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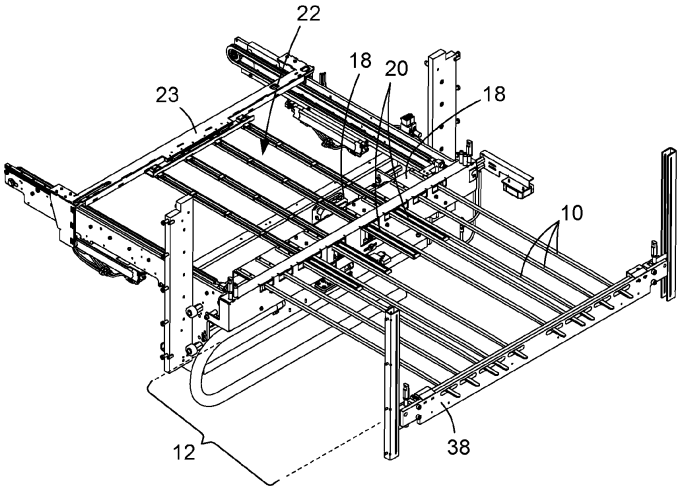
(54) DEVICE AND METHOD FOR CHANGING A STACK OF SHEETS IN A SHEET FEEDER

(57) The invention refers to a device for changing a stack of sheets in a sheet feeder (2) for a converting machine (1) that can be operated without interruptions. The device can change a stack of sheets while consuming a residual stack of sheets. The residual stack of sheets is held by a non-stop device (16) made of a set of holding bars. The device has an additional stabilizing device (22) that cooperates with the holding bars to prevent the sheet from getting damaged when merging two stacks of sheets into a single one. The stabilizing device uses a set of inflatable bars (20), which are easy to handle and result in a robust and efficient solution to the changing of the stack of sheets.

Fig. 4



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Description

[0001] The invention refers to a device for changing a stack of sheets in a sheet feeder for a sheet-converting machine that can be operated without interruptions.

[0002] The machine comprises a main supporting unit with an actuating unit for lifting and lowering the main supporting unit. The main supporting unit has a supporting surface to support a pallet carrying a stack of sheets. The sheet feeder also has a residual stack supporting unit with an actuating unit for lifting and lowering the residual stack supporting unit. Having a residual stack in addition to another pile allows the feeder to work without interruptions. The residual stack supporting unit comprises a plurality of residual stack bars extending substantially parallel to each other, substantially parallel to the supporting surface and substantially horizontally. the residual stack bars are coupled to an actuating unit for deploying the residual stack bars into a sheets region and retracting the residual stack bars from said region. The residual stack bars are arranged in the related supporting unit in a rake-like manner such that they can be deployed in respective slots of the pallet. Said pallet sits on the main supporting unit when the residual stack bars are deployed in the sheet region.

[0003] Sheet converting machines in the sense of the present patent application are for example sheet cutting machines, sheet creasing machines or sheet printing machines.

[0004] In general, sheet-converting machines can be adapted to any kind of sheet material. Examples thereof are paper, cardboard, plastics, metal, composite materials, and leather.

[0005] The rake-like arrangement of the residual stack bars means that a plurality of residual stack bars extends in a substantially parallel manner from a common basis. Thereby, one end of each residual stack bar is connected to this common basis, wherein a respective opposite end freely protrudes therefrom. Other words designating this arrangement are "fork-like" or "grid". In the present patent application, these terms are seen as synonyms.

[0006] Additionally, the invention is related to a method for changing a stack of sheets without having to stop the machine. The method follows the following steps:

- detecting when a given percentage of the stack of sheets has been processed by sensing when the bottom of the stack of sheets has reached a predefined height,
- deploying a plurality of residual stack bars into respective slots of the pallet supporting the stack of sheets, so that the stack of sheets is now supported by the bars.
- bringing down the main supporting unit, and exchanging the pallet with a replacement pallet carrying a replacement stack of sheets,
- raising the replacement stack of sheets until reaching the residual stack bars,
- retracting the residual stack bars such that the two stacks of sheets merge into a single stack.

[0007] Such devices and methods are known in the art. For example, EP 0 958 215 B1 discloses a device as described above, which can be used to carry out a method as described above.

[0008] In known devices for changing a stack of sheets the movement of the main supporting unit is usually synchronized to the sheets being taken from the stack. This means that the main supporting unit is raised by a distance corresponding to a thickness of a sheet each time a sheet is taken from the stack of sheets. As a result, such a device for changing a stack of sheets allows changing a stack of sheets without having to interrupt the flow of sheets being fed from the sheet feeder to the converting machine. Consequently, the converting machine can be operated non-stop.

[0009] It has always been a challenge to perform the last step of the above-mentioned method, namely the retracting of the residual stack bars without damaging the bottommost sheet the stack of sheets or the topmost sheet of the replacement stack of sheets.

[0010] EP 3 924 281 B1 discloses a method where the residual stack bars may be retracted individually, resulting in a complex system. WO2021122109 discloses a method where the residual stack bars are retracted using an oscillating motion, thereby generating vibrations in the whole converting machine.

[0011] It is therefore an objective of this invention to provide a device for changing a stack of sheets in a sheet feeder which is simple to build and prevents damaging the sheets when merging two stacks of sheets.

[0012] The invention is described in claim 1 and in the following claims. In particular, the invention adds, to a device for changing a stack of sheets described in the introductory part of this disclosure, a stabilizing unit with a stabilizing bar actuating unit adapted to deploy and retract at least one stabilizing bar into and from the feeder region, where stacks of sheets are operated. The stabilizing bar is deployed between the residual stack bars and are substantially parallel to the supporting surface. The stabilizing unit comprises a hindering actuating unit configured to change the thickness of the stabilizing bar from a sliding configuration to a hindering configuration and vice-versa. The thickness is measured along the lifting direction of the main supporting unit. The stabilizing unit prevents damage to the sheets when the residual stack bars are retracted. While the system may work with one stabilizing bar, it is preferred to use two to four stabilizing bars.

[0013] The invention is also about a method for changing a stack of sheets in a sheet feeder for a sheet converting machine, comprising the following steps:

sensing when the bottom of the stack of sheets has reached a predefined height, while the stack of sheets is positioned on a pallet placed on a primary

support unit,

providing support to the stack of sheets using a residual stack supporting unit, where multiple residual stack bars are inserted into corresponding slots on the pallet, then,

replacing the pallet with a replacement pallet carrying a replacement stack of sheets on the main supporting unit,

deploying at least one, but preferably several stabilizing bars in-between the residual stack bars,

elevating the replacement stack of sheets until it touches the residual stack bars, thereby engaging the residual stack bars between the bottommost sheet of the stack of sheets and the topmost sheet of the replacement stack of sheets.

setting the stabilizing bars into hindering configuration using the hindering actuating unit, then

retracting the residual stack bars from the feeder region such that at least part of the stack of sheets is supported on the replacement stack of sheets,

retracting the stabilizing bars when part of the stack of sheets is supported on the replacement stack of sheets, thereby merging the stack of sheets and the replacement stack of sheets into a single stack of sheets.

Brief description of the figures

[0014] Embodiments of the present invention are illustrated by way of example in the accompanying drawings in which reference numbers indicate the same or similar elements and in which:

- Figure 1 shows an example of converting machine with the device for changing the stack of sheets according to the invention,
- Figure 2 show an example of residual stacks bars and stabilizing bars in a feeder region,
- Figure 3 shows an example of a residual stack bars unit and a stabilizing unit in a retracted configuration,
- Figure 4 shows the example of a residual stack bars unit and a stabilizing unit of Figure in a deployed configuration,
- Figure 5 show a pallet with slots,
- Figure 6 shows an example of an inflatable stabilizing bar,
- Figure 7 shows another example of stabilizing bar,
- Figure 8 shows another example of stabilizing bar,
- Figure 9 A to F shows how the residual stack bars and the stabilizing bars interact when merging a replacement stack with the residual stack.

Detailed description of the invention and of some of its embodiments

[0015] Figure 1 shows a converting machine 1 with a sheet feeder 2. The sheet feeder 2 comprises a device 3 for changing a stack of sheets 4 in the sheet feeder 2. The device has a main supporting unit with a main stack actuating unit for lifting and lowering the main stack 4 by lifting or lowering the main supporting unit. The main supporting unit comprises a supporting surface 5 able to support a pallet 6 carrying a stack of sheets. The device also has a residual stack supporting unit 16 with a residual stack actuating unit for lifting and lowering a second stack of sheets by lifting and lowering the residual stack supporting unit 16. The second stack is a stack of sheets that has been partly consumed, where the supporting pallet 6 was removed to go fetch the next, replacement stack to be processed.

[0016] The residual stack supporting unit 16 comprises a plurality of residual stack bars extending substantially parallel to each other and being substantially parallel to the supporting surface 5, i.e., being substantially horizontal.

[0017] The residual stack bars 10 are coupled to a bar actuating unit 18 able to move the residual stack bars 10 into the feeder region 12 and retract the residual stack bars 10 from the feeder region 12, usually under the feed table 14 of the converting machine 1. The feeder region 12 is defined as the space in the feeder of the machine where the stacks of sheets are loaded and/or lifted.

[0018] As shown in Figures 3 and 4, the residual stack bars 10 are arranged in the residual stack supporting unit 16 in a rake-like manner such that they can be positioned in respective slots 40 of a pallet 6 being supported on the main supporting unit when the residual stack bars 10 are in the feeder region 12.

[0019] The device also has a stabilizing unit 22 with a stabilizing bar actuating unit 23 for deploying at least one, but preferably several stabilizing bars into the feeder region 12 and retracting them from the feeder region 12.

[0020] The stabilizing bars 20 are moved into the feeder region 12 in-between the residual stack bars 10. They have the function of stabilizing the residual stack (i.e. the upper stack) and/or the replacement stack (i.e. the lower stack) to allow the residual stack supporting bars to retract without dragging the lowest sheet of the upper stack or the top sheet of the lower stack with them. The damages to the sheet occur when one of these sheets is dragged with the bars when the bar retracts. A damaged sheet may cause a machine jam and an interruption of the

production process.

[0021] In this disclosure we refer to the upper stack of sheets as the *residual stack of sheets 8,* the *second stack of sheets* or simply the *stack of sheets.* We refer to the lower stack of sheets as the *replacement stack of sheets* 4 or sometimes as *the main stack of sheets.*

[0022] One way of moving the stabilizing bars 20 in between the residual stack bars 10 is by ensuring that the stabilizing bars 20 are thinner than the residual stack bars 10 and located in the same horizontal space/plane. Thus, said bars can be freely introduced between the residual stack of sheets 8 and the replacement stack of sheets 4 without touching the sheets.

[0023] Another way of introducing the stabilizing bars 20 is to insert them into the feeder region 12 at a lower height than the residual stack bars 10 when there is enough space between the residual stack and the replacement stack of sheets 4, and then raising the stabilizing bars 20 to the height of the residual stack bars 10. By doing so, the stabilizing bars 20 do not need to be thinner than the residual stack bars 10 in the introductory step of the method.

[0024] The stabilizing unit 22 comprises a hindering actuating unit 24. It is configured to set the thickness of the stabilizing bars 20 from a sliding/thin configuration to a hindering/thick configuration and vice-versa. The thickness is measured along the lifting direction of the main supporting unit, in other words, we measure the thickness along a vertical direction.

[0025] For example, in Figure 4, the bars have an inflatable part driven by a piston. The piston 58 can push compressed air in the inflatable part thereby increasing the thickness of the stabilizing bars 20.

[0026] Another example is shown in Figure 5, where the bars are made of two parts 61, 62 with an inclined surface 60 between them. When shifting the upper part of the stabilizing bar relative to the lower part, the bar can be made thicker or thinner. In this example, the hindering actuating device is a device that moves the upper part of the stabilizing bar relative to the lower one, for example, using a rotation screw and a motor.

[0027] Another example is shown in Figure 6, where the stabilizing bars 20 comprise two surfaces separated by inclined, flexible, blades. Similarly to the former example, the thickness of the stabilizing bars 20 can be varied by moving the upper surface relative to the lower surface of the bar.

[0028] The inflatable bar is currently the preferred solution because inflating the bar does not induce any horizontal motion and is simpler to implement.

[0029] To ensure a continuous operation, the sheet feeder 2 works as follows: The stack of sheets is supported on a pallet 6 arranged on a main supporting unit. Once the bottom of the stack has reached a given height a substantial part of the stack of sheets is consumed and the machine starts replacing the stack by a new one. Thus, once a predefined height is reached, a plurality of residual stack bars is pushed into the respective slots of the pallet 6 supporting the stack of sheets. The bars are part of a residual stack supporting unit 16. The pallet 6 is moved away, and thus the stack of sheets is (solely) supported by the residual stack bars 10.

[0030] Then, the pallet 6 is withdrawn and replaced by a new one carrying a replacement stack of sheets 4. The new pallet 6 is placed on the main supporting unit. A plurality of stabilizing bars is introduced between the residual stack bars 10. The replacement stack of sheets 4 is raised until it touches the residual stack bars 10, such that the residual stack bars 10 are engaged between the bottommost sheet of the residual stack of sheets 8 and the topmost sheet of the replacement stack of sheets 4. The stabilizing bars 20 are made thicker, i.e., set into hindering configuration using the hindering actuating unit 24. This configuration reduces the contact forces between the residual stack bars 10 and the sheets in contact with said bars. It also induces friction forces between the stabilizing bars 20 and said uppermost and lowermost sheets of the stacks, which contributes to keeping said sheets in place.

[0031] Then, the device retracts the residual stack bars 10 from a feeder region 12 such that the residual stack of sheets 8 is at least partly supported by the replacement stack of sheets 4. Finally, the device retract the stabilizing bars 20, thereby merging the two stacks into a single one. The retractation of the stabilizing bars 20 may be performed after the retractation of the residual stack bars 10 or may overlap timewise. Nevertheless, the retractation of the residual stack bars 10 starts first. The retractation of the stabilizing bars 20 may start once the two stacks are partially merged. The merge of the two stacks induces a friction force that prevents the sheets from following the retractation path of the bars. Preferably, the stabilizing bars 20 are set into a sliding configuration before retracting them. Also, preferably, the stabilizing bars 20 are removed approximately at the same time as the end sections of the residual stack bars 10. In other words, once the end sections of the residual stack bars 10 approach the end section of the stabilizing bars 20, the stabilizing bars 20 are set into sliding configuration and are retracted along with the end sections of the residual stack bars 10.

[0032] The stabilizing bars 20 have a length 32 which is a fraction of the length 30 of the residual stack bars 10. For example, 1/3 of the length. We could also make them half the length, a quarter of the length or 20% of the length. The reduced length of the stabilizing bars 20 allows for the stacks to merge while the stabilizing bars 20 are fully deployed, as shown in Figures 9a through 9f. In Figures 9a through 9f, the thickness of the bars is exaggerated compared to the size of the sheets to better illustrate the method.

[0033] Figure 9a shows the residual stack of sheets 8 and the replacement stack of sheets 4 in contact with fully deployed residual stack bars, with a stabilizing bar in sliding configuration (and also fully deployed). In Figure 9b, the stabilizing bars 20 are made thicker than the

residual stack bars 10. Thus, the stabilizing bars 20 reduce the contact forces between the stack of sheets and the residual stack bars 10. In Figures 9c and 9d, the residual stack bars 10 are being retracted, thus creating a region where the replacement stack and the residual stack of sheets 8 join. In Figure 9d, the end sections of the residual stack bars 10 approach the end section of the stabilizing bars 20. Thus, at this approximate moment, the stabilizing bars 20 are made thinner. In Figure 9e, the stabilizing bars 20 start to retract along with the residual stack bars 10, until Figure 9f where the two stacks of sheets are merged. Please note that if the stabilizing bars 20 are removed along with the residual stack bars 10 while in the sliding state 52, the stabilizing bars 20 are not in contact with the sheets while retracting, thanks to their smaller thickness.

[0034] The stabilizing bars 20, when in hindering state 50, must protrude from the plane formed by the residual stack bars 10, either on the top side, on the bottom side, or on both sides as shown in Figure 9. Protruding from the top side prevents the bottommost sheet from the residual stack from being damaged. Protruding from the bottom side prevents the topmost sheet of the replacement stack to be damaged. This can be achieved by having the stabilizing bars 20 in a sliding configuration thinner than the residual stack bars 10 and having the stabilizing bars 20 in the hindering configuration thicker than the residual stack bars 10.

[0035] An example of a stabilizing bar is shown in Figure 6. The bar is made of a metal frame 54, for example made of steel or aluminum, and a flexible membrane 56, for example made of rubber. A Stabilizing bar actuating unit 23, for example a piston 58, injects compressed air into the bar and inflates the flexible surface, thereby increasing the thickness of the bar, and setting the bar into the hindering configuration. By releasing the air pressure, the bar gets back into the sliding configuration.

[0036] Preferably, the surface of the top or bottom surface of the stabilizing bars 20 exhibit, when in hindering state 50, a higher friction coefficient with paper or cardboard than the residual stack bars 10. By top and bottom surfaces, we mean the surfaces that may be in contact with the sheets.

[0037] Also, preferably, the surface of the top or bottom side of the stabilizing bars 20 exhibits, when in hindering state 50, a higher friction coefficient with paper or cardboard than the surface of the stabilizing bars 20, which is in contact with the sheets when in a sliding state 52. This can be done, for example, by using the inflatable bar with a rubber or plastic membrane, and ensuring that the membrane gets in contact with the surface of the sheet in hindering (inflated) state, while the metal of the frame gets in contact with the sheet in deflated, sliding state 52.

[0038] As an alternative to the inflatable bars, a stabilizing bar may have two sliding parts with an inclined surface 60. By configuring the Stabilizing bar actuating unit 23 to slide one of the parts over the other along the length of the bar, we obtain a bar with a varying thickness, as shown in Figure 7. The Stabilizing bar actuating unit 23 may be made of a screw and a motor or made of a pneumatic actuator. Also, a frame can be added, made of a material with a lower friction coefficient than the sliding parts (for example metal), so that the sliding parts are in contact with the sheets in hindering state 50, while the frame is in contact with the sheets in sliding state 52.

[0039] As a further alternative to the inflatable bar, a stabilizing bar may have two parts 61, 62 connected by inclined flexible blades 64, as shown in Figure 8. By configuring the Stabilizing bar actuating unit 23 to slide one of the parts over the other along the length of the bar, we obtain a bar with a varying thickness. The Stabilizing bar actuating unit 23 may be made of a screw and a motor or made of a pneumatic actuator. A similar frame with a lower friction coefficient can also be added to this alternative.

[0040] For making the residual stack supporting unit 16 sturdy, end sections of the residual stack bars 10 facing away from the bar actuating unit 18 may be supported on a second supporting bar 38, when the residual stack bars 10 are fully deployed.

Claims

1. Device for changing a stack of sheets in a sheet feeder (2) for a sheet converting machine (1), comprising

- a main supporting unit with a main stack actuating unit for lifting and lowering the main supporting unit, wherein the main supporting unit comprises a supporting surface (5) adapted to support a pallet (6) carrying a stack of sheets (4),
- a residual stack supporting unit (16) with a residual stack actuating unit for lifting and lowering the residual stack supporting unit (16),

  - wherein the residual stack supporting unit (16) comprises a plurality of residual stack bars extending substantially parallel to each other and being substantially parallel to the supporting surface,
  - wherein the residual stack bars (10) are coupled to a bar actuating unit (18) configured to deploy the residual stack bars (10) into a feeder region (12) and retract the residual stack bars (10) from said region,
  - wherein the residual stack bars (10) are arranged in the residual stack supporting unit (16) in a rake-like manner such that they can be deployed into respective slots of the pallet (6) carrying the stack of sheets,

characterized in that it further comprises

- a stabilizing unit (22) with a stabilizing bar actuating unit (23) adapted to deploy at least one stabilizing bar into the feeder region (12) and retract the stabilizing bar (20) from said region,
- wherein the stabilizing bar (20) is deployed between the residual stack bars (10) and is substantially parallel to the supporting surface,
- wherein the stabilizing unit (22) comprises a hindering actuating unit (24) configured to change the thickness of the stabilizing bar (20) from a sliding configuration to a hindering configuration and vice-versa, the thickness being measured along the lifting direction of the main supporting unit.

2. Device according to claim 1, wherein the stabilizing bar (20) has a length which is a fraction of the length of the residual stack bars (10) when fully deployed.

3. Device according to any of the preceding claims, wherein the stabilizing bar (20) in the sliding configuration is thinner than the residual stack bars (10).

4. Device according to any of the preceding claims, wherein the stabilizing bar (20) in the hindering configuration is thicker than the residual stack bars (10).

5. Device according to any of the preceding claims, wherein the top and bottom surfaces of the stabilizing bar (20) in the hindering configuration have a higher friction coefficient with paper or cardboard than the top and bottom surfaces of the residual stack bars (10).

6. Device according to any of the preceding claims, wherein the top and bottom surfaces of the stabilizing bar (20) in the hindering configuration have a higher friction coefficient with paper or cardboard than the top and bottom surfaces of the stabilizing bar (20) in the sliding configuration.

7. Device according to any of the preceding claims, wherein the stabilizing bar comprises an inflatable surface.

8. Device according to any of the preceding claims, further comprising a source of compressed gas for inflating or deflating the stabilizing bar (20).

9. Device according to any of the preceding claims, wherein the stabilizing bar comprises two cooperating inclined surfaces (60) for changing the thickness of the stabilizing bar (20).

10. Device according to any of the preceding claims, wherein the stabilizing bar comprises two surfaces separated by at least two inclined flexible blades (64) for changing the thickness of the stabilizing bar (20).

11. Device according to any of the preceding claims, **characterized in that** the end sections of the residual stack bars (10) facing away from the bar actuating unit (18) are supported on a second supporting bar (38) when fully deployed.

12. Method for changing a stack of sheets in a sheet feeder (2) for a sheet converting machine (1), comprising the following steps:

a) sensing when the bottom of the stack of sheets (8) has reached a predefined height, while the stack of sheets (8) is positioned on a pallet (6) placed on a primary support unit,
b) providing support to the stack of sheets (8) using a residual stack supporting unit (16), where multiple residual stack bars are inserted into corresponding slots on the pallet (6), then,
c) replacing the pallet (6) with a replacement pallet (6) carrying a replacement stack of sheets (4) on the main supporting unit,
d) deploying at least one stabilizing bar in-between the residual stack bars (10),
e) elevating the replacement stack of sheets (4) until it touches the residual stack bars (10), thereby engaging the residual stack bars (10) between the bottommost sheet of the stack of sheets (8) and the topmost sheet of the replacement stack of sheets (4).
f) setting the stabilizing bar (20) into hindering configuration using the hindering actuating unit (24), then
g) retracting the residual stack bars (10) from the feeder region (12) such that at least part of the stack of sheets (8) is supported on the replacement stack of sheets (4),
h) retracting the stabilizing bar (20) when part of the stack of sheets (8) is supported on the replacement stack of sheets (4), thereby merging the stack of sheets (8) and the replacement stack of sheets (4) into a single stack of sheets.

Fig. 1

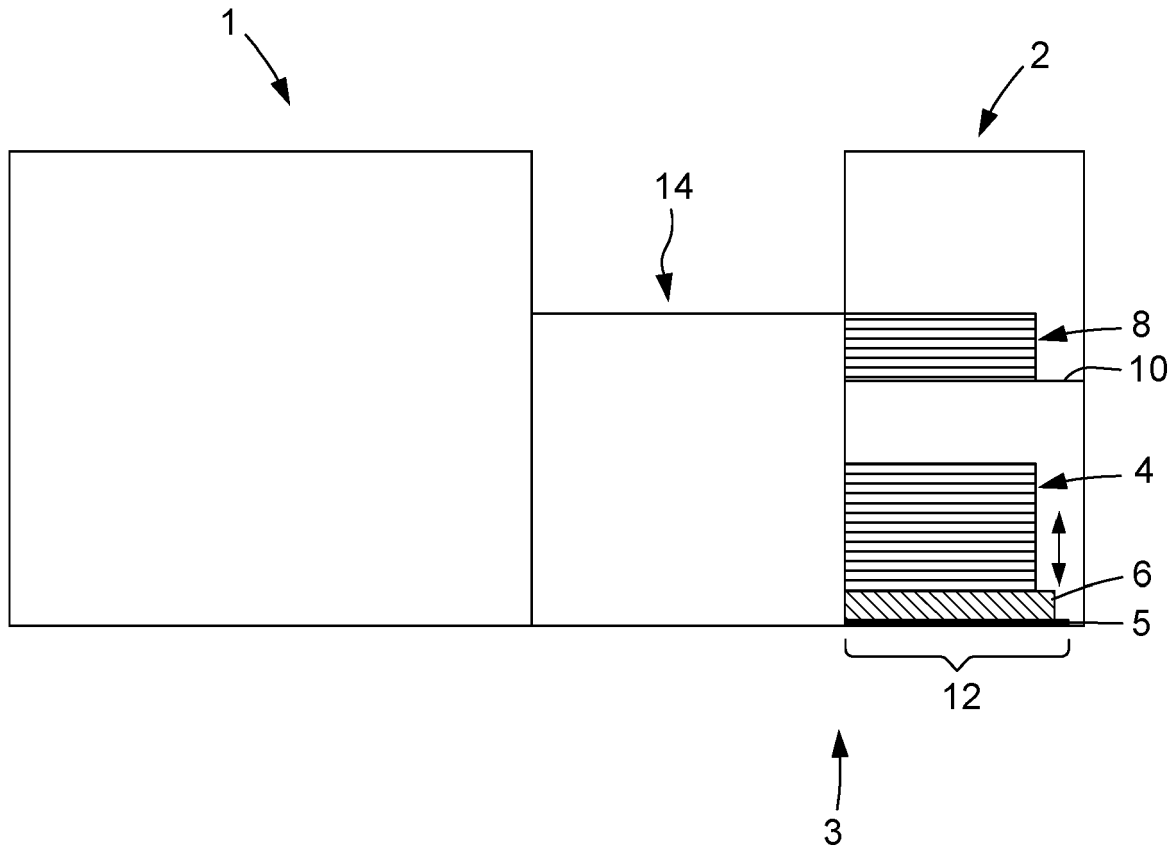


Fig. 2

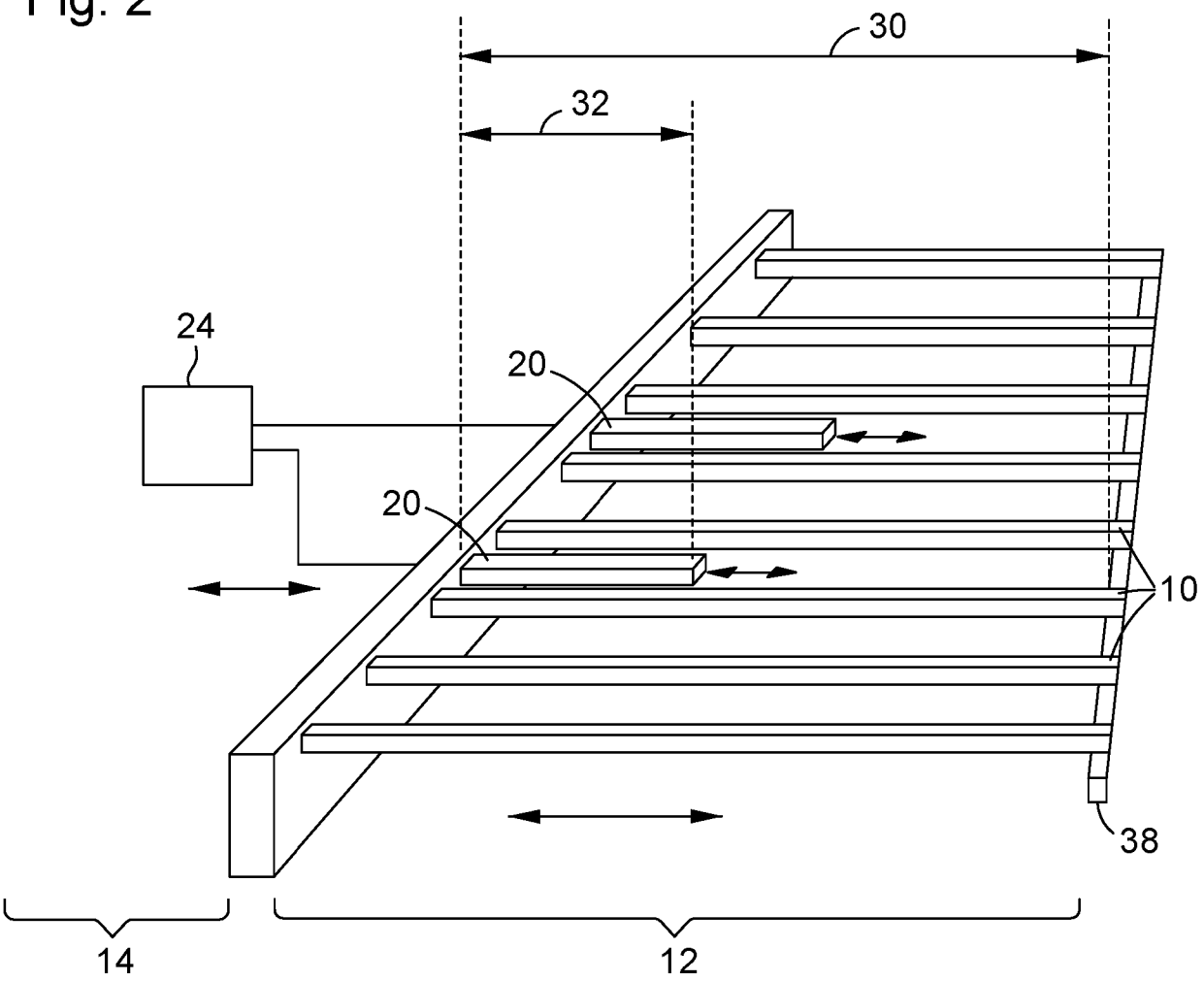


Fig. 3

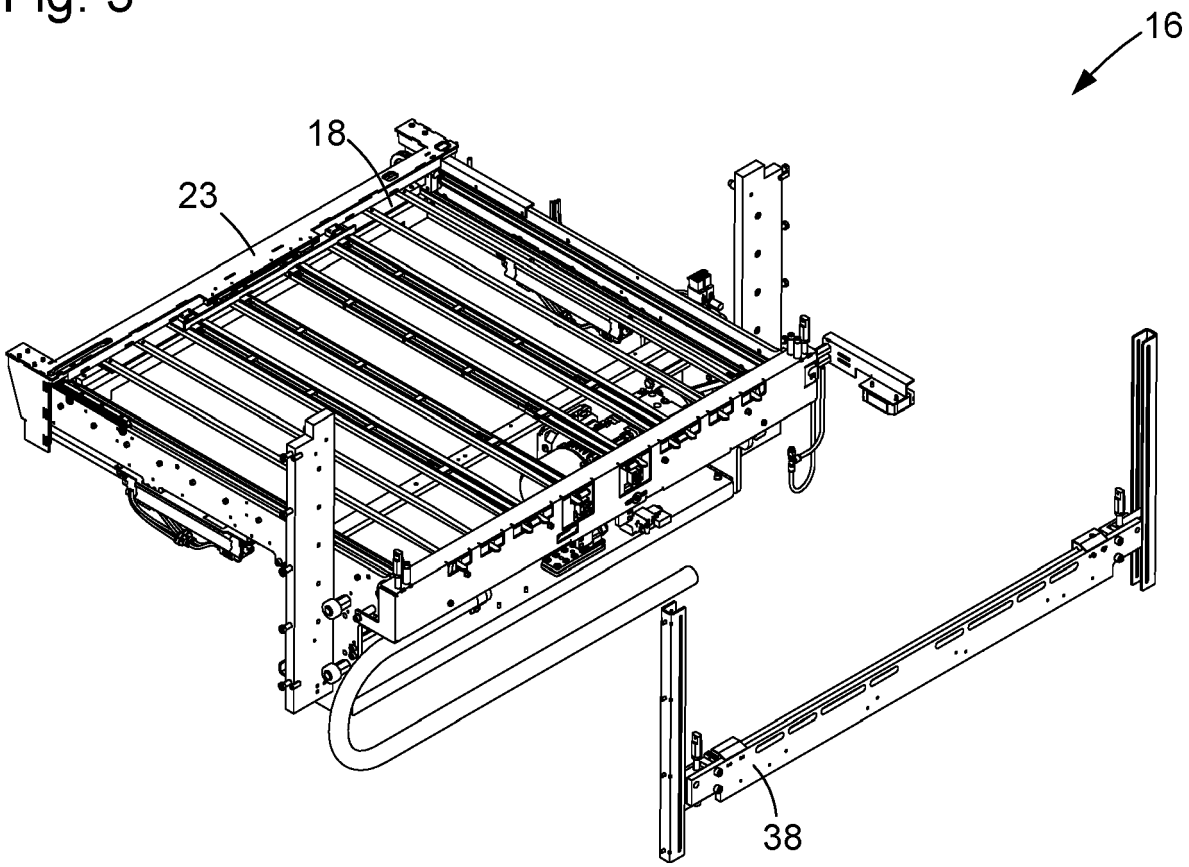


Fig. 4

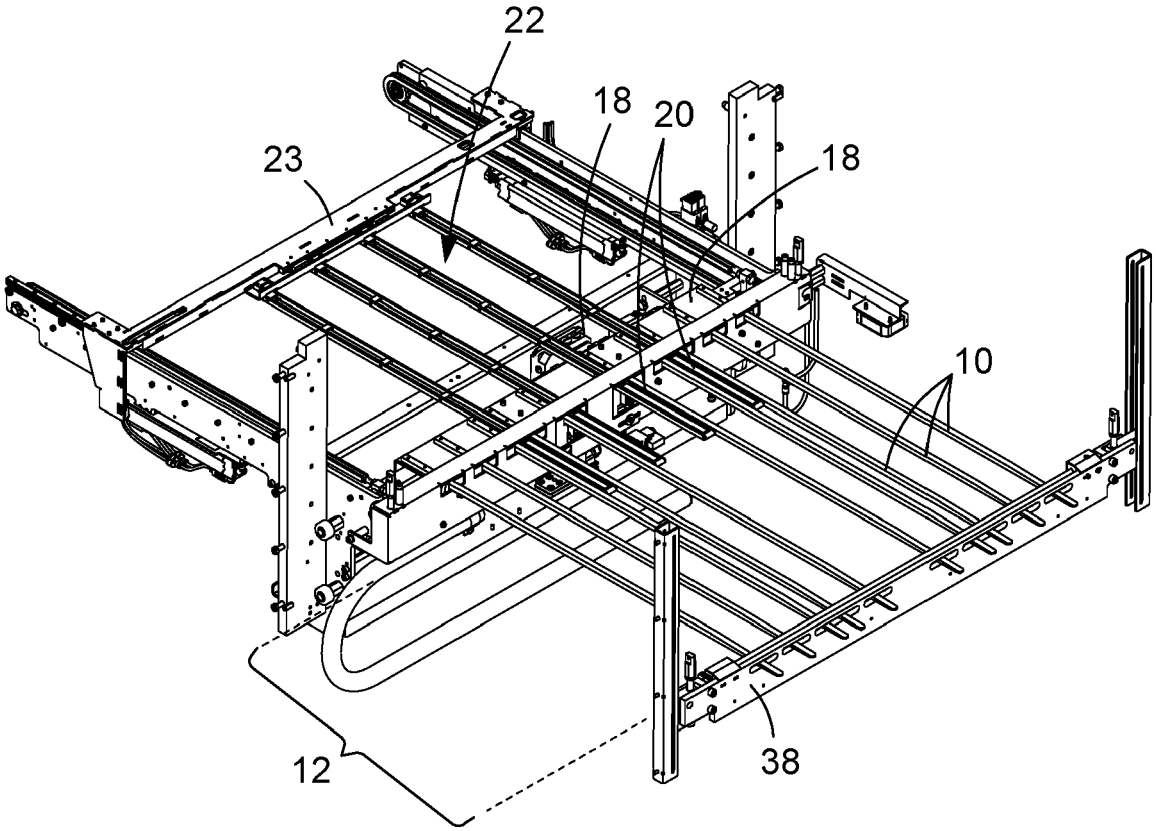


Fig. 5

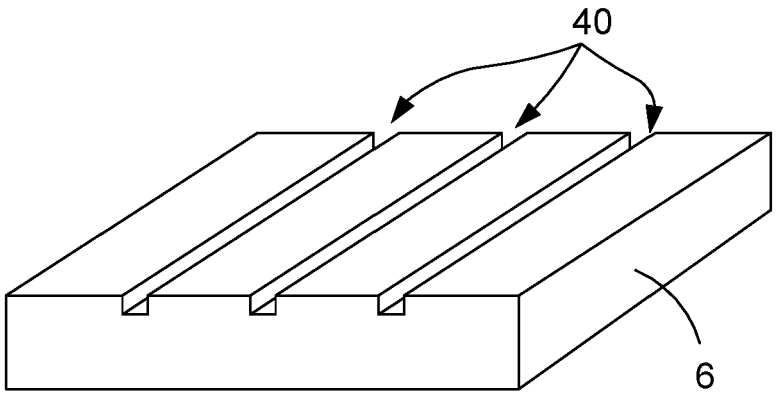


Fig. 6

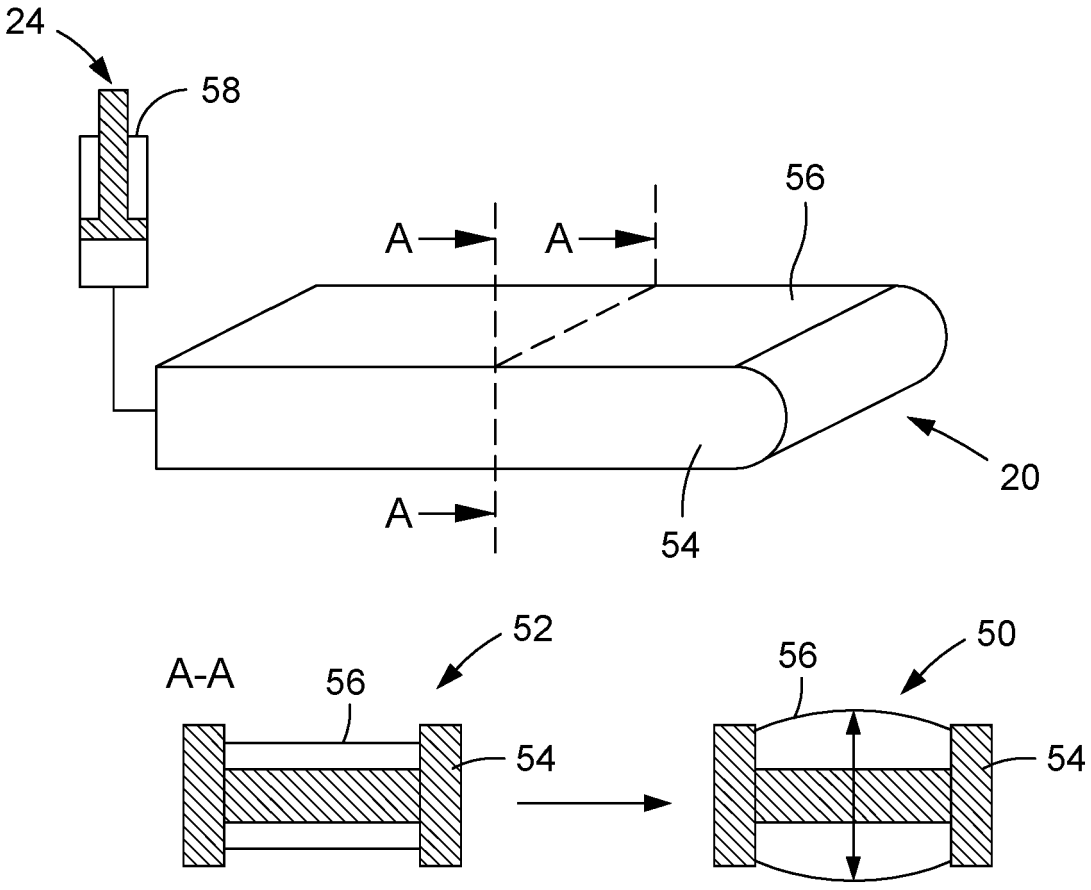


Fig. 7

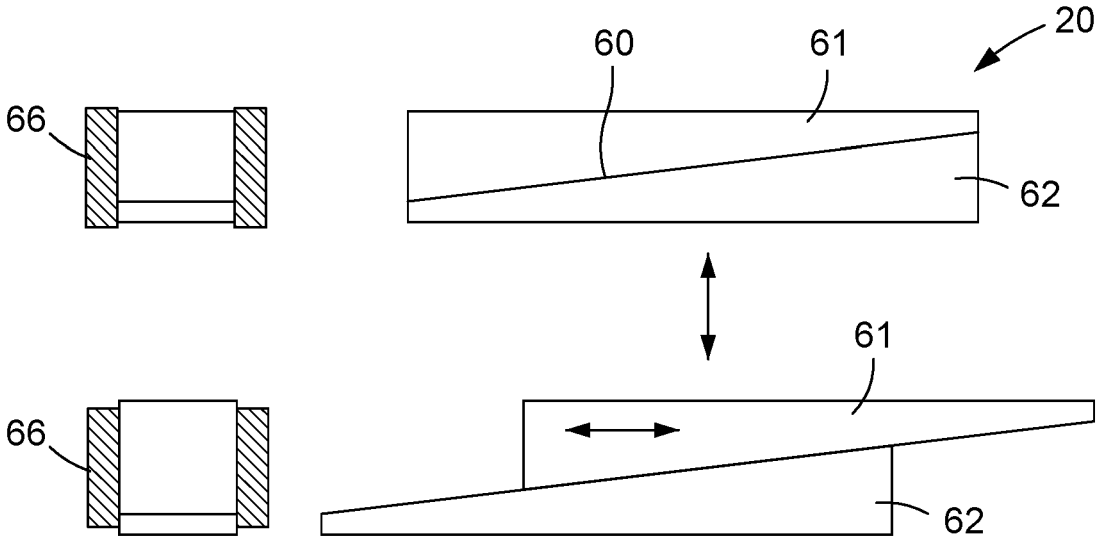


Fig. 8

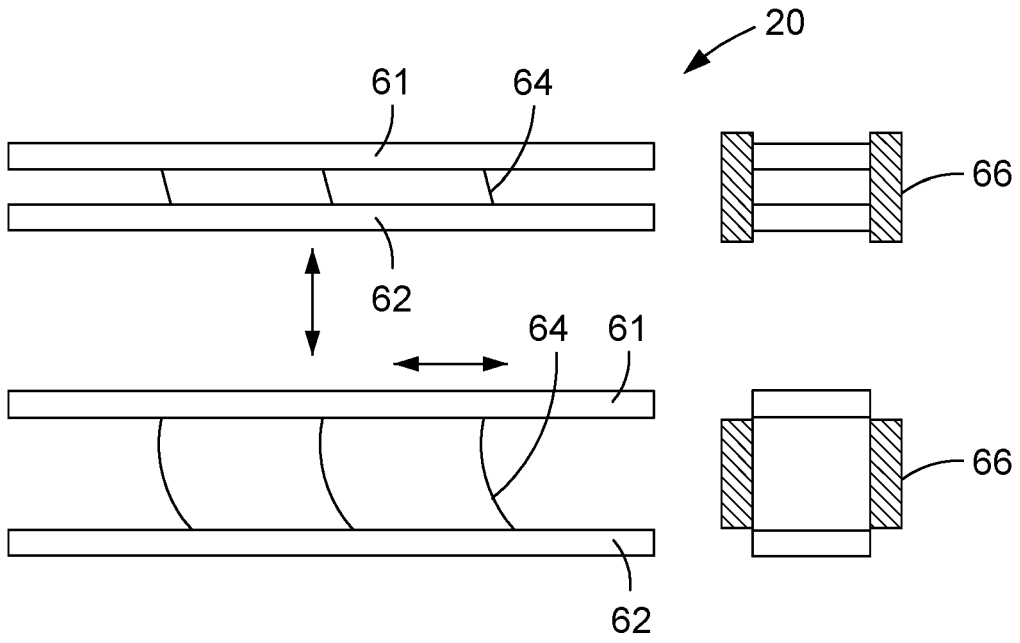


Fig. 9a

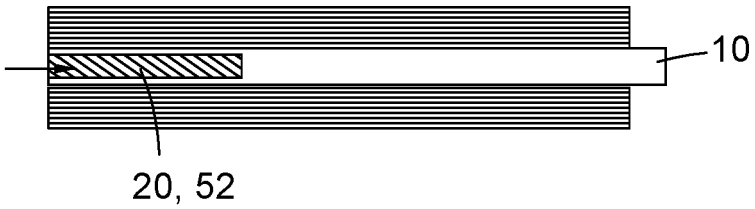


Fig. 9b

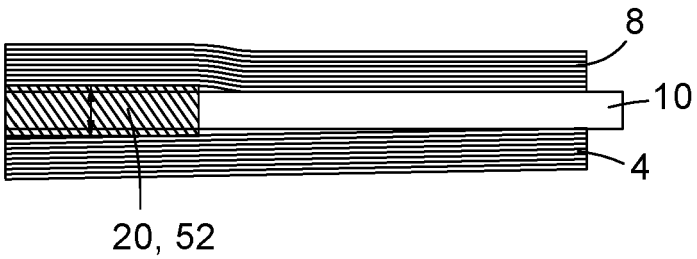


Fig. 9c

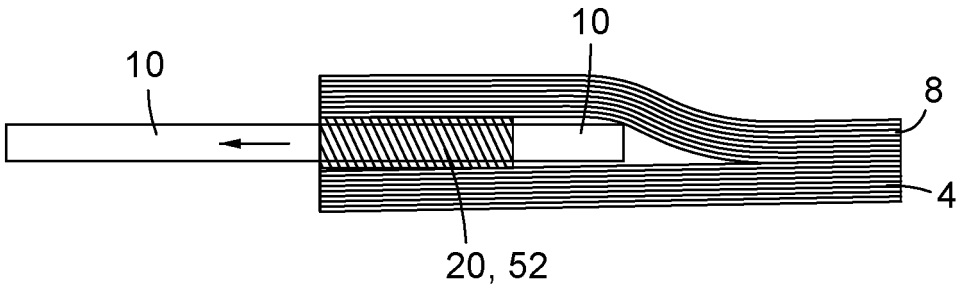


Fig. 9d

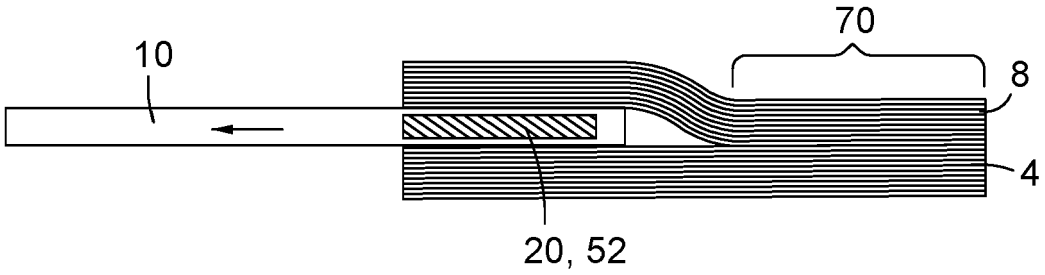


Fig. 9e

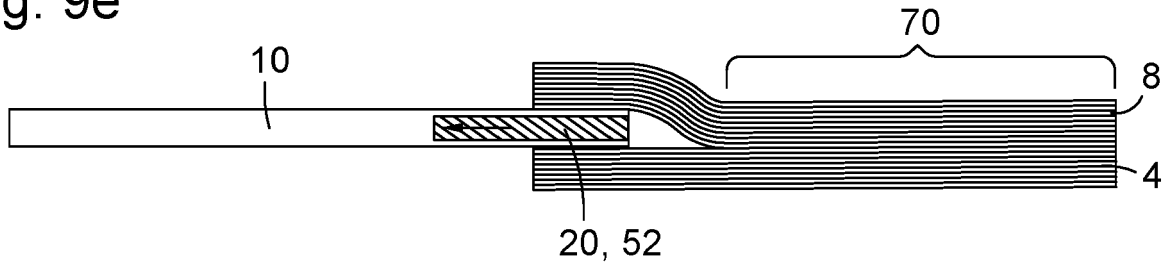
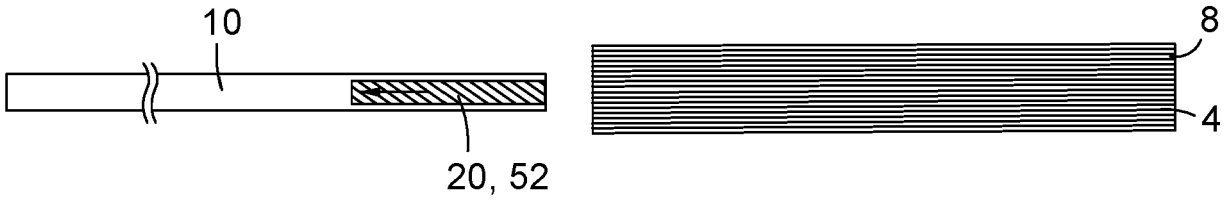


Fig. 9f



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EUROPEAN SEARCH REPORT

Application Number
EP 23 18 1786

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24 November 2023	Athanasiadis, A

CATEGORY OF CITED DOCUMENTS

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