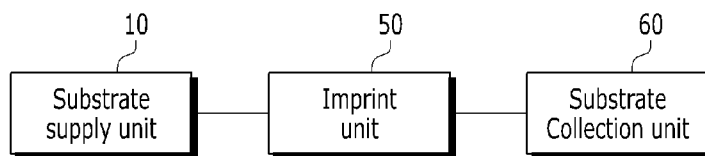
[Fig. 1]



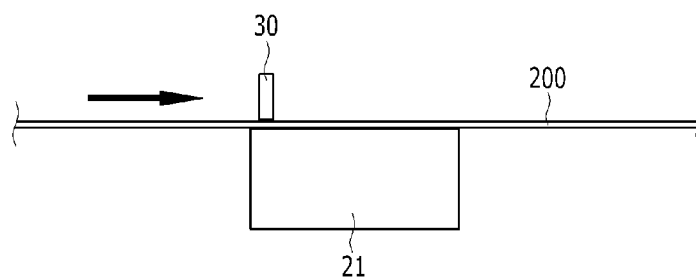
[Fig. 2]



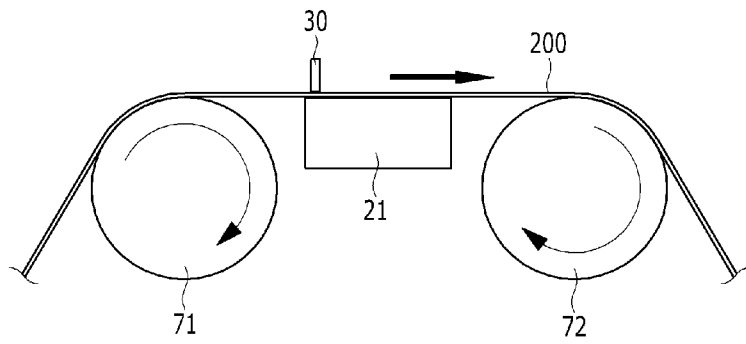
[Fig. 3]



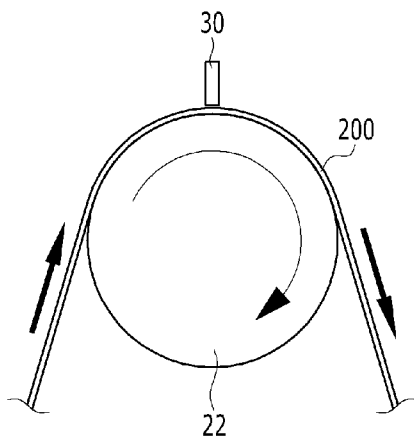
[Fig. 4]



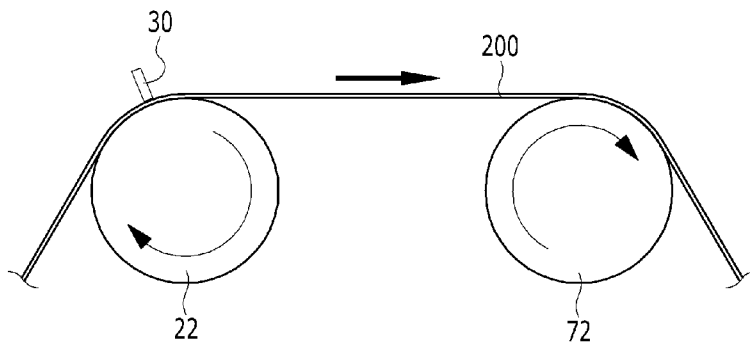
[Fig. 5]



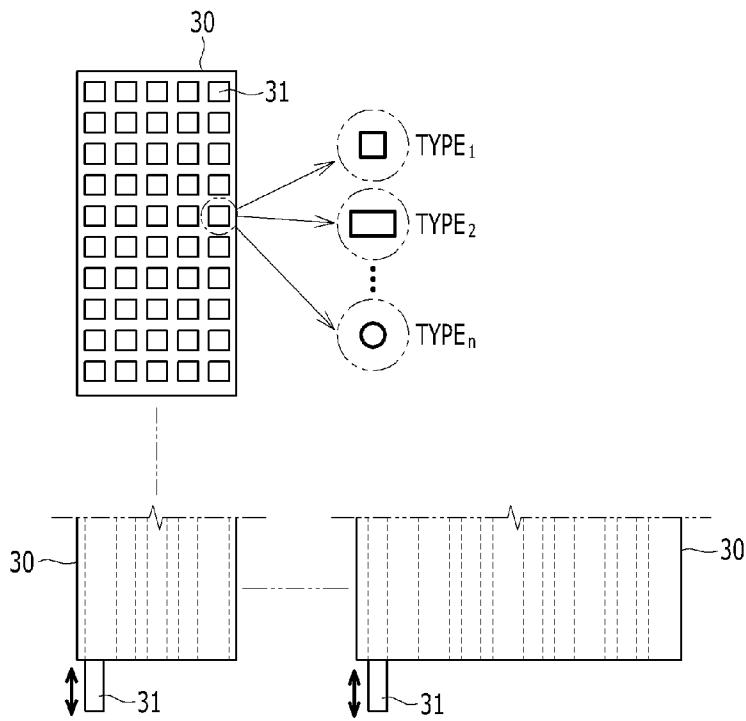
[Fig. 6]



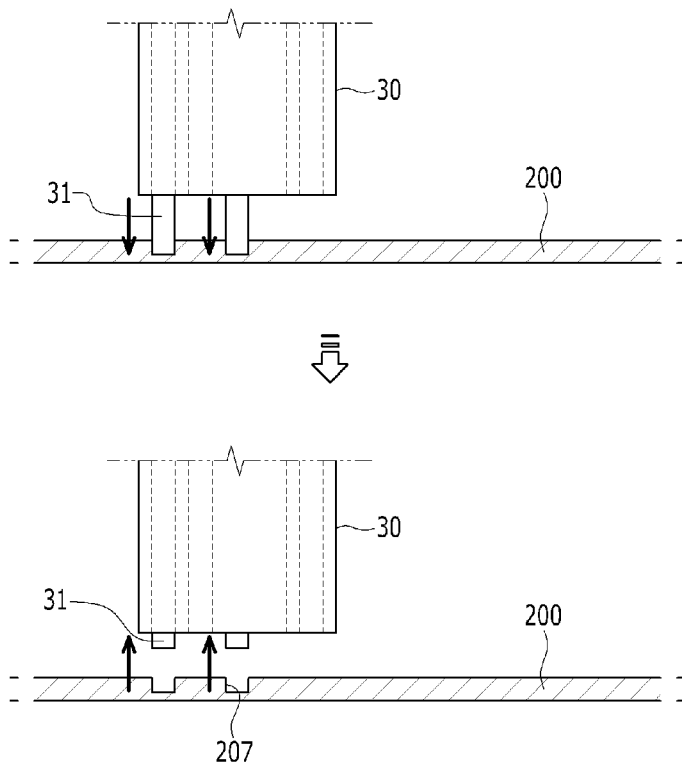
[Fig. 7]



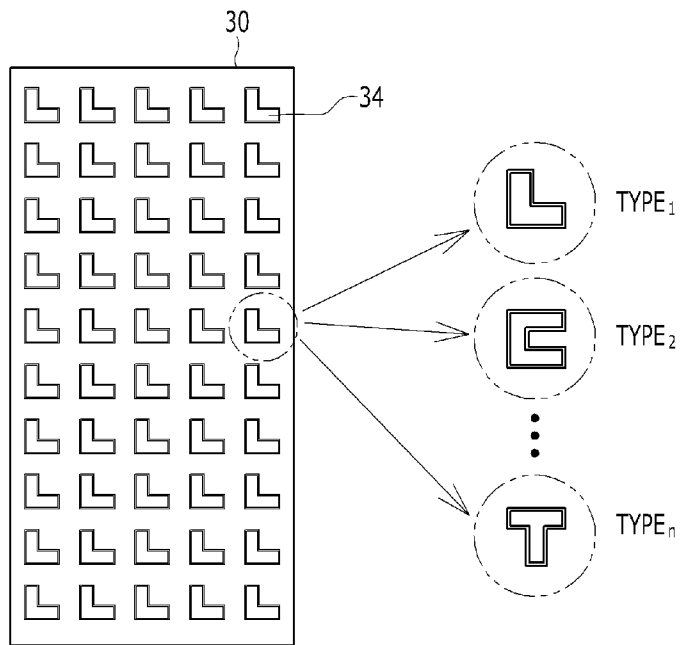
[Fig. 8]



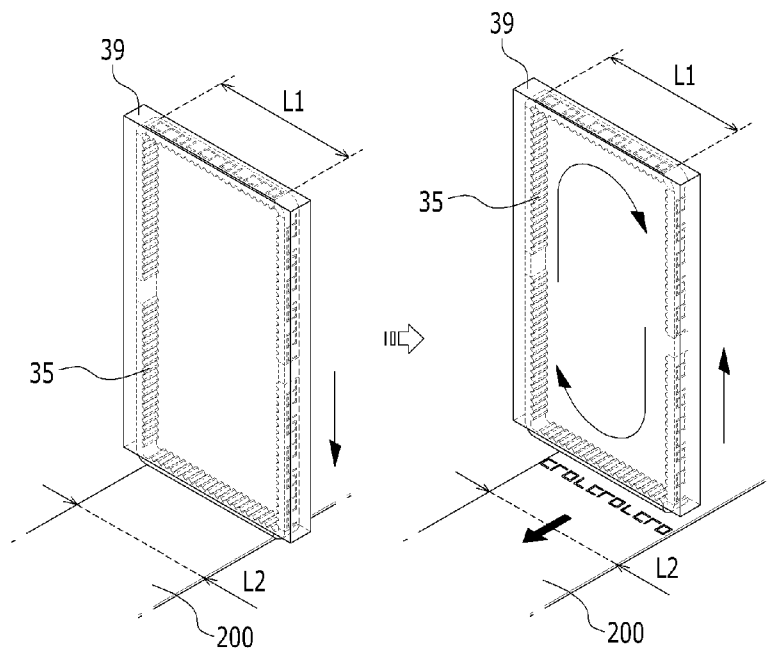
[Fig. 9]



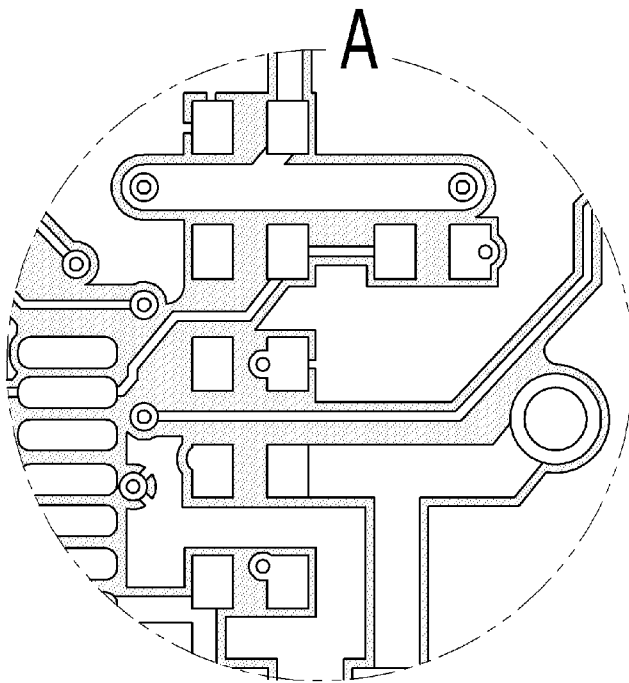
[Fig. 10]



[Fig. 11]



[Fig. 12]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2011/005297**A. CLASSIFICATION OF SUBJECT MATTER*****B41F 19/02(2006.01)i, B41M 1/24(2006.01)i, B41J 3/38(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)

B41F 19/02; H01L 21/027; B82Y 40/00; H05K 3/00; H05K 1/02; B29C 59/02

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: impact, print, embossing, hot, imprint, dot, heat, pin

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	KR 10-0761212 B1 (Korea Institute of Machinery & Materials, et al.) See the abstract, paragraphs 29-34, 91; claims 1-11 and figures 1-5.	1-4,7,8,10,11,15 9,12 5,6,13,14
Y	KR 10-2009-0120136 A (SAMSUNG ELECTRO-MECHANICS CO., LTD.) 24 November 2009 See the abstract, paragraphs 20-26; claims 1-4 and figures 1,2.	9,12
A	KR 10-2008-0106261 A (MICRONIC LASER SYSTEMS AB) 04 December 2008 See the whole document.	1-15
A	US 2009-0272564 A1 (YOSHIOKA SHINGO et al.) 05 November 2009 See the whole document.	1-15

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

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