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(71) Applicant: **Tetra Laval Holdings & Finance S.A.**
**1009 Pully (CH)**

(72) Inventors:
- **Raimondi, Federico**
  **41100 Modena (IT)**
- **Baldini, Claudio**
  **41015 Nonantola (IT)**

(74) Representative: **Franzolin, Luigi et al**
**STUDIO TORTA S.r.l.,**
**Via Viotti, 9**
**10121 Torino (IT)**

## (54) Device for controlling the position of packages on a production line

(57) A device (38) for controlling the position of packages (3) of pourable food products on a unit (1) for applying opening devices (2) to the packages, the device having an optical sensor (43) for simultaneously detecting the position of a prelaminated hole (5) on a package (3) and position reference marks (46) associated with a respective supporting and conveying device (8) for supporting and conveying the package (3); and adjusting means (36, 33) for adjusting the relative position of each of the packages (3) in response to an error in the position of the respective hole (5) within a reference system (45) defined by the aforementioned marks (46).

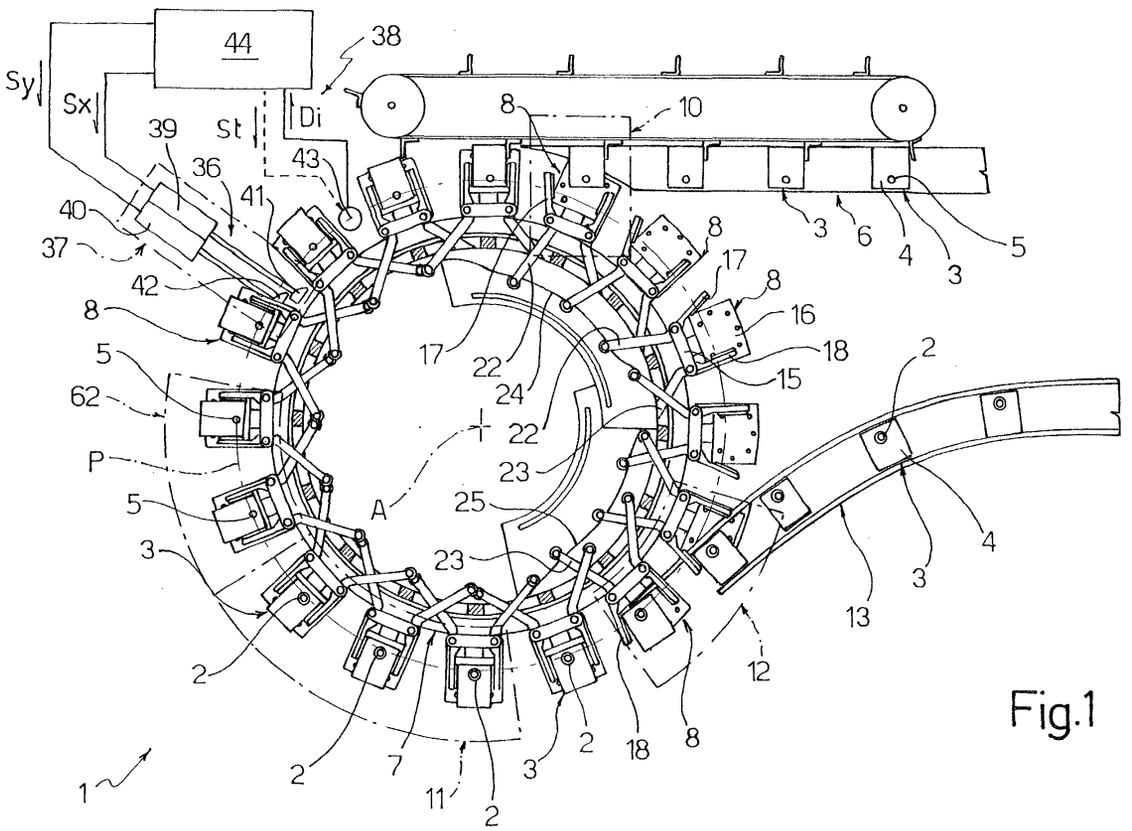


Fig.1

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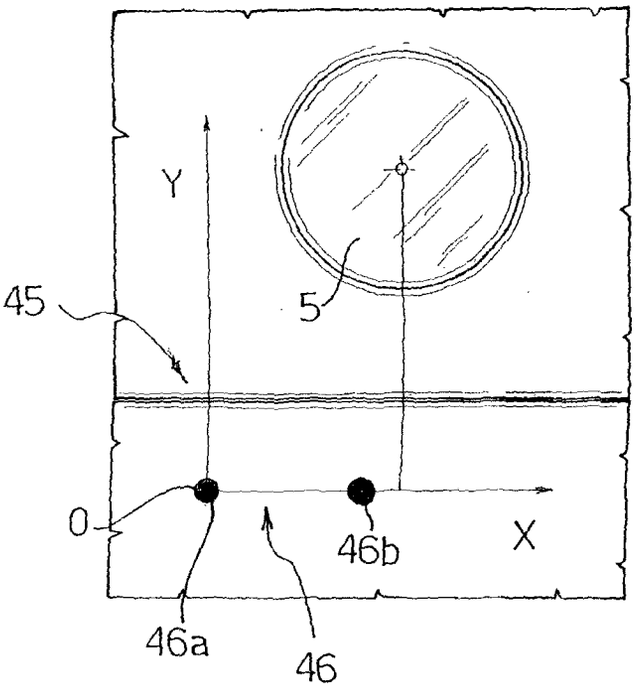



Fig.3

## Description

**[0001]** The present invention relates to a device for controlling the position of packages of pourable food products on a production line on which the packages are conveyed successively.

**[0002]** As is known, many pourable food products, such as fruit juice, UHT (ultra-high-temperature processed) milk, wine, tomato sauce, etc., are sold in packages made of sterilized packaging material.

**[0003]** A typical example of such a package is the parallelepiped-shaped package for liquid or pourable food products known as Tetra Brik Aseptic (registered trademark), which is formed by folding and sealing a web of laminated packaging material. The packaging material has a multilayer structure comprising a layer of fibrous material, e.g. paper, covered on both sides with layers of heat-seal plastic material, e.g. polyethylene, and, in the case of aseptic packages for long-storage products, such as UHT milk, also comprises a layer of oxygen-barrier material defined, for example, by an aluminium film, which is superimposed on a layer of heat-seal plastic material and is in turn covered with another layer of heat-seal plastic material eventually defining the inner face of the package contacting the food product.

**[0004]** As is known, such packages are made on fully automatic packaging machines, on which a continuous tube is formed from the web-fed packaging material; the web of packaging material is sterilized on the packaging machine itself, e.g. by applying a chemical sterilizing agent, such as a hydrogen peroxide solution, which, after sterilization, is removed, e.g. vaporized by heating, from the surfaces of the packaging material; and the web of packaging material so sterilized is maintained in a closed sterile environment, and is folded and sealed longitudinally to form a vertical tube.

**[0005]** The tube is filled with the sterilized or sterile-processed food product, and is sealed and cut at equally spaced cross sections to form pillow packs, which are then folded mechanically to form the finished, e.g. substantially parallelepiped-shaped, packages.

**[0006]** Alternatively, the packaging material may be cut into blanks, which are formed into packages on forming spindles, and the resulting packages are filled with the food product and sealed. One example of such a package is the so-called "gable-top" package commonly known by the trade name Tetra Rex (registered trademark).

**[0007]** Once formed, packages of the above type may undergo further processing, such as the application of a closable opening device, to which reference is made herein purely by way of example.

**[0008]** The most commonly used opening devices comprise a frame defining an opening and fitted about a pierceable or removable portion of the top wall of the package; and a cap hinged or screwed to the frame and which can be removed to open the package. Other, e. g. slidable, opening devices are also known to be used.

**[0009]** The pierceable portion of the package may be defined, for example, by a so-called "prelaminated" hole, i.e. a hole formed in the fibrous layer of the packaging material before the fibrous layer is joined to the barrier layer, which is thus whole and closes the hole to ensure hermetic, aseptic sealing, while at the same time being easily pierced.

**[0010]** In the case of aseptic packaging machines, the opening devices described are normally fitted continuously straight on to the formed packages on on-line application units downstream from the packaging machine.

**[0011]** Known units for applying opening devices substantially comprise a chain conveyor for feeding the packages successively along a normally straight transfer path; first heating means for locally heating the packages at the pierceable portions; second heating means for heating the opening devices; and application means activated along the transfer path to apply the opening devices on to the packages.

**[0012]** On known conveyors, the position of the packages on the conveyor is normally determined by the lateral walls of the packages mechanically contacting respective movable push walls and fixed guide surfaces on the conveyor. The accuracy with which the packages are positioned with respect to the application means, however, is affected by various factors, such as conveyor tolerances and the intrinsically changing shape of the package, which is made of flexible material, as opposed to being rigid.

**[0013]** Heat sealing the opening devices, especially in the case of packages with prelaminated holes, on the other hand, calls for extremely accurate positioning of the packages with respect to the application means. Applying the opening device in the wrong position may result in various problems, such as poor adhesion to the package and malfunctioning of the opening device itself, which in turn may result in difficulty in opening the package, product leakage, or splashing when the product is poured out.

**[0014]** A demand therefore exists in the industry for precise on-line position control of the packages, to ensure application of the opening devices and any other auxiliary processing of the packages are performed to a high degree of precision.

**[0015]** It is an object of the present invention to provide a reliable, low-cost device for controlling the on-line position of packages of pourable food products, while at the same time permitting high production speed.

**[0016]** According to the present invention, there is provided a device for controlling the position of packages of pourable food products on a production line on which the packages are conveyed successively and subjected to an operation performed by an operating head; said packages having optically detectable first position reference means; the device being characterized by comprising:

a number of supporting and conveying devices for supporting and conveying said packages;

optically detectable second position reference means associated with each said supporting and conveying device and defining, for each said supporting and conveying device, a position reference system integral with the supporting and conveying device;

optical sensing means having such a viewing range as to simultaneously detect said first and said second position reference means;

a control unit having processing means for determining the position of said first position reference means with respect to said position reference system defined by said second position reference means; and

adjusting means for adjusting the relative position of each of said packages with respect to said operating head, and controlled by said control unit in response to a position error of said first position reference means within said position reference system defined by said second position reference means.

**[0017]** According to the present invention, the position of each package is therefore adjusted individually with respect to the operating head by optical detection, thus enabling the relative position of the package to be adjusted accurately with no interference factors, such as deformation of the package itself.

**[0018]** Moreover, optical detection is performed with respect to a reference system integral with the respective supporting and conveying device, as opposed to an absolute reference system, thus enabling accurate detection at any time and regardless of how accurately the sensor is positioned. As a result, high-cost, high-precision-timing control systems are not required, even at high production speeds; and, providing the first and second position reference means remain within the viewing range of the optical sensor, detection precision remains constant, even in the event of minor static or dynamic variations, e.g. due to shock or vibration, in the position of the sensor. The device is therefore highly reliable and calls for very little maintenance.

**[0019]** The invention is conveniently used on a unit for applying opening devices to respective packages, in particular packages comprising a prelaminated hole, which is used as an optically detectable position reference element.

**[0020]** According to a further aspect of the present invention, the opening device application unit is a rotary type featuring a rotary table to which the package supporting and conveying devices are fixed rigidly. This provides for further improving precision as compared with known linear application units featuring chain conveyors, which are invariably affected by inevitable slack on the chain.

**[0021]** A preferred, non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a schematic plan view of a unit for applying opening devices to packages of pourable food products and featuring a package position control device in accordance with the present invention;

Figure 2 shows a view in perspective of a detail of the control device according to the invention;

Figure 3 shows, schematically, an image picked up by an optical sensor forming part of the control device;

Figure 4 shows a partial view in perspective of the Figure 1 unit;

Figure 5 shows a block diagram of a sequence of operations performed by a control unit of the device according to the invention.

**[0022]** Number 1 in Figure 1 indicates as a whole a unit for applying opening devices 2 to aseptic packages 3 of pourable food products.

**[0023]** Packages 3 are made on a packaging unit (not shown) from a web of sheet packaging material comprising a layer of paper material covered on both sides with layers of heat-seal plastic material, e.g. polyethylene; and a layer of barrier material, e.g. aluminium, located on the inside of the paper material layer and in turn covered on the inside with another layer of plastic material.

**[0024]** A top face 4 of each of packages 3, which, in the example shown are substantially parallelepiped-shaped, has a pierceable portion 5 conveniently defined by a so-called "prelaminated" hole, i.e. a hole formed in the paper layer of the packaging material before the paper layer is joined to the barrier layer, which thus closes the hole to ensure hermetic, aseptic sealing, while at the same time being easily pierced.

**[0025]** Unit 1 comprises a rotary table 7, of axis A, rotated about its axis at constant speed by drive means not shown. Rotary table 7 supports a number of supporting and conveying devices 8 for supporting and conveying packages 3, and which are fixed in equally spaced manner to, and project radially from, a substantially cylindrical peripheral lateral wall 9 of rotary table 7 (Figure 4).

**[0026]** Devices 8 receive respective packages 3 from a known input conveyor 6 tangent to rotary table 7 at a supply station 10 and for conveying packages 3 in equally spaced manner and at a constant speed equal to the linear speed of devices 8. Rotating together with rotary table 7, devices 8 feed packages 3 along a circular path P through an application station 11 for applying opening devices 2 and up to an unloading station 12 where packages 3 are removed by an output conveyor 13.

**[0027]** More specifically, each device 8 (Figures 2 and 4) comprises a vertical wall or back 15 fixed to wall 9 of rotary table 7; a base 16 on which a respective package

3 rests; and two lateral retaining members 17, 18 hinged to the sides of vertical wall 15 and loaded by respective springs 19 so as to cooperate with respective lateral faces of package 3 and keep the package steady on base 16 throughout the time it remains on rotary table 7.

**[0028]** Members 17 and 18, which are located down- and upstream respectively of respective package 3 along path P, have respective control arms 22, 23 extending inwards of rotary table 7 through openings 19 in wall 9, and which interact with respective fixed cams 24, 25 close to stations 10, 12 respectively (Figure 1).

**[0029]** Cam 24 acts on arms 22 to produce a rotary opening movement of members 17, i.e. away from the corresponding members 18, and so permit insertion of packages 3 inside respective devices 8 without interfering with members 17. Similarly, cam 25 acts on arms 23 to produce a rotary opening movement of members 18 at unloading station 12 and so permit withdrawal of packages 3 without interfering with members 18 (Figure 1).

**[0030]** Base 16 of each device 8 (Figure 4) substantially comprises a supporting plate 30 connected rigidly to a bottom edge of, and projecting from, wall 9 of rotary table 7; and a movable plate 31 on top of supporting plate 30, and the top face 32 of which defines a horizontal supporting surface for a respective package 3. Movable plate 31 is connected to plate 30 with a certain amount of freedom to move in both a tangential direction X and a radial direction Y with respect to rotary table 7, and can be adjusted in position with respect to supporting plate 30 and in said directions by means of a mechanism 33 - not described in detail by not forming part of the present invention - housed between plates 30 and 31 and controlled by a lever 34 to adjust the X position, and by a lever 35 to adjust the Y position. Levers 34, 35 are located beneath base 16, are hinged to supporting plate 30, and are activated by an adjusting device 36 located along path P, at an adjusting station 37 between supply station 10 and station 11 for applying opening devices 2, and forming part of a device 38 for controlling the position of packages 3.

**[0031]** Device 38 (Figure 1) comprises two servomotors 39, 40 for controlling the position of respective cams 41, 42 designed to interact with levers 34, 35 of each device 8 traveling through adjusting station 37; for which purpose, levers 34, 35 comprise respective cam follower rollers 34a, 35a.

**[0032]** Device 38 comprises an optical sensor 43 - conveniently a video camera - located over path P between supply station 10 and adjusting station 37; and a control unit 44 connected to optical sensor 43 and to servomotors 39, 40, and which supplies the servomotors with respective control signals Sx, Sy in response to input data Di received from optical sensor 43.

**[0033]** Control unit 44 - which may be defined by the main, e.g. PLC, control unit of unit 1 - generates a trigger signal St for enabling optical sensor 43, and which is conveniently defined by a succession of pulses synchronized with the travel of each device 8 within the viewing range of optical sensor 43.

**[0034]** More specifically, and as shown in Figure 3, the viewing range of optical sensor 43 is such as to simultaneously detect prelaminated hole 5, and reference marks 46 located in a fixed position on device 8 and defining a reference system 45 by which to define the position of prelaminated hole 5. In the example shown, the reference marks are defined by two circular marks 46a, 46b made on a supporting plate 47 fixed rigidly to wall 15 of device 8, and aligned with each other in a tangential (X) direction with respect to rotary table 7. Marks 46a, 46b therefore define a point O, e.g. coincident with the center of mark 46a and defining the origin of the cartesian reference system; and an axis (X) of the cartesian reference system, defined by the line joining the centers of marks 46a, 46b.

**[0035]** Unit 1 also comprises a number of application devices 50 (Figure 4), each secured to rotary table 7 over a respective supporting device 8, and which, not forming part of the invention, are only described as required for a clear understanding of the invention. Very briefly, each application device 50 comprises a vertical guide 54 secured to the rotary table; and an operating head 55 having jaws 56 for gripping an opening device 2, and which is movable along guide 54 between a raised rest position (Figure 4) and a lowered work position in which opening device 2 is pressed onto package 3 at prelaminated hole 5. The operating head is maintained in the rest position by springs 57; and the movement of operating head 55 is controlled by a fixed cam (not shown) extending along path P at application station 11 and over rotary table 7, and which cooperates with a cam follower 58 fixed to operating head 55.

**[0036]** By means of a conventional device not shown, the opening devices are conveniently supplied successively to unit 1 at supply station 10, where they are picked up by jaws 56. Jaws 56 are opened and closed by a pneumatic actuator (not shown) housed in operating head 55 and activated by a mechanically controlled valve 60, a control roller 61 of which interacts with a fixed cam (not shown) coaxial with rotary table 7, so as to close the jaws at station 10 as soon as opening device 2 is supplied, and open the jaws once device 2 is applied to respective package 3.

**[0037]** Opening devices 2 are conveniently applied by heat sealing; for which purpose, packages 3 and opening devices 2 are first heated in known manner not described, e.g. by means of hot-air jets, at a heating station 62 immediately upstream from application station 11.

**[0038]** Operation of device 38 for controlling the position of packages 3 on unit 1 will now be described with reference to the Figure 5 diagram, which shows the sequence of operations performed by control unit 44 to adjust the position of each package 3; which operations are obviously performed cyclically and in time with the rotation of table 7, i.e. with a period equal to the time taken by the table to rotate through the angle between

two consecutive devices 8.

**[0039]** A start block 64 is followed by a block 65 where control unit 44 generates a trigger pulse St to enable acquisition of the image by optical sensor 43, and which is followed by a block 66 in which data Di from sensor 43 is acquired.

**[0040]** Block 66 goes on to an image processing block 67, which, on the basis of conventional pattern recognition algorithms not described in detail, determines the centers of marks 46a, 46b (block 67a) defining the local coordinate system (origin O and X axis), and the center C of prelaminated hole 5 (block 67b).

**[0041]** The next block 68 calculates the hole center C coordinates within the local coordinate system defined by marks 46, and then goes on to a block 69, which compares the coordinates with respective theoretical reference values relative to the theoretical or design position of prelaminated hole 5, and calculates respective error values $\Delta X$, $\Delta Y$.

**[0042]** In response to values $\Delta X$, $\Delta Y$, the next block 70 generates signals Sx, Sy controlling servomotors 39, 40 to set cams 41, 42 of adjusting device 36 to a given correction position to correct the position error of prelaminated hole 5. More specifically, as device 8 travels through adjusting station 37, cam followers 34a, 35a of levers 34, 35 interact with respective cams 41, 42, and levers 34, 35 rotate to shift movable plate 31 of device 8 by a quantity $-\Delta X$ in direction X and by a quantity $-\Delta Y$ in direction Y, and so ensure prelaminated hole 5 is positioned correctly with respect to relative application device 50.

**[0043]** When device 8 reaches station 11, the respective opening device 2 is applied by application device 50 perfectly aligned with prelaminated hole 5.

**[0044]** Clearly, changes may be made to unit 1 and control device 38 as described herein without, however, departing from the scope of the accompanying Claims.

**[0045]** In particular, device 38 may be used in any application in which packages 3 are subjected successively to an operation performed by an operating head and requiring a high degree of precision. The position of package 3 may be detected by reading any other type of reference mark or optical code, and may be used to correct, each time, the position of the operating head as opposed to the package. Finally, precision permitting, rotary table 7 may be replaced with a linear conveyor.

## Claims

1. A device (38) for controlling the position of packages (3) of pourable food products on a production line (6, 7, 13) on which the packages (3) are conveyed successively and subjected to an operation performed by an operating head (55); said packages (3) having optically detectable first position reference means (5); the device being **characterized by** comprising:

   a number of supporting and conveying devices (8) for supporting and conveying said packages (3);

   optically detectable second position reference means (46) associated with each said supporting and conveying device (8) and defining, for each said supporting and conveying device (8), a position reference system (45) integral with the supporting and conveying device (8);

   optical sensing means (43) having such a viewing range as to simultaneously detect said first (5) and said second (46) position reference means;

   a control unit (44) having processing means (67) for determining the position of said first position reference means (5) with respect to said position reference system (45) defined by said second position reference means (46); and

   adjusting means (36, 33) for adjusting the relative position of each of said packages (3) with respect to said operating head (55), and controlled by said control unit (44) in response to a position error of said first position reference means (5) within said position reference system (45) defined by said second position reference means (46).

2. A device as claimed in Claim 1, **characterized in that** the optically detectable first position reference means are defined by a prelaminated hole (5) on said packages (3).

3. A device as claimed in Claim 1 or 2, **characterized in that** said second position reference means (46) comprise at least two marks (46a, 46b) defining a direction (X) and an origin (O) of said position reference system (45) integral with said supporting and conveying device (8).

4. A device as claimed in Claim 2 or 3, **characterized in that** said control unit (44) comprises calculating means (68) for calculating the position of the center of the prelaminated hole (5) within said position reference system (45) integral with said supporting and conveying device (8).

5. A device as claimed in any one of the foregoing Claims, **characterized in that** said supporting and conveying devices (8) each comprise a base (16) having at least one supporting member (31) for supporting said package (3) and movable in a plane (X, Y); said adjusting means (36) for adjusting the relative position of each of said packages (3) with respect to said operating head (55) comprising actuating means (39, 40) for moving said supporting member (31) along said plane (X, Y).

6. A unit (1) for applying opening devices (2) to pack-

ages (3) of pourable food products, the unit comprising a conveyor (7) having a number of supporting and conveying devices (8) for successively feeding said packages (3) along a path (P); and application means (50) for applying said opening devices (2) to said packages (3); said packages having optically detectable first position reference means (5); and the unit being **characterized by** comprising a device (38) for controlling the position of each of said packages (3) with respect to said application means (50) and in turn comprising:

optically detectable second position reference means (46) associated with each said supporting and conveying device (8) and defining, for each said supporting and conveying device (8), a position reference system (45) integral with the supporting and conveying device (8);
optical sensing means (43) having such a viewing range as to simultaneously detect said first (5) and said second (46) position reference means;
a control unit (44) having processing means (67) for determining the position of said first position reference means (5) with respect to said position reference system (45) defined by said second position reference means (46); and
adjusting means (36, 33) for adjusting the relative position of each of said packages (3) with respect to said operating head (55), and controlled by said control unit (44) in response to a position error of said first position reference means (5) within said position reference system (45) defined by said second position reference means (46).

**7.** A unit as claimed in Claim 6, **characterized in that** said conveyor is a rotary table (7); said supporting and conveying devices (8) being fixed to the periphery of said rotary table (7).

**8.** A unit as claimed in Claim 6 or 7, **characterized in that** said supporting and conveying devices (8) each comprise a base (16) having at least one supporting member (31) for supporting a respective said package (3) and movable in a plane (X, Y); said adjusting means (36) for adjusting the relative position of each of said packages (3) with respect to said application means (50) comprising actuating means (39, 40) for moving said supporting member (31) along said plane (X, Y).

**9.** A unit as claimed in Claim 8, **characterized by** comprising a supply station (10) for feeding said packages on to said rotary table; an application station (11) for applying said opening devices (2); and an unloading station (12) for unloading said packages (3) off said rotary table (7); said actuating means (39, 40) being located close to said rotary table (7), upstream from said application station (11) for applying said opening devices (2), and interacting successively with each said supporting and conveying device (8) to correct the position of the respective said movable supporting member (31).

**10.** A unit as claimed in one of Claims 6 to 9, **characterized in that** said optically detectable first position reference means are defined by a prelaminated hole (5) on said packages (3).

**11.** A unit as claimed in Claim 10, **characterized in that** said control unit (44) comprises calculating means (68) for calculating the position of the center (C) of said prelaminated hole (5) within said position reference system (45) integral with said supporting and conveying device (8).

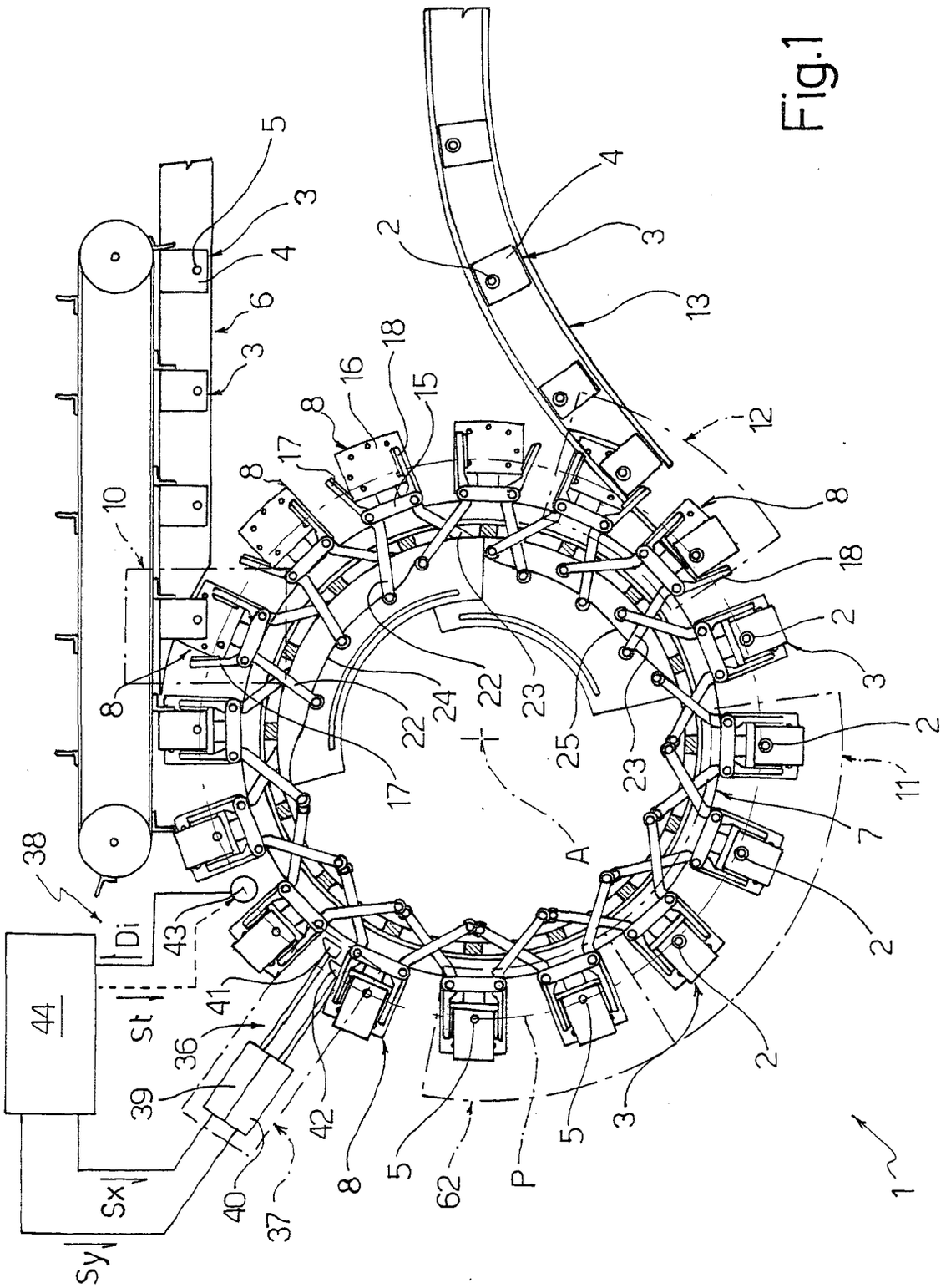


Fig.1
44
Di
St
Sx
Sy
A
P

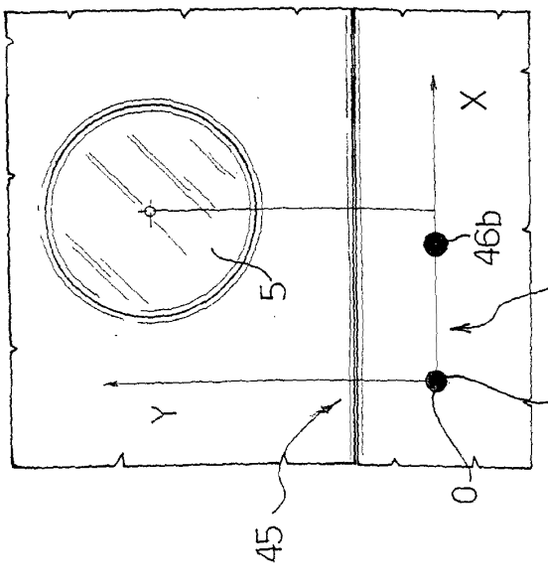



Fig.3

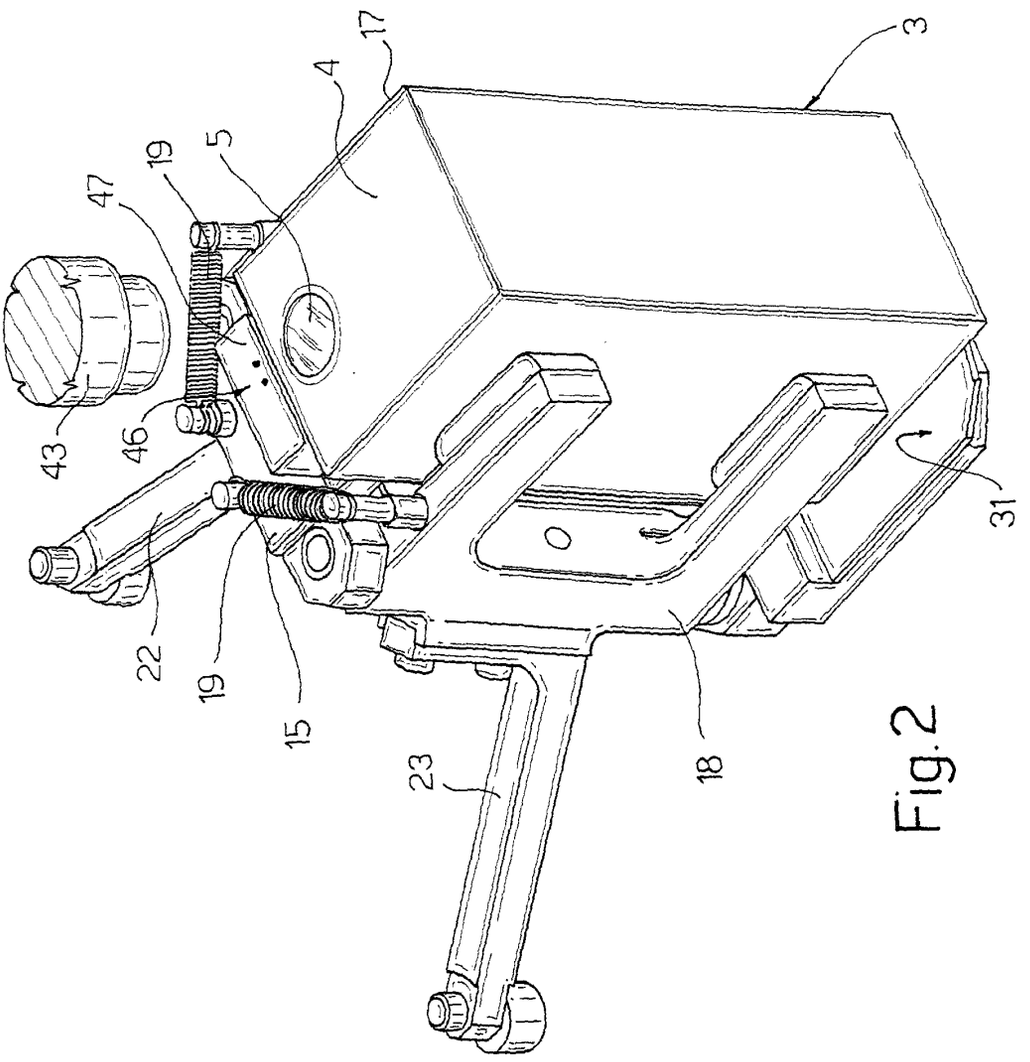
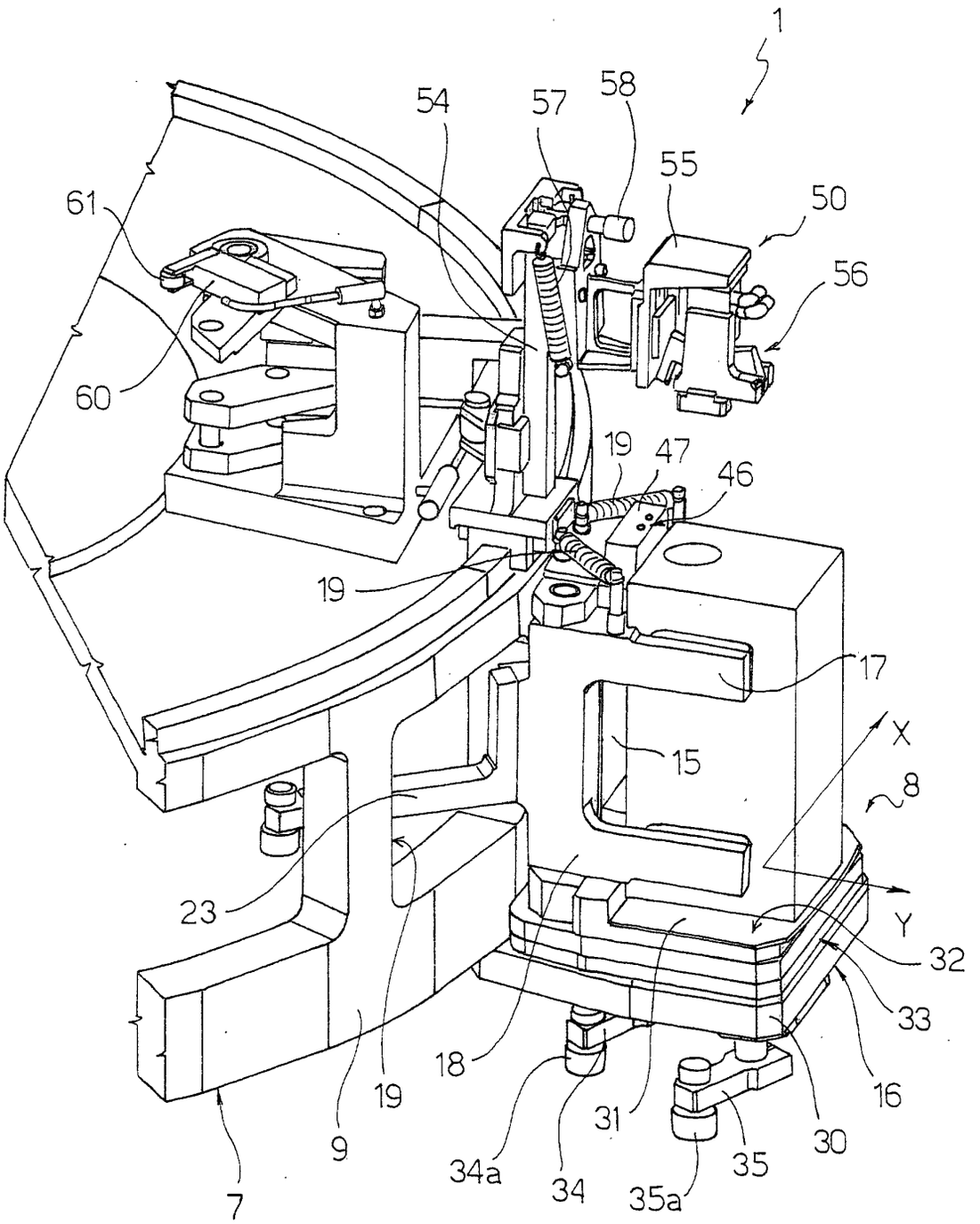



Fig.2


1
54
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47
46
19
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X
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16
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34a
34
35
35a
7

Fig.4

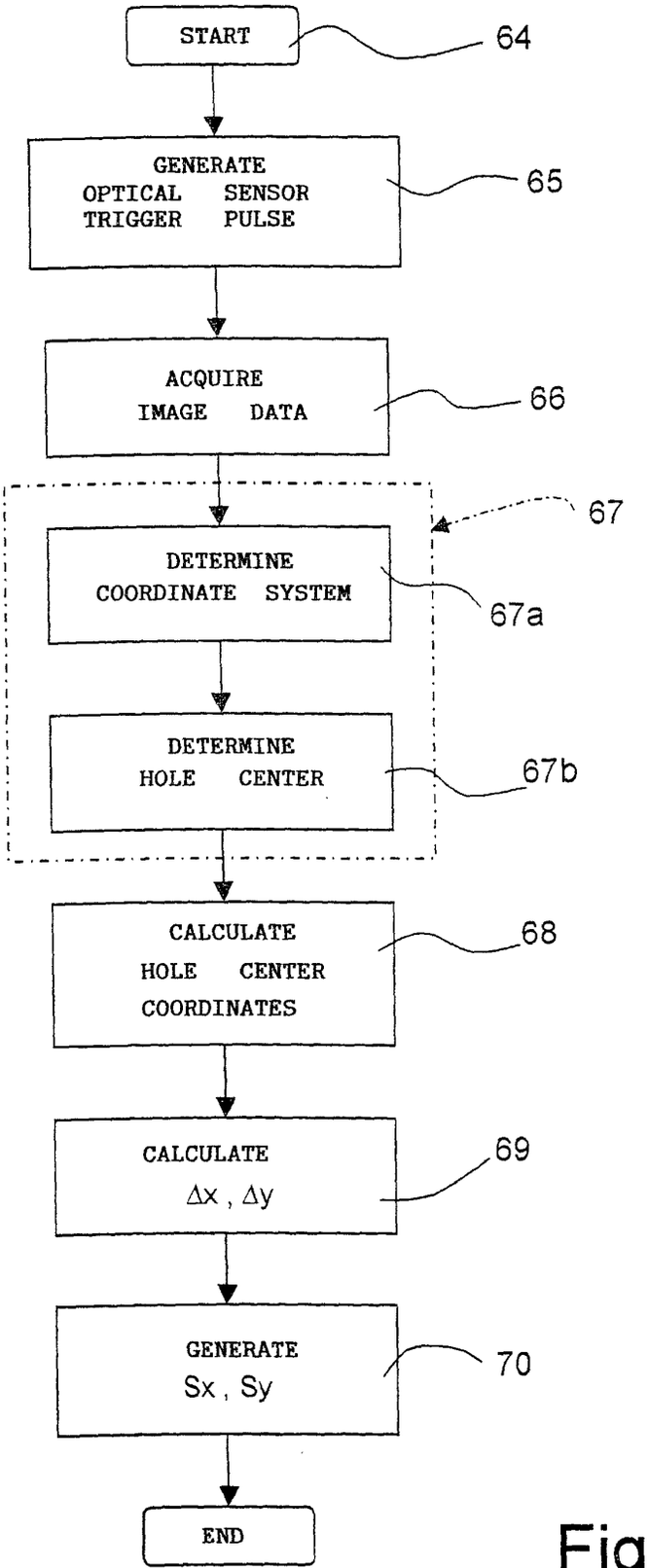
START
64
GENERATE OPTICAL SENSOR TRIGGER PULSE
65
ACQUIRE IMAGE DATA
66
67
DETERMINE COORDINATE SYSTEM
67a
DETERMINE HOLE CENTER
67b
CALCULATE HOLE CENTER COORDINATES
68
CALCULATE Δx , Δy
69
GENERATE Sx , Sy
70
END

Fig.5

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 00 83 0804

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.7) |
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

B65B
B65C
B31B

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
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CATEGORY OF CITED DOCUMENTS

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## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 83 0804

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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16-07-2001

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