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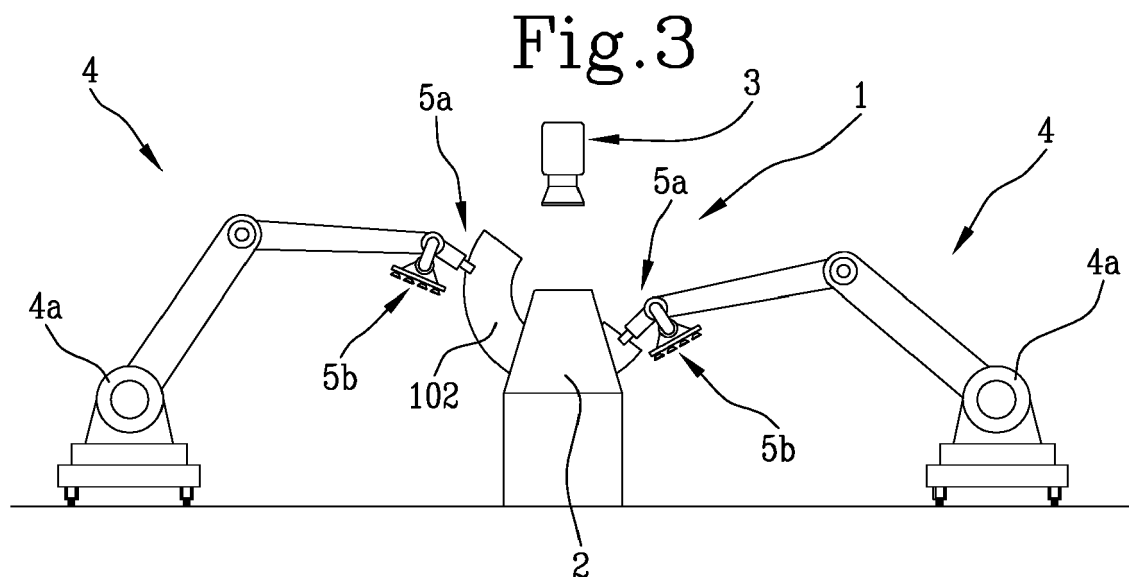
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(54) **METHOD AND APPARATUS FOR MANUFACTURING A SPIRAL DESTINED TO AN AUGER**

(57) A method for manufacturing a spiral (101) for an auger (100), comprising the steps of:
- providing a suitably shaped plate (102) for obtaining a spiral (101) for the auger,
- forming a folding of a first portion (107) of the plate (102) with the aid of a folding device (2),
- detecting geometric data being indicative of the three-dimensional shape of at least the first portion (107) of the plate (102) after the folding step,

- comparing said identifying geometric data with a reference virtual model and identifying the deviation, if any,
- following the comparison step, forming a folding of a second portion (108) of the plate (102) contiguous to the first portion (107) through the folding device (2).

The step of folding the second portion (108) of the plate (102) comprises a sub-step of compensating the deviation when the deviation is greater than a certain threshold value.



Description

[0001] The present invention relates to a method for manufacturing a spiral for an auger.

[0002] In particular, the method relates to the manufacturing of spirals, or portions of spirals, which can be joined, through joining methods of the prior art (e.g.: welding, bolted join) for manufacturing large augers.

[0003] Nowadays very thick spirals are often prevalently formed through a folding process of flat metal shapes that are inserted into a horizontal press equipped with a mould and a counter-mould manufactured *ad hoc* for the type of spiral to be produced.

[0004] The spiral thus obtained through pressing is then positioned on a template to be checked; if the spiral is not folded correctly, the operator generally performs a series of corrective folds manually.

[0005] The check is typically performed visually or with the aid of measuring tools. The mechanical post-folding manual corrective actions cannot however guarantee the necessary precision for manufacturing a good quality spiral, which does not jeopardise the correct interconnection with subsequent spirals for manufacturing the designed auger.

[0006] In fact, the check depends on the sensitivity of the operator and the corrective actions that the latter needs to perform are often lengthy and complicated.

[0007] In this context, the technical task underpinning the present invention is to provide a method for manufacturing a spiral for an auger that obviates one or more drawbacks of the prior art as cited above.

[0008] In particular, an object of the present invention is to provide a method and an apparatus for manufacturing a spiral for an auger that allows the checking time to be optimised and the precision of the folding steps to be improved.

[0009] The technical task set and the objects specified are substantially attained by a method and an apparatus for manufacturing a spiral for an auger, comprising the technical characteristics set out in one or more of the accompanying claims.

[0010] In particular, according to a first aspect, the present invention relates to a method for manufacturing a spiral for an auger, comprising the steps of:

- providing a suitably shaped plate for obtaining a spiral for the auger or a part thereof,
- forming a folding of a first portion of the plate with the aid of a folding device,
- detecting geometric data being indicative of the three-dimensional shape of at least the first portion of the plate after the folding step,
- comparing said identifying geometric data with a reference virtual model and identifying the deviation, if any,
- following the step of comparing the identifying geometric data, forming a folding of a second portion of the plate contiguous to the first portion through the

folding device.

[0011] Advantageously, the step of folding the second portion of the plate comprises a sub-step of compensating the deviation when the deviation is greater than a certain threshold value.

[0012] Thanks to the comparison between the identifying geometric data of the spiral with the reference virtual model, it is possible to check the correctness of the folding step and provides for the subsequent folding so as to correct any deviation, when it is higher than a certain threshold value for which intervention is required.

[0013] Advantageously, the continuous retrofit on the folding step, obtained through the detection and comparison of the identifying geometric data and the subsequent arrangement of the corrective intervention, prevents any possible propagation of the folding error.

therefore, advantageously, thanks to the present method, it is possible to improve the efficiency of the entire spiral production process.

[0014] In accordance with a possible aspect, the present invention further relates to an apparatus for manufacturing a spiral for an auger comprising:

- a folding device of a plate, wherein the plate has a suitable shape for the realization of a spiral for an auger or a part of the spiral, wherein the folding device is configured to fold at least a first portion of the plate and a subsequent second portion of the plate contiguous to the first,
- a unit for detecting the identifying geometric data of the three dimensional shape of at least the first portion of the plate,
- handling means configured for moving the plate between a first folding position, in which the folding device is operable on the first portion, and a second folding position, in which the folding device is operable on the second portion, wherein the handling means preferably comprises at least one robot having gripping means suitable to grasp and move the plate.
- a control and command unit configured to control the folding of the plate in the first and second folding position.

[0015] Advantageously, the control and command unit is configured to receive the identifying geometric data, compare them with a reference virtual model and identify any deviation so as to command the handling means and/or the folding device to compensate the deviation when the deviation is greater than a certain threshold value.

[0016] In this way, the machine advantageously allows a retroactive automated check which guarantees the optimal folding of the plate for the realization of a spiral as coherent as possible with the ideal reference model. Advantageously, thanks to the presence of the command and control unit interconnected with the folding device

and the handling means, the apparatus is able to operate in complete autonomy, automatically moving the plate from the beginning to the end of the folding process, without the need for any manual intervention by an operator.

[0017] Further characteristics and advantages of the present invention will more fully emerge from the indicative, thus non-limiting description of a preferred but not exclusive embodiment of an apparatus for realizing a spiral for an auger, as illustrated in the accompanying drawings, in which:

- figure 1 is a schematic perspective view of an auger in which a spiral is highlighted obtainable through the method and the apparatus according to the present invention,
- figure 2A is an enlarged schematic perspective view of the spiral identified in the auger of figure 1,
- figure 2B is a projection on the horizontal plane of the spiral identified in figure 1,
- figure 3 is a schematic front view of an apparatus according to the present invention during a first folding step,
- figure 4 is a schematic front view of an apparatus according to the present invention during a second folding step,
- figure 5 is a schematic front view of an apparatus according to the present invention during a third folding step,
- figure 5A is a schematic lateral view of the apparatus illustrated in figure 5 according to the arrow V,
- figures 6A-6C are relative positioning diagrams of the plate and of the folding device respectively in the first, second and third folding steps, illustrated in figures 3-5,
- figure 7 is a schematic view of a detail of the apparatus handling means; and
- figure 8 is a further possible relative positioning means for positioning the plate and the folding device for compensating the deviation.

[0018] With reference to the appended figures, 1 indicates an apparatus for the realization of a spiral for an auger as a whole.

[0019] With reference to figure 1, a possible embodiment of an auger 100 is indicated, in particular a conical auger, however the invention is also applicable for the realization of cylindrical augers.

[0020] According to the present invention, the auger 100 is realized through the assembly of spirals 101 or parts of spirals 101, not illustrated.

[0021] The spirals 101 for augers 100 are realized according to the method of the present invention, which above all envisages the step of providing a plate 102 having a suitable shape for the realization of a spiral 101 for an auger 100 or of a part of a spiral 101.

[0022] In particular, it is to be noted that the plate 102 usable for the realization of the spiral 101 comprises the projection in the horizontal plane P of the spiral 101 itself.

[0023] Preferably, the method comprises a design step in which, through an electronic processing device not illustrated in the appended figures, a reference virtual model of the auger 100 to be realized is identified. "Reference virtual model" means a mathematical model and/or a three-dimensional model (e.g. a 3D drawing) of the auger 100 to be realized. For example, during the design step, the operator can acquire the reference virtual model intended to be realized from the client, or can realize the reference virtual model based on the specific requirements and instructions dictated by the client.

[0024] Once the reference virtual model of the auger 100 has been defined, it is broken down virtually into spirals 101 for optimizing the folding process and identifying the correct number of spirals to be realized.

[0025] The spirals 101 are analysed by the electronic processing device for identifying the geometric data indicative of their three-dimensional shapes. With reference to figure 2B, the electronic processing device splits the spiral 101 into sectors 103 delimited laterally by directrices 104 having their origin in the centre 105 of the spiral 101.

[0026] The directrices 104 define, as will become clear in the following description, the possible folding lines of the plate 102.

[0027] Preferably, the sectors 103 have an angular amplitude α , measured between two consecutive directrices 104, having a value comprised between 10° and 60° , preferably equal to 20° ; even more preferably, the sectors 103 have a constant angular amplitude α .

[0028] With reference to figure 2A, the electronic processing device determines the distances 106 between a horizontal plane and the upper surface and/or the lower surface of the spiral 101 at the directrices 104 and detects the trend of the upper surface and/or the lower surface of the spiral.

[0029] The reference virtual model of the spiral 101 being defined in this way, the method according to the present invention comprises the following successions of steps:

- forming a folding of a first portion 107 of the plate 102 with the aid of a folding device 2,
- detecting the identifying geometric data of the three dimensional shape of at least the first portion 107 of the plate 102,
- comparing said identifying geometric data with the reference virtual model and identifying the deviation, if any,
- forming a folding of a second portion 108 of the plate 102 contiguous to the first portion 107 through the folding device 2, wherein this step advantageously comprises a sub-step of compensating the deviation when the deviation is greater than a certain threshold value.

[0030] Preferably, the identifying geometric data detected by the real spiral 101 are at least the values of the

angular amplitudes α and the values of the distances 106.

[0031] In this way, following the first folding, the apparatus 1, detecting the identifying geometric data and comparing them with the reference virtual model available (e.g. by virtually superimposing the three-dimensional shape of the reference virtual model with the three-dimensional shape of the plate 102 in the real current state after folding), is able to check if the first folding was performed correctly (or if the first portion 107 of the plate 102 folded corresponds in geometric/dimensional terms to the corresponding first portion of the reference virtual model of the spiral 101 to be realized) and if it is necessary, before performing the second folding, to compensate so as to correct any deviation detected.

[0032] The present method therefore provides for the discretization of the folding process and at the same time a discretization of the control process with a retroactive effect, allowing a final product to be obtained (the spiral 101) which is as faithful and corresponds as much as possible to the reference virtual model designed.

[0033] In fact, the progressive advancement of the folding process in portions 107, 108 allows any previous error to be compensated, detecting a deviation value, with a corrective intervention on the folding of the subsequent portion.

[0034] Thanks to the present invention, the necessary time for obtaining a spiral 101 is notably reduced, since it is not necessary at the end of the realization process thereof, to perform any checks through a manual process, but by performing a rapid automatic step-by-step check.

[0035] At the end of the second folding, the procedure described is repeated based on the number of folds to perform, proceeding on the adjacent portions in sequence.

[0036] Advantageously, the level of reliability of the method and the apparatus 1 according to the invention with respect to traditional methods and machines is much higher, thanks to the continuous checking step at each fold.

[0037] By performing a check at the end of every fold of the plate portions 102 it is possible to prevent the propagation of any error that at the end of the folding process may be unacceptable.

[0038] The advancement in portions also allows great versatility of the apparatus 1, which does not need moulds for entire spirals 101 realized *ad hoc*, since it can be adapted to the most varied production requirements.

[0039] Preferably, the step of performing the folding of the second portion 108 of the plate 102 is preceded by a correction step of the relative position between the plate 102 and the folding device 2 as a function of the deviation previously detected, i.e. the deviation is greater than the certain threshold value.

[0040] In other words, it is possible to correct the positioning of the plate 102 and/or the folding device 2 so that during the second folding the necessary compensation is brought about for recovering the correspondence

with the reference virtual model so as to absorb at least partially the deviation detected.

[0041] Preferably, the correction step is performed through one or more of the sub-steps:

- adjusting the position of the plate 102 according to an adjustment plane parallel to a lying plane of the second portion 108 of the plate 102,
- adjusting an inclination of the plate 102,
- changing a spatial configuration of the folding device.

[0042] Even more preferably, the first and the second folding steps are realized by providing, respectively, the first portion 107 and the second portion 108 of the plate 102 in a vertical arrangement, and the correction step is realized through one or more of the following sub-steps:

- adjusting the position in elevation of the plate 102,
- adjusting an inclination of the plate 102 with respect to a vertical plane,
- changing a spatial configuration of the folding device 2.

[0043] Preferably, the step of folding the second portion 108 of the plate 102 is preceded by a correction step of at least one working parameter of the folding device 2 as a function of the deviation previously detected, i.e. the deviation is greater than the certain threshold value.

[0044] Preferably, the working parameter is a pressure value exerted by the folding device 2 on the plate 102 during a folding step.

[0045] In other words, by adjusting the pressure value of the folding device 2 on the plate 102 it is possible to change the folding of the second portion 108 for compensating and absorbing the deviation and compensating any possible elastic return due to the previous pressing.

[0046] Preferably, the step of detecting the geometric identifying data is achieved by use of detection means 3 of the optical type, for example a camera or a scanner.

[0047] Advantageously, the video acquisition of the three-dimensional shape of the plate 102 allows the instantaneous analysis of the folding status at least of the folded portion 107, 108 and the creation of a real model to be compared with the reference virtual model for identifying and assessing any dimensional deviations.

[0048] Preferably the step of predisposing the plate 102 is implemented by handling means 4, preferably comprising at least one robot 4a having gripping means 5 suitable for gripping and moving the plate 102. Advantageously the use of handling means 4 and in particular robots 4a allows the entire process of creating the spiral 101 to be automated and continuous operation in safe conditions and with high precision.

[0049] Consider that the plates 102 with which the spirals 101 are realized can reach dimensions and weight such as to make them bulky and heavy, therefore it is very difficult to move them manually. In fact, preferably

the spirals 101 have a thickness comprised between 5 mm and 25 mm, a diameter comprised between 50 cm and 210 cm and a mass comprised between 5 kg and 200 kg.

[0050] In particular, the use of handling means 4 allows a plate 102 to be taken from a picking station 109, moved in order to be arranged in the folding device 2 according to a certain position as a function of the reference virtual model, moved between one fold and the next and possibly its position changed for any corrective operations.

[0051] Preferably, the folding steps are performed by moving a pressing member 6 movable in a forward direction towards a fixed counter-pressing member 7 with interposition of the plate 102.

[0052] In other words, the plate 102 is pressed between the pressing member 6 and the counter-pressing member 7 for performing the folding steps. Preferably, the pressing member 6 defines a pressing surface having a smaller area than the surface area of the plate 102.

[0053] Even more preferably, the pressing member 6 defines a pressing surface having an equal area to the portion 107, 108 of the plate 102 to be folded. In this way it is possible, through the use of the handling means 4, to retain the plate 102 during the folding steps; advantageously, it is possible to move the plate 102 between one folding step and the next and make any compensations without losing the correct reference.

[0054] In particular, in the case in which the pressing member 6 is a mould (embodiment not illustrated in the appended figures), the area of the mould coincides with the pressing surface which coincides in turn with the area of the portion 107, 108 of plate 102 to be pressed.

[0055] Preferably, in accordance with the embodiment of the apparatus 1 illustrated in the appended figures, the folding steps are performed along folding lines 110 and even more preferably folding lines 110 converging into a point defining the centre 105 of the spiral 101 to be realized.

[0056] In other words, preferably the folds of the plate 102 are performed at the directrices 104 of the spiral 101, therefore the centre 105 of the spiral 101 corresponds to a centre 9 of the folding lines 110.

[0057] With reference to figures 6A-6C, preferably there are at least three folding lines 110 (folding lines 110a, 110b, 110c) and the first folding line 110a of the second folding step is realized along the third folding line 110c of the first step (except for any compensations that imply a possible change to the positioning of the plate 102).

[0058] In that case, as will be clarified below, the pressing member 6 preferably comprises three folding knives 8a, 8b, 8c extending respectively according to the folding lines 110a, 110b, 110c and converging into the centre 9 of the folding lines 110.

[0059] The pressing surface in the case of using folding knives 8a, 8b, 8c coincides with the area defined between the first folding knife 8a and the third folding knife 8c.

[0060] Part of the invention is also formed by an appa-

atus 1 for the realization of a spiral 101 for an auger 100 comprising:

- a folding device 2 of a plate 102 configured to fold at least a first portion 107 of the plate 102 and a subsequent second portion 108 of the plate 102 contiguous to the first portion 107,
- detection means 3 of the optical type being indicative of the geometric data of the three dimensional shape of at least the first portion 107 of the plate 102,
- handling means 4 configured for moving the plate 102 between a first folding position, in which the folding device 2 is operable on the first portion 107, and a second folding position, in which the folding device 2 is operable on the second portion 108,
- a control and command unit, not illustrated in the appended figures, configured to command the folding of the plate 102 in the first and the second folding position and configured to receive the identifying geometric data, compare them with a reference virtual model and identify any deviation so as to command the handling means 4 and/or the folding device 2 to compensate the deviation when the deviation is greater than a certain threshold value.

[0061] Advantageously, the control and command unit allows the folding process to be handled independently, discretizing the steps of folding the plate 102 and performing an instantaneous check at every fold for checking the conformity of the fold and possibly commanding a specific corrective operation.

[0062] Preferably, the handling means 4 comprises at least one robot 4a (in particular in the embodiment illustrated in the appended figures two robots 4a are present sliding on tracks arranged externally to the folding device 2) having a gripping means 5 adapted to grasp and move the plate 102.

[0063] In particular, the robots 4a are preferably equipped with at least one gripper head 5a and at least one sucker head 5b. Alternatively the robots 4a could be equipped with a gripper a of a magnet (variant not represented in the appended figures).

[0064] The sucker head 5b, illustrated in more detail in figure 7, can be advantageously used to grasp the plate 102 in the step of picking a plate 102 from the picking station 109, while the gripper head 5a can be advantageously used for moving and positioning the plate within the folding device 2.

[0065] Preferably, the robots 4a take one plate 102 at a time through the use of sucker heads 5b and position it on a resting surface to then be able to grasp it at the lateral ends through the gripper heads 5a.

[0066] The robots 4a move the plate 102 between the pressing member 6 and the counter-pressing member 7 into the first folding position, illustrated for example in figure 3, so that the folding knives 8a-8c of the pressing member are arranged at the directrices 104 defining the first portion 107, as illustrated in figure 6A.

[0067] Once the plate 102 is positioned in the first folding position, the control and command unit commands the first fold and subsequently the detection means 3 detects the identifying geometric data of the first portion 107. The control and command unit compares the identifying geometric data with those of the reference model and if necessary commands a corrective operation to compensate the deviation.

[0068] At this point the robots 4a move the plate 102 into the second folding position, illustrated in figures 4 and 6B, applying if necessary any compensation.

[0069] The control and command unit now activates the pressing member 6 to perform the second fold and the detection means 3 again detects the data to be sent to the control and command unit that compares them again with the reference virtual model.

[0070] At this point the operations may be repeated to obtain "n" folds of "n" plate portions 102.

[0071] For example, in figures 5, 5A and 6C a third folding step is illustrated wherein the first folding knife 8a is arranged at the third folding line 110c of the second fold illustrated in figure 6B.

[0072] Figure 8 further illustrates a possible corrective operation wherein the plate 101 is translated vertically upwards so that the geometric centre 105 of the spiral 101 is arranged below the centre 9 of the folding lines 110; in this way the fold will compensate the deviation detected preventing the propagation of the error in the subsequent fold.

[0073] The present invention reaches the proposed objects, overcoming the drawbacks noted in the prior art and providing the user with a method and an apparatus for realizing a spiral for an auger able to improve the production efficiency of the folding process of plates, proceeding portion by portion and continuously checking the correctness of the folds.

Claims

1. A method for manufacturing a spiral (101) destined to an auger (100) comprising the steps of:

- providing a suitably shaped plate (102) for obtaining a spiral (101) for the auger (100) or a part of said spiral (101),
- forming a folding of a first portion (107) of the plate (102) with the aid of a folding device (2),
- detecting geometric data being indicative of the three-dimensional shape of at least said first portion (107) of the plate (102) after said folding step,
- comparing said identifying geometric data with a reference virtual model and identify the deviation, if any,
- following the step of comparing said identifying geometric data, forming a folding of a second portion (108) of said plate (102) contiguous to

said first portion (107) through said folding device (2);

wherein said step of forming the folding of said second portion (108) of the plate (102) comprises a sub-step of compensating said deviation when the deviation is greater than a certain threshold value.

2. A method according to any preceding claim, wherein said step of forming the folding of said second portion (108) of the plate (102) is preceded by a correction step of the relative position between the plate (102) and the folding device (2) as a function of the previously detected deviation, when said deviation is greater than the certain threshold value.

3. A method according to claim 2, wherein said correction step is accomplished by way of one or more of the following sub-steps:

- adjusting the position of the plate (102) according to an adjustment plane parallel to a lying plane of said second portion (108) of the plate (102),
- adjusting an inclination of the plate (102),
- changing a spatial configuration of said folding device (2).

4. A method according to claim 3, wherein said first and second folding steps are realized by providing, respectively, the first portion (107) and the second portion (108) of the plate (102) in a vertical arrangement, and wherein said correction step is realized through one or more of the following sub-steps:

- adjusting the position in elevation of the plate (102),
- adjusting an inclination of the plate (102) with respect to a vertical plane,
- changing a spatial configuration of said folding device (2).

5. A method according to any preceding claim, wherein said step of folding the second portion (108) of the plate (102) is preceded by a step of correcting at least one working parameter of the folding device (2) as a function of the previously detected deviation, where said deviation is greater than the certain threshold value, wherein said at least one working parameter is preferably a value of pressure exerted by the folding device (2) on the plate during a folding step.

6. A method according to any preceding claim, wherein said step of detecting geometrical identification data is achieved by use of detection means (3) of the optical type, for example a camera or a scanner.

7. A method according to any preceding claim, wherein said step of predisposing the plate (102) is implemented by handling means (4), preferably comprising at least one robot (4a) having gripping means (5) suitable for gripping and moving said plate (102). 5
8. A method according to any preceding claim, wherein said folding steps are carried out by moving a pressing member (6) movable in a forward direction towards a fixed counter-pressing member (7) with interposition of said plate (102). 10
9. A method according to claim 8, wherein said pressing member (6) defines a pressing surface having a smaller area than the surface of the plate (102), preferably said pressing member (6) defines a pressing surface having equal area to the portion (107, 108) of the plate (102) to be folded. 15
10. A method according to any preceding claim, wherein said folding steps are implemented along folding lines (110a, 110b, 110c), preferably converging in a point defining the center (105) of the spiral (101) to be formed. 20
11. A method according to claim 9, wherein said folding lines (110a, 110b, 110c) are equal in number to three and wherein the first folding line (110a) of the second folding step is obtained along the third folding line (110c) of the first folding step. 25 30
12. An apparatus (1) for the realization of a spiral (101) intended for an auger (100) comprising:
 - a folding device (2) of a plate (102), said plate (102) having a suitable shape to the realization of a spiral (101) for an auger (100) or a part of said spiral (101), said folding device (2) being configured to fold at least a first portion (107) of said plate (102) and a subsequent second portion (108) of said plate (102) contiguous to said first portion (107), 35 40
 - detection means (3) of the optical type being indicative of the geometric data of the three dimensional shape of at least said first portion (107) of the plate (102), 45
 - handling means (4) configured for moving said plate (102) between a first folding position, in which the folding device (2) is operable on the first portion (107) of said plate (102), and a second folding position, in which the folding device (2) is operable on the second portion (108) of said plate (102), said handling means (4) preferably comprising at least one robot (4a) having gripping means (5) suitable to grasp and move the plate (102), 50 55
 - a control and command unit configured to control folding of said plate (102) in said first and

second folding position; said control and command unit being configured to receive said identification geometric data, compare the same with a reference virtual model and identify a possible deviation so as to control said handling means (4) and/or said folding device (2) in order to compensate said deviation when the deviation is greater than a certain threshold value.

Fig.1

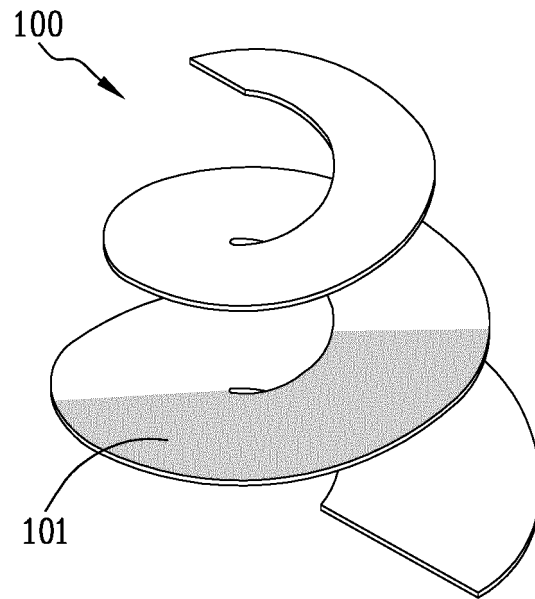


Fig.2A

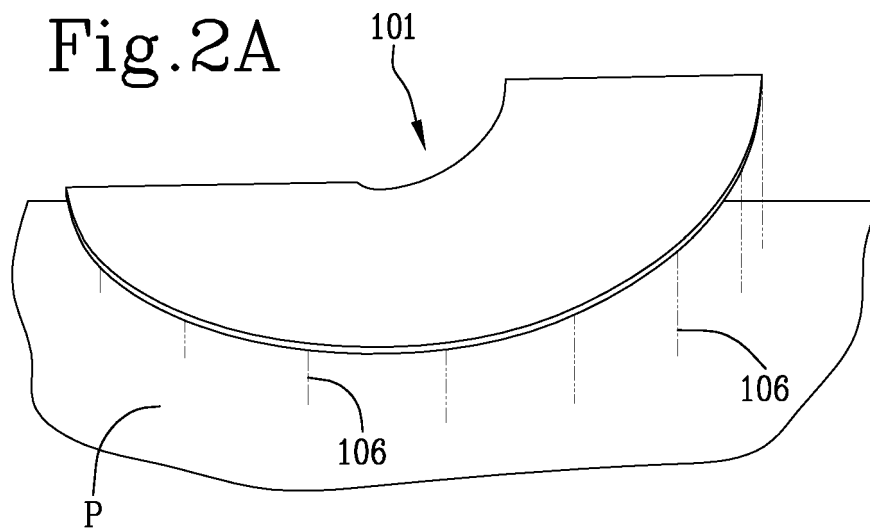


Fig.2B

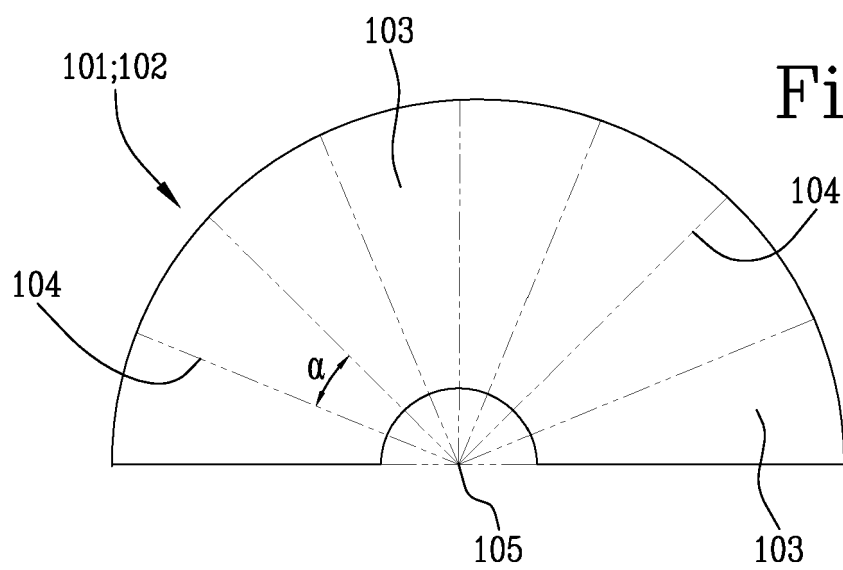


Fig.3

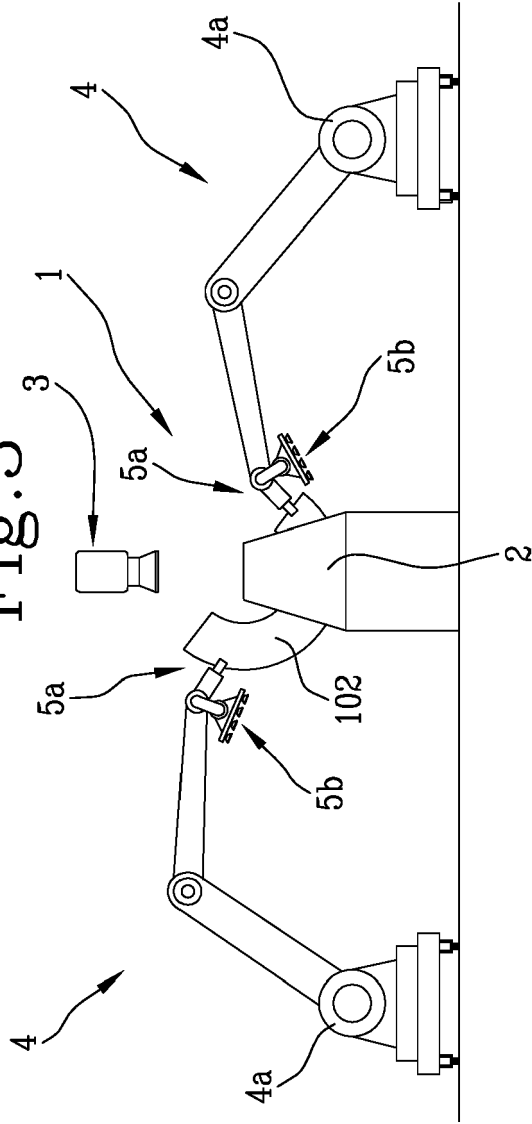
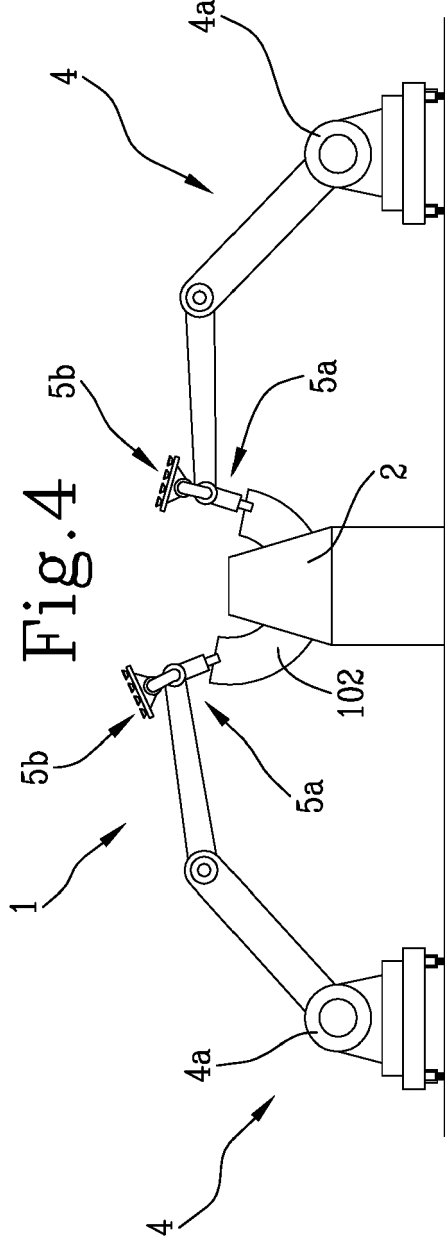
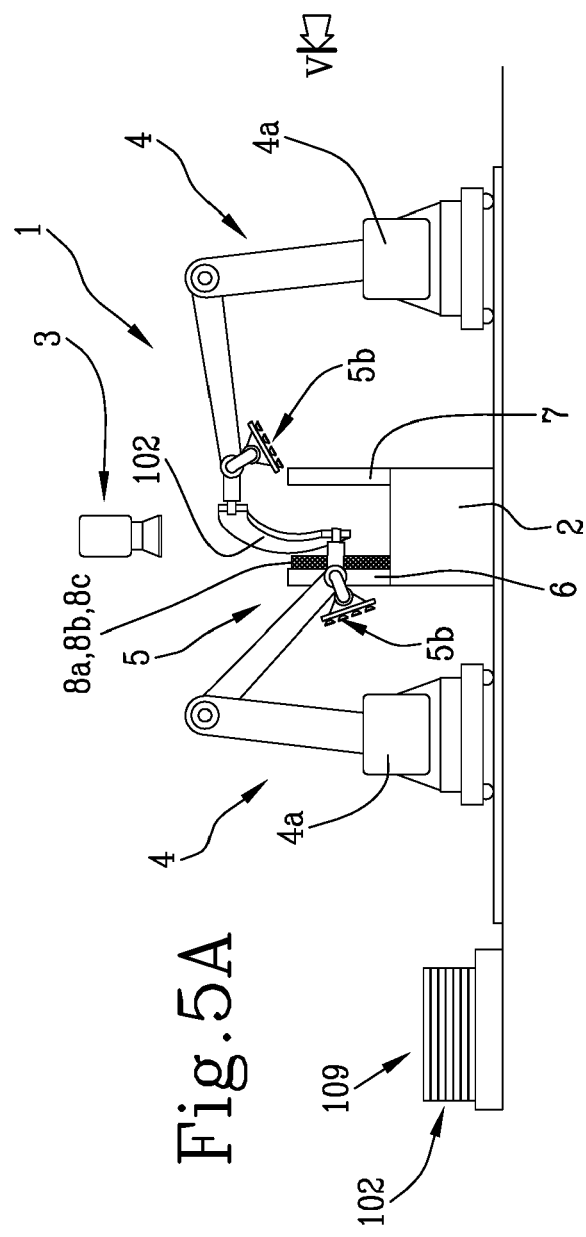
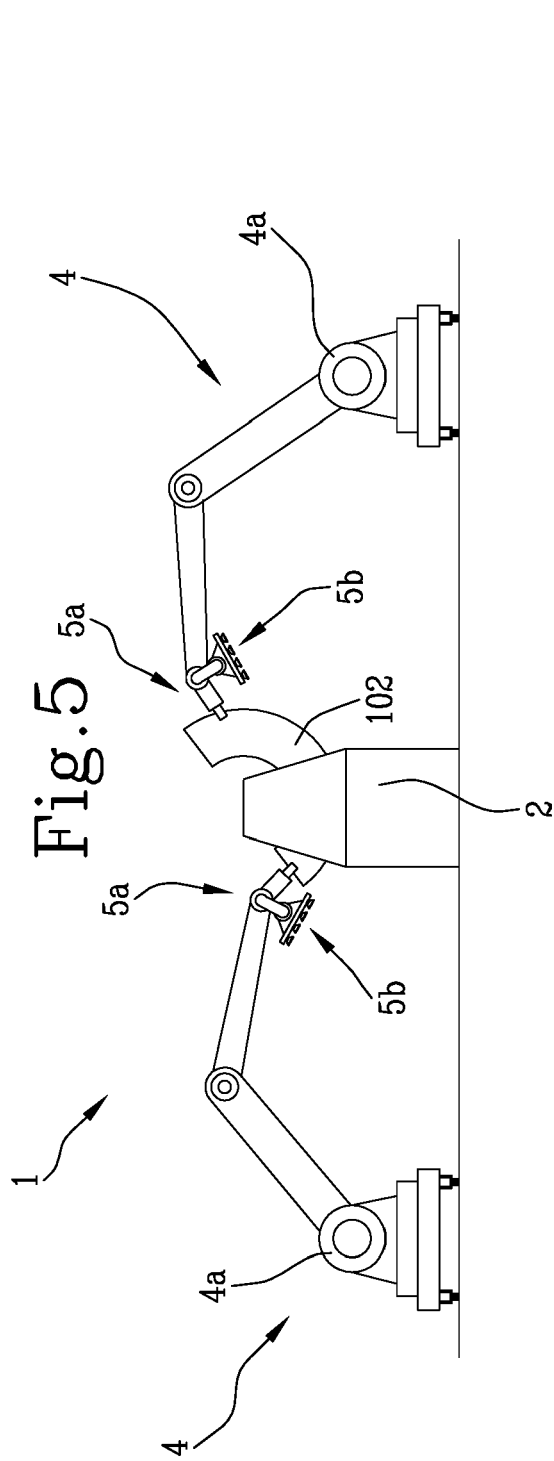


Fig.4





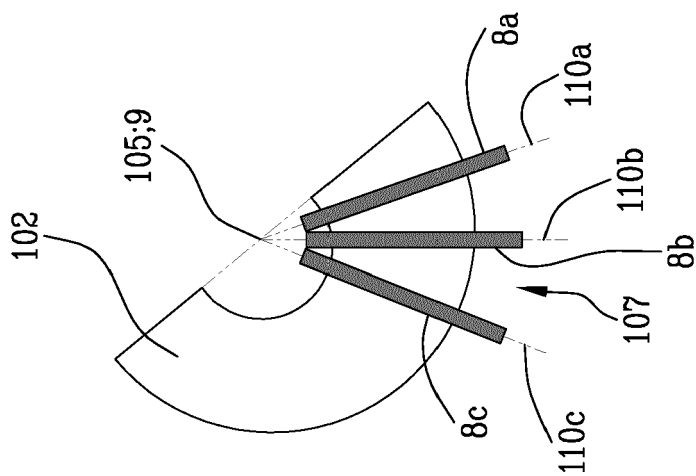


Fig. 6A

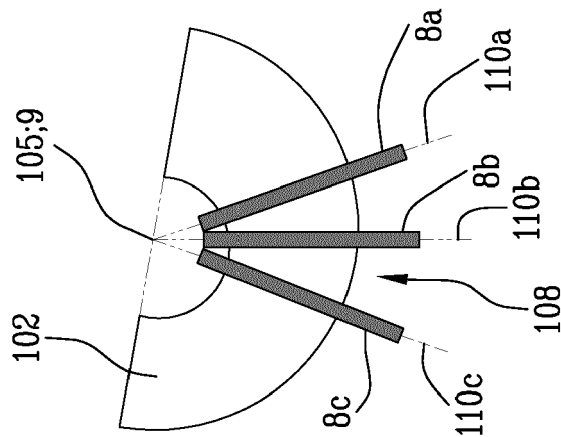


Fig. 6B

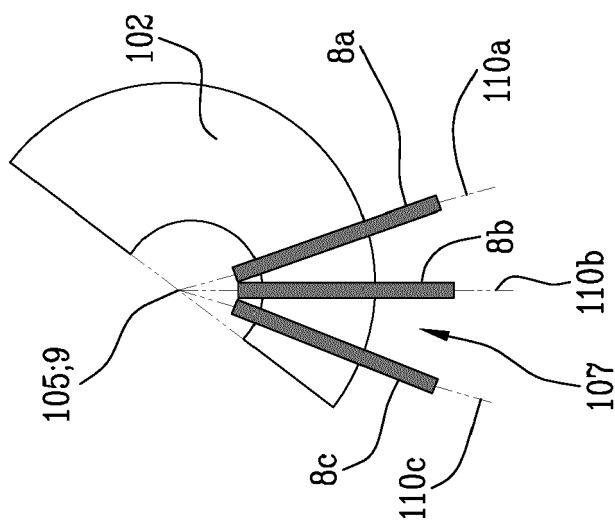
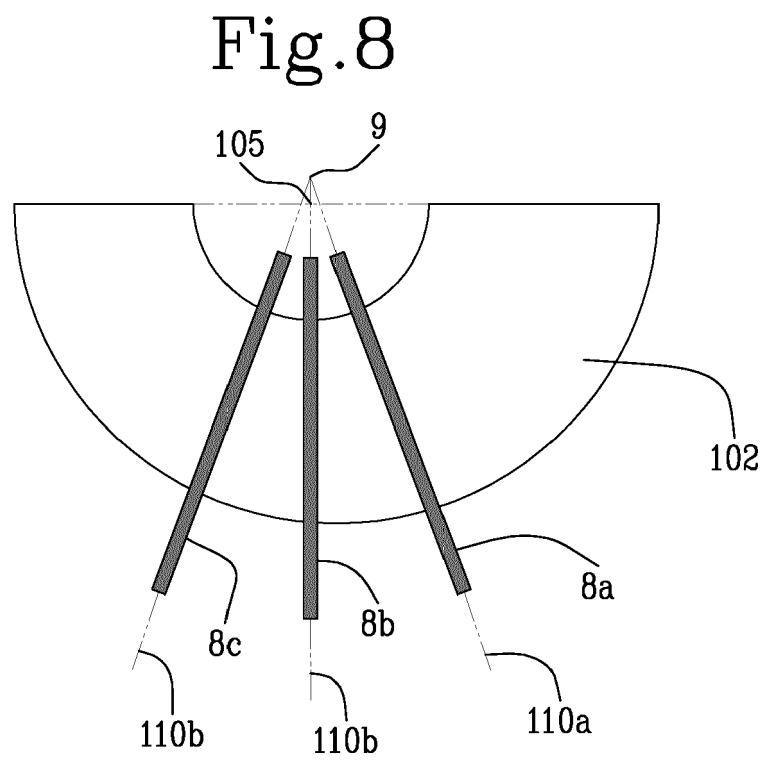
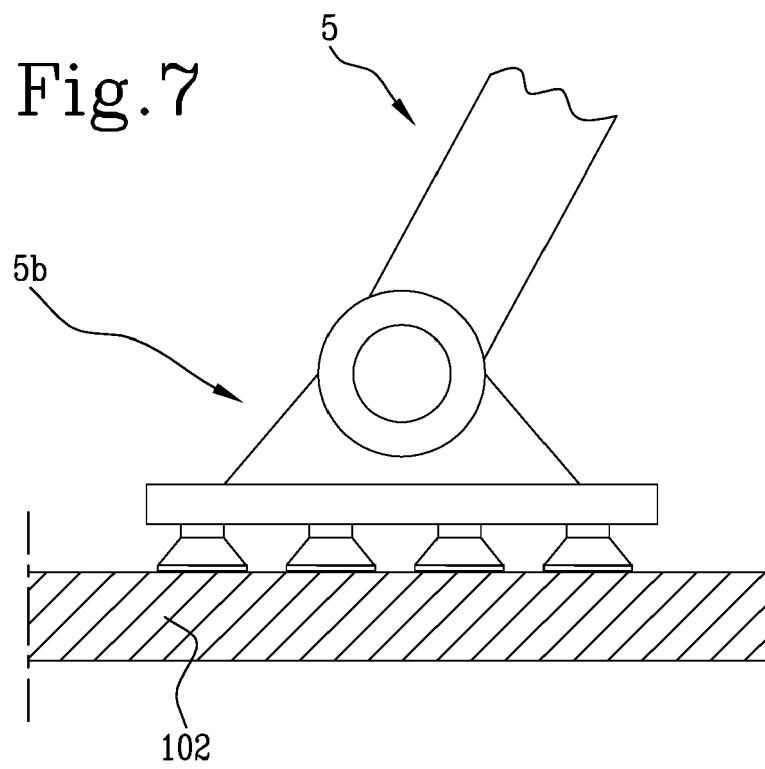


Fig. 6C





EUROPEAN SEARCH REPORT

Application Number
EP 17 17 3615

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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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