



- (51) International Patent Classification:
G05B 19/418 (2006.01)
- (21) International Application Number:
PCT/IB2012/051161
- (22) International Filing Date:
12 March 2012 (12.03.2012)
- (25) Filing Language:
Italian
- (26) Publication Language:
English
- (30) Priority Data:
TO2011A000214 10 March 2011 (10.03.2011) IT
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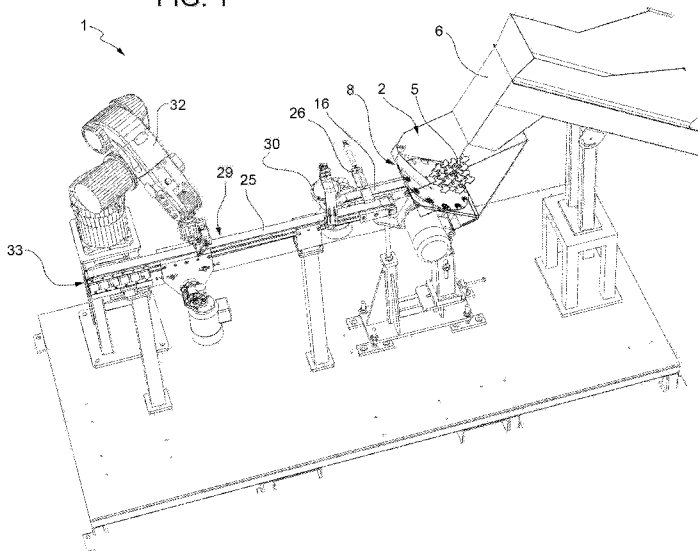
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) Title: TRANSFER SYSTEM FOR SETTING A PIECE IN A REQUIRED ORIENTATION, AND ROBOT GRIPPER FOR SAID TRANSFER SYSTEM

FIG. 1



(57) Abstract: A piece (5) is set in a required orientation via rotations about at least two mutually transverse axes (52, 57), on the basis of the differences between the required orientation and the position represented in a captured image while the piece (5) is arriving on a resting plane (29), and on the basis of the outcome of a comparison between the data of the captured image and the data stored of images that show a sample element equal to the piece (5) to be transferred and set in respective different stable resting positions.



"TRANSFER SYSTEM FOR SETTING A PIECE IN A REQUIRED ORIENTATION, AND ROBOT GRIPPER FOR SAID TRANSFER SYSTEM"

TECHNICAL SECTOR

5 The present invention relates to a transfer system for setting a piece in a required orientation.

PRIOR ART

10 Automated transfer systems are known that comprise a so-called singulator, i.e., a device that, starting from pieces heaped in bulk, forms an orderly flow of products that are then conveyed at a substantially constant pitch by a belt conveyor towards a subsequent machine or station, where operations of packaging and/or assembly and/or palleting are performed.

15 Automated transfer systems of a known type are scarcely satisfactory for pieces having a complex geometry in so far as the pieces set in a row on the belt conveyor have a random orientation in space that in general differs from one piece to
20 the next. In other words, the pieces rest on the belt conveyor on any of their own faces, so that a manual intervention is necessary on the part of an operator in the station of arrival for setting the pieces in the required orientation.

25 Said diversity of orientation is found, for example, for pieces of toys or games made of plastic material that are to be inserted as surprises in packages of foodstuff products.

30 Furthermore, known transfer systems do not always manage to guarantee high rates of production, do not carry out quality control, and are particularly sensitive to processing waste and also to small variations of shape and dimensions in the pieces to be transferred. Said small variations, for example,
35 can be due to the dimensional tolerances of previous moulding processes and/or to deformations of the plastic material, and are a cause of jamming and stoppages of the transfer systems

and/or are a cause of rejects of the pieces.

In general, the singulator is defined by a vibration device or else by a mechanical device designed specifically for a particular shape of pieces. As the shape changes, the singulator must be replaced completely or must be modified substantially in its mechanical and electrical parts. Said adaptations entail a considerable expenditure in time and in general require a highly specialized labour force.

The patent No. EP1043642 corresponds to the preamble of Claim 1 and describes a robotized system having an image-processing function, for picking up one piece at a time from a container where the pieces are accumulated randomly in bulk. Said system comprises a robot having a wrist that carries a sensor, for example a photographic machine for capturing images of the pieces. A processor compares the captured image of a piece with a series of models stored for determining what should be the position and orientation of the robot so that the latter picks up the piece correctly.

AIM OF THE INVENTION

The aim of the present invention is to provide a transfer system for setting a piece in a required orientation that will enable a simple and economically advantageous solution of the problems set forth above.

According to the present invention, a transfer system for setting a piece in a required orientation is provided as defined in Claim 1.

The present invention moreover regards a robot gripper according to Claim 19.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described with reference to the

annexed drawings, which illustrate a non-limiting example of embodiment thereof, and in which:

- Figure 1 is a perspective view of a preferred embodiment of the transfer system for setting a piece in a required orientation according to the present invention;
- Figure 2 shows the system of Figure 1 from a different standpoint and with parts represented schematically;
- Figure 3 illustrates a particular of Figure 2 at an enlarged scale;
- Figure 4 illustrates, from above and at an enlarged scale, a further particular of the system of Figure 1;
- Figure 5 shows a variant of the particular of Figure 4;
- Figure 6 is a perspective view of a further preferred embodiment of the transfer system for setting a piece in a required orientation according to the present invention;
- Figure 7 is a different perspective view of the system of Figure 6, at an enlarged scale;
- Figure 8 illustrates a particular of Figure 7 with parts in exploded view and at an enlarged scale; and
- Figure 9 is a side view of another particular of Figure 7, at an enlarged scale.

PREFERRED EMBODIMENTS OF THE INVENTION

Designated by 1 in Figure 1 is a transfer system comprising a housing 2, open upwards and containing a heap of pieces 5 set in bulk. The pieces 5 are dropped into the housing 2, for example through a hopper 6, and are made to come out of the housing 2, still facing upwards, via a so-called singulator 8, i.e., a device that forms an orderly flow of pieces 5.

With reference to Figure 4, the singulator 8 comprises a hub (not visible) and a wheel 9, which is coaxially fixed on said hub along an axis 10. The hub is motor-driven for rotating axially, and the wheel 9 is housed in a circular seat 11 defined by a side 12 of the housing 2.

The side 12 and the wheel 9 define laterally a plurality of retention seats 13, which have dimensions and a shape such as to receive, each, a corresponding piece 5 during the passage in the heap of pieces 5 to the bottom of the housing 2. The seats 13 are closed at the rear by a wall 14, which is fixed with respect to the side 12 and is parallel to the wheel 9 and to the side 12. The wall 14, the wheel 9, and the side 12 are inclined with respect to the vertical so that the collected pieces 5 rest on the wall 14 and remain in the seats 13 during rotation towards the top dead centre. At top dead centre, the wall 14 has an opening, so that the pieces 5 drop from the respective seats 13 onto a conveyor 16, for example a belt conveyor, which is set underneath the wheel 9 and then conveys the pieces 5 in a row in a horizontal direction 17.

In the variant of Figure 5, the wheel 9 is replaced by a wheel 9a, which has, instead of the seats 13, a plurality of suction mouths 18 set along its own periphery. The suction mouths 18, behind the wheel 9a, are connected through respective tubes (not visible) to the motor-driven hub, which, in turn, communicates in a way not illustrated with a vacuum source. An elastic wall 19 is provided in a fixed position at the top end of the housing 2, immediately after the top dead centre of the wheel 9a, for detaching the pieces 5 and getting them to jump onto the conveyor 16 when the suction mouths 18 pass under the wall 19 during rotation. Preferably, the wheel 9a and the aforesaid tubes are interchangeable with the wheel 9 and the wall 14 so that is possible to use the seats 13 and the suction mouths 18 alternatively on one and the same singulator 8.

With reference to Figure 1, the system 1 further comprises a conveyor 25, parallel to and set alongside the conveyor 16, and a device 26 that transfers the pieces 5, one at a time from the conveyor 16 onto the conveyor 25.

The conveyor 25 is preferably of the belt type and defines a movable horizontal plane 29, on which the pieces 5 rest with a random spatial orientation, in general different from one piece to the next. The pitch between the pieces 5 depends upon the angular distance between the retention members of the wheels 9, 9a and is substantially constant, in the absence of rejects.

The system 1 further comprises a digital vision device 30, which is defined by a video camera or a photographic camera, is set above the plane 29, at a distance such as to have images in focus and capture at least one image for each of the pieces 5 that advance.

According to what is illustrated in Figure 2, the device 30 sends the data of the captured images to a control and command unit 31 (illustrated schematically), which controls a movement assembly 32 in a way synchronised with the speed of the conveyor 25. The assembly 32 grips one piece 5 at a time and places it in a station 33, defined for example by a temporary-deposit station, by an assembly station, or by a packaging station, where a pre-set spatial orientation is required. The assembly 32, under the command of the unit 31, turns each piece 5 about at least two mutually transverse axes during transfer from the plane 29 to the station 33 to obtain the required spatial orientation. In particular, the assembly 32 has characteristics such as to turn the pieces 5 about two mutually orthogonal axes, as will be described more fully in what follows.

The unit 31 is configured with algorithms that operate as a function of the data of the images captured by the device 30 and as a function of the outcome of a processing operation that compares the data of the captured images with the data of a set of images stored in a memory 37. The stored images represent at least one sample, which is similar to the piece 5

and is set in respective different stable resting positions, so that said images show the various orientations that are possible for the pieces 5 arriving on the plane 29. The processing performed by the unit 31 identifies, in the set of
5 stored images, the one representing the sample with resting position closest to the one illustrated in the captured image, and, on the basis of the differences between the captured image, the identified image, and the final orientation to be obtained, the unit 31 automatically sets the optimal sequence
10 and the angles of the rotations to be imparted to bring the piece 5 into the required spatial orientation.

Preferably, the unit 31 also sets the points of the piece 5 in which to carry out gripping, which is hence variable: on the
15 basis of the geometry of the piece 5 and the orientation visible in the captured image, the algorithms enable the unit 31 to set automatically an ideal or optimal condition for gripping.

20 In the preferred embodiment illustrated in Figures 1 and 2, the assembly 32 is defined by an anthropomorphic robot, which comprises two arms 40, 41 hinged at one end about a horizontal axis 42. At the opposite end, the arm 40 is coupled to a base 43 so as to be able to rotate about a vertical axis 44 and
25 about an axis 45 parallel to the axis 42, and the arm 41 is coupled to a gripper 47 via a wrist 48. In particular, the wrist 48 is coupled to the arm 41 so as to be able to rotate about an axis 49 parallel to the axis 42 and defines an articulated joint that enables the gripper 47 to rotate about
30 an axis 52 orthogonal to the axis 49. The rotations about the axes 44, 45, 42, 49, 52 are performed by respective motors not described in detail, controlled by the unit 31. The unit 31 controls the motors correspondent to the axes 45, 42, 49 in order to keep the axis 52 vertical so that the gripper 47
35 takes and picks up the pieces 5 acting from above.

With reference to Figure 3, the gripper 47 comprises two fingers 53, 54, which carry respective surfaces 55, 56 coaxial along a longitudinal axis 57 orthogonal to the axis 52 and are coupled to the structure 51 so as to be able to approach/move
5 away the surfaces 55, 56 longitudinally. In other words, the surfaces 55, 56 define an empty space 58 for housing a piece 5, with which they come into contact when they are brought up to one another. In particular, the fingers 53, 54 are coupled to a guide 59 of the structure 51 for translating parallel to
10 the axis 57. The gripper 47 further comprises an actuator 60, in particular an electric actuator, which is coupled to the structure 51 and is controlled for displacing the fingers 53, 54 with respect to one another so as to grip/release the piece 5.

15 The surfaces 55, 56 are defined by respective disks 61, 62, which are rotatably coupled to the fingers 53, 54 about the axis 57. The disk 61 turns idle, whereas rotation of the disk 62 is driven by an actuator 63, fixed to the finger 54 and
20 defined in particular by an electric motor. A belt transmission 64 transmits the rotation from an output shaft 65 of the actuator 63 to a pin 66, which is fixed and coaxial with respect to the surface 56, is parallel to the output shaft 65, and projects from the finger 54 towards the outside
25 of the gripper 47, i.e. in a direction opposite to the space 58.

In use, after the piece 5 has been gripped between the surfaces 55, 56 in response to the operation of the actuator
30 60, the unit 31 controls the motors associated to the axes 44, 45, 42, 49 so as to pick up the piece 5 from the plane 29 and then transfer the piece 5 into the station 33. During transfer, the unit 31 controls the rotations about the axes 52 and 57 in response to the results of the comparisons of the
35 captured and stored images so as to bring the piece 5 into the required final orientation. After reaching the station 33, the

unit 31 issues a command to the actuator 60 to release the piece 5 and then brings the gripper 47 back above the conveyor 25 for gripping the next piece 5 and perform a new cycle.

5 According to a variant (not illustrated), the actuator 60 conveniently comprises two actuation stages set in series that can be actuated independently of one another. The first stage is driven by the unit 31 for adjusting the axial width of the space 58 between the surfaces 55, 56 and thus adapt the
10 gripper 47 to different dimensions of the pieces to be gripped. This adaptation is made at the start of each lot of equal pieces to be transferred. The second stage is driven by the unit 31 so as to carry out the effective movement of gripping/release.

15 According to a further variant (not illustrated), the gripper 47 is equipped with an additional gripping member with vertical axis, for example a suction pad.

20 According to a further variant (not illustrated), the system 1 comprises a plurality of transfer lines, which are set alongside one another, transfer components different from one another, and each comprise a corresponding singulator 8, a corresponding conveyor 25, and a corresponding device 30. One
25 or more robots are set at the end of said lines in a station where the various components arriving, respectively, on the transfer lines are assembled together or packaged.

According to a further variant (not illustrated), the pieces
30 conveyed by the conveyor 25 under the device 30 are different from one another. The unit 31 is configured with appropriate algorithms so as to recognize the type of the various pieces, in addition to recognizing their spatial orientation on the plane 29, on the basis of the captured images and of the
35 comparison with the stored images.

Figures 6 to 9 show a further embodiment of the system according to the present invention, designated by the reference number 1a. The parts that constitute the system 1a are identified, where possible, by the same reference numbers used for the system 1. In the system 1a, the assembly 32
5 comprises two distinct rotation devices, designated, respectively, by the reference numbers 63a and 48a, set along the path of the conveyor 25. The device 63a is configured so as to tip over each piece 5 about a horizontal axis 57a; the
10 device 48a, on the other hand, is configured so as to rotate the piece 5 about a vertical axis 52a while the piece 5 is in contact with the plane 29.

The device 30 is replaced by two digital vision or image-capturing devices 30a, 30b (Figure 6), of the same type as the
15 device 30. The device 30a is set along the path of the conveyor 25 upstream of the device 63a, considering the flow of the pieces 5; the device 30b, instead, is set between the devices 63a and 48a. Moreover, the system 1a comprises a
20 further digital vision or image-capturing device 30c, which is set after the device 48a and is also connected to the unit 31, said unit being configured so as to compare the position/orientation of each piece 5 in the captured image by
25 the device 30c with the final orientation to be obtained, to carry out a quality control. Possible pieces that have an orientation different from the one required are discarded in a way not illustrated, for example via a jet of air directed
across the path of the conveyor 25, so as to blow said pieces towards a container or a recirculation system set alongside
30 the conveyor 25.

Also the device 63a is set alongside the conveyor 25 and comprises a tipping-over member 71, which is coupled to a structure 72 fixed so as to rotate about a horizontal axis
35 under the action of a motor 73 (Figures 7 and 8). In particular, the motor 73 is set underneath the member 71 and

is coupled to the latter via a transmission 74 (Figure 6), for example a belt transmission. The axis of rotation of the member 71 is orthogonal to the path of the conveyor 25, is set at the height of the flow of pieces 5 on the plane 29, and coincides with the axis 57a about which the pieces 5 are tipped over through 180°.

In particular, with reference to Figure 8, the member 71 comprises a disk 76 having a circular outer edge coupled by rolling to three rollers 77, which are mounted on the structure 72 in positions at angular distances apart from one another. The member 71 has two compartments 79, which are diametrically opposite with respect to the axis 57a and have the same shape and dimensions, sufficient for each to house a corresponding piece 5. The compartments 79 are open at the front, i.e., towards the conveyor 25, to enable input and output of the respective pieces 5, and have respective rear openings 81, i.e., on the opposite side with respect to the conveyor 25.

Preferably, the compartments 79 are defined by respective inserts 80, which are fixed to the disk 76, can be replaced with other inserts having compartments of a different shape and/or dimensions, and in particular project at the rear from the disk 76.

The motor 73 is controlled by the unit 31 so as to set the compartments 79 selectively in a first position and a second position, in which the compartments 79 are aligned with respect to one another horizontally, i.e., in a direction parallel to the path of the conveyor 25.

As illustrated in Figure 7, the openings 81 of the compartments 79 are aligned with a suction device 82 and, respectively, with a thrust device 83. The device 82 defines a pick-up system that displaces the pieces 5 from the plane 29

into the member 71. The device 82, for example, comprises a valve controlled by the unit 31 so as to control the flow of air in a duct 85, which sets a vacuum source in communication with an inlet mouth 86 located at the first position of the compartments 79.

With reference to Figure 8, the inlet mouth 86 is defined by a perforated portion of a plate 87, which is set in a fixed position behind the member 71, is orthogonal to the axis 57a, is housed in an opening 88 of the structure 72, and has a hole 89 corresponding to the second position of the compartments 79. In this way, on one hand, the perforated portion of the plate 87 defines a stop surface for the piece 5 that is sucked into the member 71 and, on the other hand, the hole 89 enables the device 83 to enter the compartment 79 and expel the piece 5 from the member 71 after it has been tipped over through 180°.

With reference to Figure 9, the device 83 comprises a slide 90, which is aligned with the hole 89 and with the second position of the compartments 79 in a direction 91 parallel to the axis 57a, is coupled to a guide 93 for translating along the direction 91, and is driven by a motor 94 controlled by the unit 31.

Preferably, a crankshaft transmission 95 transmits motion from the motor 94 to the slide 90. In this way, the accelerations of the slide 90 in the proximity of the points of start and end of travel (top dead centre and bottom dead centre of the transmission 95) are relatively low so that the piece 5 is accompanied gently by the tip of the slide 90 while it is being pushed onto the plane 29.

In use, substantially as for the system 1 described above, according to the image captured by the device 30a, for each piece 5 the unit 31 establishes whether it is necessary to tip

the piece 5 over through 180° about the axis 57a and, if so, issues a command to the device 82 to displace the piece 5 from the plane 29 into the device 63a. Obviously, the instant of activation of the device 82 depends upon the speed of the conveyor 25 and/or upon the detected position of the piece 5. Advantageously, the unit 31 issues a command to the device 82 so that it will vary the instant at which suction starts also as a function of the position and/or orientation of the piece 5 in the image captured by the device 30a. In this way, if necessary, it is possible to impart on the piece 5 already a small rotation during its movement towards the inlet mouth 86 (Figure 7), after which the unit 31 issues a command to the device 63a to tip the piece 5 over through 180°.

Preferably, the device 83 is controlled by the unit 31 together with the device 82 so as to carry out simultaneously picking-up of a piece 5 that must be tipped over and expulsion of another piece 5 that must be sent back onto the conveyor 25. In this way, the picked-up piece 5 is replaced with another having an orientation closer to, or the same as, the required one, and the row of pieces 5 remains substantially unaltered.

According to what is illustrated in Figure 6, according to the image captured by the device 30b, for each piece 5 the unit 31 establishes whether there is necessary a rotation about the axis 52a and, if so, issues a command to the device 48a. The latter comprises: a head or buffer 96, set above the plane 29; a linear actuator 97, preferably a pneumatic actuator, controlled by the unit 31 for translating the head 96 along the axis 52a; and a motor 98 controlled by the unit 31 for rotating the head 96 about the axis 52a after the head 96 has been lowered by the actuator 97 and has come into contact with an underlying piece 5. As a result of the friction between the bottom surface of the head 96 and the piece 5, the latter turns through the angle set by the head 96 itself sliding on

the plane 29. After rotation, the actuator 97 is controlled to lift the head 96 up again so that the conveyor 25 continues to transfer the piece 5 towards the device 30c.

5 Preferably, the actuator 97 is set between the motor 98 and the head 96 and comprises a sleeve (not visible in Figure 6), which is coaxial and fixed with respect to the rotary shaft of the motor 98. Said sleeve is housed in a casing 101, which is angularly fixed and defines at least part of a pneumatic
10 distributor. The device 48a further comprises at least one stem 105, which is parallel and eccentric with respect to the axis 52a and guides axial translation of the head 96, constraining it angularly with respect to the sleeve of the actuator 97.

15 From the foregoing it emerges clearly that the systems 1, 1a not only transfer the pieces 5, but orient them automatically in the required way. The system 1 does not need structural modifications to be able to transfer pieces having a different
20 shape and/or different dimensions. In fact, automatic orientation of the pieces is obtained by a unit 31 that receives the data of the captured images and compares them automatically with the data stored corresponding to various possible orientations and to the required final orientation.
25 When a lot of pieces with a different shape and/or different dimensions must be transferred, it is necessary to store the images of the various possible orientations of the new type of pieces, and a new setting of operating parameters in the algorithms of the unit 31 could be necessary, without any need
30 for adjustment or replacement of mechanical parts. Programming of the unit 31 can be performed also remotely, for example via the Internet.

The system 1a could require structural modifications (for
35 example, a replacement of the inserts 80), but said modifications are extremely small as compared to those of

assemblies for transfer of pieces in a row according to the known art. On the other hand, the system 1a enables positioning of the pieces 5 in the required orientation with negligible margins of error and reduced numbers of rejects, and enables a high production rate to be achieved. The images captured by the device 30 are used by the unit 31 in a known way to identify the co-ordinates of the position of each piece on the plane 29 so as to set the gripper 47 in the correct horizontal position during picking up, and can be exploited to carry out a quality control on the pieces 5 transferred.

The systems 1, 1a described can be used in sectors extremely different from one another and for different purposes, in which it is necessary to orient components randomly resting on a plane.

Also the singulator 8 is suited to conveying pieces of different shape and dimensions, provided that said dimensions fall within a maximum size range, thanks to the use of the seats 13 or of the suction mouths 18, without having to make modifications to the mechanical parts.

The characteristics of the gripper 47 and of the robot make it possible to prevent any sliding on the plane 29, to carry out just two rotations for setting each piece 5 in any required final orientation, and to carry out said rotations simultaneously, precisely during transfer of the piece 5 from the plane 29 to the station 33, hence saving time and encumbrance and preventing any friction.

In addition to obtaining fast transfer, the gripper 47 and the robot enable precision to be obtained for the position and for the orientation of the pieces 5 left in the station 33.

Finally, from the foregoing it emerges clearly that modifications and variations may be made to the systems 1, 1a

described with reference to the attached figures, without thereby departing from the sphere of protection of the present invention, as defined in the annexed claims.

5 In particular, the fingers 53, 54 could present a motion of a rotary type with respect to the structure 51; and/or one of the fingers 53, 54 could be fixed with respect to the structure 51; and/or the surfaces 55, 56 could be defined by resting elements with a shape different from that of the disks
10 61, 62; and/or at least one of the disks 61, 62 could be provided with axial translation with respect to the corresponding finger 53, 54 (possibly with the fingers 53, 54 fixed with respect to the structure 51); and/or the motor 62 could be set in different positions, for example along the
15 axis 57 without the transmission 64.

The movement assembly 32 could be defined by a robot of a type different from an anthropomorphic one, or else, instead of the robot, could comprise different equipment. For instance, the
20 assembly 32 could comprise a table, which is rotary about a vertical axis and is provided with a gripper that picks up one piece at a time from the conveyor 25 and, via rotation of the table, transfers it into a different station, in which the piece is rotated, respectively, about different axes.

25 Moreover, the pieces 5 could be brought into the required final orientation via a different sequence of rotations, for example via rotations about three transverse axes, lying in a horizontal plane.

30 In addition, the singulator 8 could be of a different type, for example of a traditional vibration type; and/or the device 30 could be set in another position: for example, it could be set alongside the conveyor 25 or else it could be carried
35 directly by the gripper 47; or else the device 30 could be aimed on the plane 29, with a viewing direction inclined with

respect to the vertical.

Furthermore, the pieces 5 could be randomly heaped in bulk on a relatively wide conveyor, instead of being conveyed in a row
5 formed by the singulator 8; or else the device 30 could capture the images of the pieces 5 while the latter are stationary on the plane 29, instead of capturing them while they are moving.

10 The device 82 could be replaced by a thrust device; or else tipping-over about the axis 57a could be performed by causing the pieces 5 to roll on the plane 29, instead of pushing them away with the device 82 and bringing them back onto the plane 29 via the device 83.

15 Finally, the singulator 8 could be used for traditional transfer lines, without the device 30, the unit 31, or the assembly 32.

20

CLAIMS

1.- A transfer system for setting a piece in a required orientation, the system comprising:

- 5 - a resting plane;
 - a vision device (30; 30a, 30b) for capturing at least one image of a piece (5) resting on said resting plane;
 - movement means (32) for rotating said piece (5);
 - control and command means that control said movement
10 means (32) so as to set said piece (5) in the required orientation, as a function of differences between the position of the piece in the captured image and the required orientation; said control and command means comprising:

15 a) storage means (37) containing stored data of images representing at least one sample element, which is the same as said piece (5) and is set in respective different stable resting positions; and

 b) processing means for comparing data of the captured
20 image with the data of the stored images;

said movement means (32) comprising first rotation means (63; 63a) for rotating said piece (5) about a first axis (57; 57a) and second rotation means (48; 48a) for rotating said piece (5) about a second axis (52; 52a) transverse to said first
25 axis (57; 57a);

characterized by further comprising a conveyor (25) having a movable horizontal plane (29) for transferring a flow of said pieces, and in that said resting plane is defined by said movable horizontal plane (29).

30 2.- The system according to Claim 1, characterized in that said vision device (30; 30a, 30b) is set in a fixed position.

35 3.- The system according to Claim 1 or Claim 2, characterized in that said first and second axes (57, 52; 57a, 52a) are orthogonal.

4.- The system according to Claim 3, characterized in that said movement means (32) comprise moving-away means (47; 82) for displacing said piece away from said movable horizontal plane (29); said first rotation means (63; 63a) being controlled so as to rotate said piece about said first axis (57; 57a) after said piece has been moved away from said movable horizontal plane (29).

10 5.- The system according to Claim 4, characterized in that said movement means (32) are defined by a robot comprising a gripper (47) for gripping said piece (5).

15 6.- The system according to Claim 5, characterized in that said gripper (47) comprises two fingers (53, 54) supporting said first rotation means (63).

7.- The system according to Claim 4, characterized in that said moving-away means (82) comprise suction means.

20 8.- The system according to any one of the preceding claims, characterized by further comprising:

- a housing (2) for containing a heap of pieces in bulk;
- a singulator (8) for forming an orderly flow of pieces from said heap; and
- conveyor means (16, 26, 25) between said singulator (8) and said vision device (30);

25 said singulator (8) comprising a motor-driven wheel (9;9a), which has, along its own periphery, a plurality of retention members for collecting and conveying respective said pieces; said retention members being defined by retention seats (13) or else by suction mouths (18).

35 9.- The system according to Claim 3 or Claim 4, characterized in that said first and second rotation means (63a, 48a) are distinct and are set along the path of said conveyor (25);

said first rotation means (63a) being configured so as to rotate said piece (5) about a horizontal axis (57a); said second rotation means (48a) being configured so as to rotate said piece (5) about a vertical axis (52a) whilst said piece
5 (5) is in contact with said movable horizontal plane (29).

10.- The system according to Claim 9, characterized in that said vision device comprises a first vision device (30a) set before said first rotation means (63a), and a second vision
10 device (30b) set along said path between said first and second rotation means (63a, 48a).

11.- The system according to Claim 9 or Claim 10, characterized by comprising a third vision device (30c) set
15 along said path after said second rotation means (48a) and connected to said command and control means (31), which are configured so as to control whether the orientation of the piece corresponds to the required orientation.

20 12.- The system according to any one of Claims 9 to 11, characterized in that said horizontal axis (57a) is orthogonal to said path.

13.- The system according to Claim 12, characterized in that
25 said first rotation means (63a) are set alongside said conveyor (25), and in that said movement means (32) comprise:

- suction means (82) for taking said piece (5) from said movable horizontal plane (29) towards said first rotation means (63a); and
- 30 - thrust means (83) for pushing back said piece (5) onto said movable horizontal plane (29) after a rotation through 180° about said horizontal axis (57a).

14.- The system according to Claim 13, characterized in that
35 said control and command means (31) control said suction means (82) so as to change the instant at which the suction of said

piece (5) starts as a function of the position and/or orientation of the piece in the captured image.

15.- The system according to Claim 13 or Claim 14,
5 characterized in that said first rotation means (63a) comprise a tipping-over member (71), which can turn about a horizontal axis set at the height of the flow of pieces on said movable horizontal plane (29) and defines at least one compartment (79); said compartment being set in an eccentric position and
10 being open on a side facing said conveyor (25).

16.- The system according to Claim 15, characterized in that said compartment (79) is open also on a side opposite to that of said conveyor (25).

15
17.- The system according to Claim 15 or Claim 16, characterized in that said tipping-over member (71) comprises two said compartments (79), which are diametrically opposite.

20
18.- The system according to any one of Claims 13 to 17, characterized in that said thrust means (83) comprise a slide (90), a motor (94), and a crankshaft transmission (95) driven by said motor (94) for translating said slide (90) parallel to said horizontal axis.

25
19.- A robot gripper for a transfer system according to Claim 6, the gripper comprising:

- two fingers (53, 54) supporting respective gripping surfaces (55, 56), which are coaxial and movable with
30 respect to one another along a longitudinal axis (57);
and
- a first actuator (60) for approaching/moving away said gripping surfaces (55, 56) longitudinally;

35 characterized in that said gripping surfaces (55, 56) can turn about said longitudinal axis (57) with respect to said fingers (53, 54), and characterised by comprising a second actuator

(63) for rotating one of said gripping surfaces (56) about said longitudinal axis (57).

20.- The robot gripper according to Claim 19, characterized in
5 that said gripping surfaces (55, 56) are longitudinally fixed with respect to the corresponding fingers (53, 54), and said first actuator (60) drives the displacement of at least one of said fingers (53, 54).

10 21.- The robot gripper according to Claim 19 or Claim 20, characterized in that said first actuator (60) comprises two actuation stages that are set in series and can be operated independently of one another.

15

FIG. 1

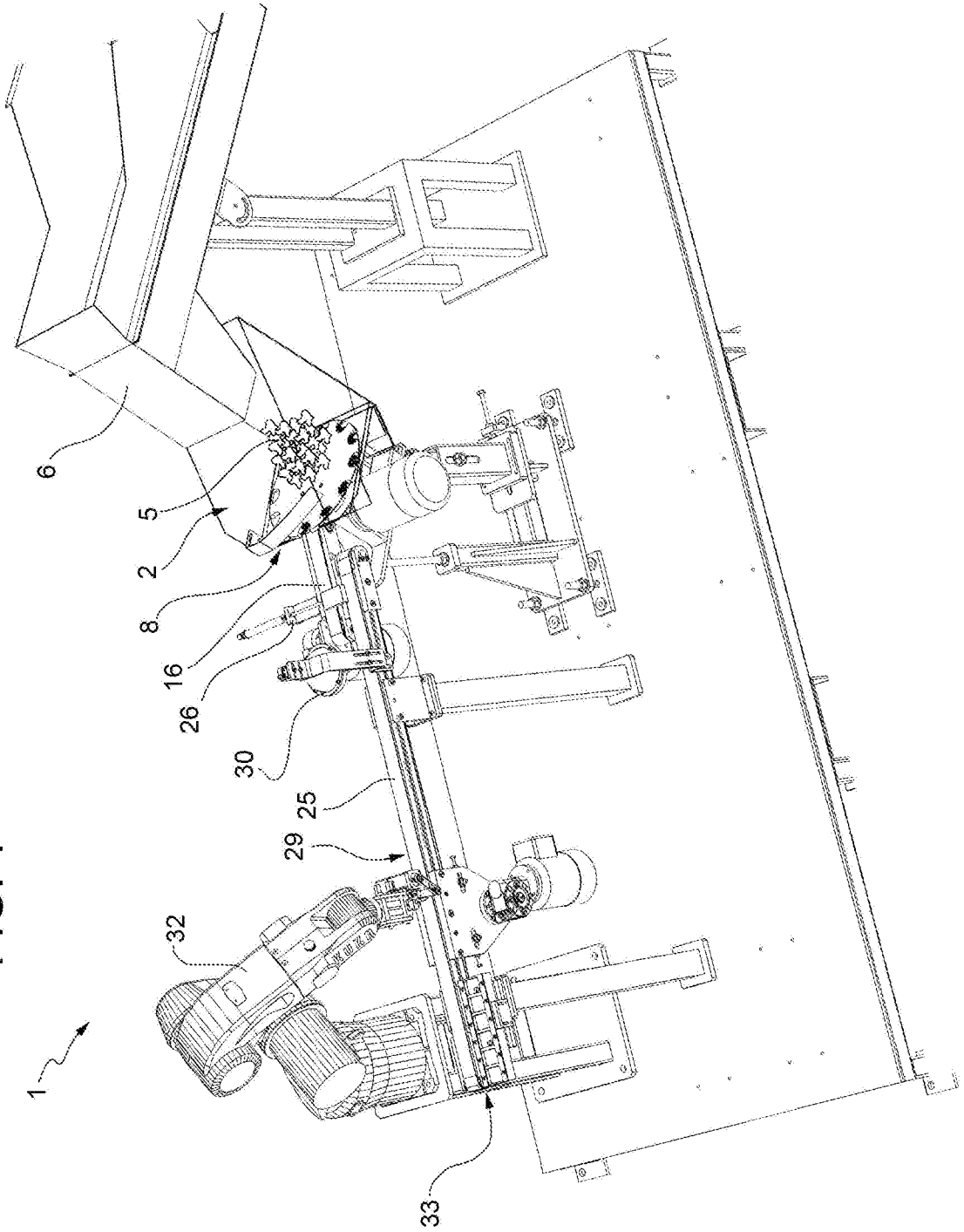
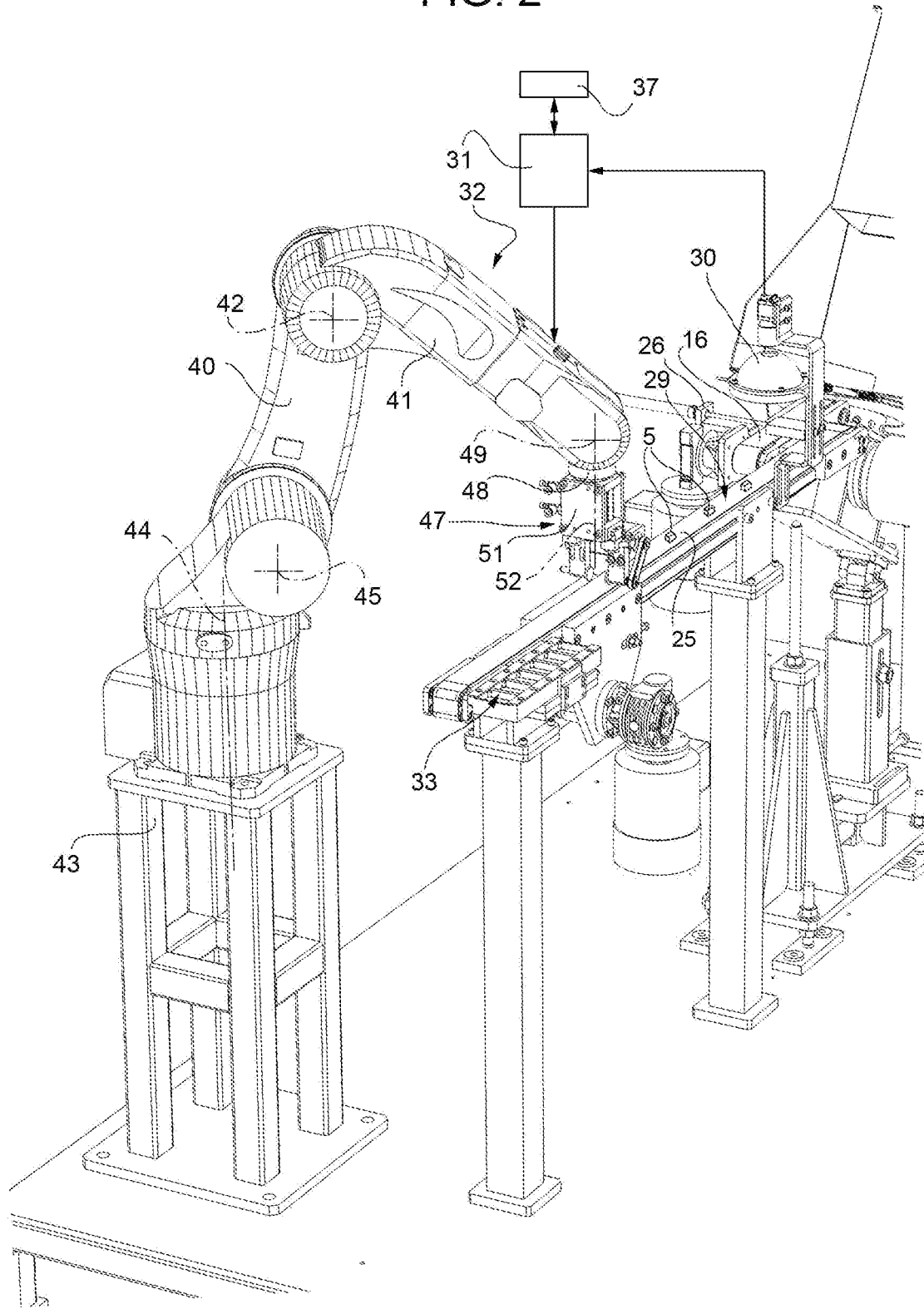
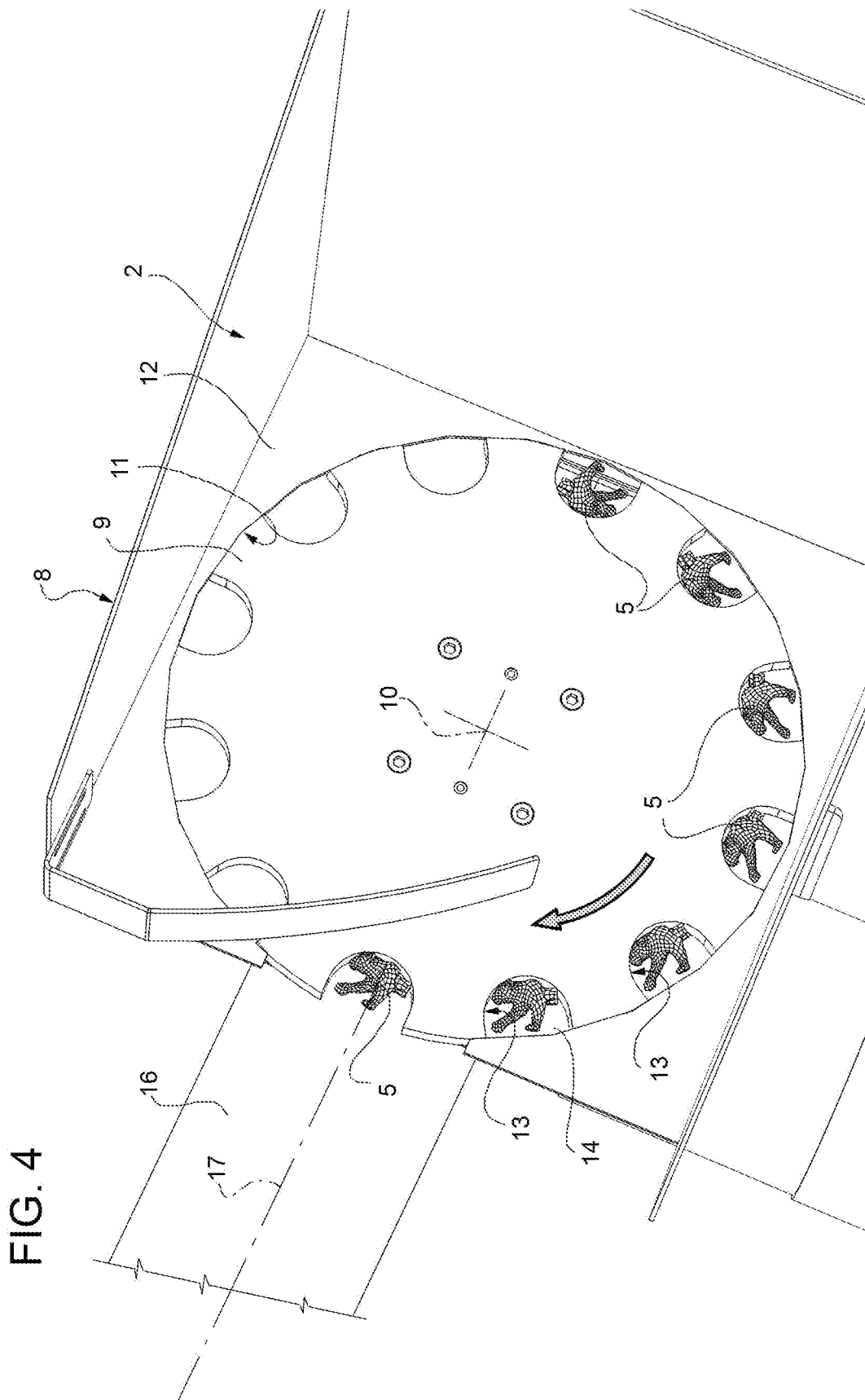


FIG. 2





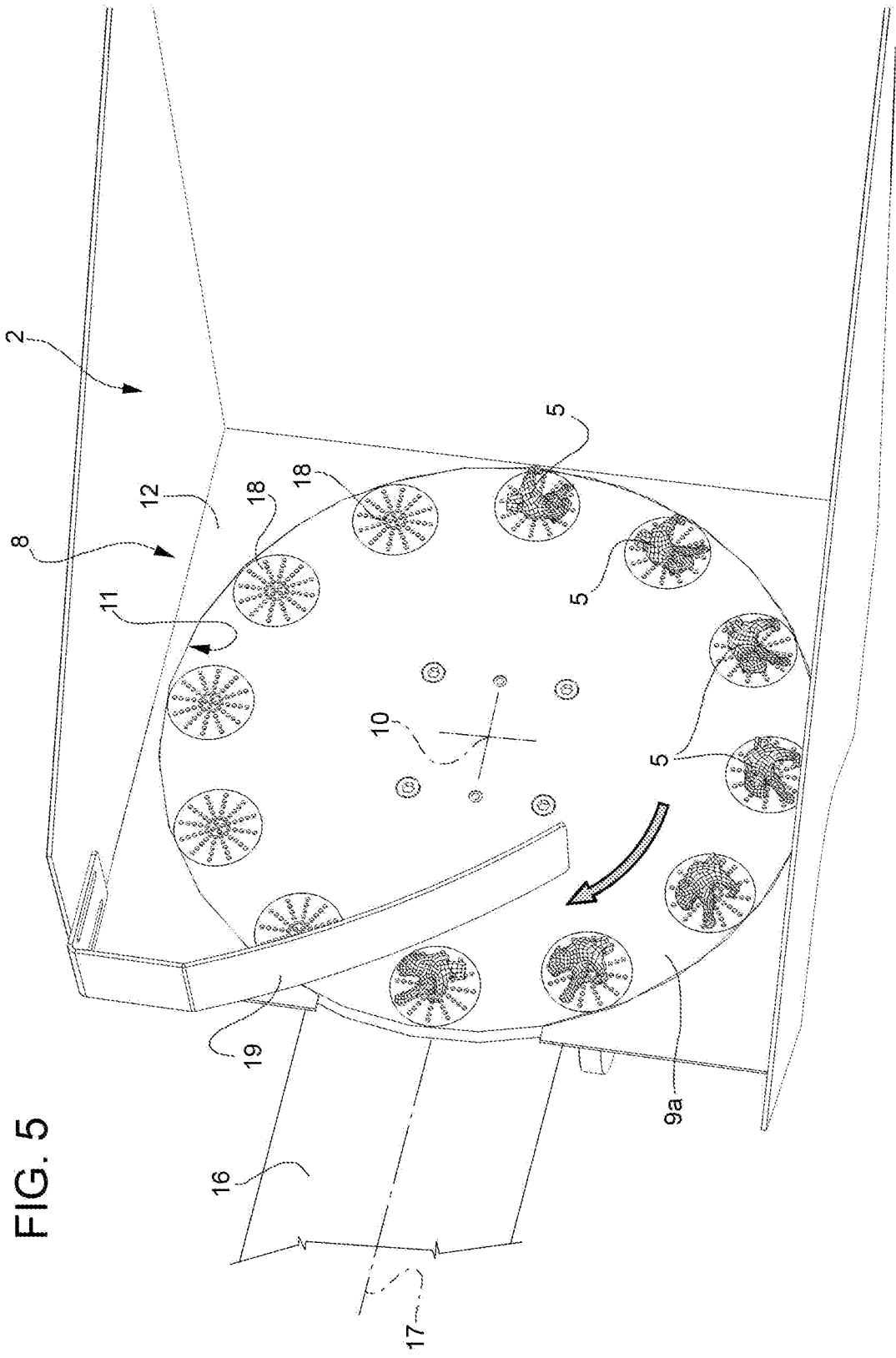


FIG. 5

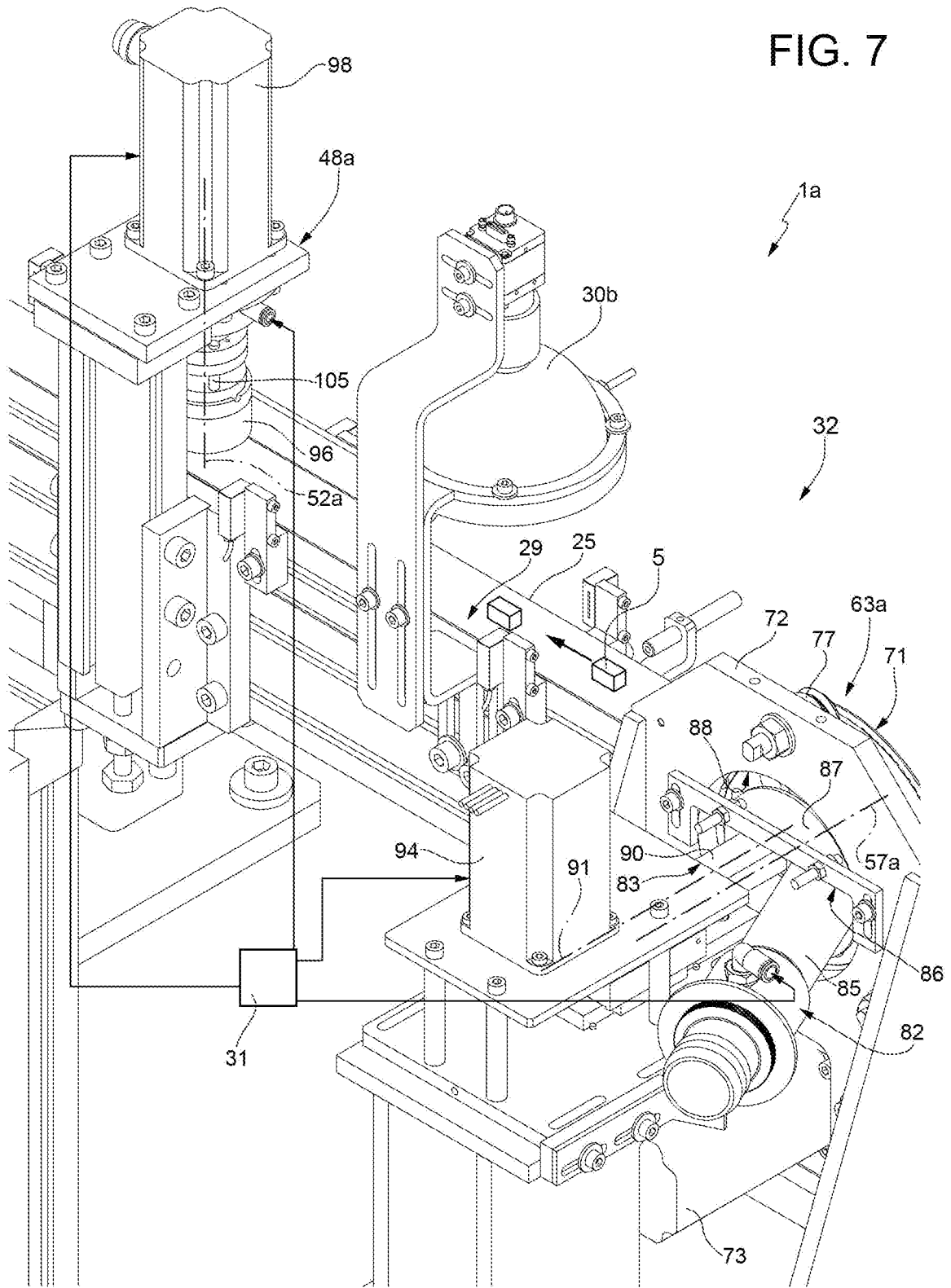
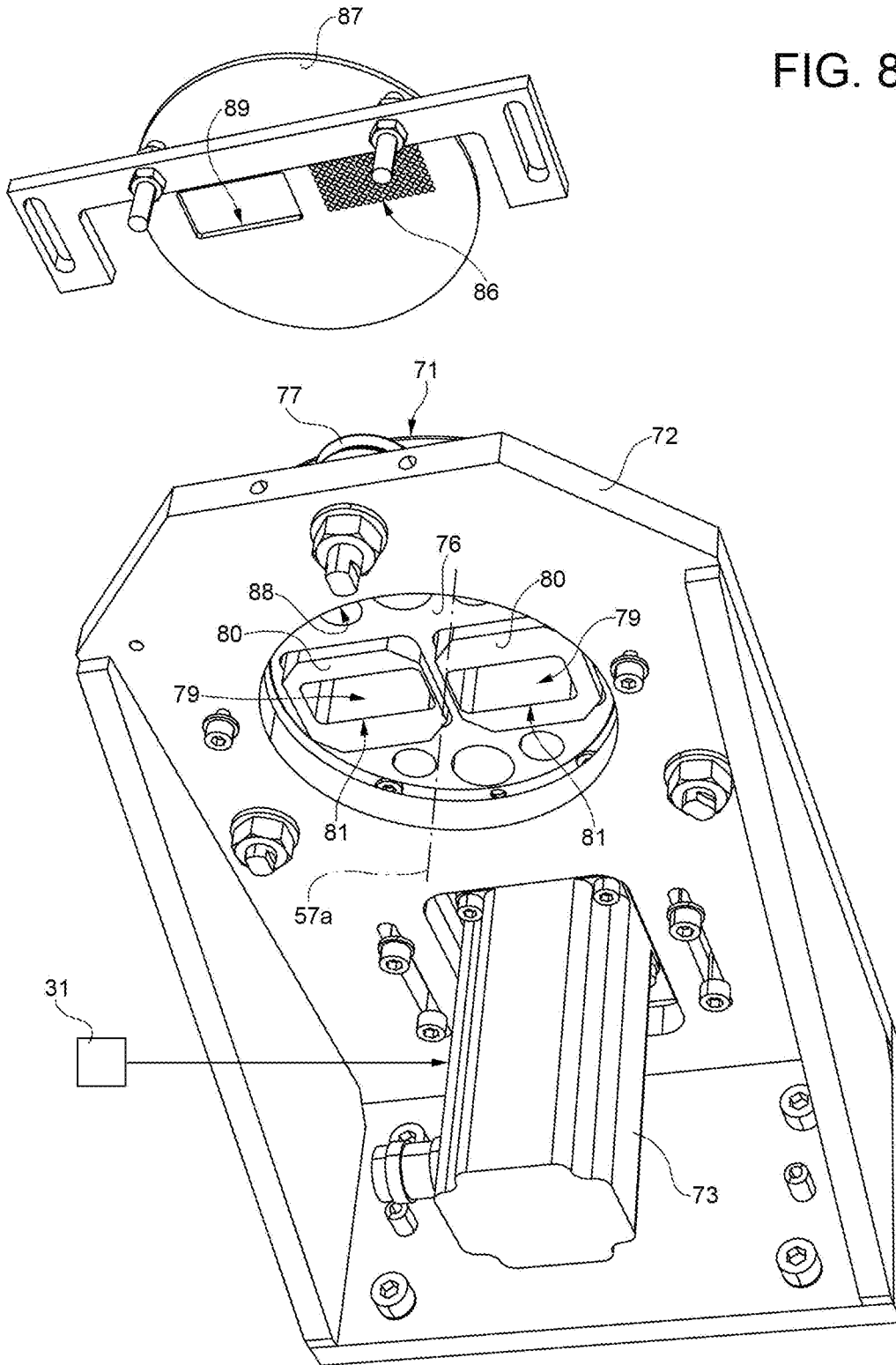


FIG. 8



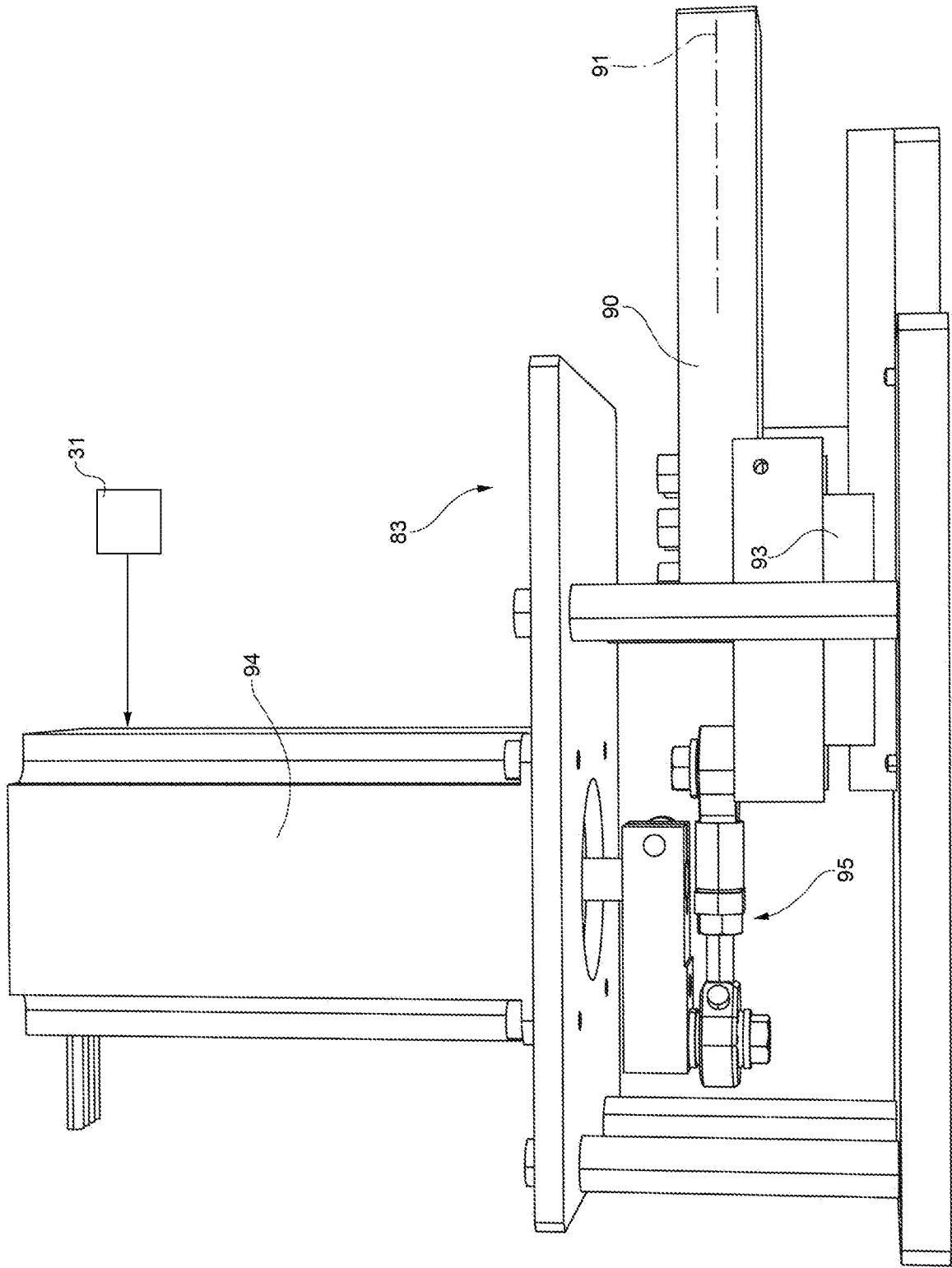


FIG. 9