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(54) **Apparatus and method for digital printing on articles constituted by containers made of sintered expanded polystyrene**

(57) An apparatus for digital printing on articles (3) constituted by containers made of sintered expanded polystyrene, comprising means for the support and advancement of the articles, which beforehand are stacked on each other and arranged on one side so as to form

packs (3a). The packs (3a) are sent to at least one first digital printing means (12), which can, move axially and at right angles to the advancement means and is arranged above the packs (3a). There is then at least one first drying region which ends with a region for unloading the packs (3a) from the apparatus (1).

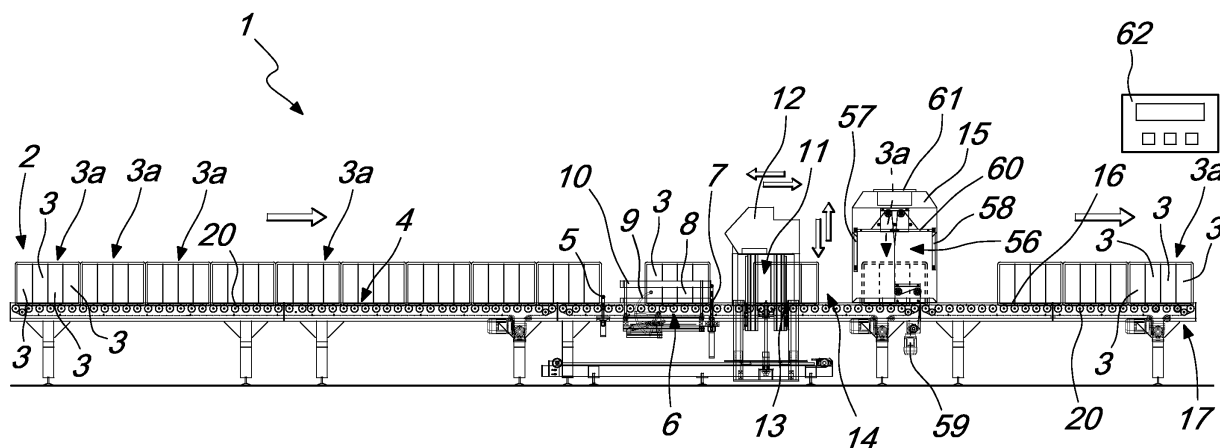


Fig. 1

Description

[0001] The present invention relates to an apparatus for digital printing on articles constituted by containers made of sintered expanded polystyrene.

[0002] Currently, various methods graphic customization are known which are used in the packaging of articles, particularly made of sintered expanded polystyrene, better known as EPS.

[0003] A first widely used method for graphic customization of packages is screen printing.

[0004] However, this type of printing has many drawbacks.

[0005] First of all, the resulting printing has poor definition and quality, is usually monochromatic and, when in two colors, difficulties arise in superimposing such colors.

[0006] Moreover, this printing utilizes single- and two-component resins that require, for cleaning, the use of solvents which, together with the gases released by them, attack the EPS; moreover, the production of the frames is constrained by extreme graphic inflexibility.

[0007] Finally, the management difficulties on the machine are not negligible, because of the vibrations and the drying times of the inks and the difficulties in managing and cleaning the frames.

[0008] Another method, which is widespread particularly in the cardboard industry, is inkjet marking.

[0009] With this method, the definition that can be obtained is barely sufficient; moreover, the oil-based inks used dry with difficulty and cause smudging problems.

[0010] The method is usually monochromatic; however, it is possible to print in multiple colors, but with very high costs.

[0011] Another known method is constituted by tampographic printing, which allows to obtain multiple-color prints with good definition and is used to customize, for example, disposable beer glasses.

[0012] The printing system, however, is inflexible, because the pad cannot be modified and has difficulties in managing both the movement under the press, which entails introducing the parts individually, causing a poor production capacity, and the necessary and frequent cleaning caused by the use of single- and two-component resins.

[0013] Finally, the fact that the costs are high is not negligible.

[0014] US 5,884,451 is also known which deals with a different subject, because it is intended explicitly for the processing of cardboard sheets.

[0015] This solution in fact describes a system for processing single prepunched cardboard sheets, which are sent one by one at a conveyor, which sends them to a unit provided with a screen, which reads a drawing to be reproduced and sends it to a printing unit; such unit can be provided with a photosensitive drum or with a printing head, which by rising and lowering prints on the flat surface of a single cardboard sheet.

[0016] There is, therefore, a unit adapted to overturn the cardboard so as to arrange the printed flat surface toward the conveyor and allow to arrange, on the unprinted flat surface, a series of articles, such as cassettes and CDs.

[0017] There is then a station adapted to fold the various flaps of the cardboard sheet around the items in order to obtain a box for containing them.

[0018] This solution, however, can be used only for single cardboard sheets but it is not suitable for use with preformed containers which thus already have a box-like shape at the outset.

[0019] Moreover, this known solution allows to print a single cardboard sheet at a time, which dries immediately once printed because the cardboard absorbs the ink immediately, and requires, in order to form the box, the preventive placement of the items on the cardboard sheet and then the folding of the various flaps of such sheet.

[0020] Therefore, if one wishes to obtain a large number of boxes, it is necessary to print beforehand an equally large number of sheets, printing them one at a time, and then collate the products on each individual sheet that has to be then folded in order to be able to obtain each individual box.

[0021] This known solution is even less usable for already-formed containers made of sintered expanded polystyrene, since printing on them requires a different method than the one used for cardboard.

[0022] Figure 14 of US 5,884,451 illustrates the use of single cardboard sheets, which are opened and folded in order to form a single box in which the CDs or cassettes are inserted, such single box being then closed and passed by a printing head: in this condition also, besides the drawbacks mentioned earlier, one observes the fact that the surfaces on which printing can be performed are restricted to the upper one and to a single lateral one, since it is not possible to print on the opposite surfaces.

[0023] Moreover, a single box at a time is always printed.

[0024] Another known method for graphic customization of preformed boxes, used in particular in the horticultural sector, consists in applying adhesive tapes to the outside of the boxes.

[0025] This solution has very low costs, but has problems in adhesion, application and color change due to the poor resistance to UV rays if stored outdoors.

[0026] Moreover, the tapes may often peel off from their support or from the box, especially in damp environments, with implications of contamination of the product contained in the box.

[0027] Moreover, the adhesive tape must be applied individually to each box.

[0028] Another method used for customizing preformed boxes is the application of Fasson adhesive made of coated paper, which allows good customization even in four-color printing, but with rather high costs depending on the quality of the medium, on the number of colors and on the minimum number of labels, which is usually

high.

[0029] Moreover, an initial investment for a rather expensive automatic labeling machine is required, and the fact that the adhesive is poorly resistant in damp environments is not negligible.

[0030] Finally, the problem of extremely inflexibility of modifications remains.

[0031] Finally, another known method is digital four-color printing, which however is usually used on paper media, which thus have limited thicknesses and exclusively flat shapes that allow easy management of the printing flow; this method, however, cannot be used straightforwardly if one wishes to use it by replacing the flat paper media with articles or boxes made of sintered expanded polystyrene, constituted usually by crates whose volume makes it unfeasible to use known digital four-color printing machines.

[0032] The aim of the present invention is to solve the above mentioned technical problems, eliminating the drawbacks of the cited background art, by providing an apparatus that allows to obtain quickly digital printing on preformed articles, which thus have a given volume, such as boxes or containment crates made of sintered expanded polystyrene.

[0033] Within this aim, an object of the invention is to provide an apparatus that allows digital printing on preformed articles made of sintered expanded polystyrene with high versatility and adaptability of the printing to the different dimensions of the articles.

[0034] Another object of the invention is to provide an apparatus that allows to quicken all the steps of the printing process and requires the smallest possible number of manual interventions of the operator.

[0035] Another object is to be able to achieve, in a short time, the printing of a large number of preformed articles made of sintered expanded polystyrene.

[0036] Another object is to be able to print, on multiple sides, a large number of preformed articles made of sintered expanded polystyrene.

[0037] Another object of the present invention is to provide an apparatus that uses or produces non-toxic materials, safeguarding the health of the users of the apparatus and allowing its use in the most disparate fields.

[0038] Another object of the present invention is to allow to graphically customize articles made of sintered expanded polystyrene in a quick and easy manner.

[0039] Another object of the present invention is to provide an apparatus that allows to perform digital printing on articles constituted by boxes or containment crates made of sintered expanded polystyrene, that can be obtained easily starting from commonly commercially available elements and materials and is highly reliable, relatively easy to provide and at competitive costs.

[0040] This aim and these and other objects that will become better apparent hereinafter are achieved by an apparatus for printing on articles constituted by containers made of sintered expanded polystyrene, **characterized in that** it comprises means for the support and ad-

vancement of said articles, stacked on each other and arranged on a chosen side so as to form packs, and in that it comprises at least one first digital printing means, which can move axially and at right angles to said advancement means and is arranged above said packs, and in that it comprises at least one first drying region and a region for the unloading of said articles from said apparatus.

[0041] Further characteristics and advantages of the invention will become better apparent from the following detailed description of a preferred but not exclusive embodiment of the apparatus for digital printing on articles, particularly on packs of containment crates made of sintered expanded polystyrene according to the invention, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a side view of the apparatus as a whole; Figure 2 is a side view of the movable means for the advancement of the articles;

Figure 3 is a side view of the stop mechanism;

Figure 4 is a side view of the central centering means;

Figure 5 is a front view of the lateral centering means;

Figure 6 is a side view of the means for moving the printing means;

Figure 7 is an exploded top view of the means for moving the printing means;

Figure 8 is a front view of a different preferred embodiment, for the drying region and for the arrangement of the articles;

Figure 9 is a side view of Figure 8;

Figure 10 is a side view of the lateral centering means and of the means for pressing of the articles;

Figure 11 is a front view of the means of Figure 10;

Figures 12 and 13 are views of a first device for the separation of the packs with respect to a fixed stop;

Figures 14 and 15 are views of a second device for separation of the packs;

Figure 16 is a side view of the overturning unit;

Figures 17, 18 and 19 are a front view and side views of the first or second printing means and of the corresponding means for correcting the position of the printing heads.

[0042] With reference to the figures, the reference numeral 1 designates an apparatus for digital printing on articles, designated by the reference numeral 3, particularly on packs 3a of articles constituted by boxes or crates for containment made of sintered expanded polystyrene and previously stacked on each other and arranged on a chosen side, for example transversely, as in Figures 8 and 9, or longitudinally, as in Figure 1, with respect to the apparatus.

[0043] Stacking of the boxes or crates for containment made of sintered expanded polystyrene is allowed because of the presence of appropriately provided interlocking elements on the bottom of the boxes.

[0044] The apparatus has support and advancement

means for the packs 3 a of crates, which comprise a loading area 2 on which the packs 3a of already stacked boxes are deposited; the loading area 2 is arranged at one end of a first accumulation roller bed 4, which is fed continuously by an operator or automatically by way of known means.

[0045] A second central roller bed 6 is contiguous to the output end of the first accumulation roller bed 4.

[0046] Ahead of the inlet of the second roller bed 6 there is a first stop mechanism 5 for the packs 3a.

[0047] The second central roller bed 6 is provided, at the output region, with a second stop mechanism 7 for the packs 3a, which divides it into an initial region 8 for arranging the packs 3a, which comprises central centering means 9 and lateral centering means 10 for the packs 3a, and into a subsequent first printing region 11, in which there is at least one first digital printing means 12 provided with adapted movement means 13.

[0048] The first digital printing means 12 is arranged above the packs 3a and can move both vertically and horizontally with respect to the underlying packs 3a.

[0049] Printing occurs at a chosen side of each article 3, in particular at the side that is directed toward the overlying digital printing means 12 and faces it; depending on the arrangement of the packs, printing on the chosen side of the article is obtained (see Figures 1 and 8).

[0050] Printing occurs preferably, but not exclusively, starting from the pack 3a that is directed toward the second central roller bed 6 and then sequentially on the others.

[0051] In the second central roller bed 6 there is, after the printing region 11, an intermediate region 14, which conveys the packs 3a that have already been printed to a first drying region, which is constituted, for example, by a drying oven 15, shown in Figure 1, or preferably by an overlying hot air conveyance unit 15a, shown in Figures 8 and 9.

[0052] After the first drying region there is a third unloading roller bed 16, which conveys the packs 3a into an unloading region 17 or to an overturning unit 95, as described hereinafter.

[0053] The whole apparatus 1 is controlled by an electrical control panel 62.

[0054] The first accumulation roller bed 4, the second central roller bed 6 and the third unloading roller bed 16 are structured in a substantially similar manner.

[0055] By way of example, the structure of the second central roller bed 6, which has a supporting structure 18 that is provided completely by means of metallic profiles and rests on feet 19 whose height is adjustable, will be described in detail hereinafter.

[0056] Longitudinally and laterally to the supporting structure 18, there are shoulders 21, which are parallel to each other and from which containment guides 22 protrude upward; rollers 20 are associated transversely and rotatably between the shoulders 21 and are advantageously coated with a protective layer 23 made of PVC in order to prevent the articles from being damaged dur-

ing their movement.

[0057] The rollers 20 are moved by means of a chain drive driven by a gearmotor 24.

[0058] The second central roller bed 6 is advantageously provided with rollers with fixed pinion in order to allow the uniformly spaced advancement of the packs of articles.

[0059] The first accumulation roller bed 4 is provided with motorized rollers or with freewheeling rollers in order to allow the operator to push the articles forward.

[0060] The third unloading roller bed 16 is provided with fixed pinion rollers in order to allow the continuous advancement of the packs 3a.

[0061] The first stop mechanism 5 is designed to stop the packs 3a of articles 3 before making them enter the second central roller bed 6, so as to allow the passage in said second roller bed of one pack of articles at a time.

[0062] The second stop mechanism 7 is designed to stop the packs 3a in the region 8 of the second central roller bed 6 in order to allow the central centering means 9 and the lateral centering means 10 to arrange correctly the chosen pack 3a before printing occurs.

[0063] The first and second stop mechanisms are structurally identical; thus, by way of example, only the stop mechanism 5 is described, which is composed of a fixed structure 25, provided by means of metallic profiles, which is anchored on the second central roller bed 6, and of a movable part 26, constituted by a vertical movement system 27, which comprises rolling guide spline bearings 28.

[0064] Upward and downward vertical movement is performed by means of a pneumatic cylinder 29 actuated by a pneumatic electric valve, not shown.

[0065] In the upper part of the movable part 26 that protrudes beyond the plane of arrangement of the rollers 20 there is an idle roller 30, which is designed to avoid friction between the packs of articles and the movable part during the lifting/lowering movement.

[0066] The central centering mechanism 9 is constituted by an oscillating lever 31 that retracts between the rollers 20 of the second central roller bed 6, such oscillating lever being provided by substantially L-shaped metallic profiles, in which one wing 31a is linear and anchored to joints 32 with ball bearings in order to allow its rotation, while the other wing 31b, which has an arc-like shape, is made to protrude between two adjacent bearings in the direction of the printing station 11.

[0067] The joints 32 are installed on a structure 33 that can slide on a first system of linear ballscrew guides 34.

[0068] The structure 33 is connected to appropriately provided handles 35, which are adapted to impose a manual movement thereof and is provided with positioning pistons 36 with spring-actuated return for interlocking in the stepwise perforations 37 arranged along the sides of the second central roller bed 6.

[0069] In this manner, during the initial calibration step, before starting the automatic cycle, the structure 33 is moved manually, by making it slide along the first system

of linear guides 34, and then is positioned correctly by allowing the insertion of the positioning pistons 36 in the stepwise perforations 37.

[0070] The lever 31 is moved by a first pneumatic cylinder 38 actuated by a pneumatic electric valve.

[0071] A pressure regulator is also installed in order to avoid an excessive pressure on each pack 3a of articles.

[0072] Finally, there are sensors connected to the first cylinder 38 in order to control the position of the lever 31 during the working steps.

[0073] The lateral centering means 10 comprise a pusher 39, which is arranged on at least one side of the second roller bed 6, which can move transversely to such second roller bed and thus pushes each pack 3a of articles against a fixed stop 40, which is mounted on the opposite side of the second roller bed 6.

[0074] The pusher 39 is constituted by two C-shaped parts 41 made of pressed metal plate and is installed on a carriage 42, which can slide on a second system of linear guides with ballscrew sliders, designated with the reference numeral 43.

[0075] Movement is provided by a second pneumatic cylinder 44 actuated by a pneumatic electric valve.

[0076] Advantageously, a pressure regulator is installed in order to avoid excessive pressure on the pack 3a.

[0077] The lateral centering means 10 can also be placed at the initial part of the machine and be used to align the individual articles 3 that constitute the packs 3a.

[0078] Further, there are means for pressing such articles, which are constituted by a supporting structure 81 constituted by two shoulders 82a, 82b made of aluminum profiles anchored on the first roller bed 4; in the inner part of such supporting structure, linear guides 83a, 83b are accommodated in order to allow the sliding of sliding blocks 84a, 84b, which are anchored to an alignment frame 85 composed of a free roller bed, which is composed of four idle rollers coated by a protective layer made of PVC in order to prevent damage to the packs of crates made of polystyrene during the passage step.

[0079] The movement of the alignment frame 85 occurs by means of a pair of pneumatic cylinders 86 or by way of a handwheel.

[0080] Finally, there are sensors connected to the second cylinder 44 for controlling the position of the pusher 39 during working steps.

[0081] The first digital printing means 12 used is preferably a digital plotter known by the Roland trademark, conveniently adapted and fed with water-based printing colors.

[0082] The first digital printing means 12 is installed above the packs 3a at the means 13 for its movement that allow its forward/backward movement, along the advancement direction of the second roller bed 6, and its ascent/descent motion with respect to the underlying second roller bed 6.

[0083] This movement allows to adapt the positioning of the first printing means 12 to the dimensions of the

underlying pack 3a of articles on which to print.

[0084] The movement means 13 are constituted by a base structure 45 and by a lifting assembly 46.

[0085] The base structure 45 is provided preferably by means of tubular elements and rests on feet 47 whose height is adjustable.

[0086] A third system with linear guides with ballscrew sliders 48 is installed above the base structure 45 in order to impose the sliding of a lifting assembly 46 along the advancement direction of the second roller bed 6.

[0087] This movement occurs by means of a toothed belt 49, which is actuated by a step motor 50 controlled by an appropriately provided encoder and supported on feet 47.

[0088] The lifting assembly 46 is preferably composed of two columns 51, which can slide on a fourth system, which is arranged vertically with respect to the second roller bed 6, of linear guides 52 with ballscrew sliders actuated by ball bearing nuts 53 with reduced clearance actuated by a ballscrew 54.

[0089] The movement of the ballscrews 54 for the rise and descent of the two columns 51 is provided by a chain drive actuated by a motor 55 of the brushless type, with a safety braking device and an encoder for position reading.

[0090] In the region in which printing occurs there is a fixed stop 87 for the packs 3a, at which there is a first device for separating the packs 3a with respect to the fixed stop 87, also referenced as zero point.

[0091] At the end of the printing operation, the device for separating the packs moves them away from the fixed stop 87 in order to prevent such stop from rubbing against it and becoming misaligned, creating drawbacks for the subsequent operations.

[0092] The device for separating the packs is composed of a pneumatic cylinder 88, which is anchored on the fixed stop 87, and by a disk 89, which is made in PVC in order to avoid marking the pack of crates made of polystyrene, anchored on the stem of the pneumatic cylinder; in the inactive step of the system, the disk retracts inside the fixed stop, while when printing has been completed the pneumatic cylinder pushes the packs of polystyrene crates by spacing the pack of about 10 mm, and then returns immediately to the resting position in order to allow the next pack to be positioned.

[0093] Figures 17, 18 and 19 illustrate the first printing means 12, or the equivalent second printing means, in which means for correcting the position of the printing heads 98 are highlighted.

[0094] The composition of the packs 3a sometimes involves minute imperfections along the whole length of the pack; this can create friction of the printing head 98 along the pack and slight damage may occur to the head itself, which over time can cause the head to break.

[0095] The means for correcting the position of the printing heads 98 are constituted by an encoder (not shown) for reading the rising and/or descending motion of the plotter, by a pair composed of a high-precision

sensor 99 and receiver 100 arranged in the region of initial printing ("heads zero" point, imaginary printing line with respect to the surface to be printed), by a pair composed of a precision sensor 101 and receiver 102 arranged after the heads 98 of the plotter ("heads zero" point, imaginary printing line with respect to the surface to be printed), by a pair composed of a sensor 103 and a reflector 104 for quickly reading the height of the pack 3a.

[0096] The operation of the apparatus is deduced from the highlighting of the following steps:

STEP 1

[0097] When the pack of polystyrene containment crates to be processed is arranged below the plotter, by means of an appropriately provided operator panel the value of the correction of the head with respect to the "heads zero" point has to be entered.

[0098] Again by means of the operator panel, the heads of the plotter are moved closer to the pack of polystyrene containment crates; at this point the plotter descends quickly until the signal of the pair constituted by the sensor 103 and the reflector 104 is interrupted by the presence of the pack.

STEP 2

[0099] At this point the speed of descent of the plotter decreases in order to allow the precision sensor 99 and receiver 100 to determine the printing start region ("heads zero" point, the imaginary printing line with respect to the surface to be printed), which is near the printing surface of the pack of containment crates made of polystyrene.

[0100] At this point, by means of the operator panel, the acquisition of the height detected by the pair constituted by the precision sensor 99 and receiver 100 is confirmed.

STEP 3

[0101] The plotter starts to print along the entire pack, while the pair constituted by the precision sensor 99 and receiver 100 arranged in the initial printing region are always active and check any excess imperfections of the pack that can damage the printing heads.

STEP 4

[0102] If the pair constituted by the precision sensor 99 and receiver 100 arranged in the initial printing region ("heads zero" point, imaginary printing line with respect to the surface to be printed) or the pair constituted by the precision sensor 101 and receiver 102 arranged after the heads of the plotter ("heads zero" point, imaginary printing line with respect to the surface to be printed) detects an excess imperfection, correction of the printing heads intervenes, i.e., the plotter rises automatically based on

the correction factor set previously on the operator panel.

[0103] This operation is performed automatically and without stopping printing; the small displacement of the plotter is controlled by an encoder installed on the ascent and/or descent columns of the plotter.

STEP 5

[0104] Once printing of the pack where the plotter has had to correct the height of the heads has ended, the plotter returns to the position detected in the initial step (step 2), ready for the next pack of containment crates made of polystyrene.

[0105] After the printing region 11 there is a first drying region that comprises, for example, the drying oven 15, shown in Figure 1, or preferably the hot air conveyance unit 15a, shown in Figures 8 and 9.

[0106] If one wishes to use the solution that employs the drying oven 15, such oven is composed of a tunnel-like structure 56, preferably made of pressed metal, with inlet doors 57 and outlet doors 58 that can open and close partially.

[0107] The movement of the doors 57, 58 occurs by means of a chain drive driven by a gearmotor 59.

[0108] In the upper part of the drying oven 15 there are finned resistors 60 for heating, which are located below axial fans 61.

[0109] The electrical control panel 62 comprises all the control logic systems, the controls, the temperature setting systems and a PLC for controlling the movement means 13.

[0110] Moreover, at the front there is a touch screen in order to set commands and view messages and alerts.

[0111] As shown in Figures 8 and 9, the first drying region is preferably constituted by a hot air conveyance unit 15a constituted by a nozzle 70 that can move on a beam 71 of a bridge crane 72 arranged transversely to the apparatus, the beam 71 being also movable at right angles to such apparatus.

[0112] One or more adapted gearmotors 73a, 73b are provided which, by means of an appropriately provided toothed belt or chain 74 or other interconnection means, move a plate 74 to which the nozzle 70 is connected and which allows the lifting or lowering of the beam 71, since the plate and the beam are movable on appropriately provided guides.

[0113] The nozzle 70 is connected to a duct 75 for the conveyance of hot air, which is forced by means of an appropriately provided fan 76.

[0114] Provisions are made for the adjustment of both the temperature and the speed of the movement of the air conveyance unit 15a.

[0115] A second device for separating the packs 3a is arranged also in the first drying region and is constituted by a pneumatic cylinder 90, which is anchored on a post 91 and on the stem 92 of which a guide 93 is associated transversely and is provided with free wheels 94 in order to avoid marking the pack of crates made of polystyrene.

[0116] The pneumatic cylinder pushes the pack of polystyrene crates by separating the pack by about 20 mm and then returning immediately in the inactive position in order to allow the subsequent pack to be positioned.

[0117] The operation of the apparatus for digital printing on articles constituted by packs 3a of containment crates made of sintered expanded polystyrene (articles) is as follows.

[0118] An operator or an automatic machine loads the packs 3a of crates 3 on the loading region 2 until the first accumulation roller bed 4 is full; each pack 3a is obtained by arranging the individual crates so that they are mutually stacked, such pack being then rotated on a chosen side and arranged along an axis that is longitudinal or transverse to the apparatus.

[0119] The packs 3a thus obtained and arranged mutually side by side along the entire line are sent until they interact with the first stop mechanism 5, which blocks them, allowing the advancement of one pack at a time.

[0120] The pack released by the first stop mechanism 5 enters the region 8 of the second central roller bed 6.

[0121] At this point, the second stop mechanism 7 blocks the advancement of the pack 3a and the central centering means 9 and the lateral centering means 10 arrange it correctly in order to perform printing.

[0122] Then the second stop mechanism 7 moves downward, allowing the pack 3a to advance in the region 9 where the first digital printing means 12, previously positioned and calibrated by way of the movement means 13, prints on the underlying pack, performing the printing on each one of the crates 3 that form the pack 3a.

[0123] After the printing of the pack has ended, the pack is made to advance in the intermediate region 14 and from there it enters the first drying region.

[0124] Once this step is completed, the unloading roller bed 16 makes the pack advance through the third unloading roller bed 16 to the unloading region 17, from where the operator can unload it and store it in an appropriately provided pallet.

[0125] As an alternative, after exit from the first drying region, the pack 3a is brought at an overturning unit 95, which is designed to pick up the pack of containment crates made of polystyrene, rotate it through 180° and rest it again on the roller bed.

[0126] The overturning unit 95 is composed of a pair of grip jaws 96, of which one is movable and one is fixed, which can be moved mutually closer or further apart by means of a pneumatic cylinder, arranged transversely to the third roller bed 16, in order to allow grip of the packs of polystyrene containment crates having various dimensions.

[0127] The pair of grip jaws 96 is installed on a rotating axis 97 in order to allow the rotation through 180° from left to right of the pack of crates and its return into position in order to pick up another pack.

[0128] In order to ensure that the pneumatic cylinder of the movable jaw does not press the pack excessively and thus ruin it, a pressure regulator is installed which is

calibrated beforehand and is controlled by appropriately provided and known sensors.

[0129] Rotating cylinders are installed at the two ends of the rotating axis 97 and are in turn installed on a system of linear guides in order to allow to raise and/or lower the axis of rotation to grip the various models of packs of crates made in polystyrene.

[0130] The height of the axis 97 is adjustable according to the format of the pack of polystyrene crates to be treated.

[0131] After the overturning unit 95 there is optionally an automatic device for pressing the crates, followed by a second printing means, similar to the first printing means 12, so as to print a further side of the crates 3 of each pack 3a; this is followed by a second drying region, similar to the first drying region.

[0132] It has thus been found that the apparatus according to the invention has achieved fully the mentioned aim and objects, since it allows, thanks to the resting arrangement on one side of the packs 3a and of the first and/or second digital printing means placed above them, to obtain a digital print on the chosen side of containment boxes or crates made of sintered expanded polystyrene, all in a quick and easy manner.

[0133] Moreover, the apparatus allows to obtain digital printing on articles with high versatility and adaptability of the printing to the different dimensions of the articles, since it is sufficient to merely adapt the arrangement of the first and/or second digital printing means according to the dimensions of the underlying individual article that composes the pack 3 a.

[0134] The apparatus, moreover, allows to quicken all the steps of the printing process and requires few manual interventions of the operator, allowing to customize graphically articles made of sintered expanded polystyrene quickly and easily.

[0135] Moreover, the fact that the printing means is fed using water-based inks allows to eliminate the risks of toxicity, protecting the health of the users of the mechanism, limiting the disposal of any residues during the cleaning of the digital printing means 12, and finally allowing the use of such apparatus for printing in the most disparate sectors, which range from the medical sector to the food sector, to the gift and fancy goods sector, et cetera.

[0136] Although the apparatus according to the invention has been conceived particularly for printing on pre-formed articles made of sintered expanded polystyrene, it may nonetheless be used, more generally, for pre-formed articles also made of another material.

[0137] The apparatus thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims; all the details may further be replaced with other technically equivalent elements.

[0138] In practice, the materials used, as well as the dimensions, may be any according to requirements and to the state of the art.

[0139] The disclosures in Italian Patent Application no. TV2009A000112, from which this application claims priority, are incorporated herein by reference.

[0140] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. An apparatus for printing on articles (3) constituted by containers made of sintered expanded polystyrene, **characterized in that** it comprises means for the support and advancement of said articles, stacked on each other and arranged on a chosen side so as to form packs (3a), **in that** it comprises at least one first digital printing means (12) which can move axially and at right angles to said advancement means and is arranged above said packs (3a), and **in that** it comprises at least one first drying region and a region for unloading said articles (3) from said apparatus (1).
2. The apparatus according to claim 1, **characterized in that** said packs (3a) are arranged longitudinally or transversely on said support and advancement means comprising a loading area (2), which is arranged at one end of a first continuously fed accumulation roller bed (4), a second central roller bed (6) being provided which is contiguous to the exit end of said first accumulation roller bed (4), with the interposition of a first stop mechanism (5) for said packs (3a) that is adapted to allow the transit, in said second roller bed (6), of a single pack (3a) of articles (3) at a time.
3. The apparatus according to claims 1 and 2, **characterized in that** said second central roller bed (6) is provided, at the output region, with a second stop mechanism (7) for said packs (3a) in a region (8) that is adapted to allow appropriately provided central centering means (9) and lateral centering means (10) to position correctly a single pack (3a) in a successive first printing region (11) in which there is at least one first digital printing means (12) provided with adapted movement means (13).
4. The apparatus according to claims 1 and 3, **characterized in that** said first digital printing means (12) is arranged above said packs (3a) and can move both vertically and horizontally with respect to said underlying packs (3a) to print on individual articles (3) of chosen dimensions, printing occurring at at least one side of each article (3), in particular at the

side that is directed toward said overlying first digital printing means (12) and faces it.

5. The apparatus according to claims 1 and 4, **characterized in that** printing occurs starting substantially from the pack (3a) that is directed toward said second central roller bed (6) and then sequentially on the others, in said second central roller bed (6) there being, after said first printing region (11), an intermediate region (14) that conveys said packs (3a), already printed, in said first drying region, which is constituted either by a drying oven (15) or by a hot air conveyance unit (15a), from which a third unloading roller bed (16) subsequently extends which conveys said already-printed packs (3a) into an unloading area (17) or to an overturning unit (95) followed by a second digital printing means (12) and by a second drying region.
6. The apparatus according to one or more of the preceding claims, **characterized in that** said second roller bed comprises a supporting structure, which is provided laterally and longitudinally with mutually parallel shoulders (21), from which containment guides (22) protrude upward, rollers (20) being rotatably and transversely associated between said shoulders (21) and being moved by means of a chain drive driven by a gearmotor (24).
7. The apparatus according to one or more of the preceding claims, **characterized in that** it comprises a first and a second digital printing means (12), with an overturning unit (95) interposed, which are installed above said packs (3a) at said means (13) for their movement, which comprise means for vertical translational motion which allow both their forward/backward movement along the advancement direction of said second roller bed (6) and their rising/descending movement with respect to the plane of arrangement of said underlying second roller bed (6), so as to adapt the positioning of said printing means (12) to the dimensions of the underlying pack (3a) and therefore of the individual articles (3) onto which printing is to be performed, said vertical translational motion means comprising a lifting assembly which has two columns for each side which can slide on a first system of linear guides, which are arranged vertically with respect to said article supporting and advancement means, which is supported by a base structure and is connected to a ballscrew that is connected by means of a chain drive to an actuation system.
8. The apparatus according to one or more of the preceding claims, **characterized in that** said central centering means (9) comprise an oscillating lever (31) that retracts between rollers (20) that constitute said second central roller bed (6), said oscillating

lever (31) being provided by substantially L-shaped metallic profiles, in which one wing (31a) is linear and anchored to joints (32) with ball bearings in order to allow its rotation while the other wing (31b), which has an arc-like shape, is made to protrude between two of said bearings (20) which are adjacent in the direction of said printing station (11), said joints (32) being installed on a structure (33) that can slide on a first system of linear ballscrew guides (34), which is connected to appropriately provided handles (35) that are adapted to impose a manual movement thereof and is provided with positioning pistons (36) with spring-actuated return for interlocking in the stepwise perforations (37) arranged along the sides of the second central roller bed (6), said lever (31) being moved by a first pneumatic cylinder (38) that is actuated by a pneumatic electric valve.

9. The apparatus according to one or more of the preceding claims, **characterized in that** said lateral centering means (10) comprise a pusher (39), which is arranged on at least one side of said second roller bed (6) and which can move transversely to said second roller bed (6) and thus pushes each pack (3a) of articles (3) against a fixed stop (40), which is mounted on the opposite side of the second roller bed (6), said pusher (39) being constituted by two parts (41) made of pressed metal which are C-shaped and being installed on a carriage (42), which can slide on a second system of linear guides (43) with ballscrew sliders, movement being provided by a second pneumatic cylinder (44) actuated by a pneumatic electric valve.
10. The apparatus according to one or more of the preceding claims, **characterized in that** it comprises a first printing region and a second printing region, after which there is a first drying region and a second drying region, each of which comprises a drying oven (15) that is composed of a tunnel-like structure (56) made of pressed metal, with inlet doors (57) and outlet doors (58) that can open and close partially, the movement of said doors (57, 58) occurring by means of a chain drive driven by a gearmotor (59).
11. The apparatus according to one or more of the preceding claims, **characterized in that** it comprises a first printing region and a second printing region, after which there is a first drying region and a second drying region, each of which comprises a conveyance unit (15a) for hot air, which is constituted by a nozzle (70) that can move on a beam (71) of a bridge crane (72) arranged transversely to said apparatus, said beam (71) being also movable at right angles to said apparatus by way of the presence of one or more gearmotors (73a, 73b), which by way of a toothed belt or chain (74) or other interconnection means moves a plate (74) to which said nozzle (70)

is connected and allows the lifting or lowering of said beam (71), said plate and said beam being movable on guides, said nozzle (70) being connected to a duct (75) for the conveyance of hot air which is forced by means of a fan (76).

12. The apparatus according to one or more of the preceding claims, **characterized in that** in the region where printing occurs there is a stop for said packs (3a), at which there is a first device for separating said packs (3a) with respect to a fixed stop (87), also termed "zero" point, at the end of printing said spacing device moving said packs (3a) away from said fixed stop (87) in order to prevent it from rubbing against it and becoming misaligned, said pack separation device being composed of a pneumatic cylinder (88), which is anchored on said fixed stop (87), and a disk (89), which is made of plastics in order to avoid marking said pack, anchored on the stem of said pneumatic cylinder, in the inactive step said disk retracting inside said fixed stop, while when printing has been completed said pneumatic cylinder pushes said pack of crates made of polystyrene by a chosen extent and then returns immediately to the inactive position in order to allow the next pack to be positioned.
13. The apparatus according to claim 12, **characterized in that** it comprises a second device for separating said packs (3a) which is arranged in said first drying region, said second device being constituted by a pneumatic cylinder (90) anchored on a post (91), on the stem (92) of which a guide (93) is transversely associated, said guide having free wheels (94) in order to avoid marking the pack of crates made of polystyrene, said pneumatic cylinder pushing said pack of polystyrene crates for a chosen extent and then returning immediately to the inactive position in order to allow the next pack to be positioned.
14. The apparatus according to one or more of the preceding claims, **characterized in that** after exit from said first drying region, said pack (3a) is transferred at an overturning unit (95), which is designed to pick up said pack of polystyrene containment crates, rotate it through 180° and deposit it back onto said third roller bed (16), said overturning unit (95) being composed of a pair of grip jaws (96), of which one is movable and one is fixed, which can be moved mutually closer or apart by means of a pneumatic cylinder, said overturning unit (95) being arranged transversely to said third roller bed (16), in order to allow the grip of packs of polystyrene containment crates having different dimensions, said pair of grip jaws (96) being installed on a rotating axis (97) in order to allow rotation through 180° from left to right of the pack of crates and return into position in order to pick up another pack, in order to ensure that said

pneumatic cylinder of said movable jaw does not press said pack excessively, a pressure regulator being installed and being calibrated beforehand and controlled by sensors, rotating cylinders being installed at the ends of said rotating axis (97) and being in turn installed on a system of linear guides in order to be able to raise and/or lower the axis of rotation to grip the various models of packs of polystyrene crates, the height of said axis (97) being adjustable according to the format of the pack of polystyrene crates to be treated.

15. The apparatus according to claim 14, **characterized in that** after said overturning unit (95) there is a second printing means, similar to said first printing means (12) and adapted to print a further side of said articles (3) of each pack (3a), followed by a second drying region, similar to said first drying region.
16. The apparatus according to claim 15, **characterized in that** said first and/or second printing means have means for correcting the position of the printing heads (98), said means comprising printing heads (98), constituted by an encoder for reading the rising and/or descending motion of a plotter, by a pair constituted by a precision sensor (99) and receiver (100) arranged in the region of initial printing, or "heads zero" point, by a pair constituted by a precision sensor (101) and receiver (102) arranged after said heads (98), or "heads zero" point, by a pair constituted by a sensor (103) and reflector (104) for the quick reading of the height of the pack (3a).
17. A method for digital printing on articles (3) constituted by containment boxes or crates made of sintered expanded polystyrene, **characterized in that** it comprises the steps that consist in:
 - a) mutually stacking and arranging on a chosen side a plurality of individual articles (3) so as to define packs (3a);
 - b) placing groups of said packs (3a) onto supporting and advancement means at at least one first digital printing means (12), which can move axially and at right angles to said advancement means and is arranged above said packs (3 a);
 - c) moving said at least one printing means (12) for its calibration on said articles (3) that constitute said packs (3a); and
 - d) printing each individual article (3) that constitutes each one of said packs (3 a).
18. The method according to claim 17, **characterized in that** it comprises the step of drying and moving said packs (3a) after said at least one first printing means (12) at an overturning unit (95) and then in a second digital printing means (12) and then in an unloading region for pickup from said apparatus.

19. The method according to claim 17, **characterized in that** it comprises the step of stopping said packs (3a) of articles (3) for the advancement of a single pack (3a) at a time and the step of stopping said packs (3a) of articles in said central region for their centering with respect to said digital printing means (12).
20. An article, particularly made of sintered expanded polystyrene, provided with a customized printed element, **characterized in that** it is manufactured according to the method of claims 17, 18 and 19.

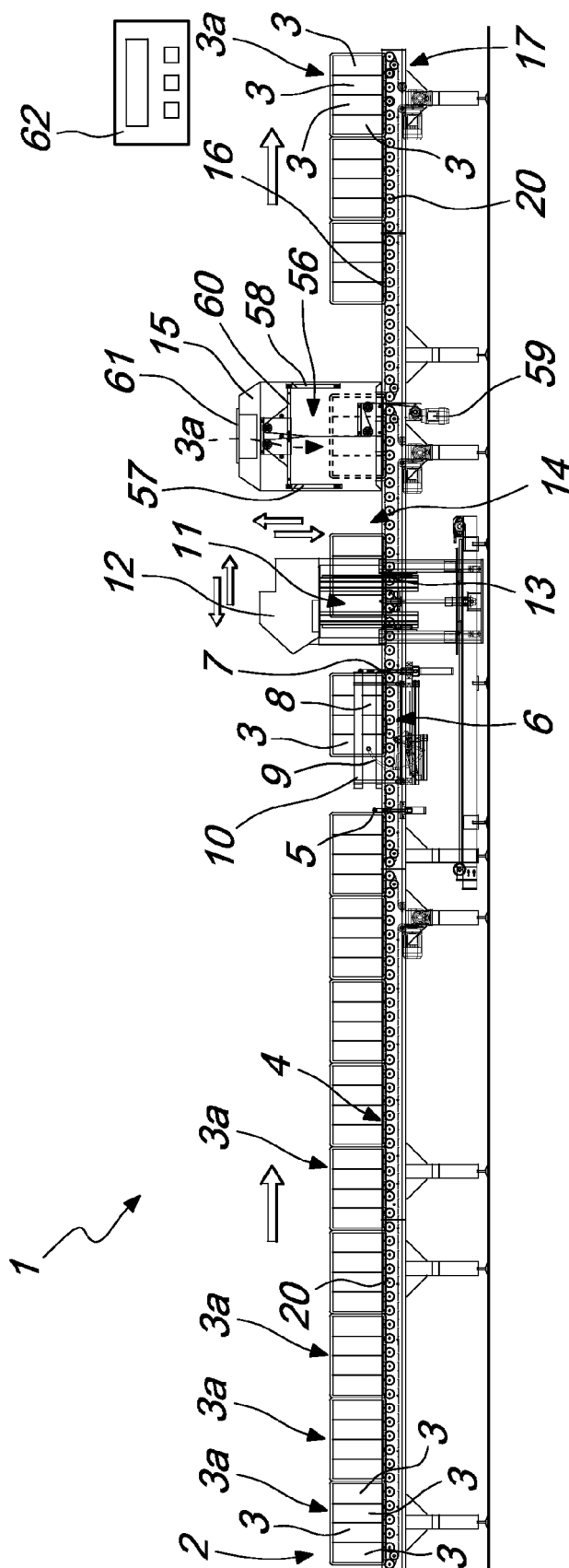
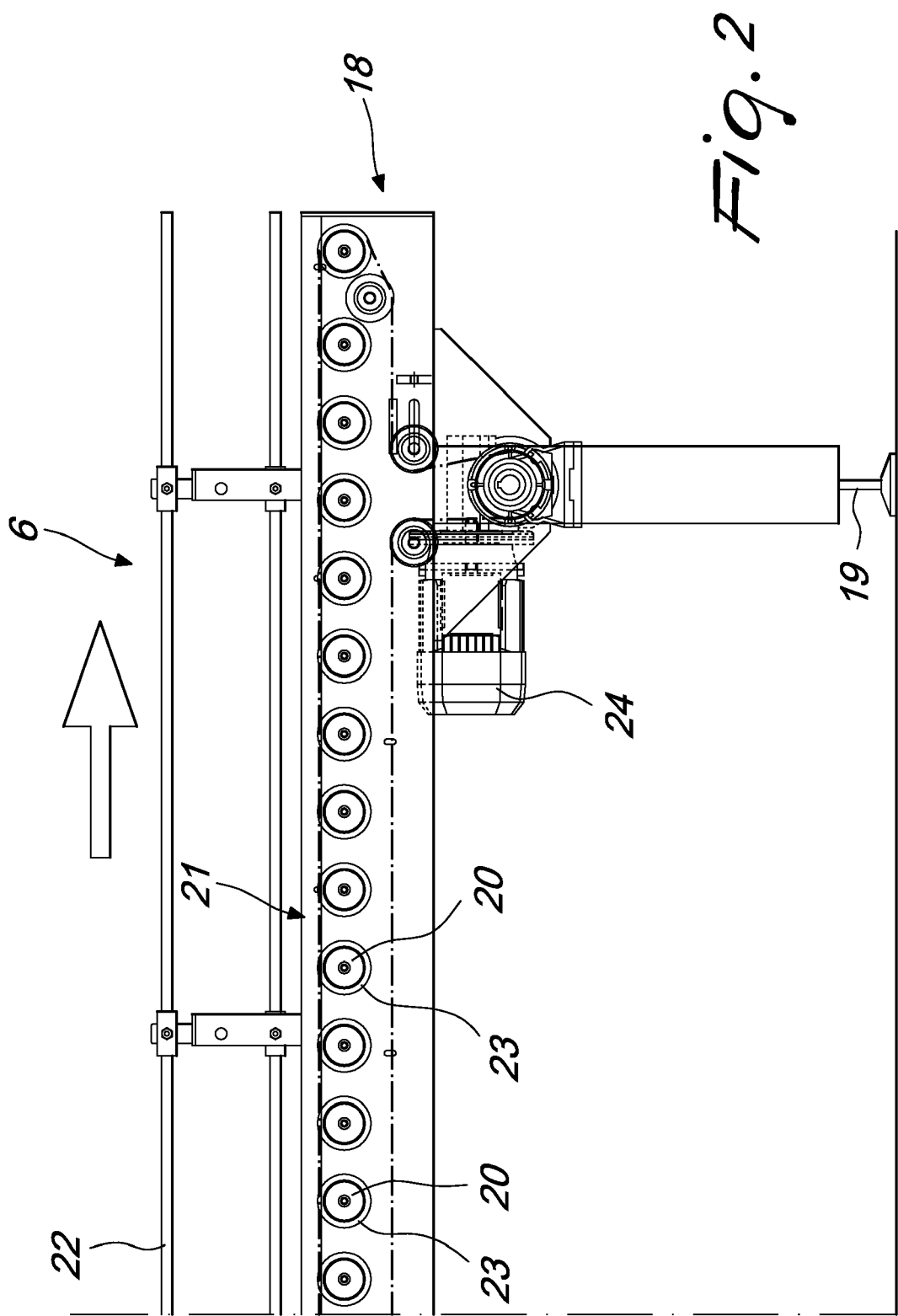
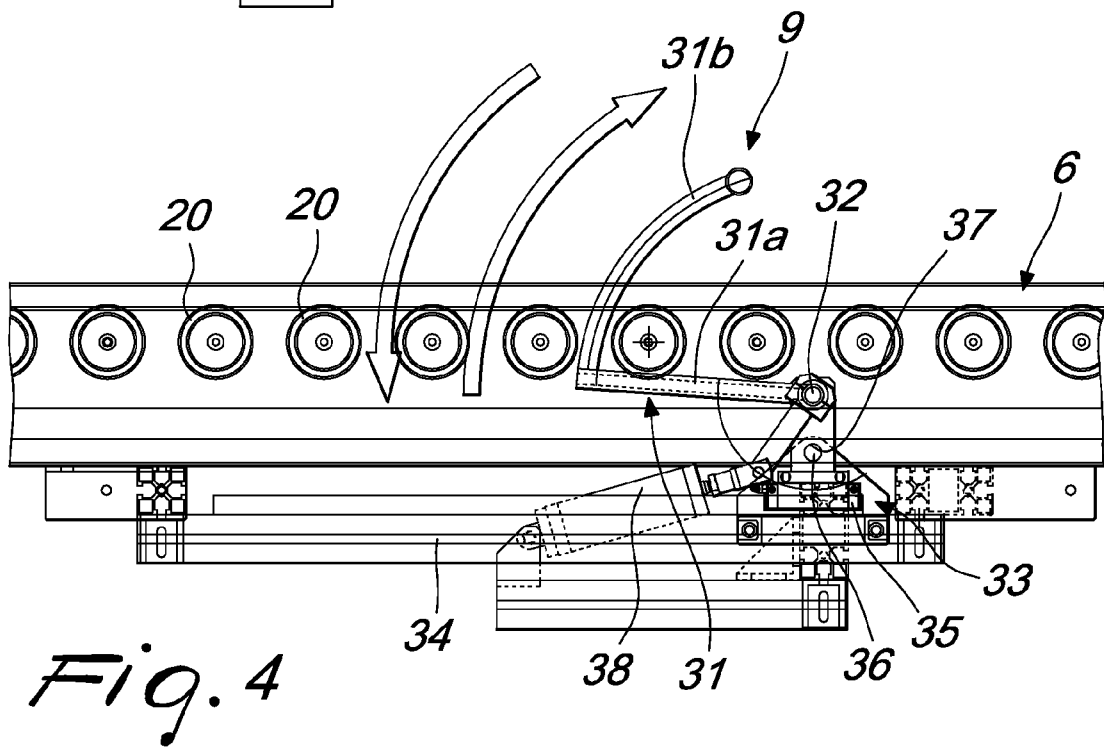
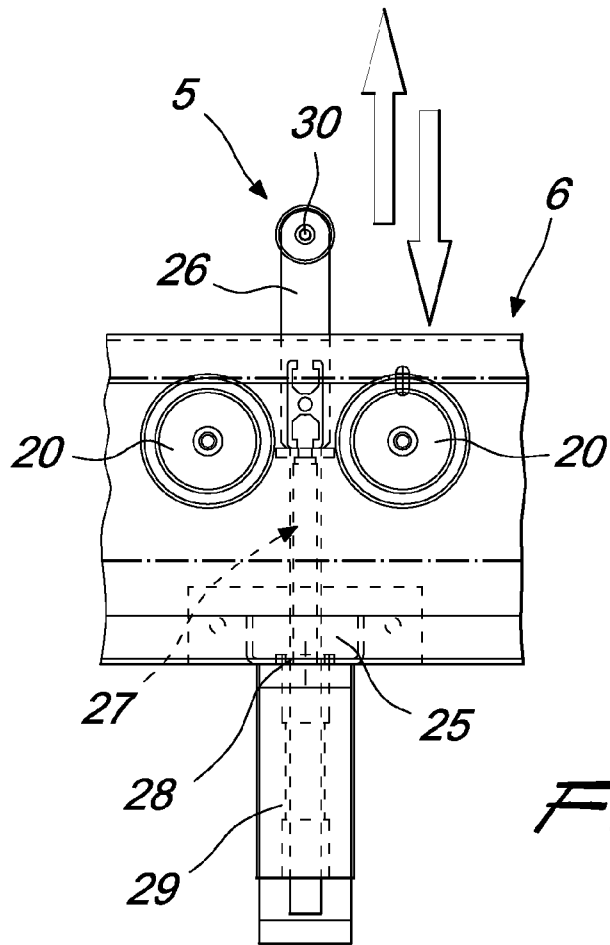


Fig. 1





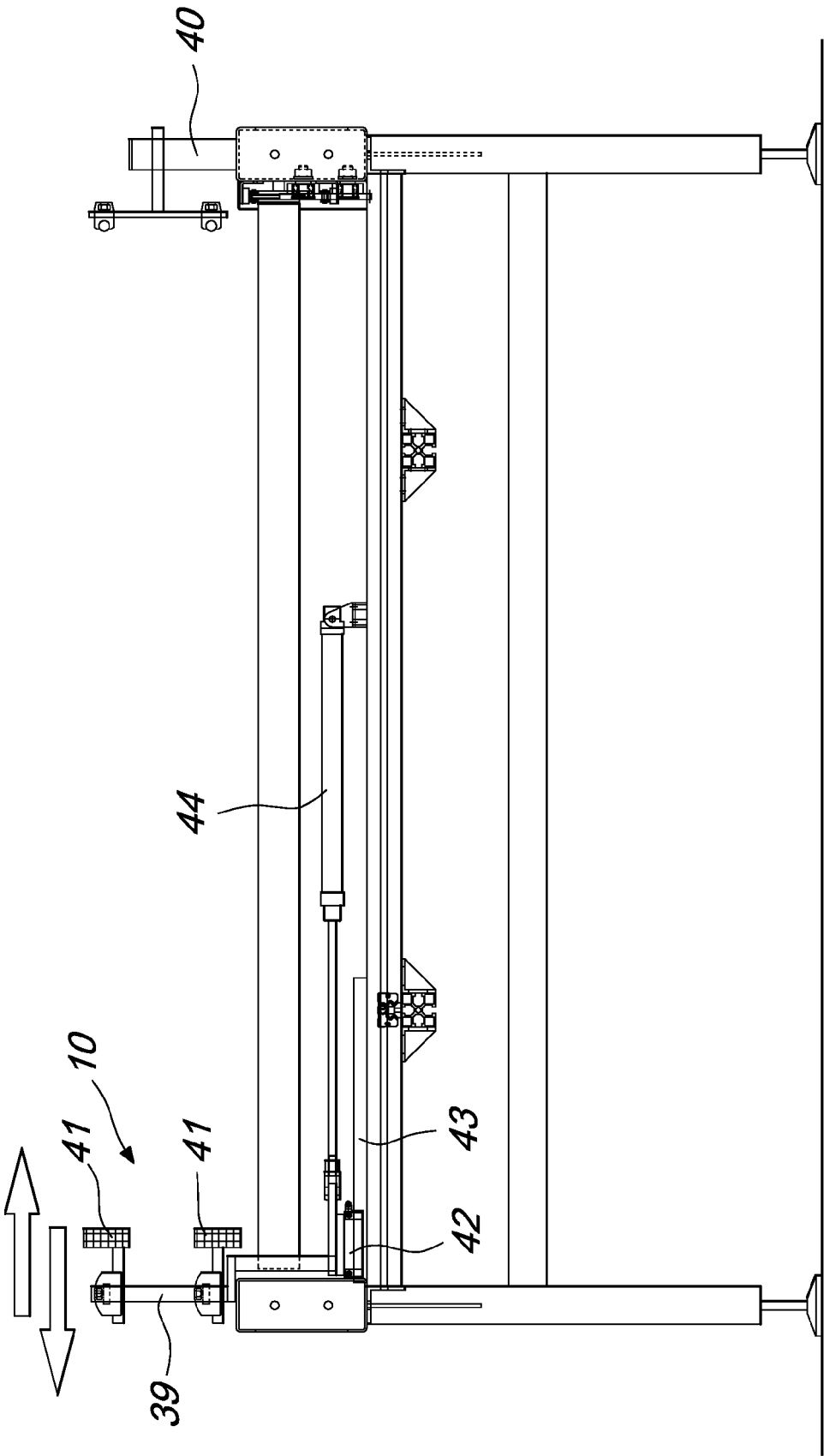
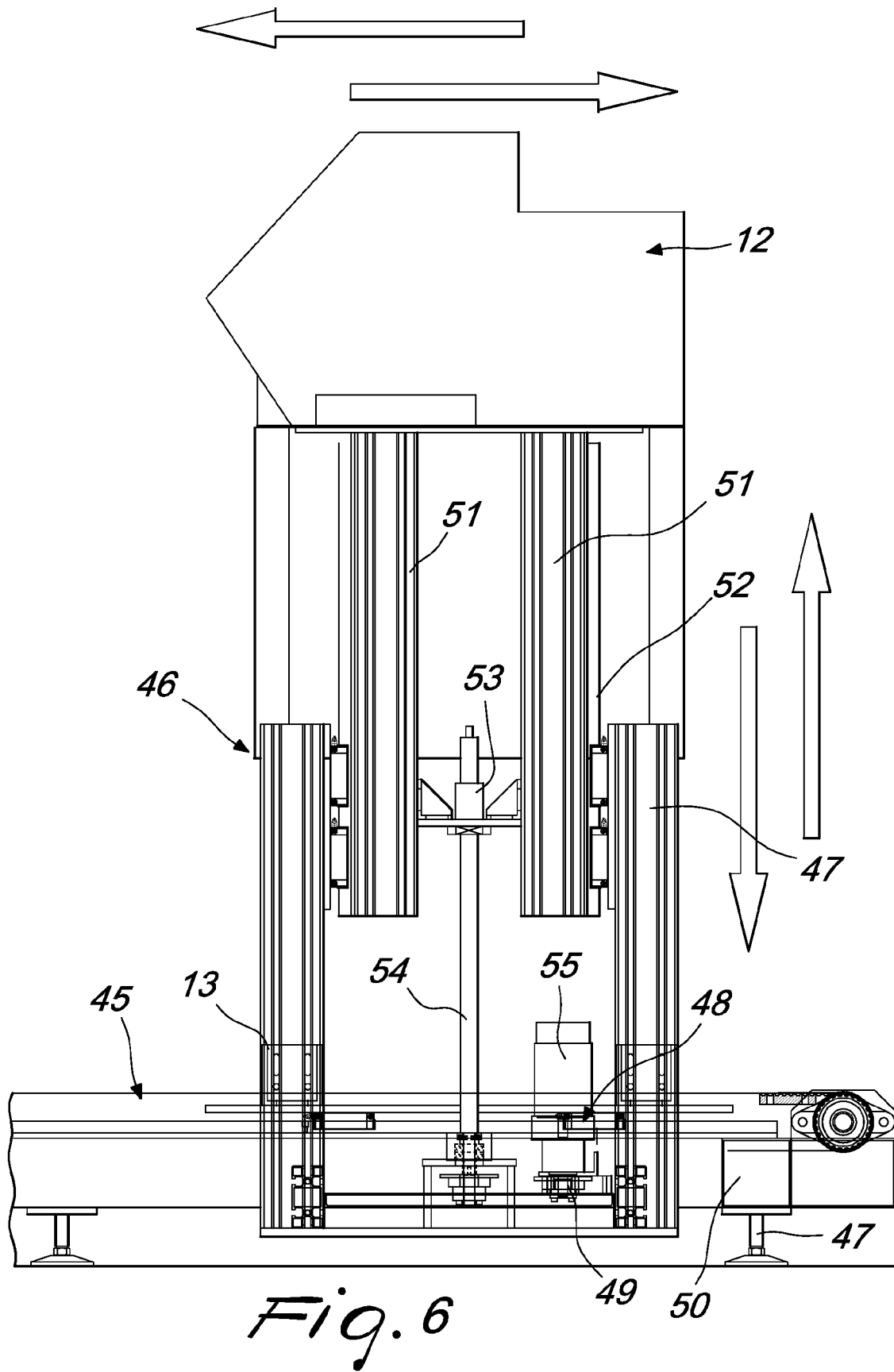


Fig. 5



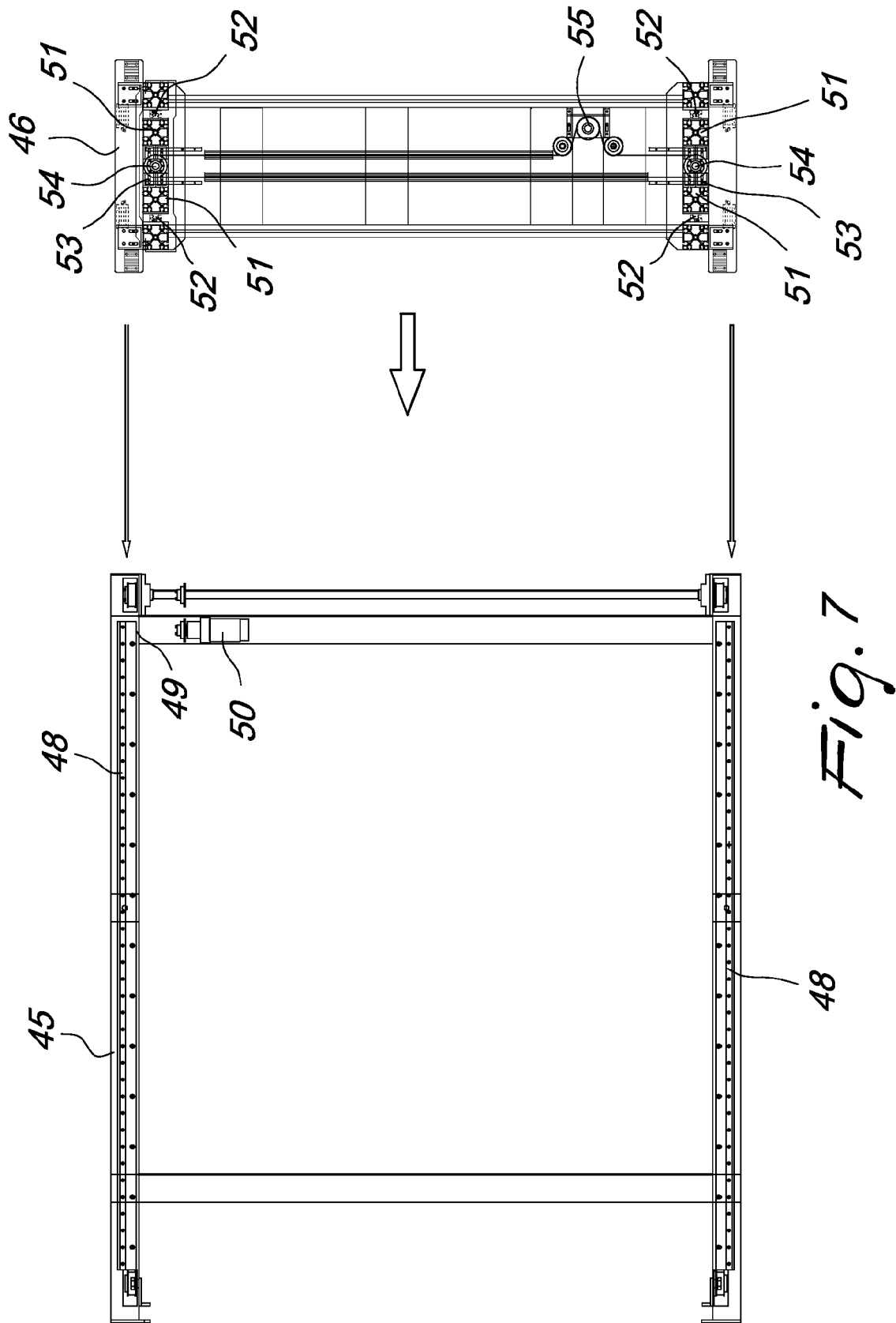


Fig. 7

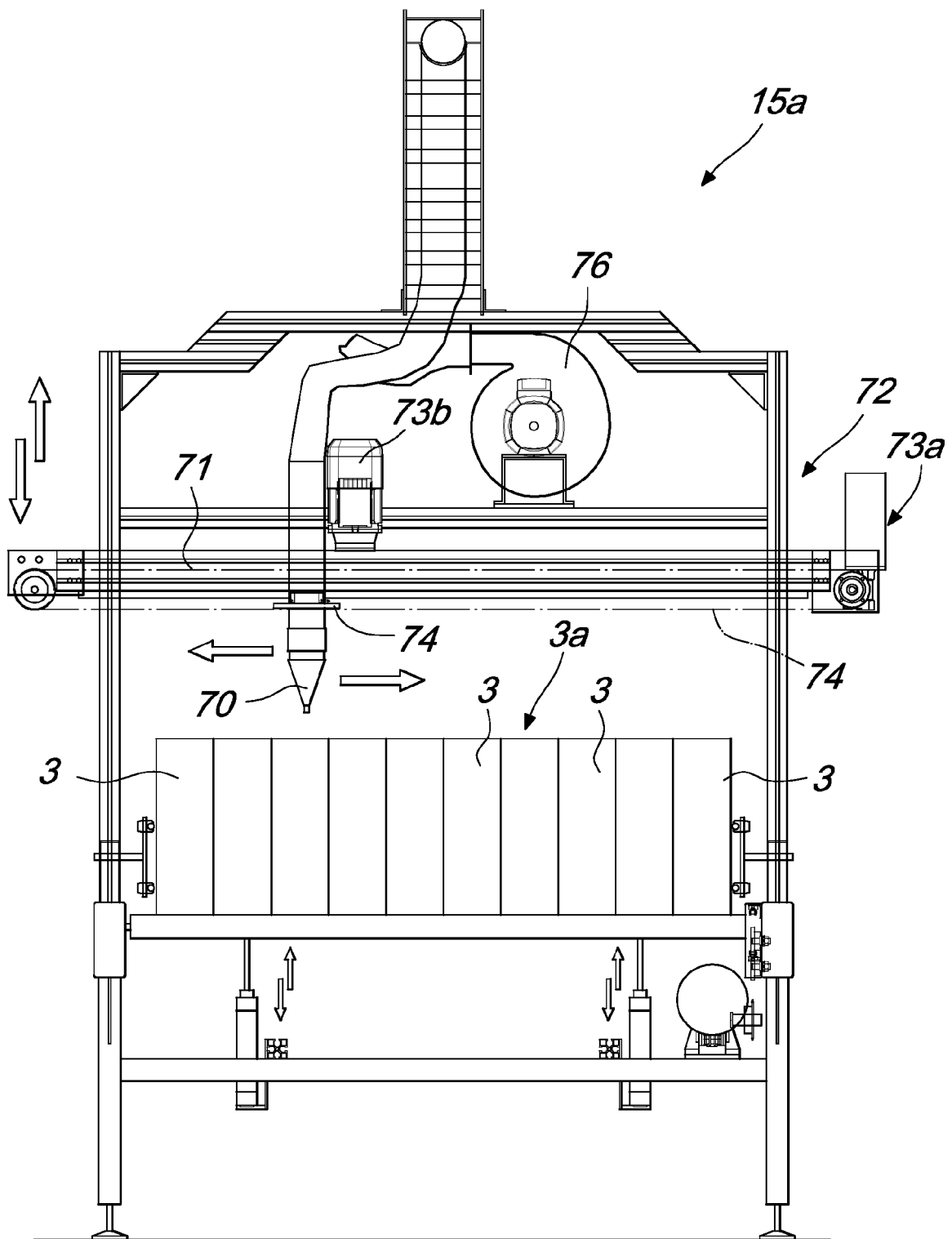
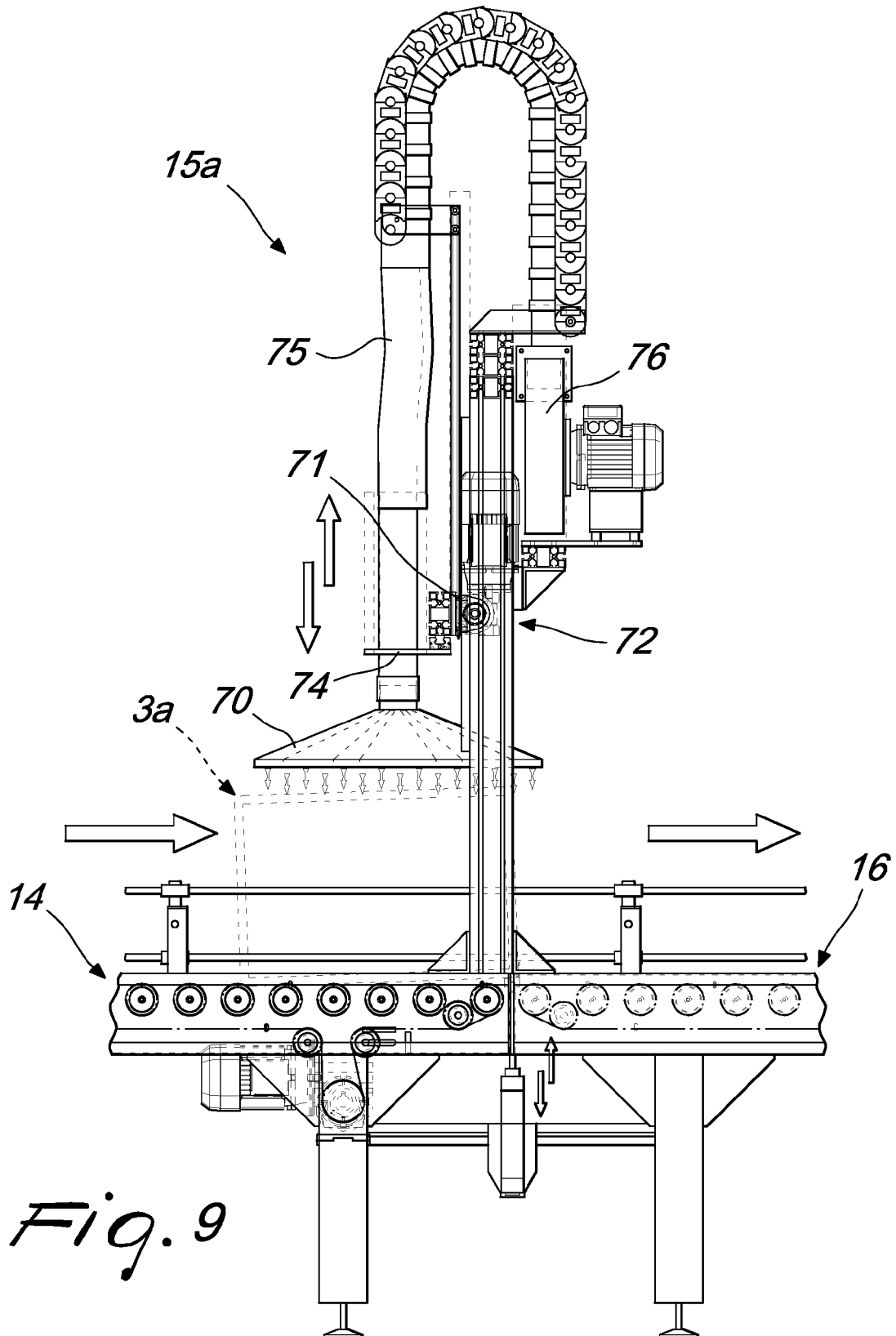


Fig. 8



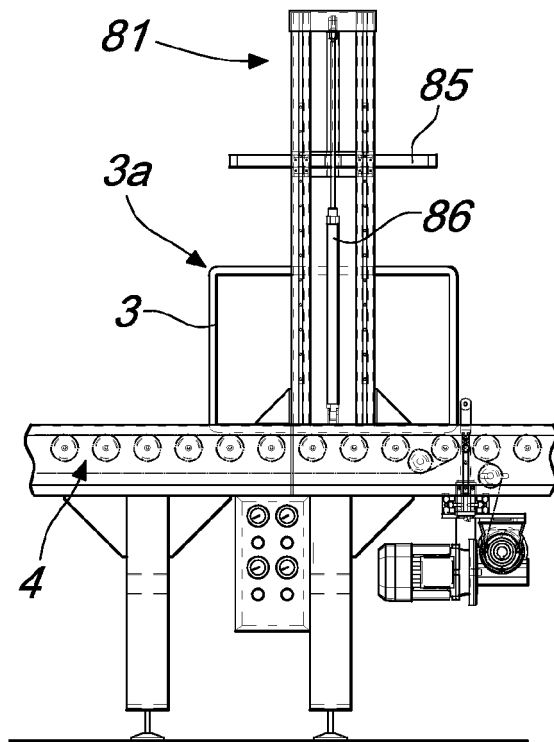


Fig. 10

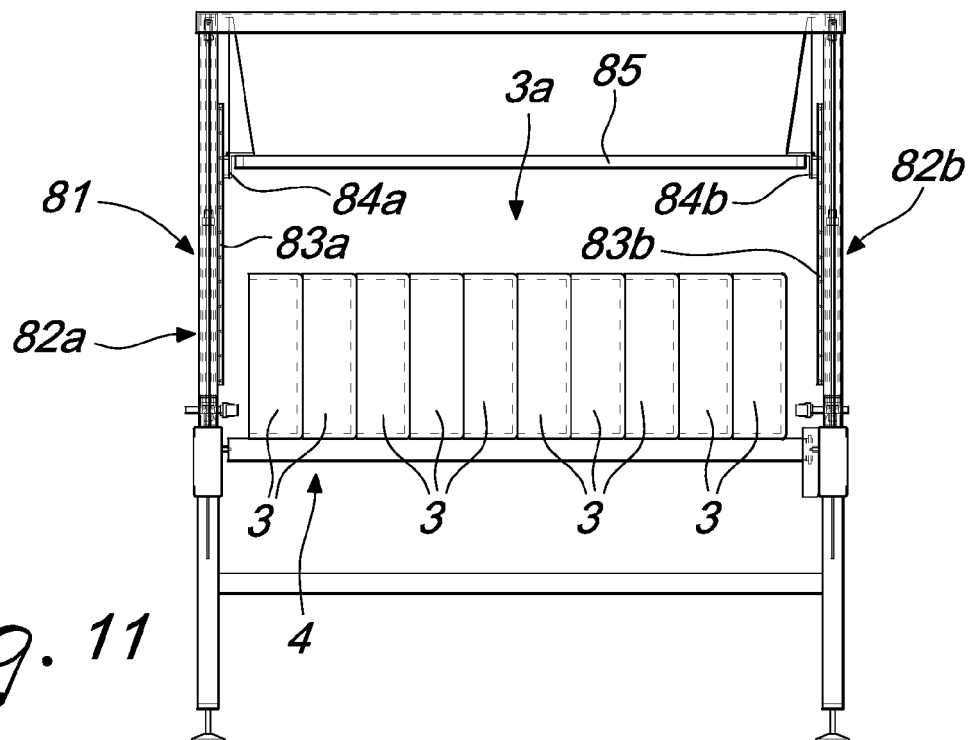


Fig. 11

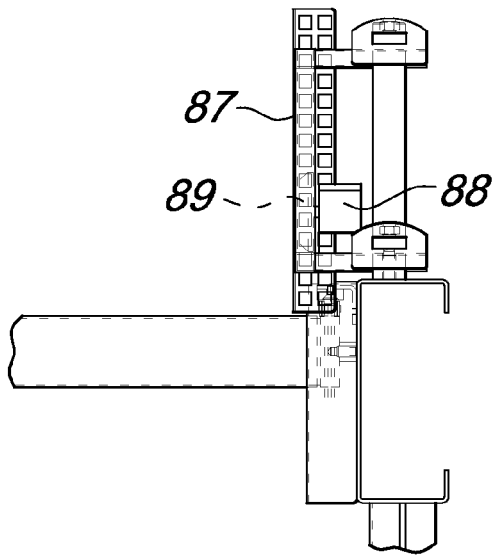


Fig. 12

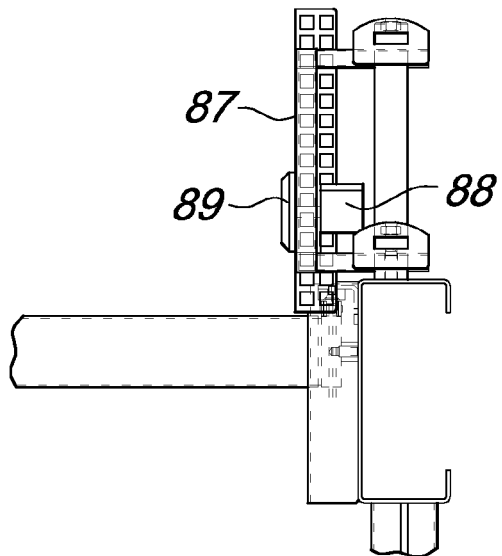


Fig. 13

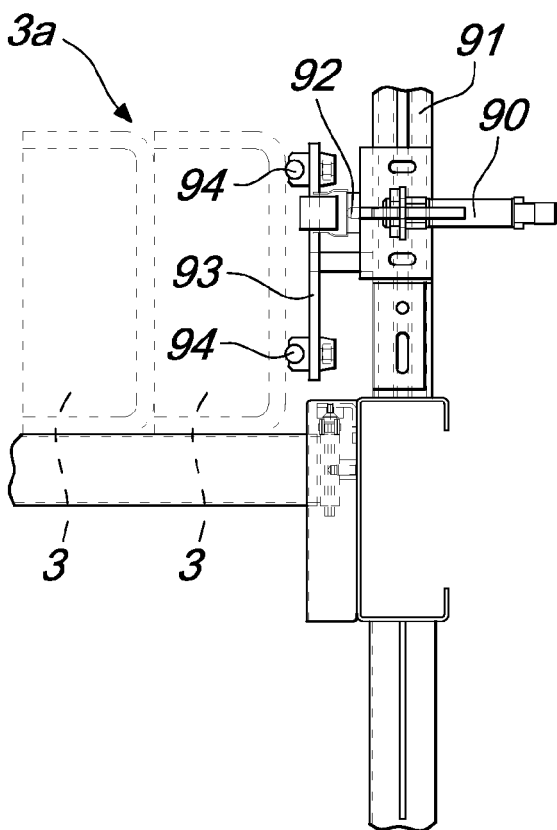


Fig. 14

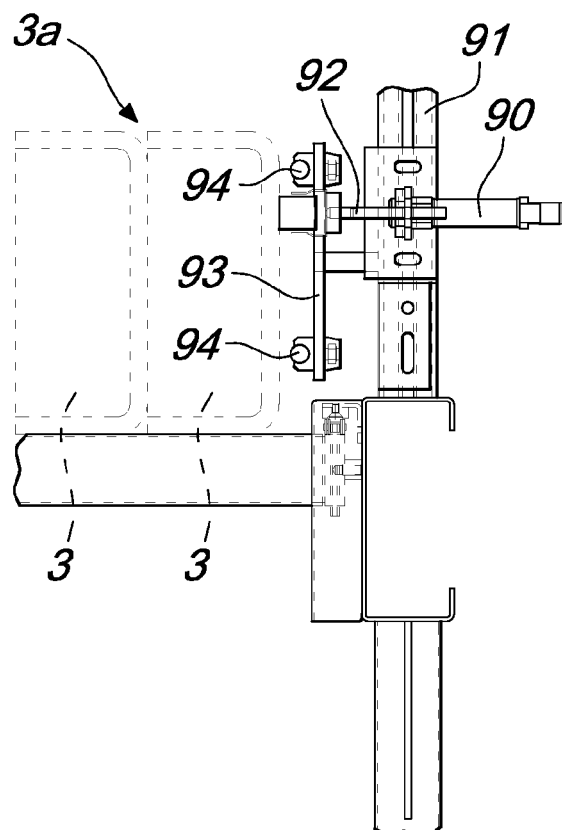
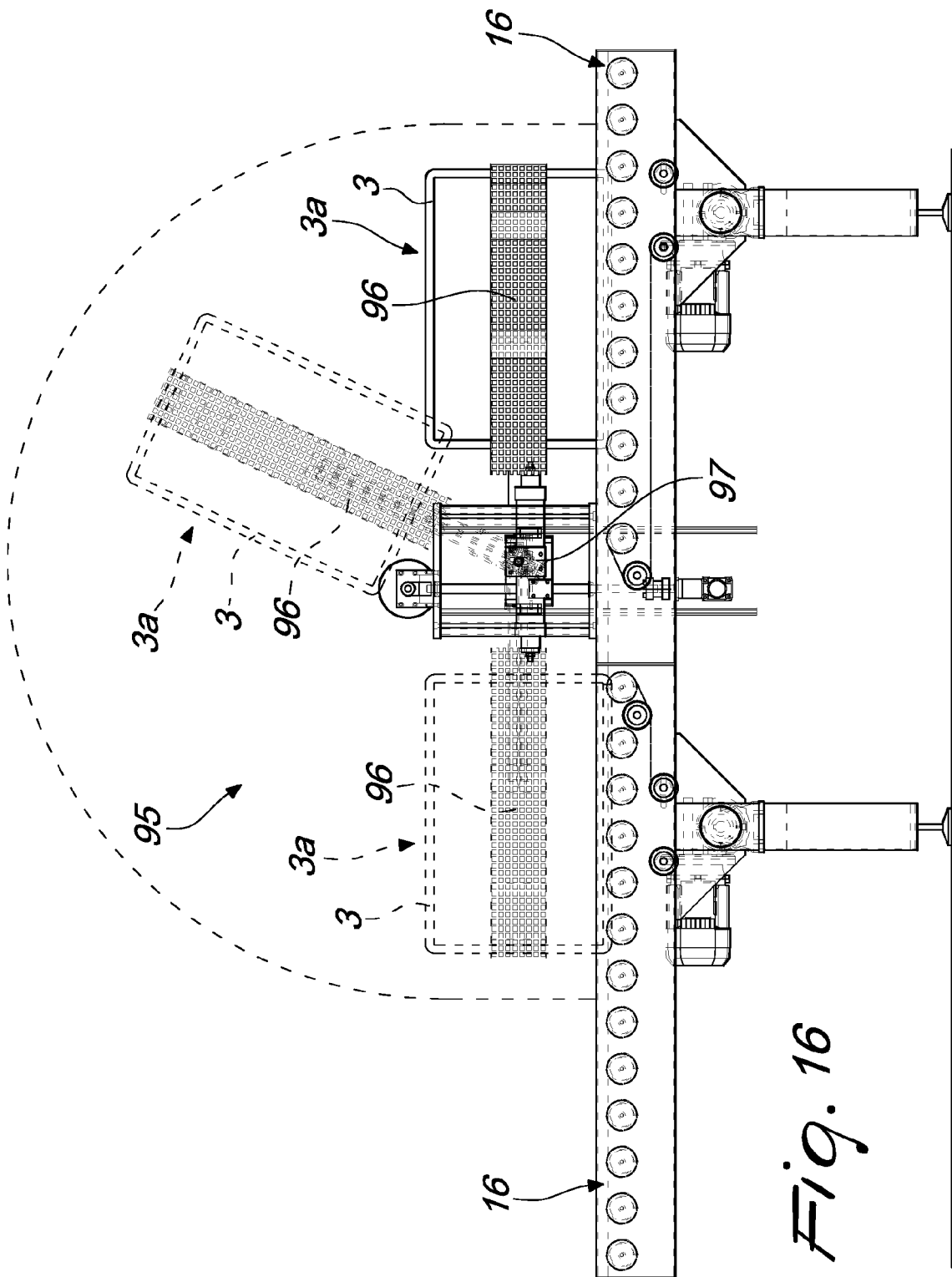


Fig. 15



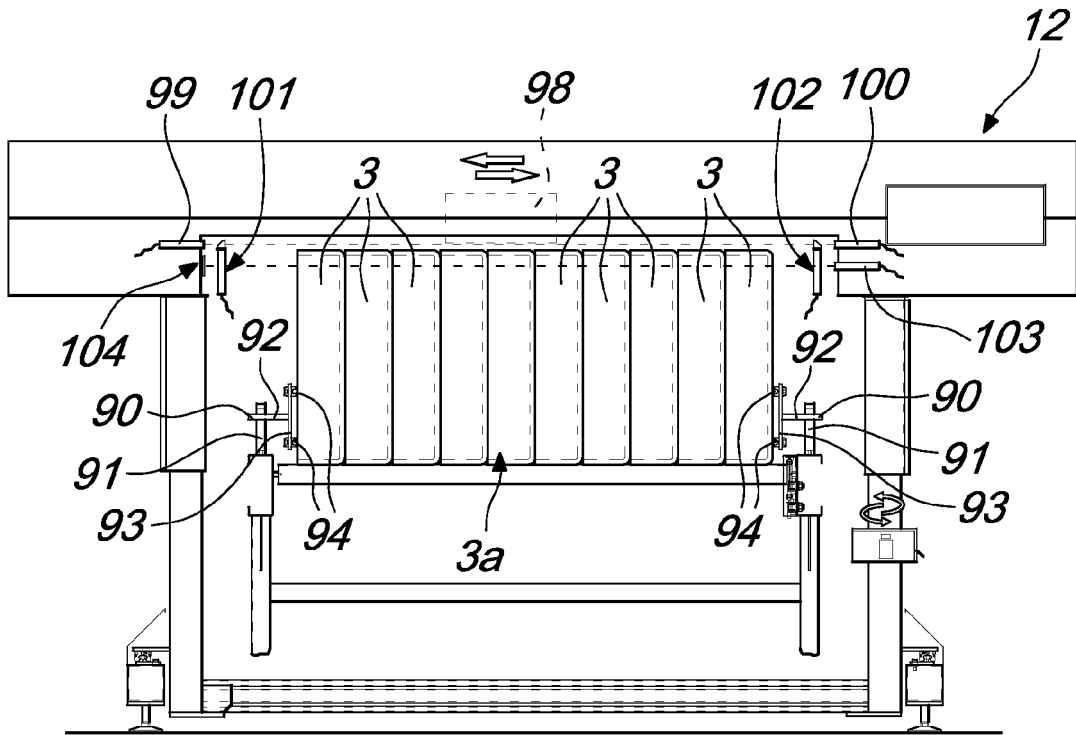


Fig. 17

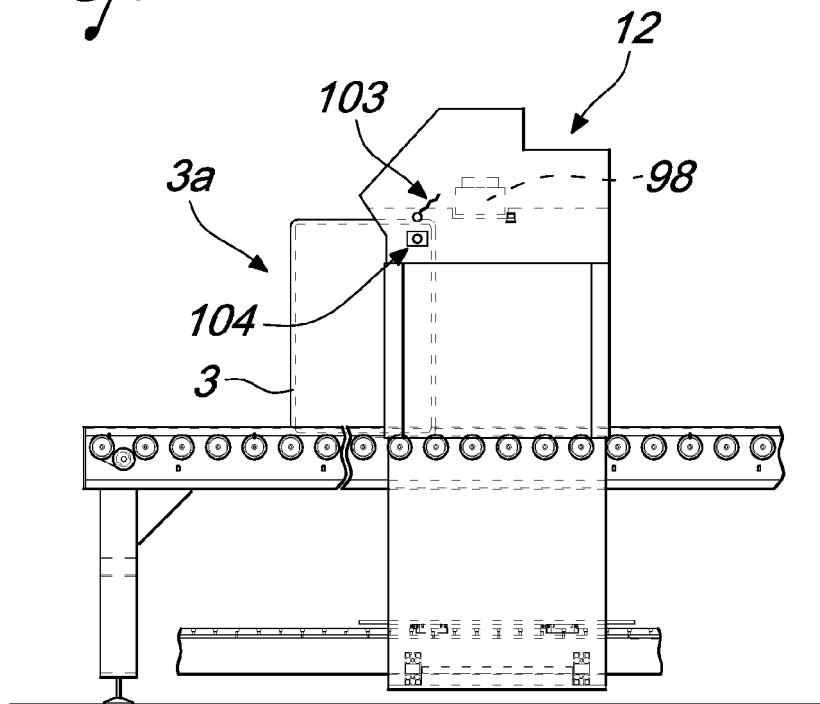
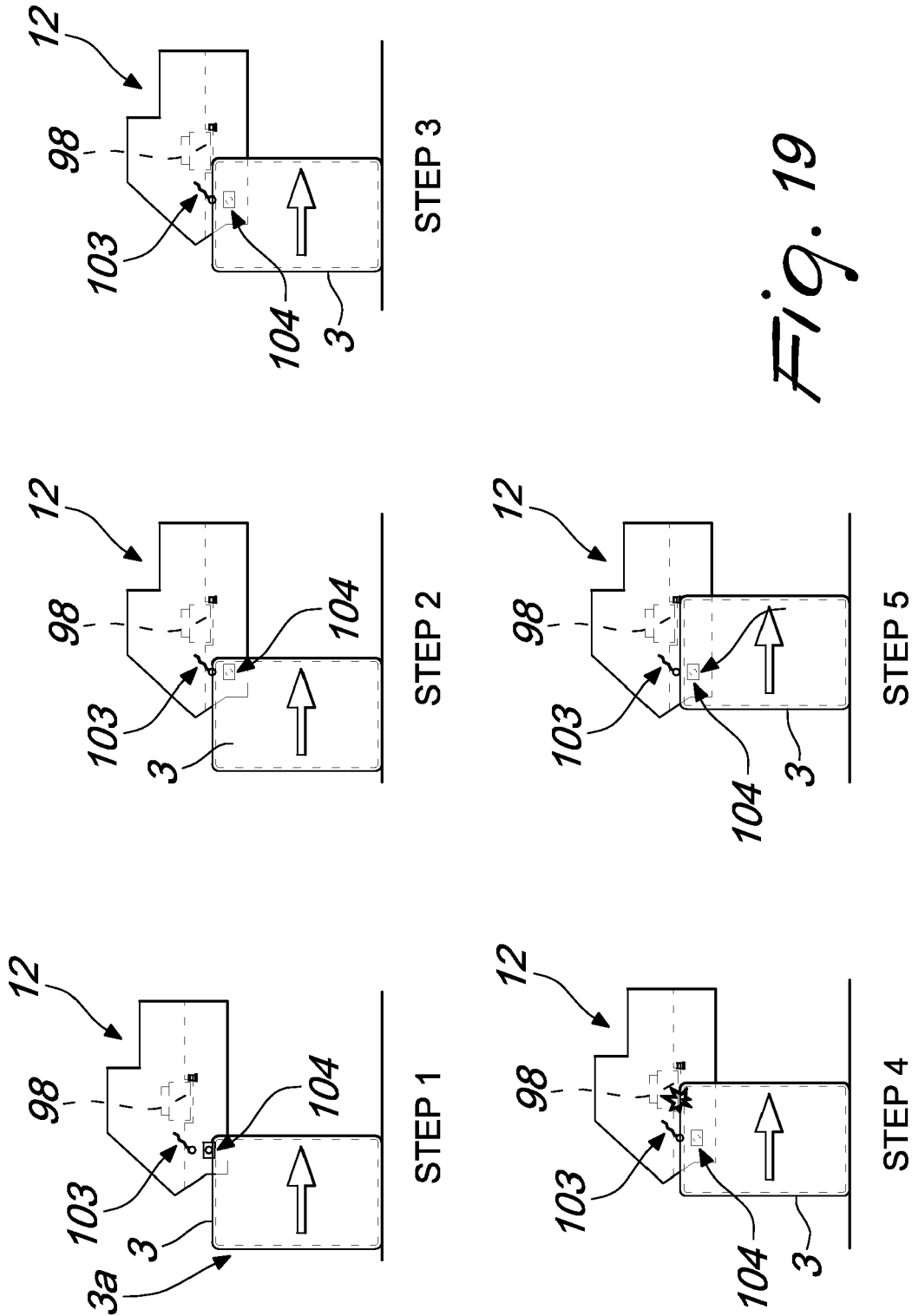


Fig. 18





EUROPEAN SEARCH REPORT

Application Number
EP 10 16 4123

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A	----- DE 10 2007 021765 A1 (BAUER JOERG R [DE]) 13 November 2008 (2008-11-13) * the whole document *	1-20	
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Place of search Munich		Date of completion of the search 5 October 2010	Examiner Zacchini, Daniela
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