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(54) **Device and method for measuring the thickness of postal objects**

(57) A method for measuring the thickness of plane rectangular postal objects comprising the steps of:

- performing a first step of measurement (30) of the thickness of a postal object (7), in which the postal object (7) is in an uncompressed condition where no force is applied on the opposite faces of the postal object, detecting a first thickness value S_1 ;
- performing a second step of measurement (35) of the thickness of the postal object in which the postal object (7) is in a compressed condition where a force is exerted on opposite faces of the postal object (7), detecting at least one second thickness value S_2 ;
- comparing (200) the first thickness value S_1 with the second thickness value S_2 for detecting postal objects that may be compressed considerably (210) and postal objects that are substantially incompressible (230);
- using the first thickness value S_1 , the second thickness value S_2 or a combination of the first value and of the second value as measurement (220) of the thickness of the postal object in the case where the postal object has been detected as being substantially incompressible; and
- using the result of the multiplication between a compression factor k and the first thickness value S_1 or else the second thickness value S_2 , or else a mathematical function f calculated on the basis of the first thickness value S_1 and of the second thickness value S_2 in the case where the postal object has been detected as being considerably compressible.

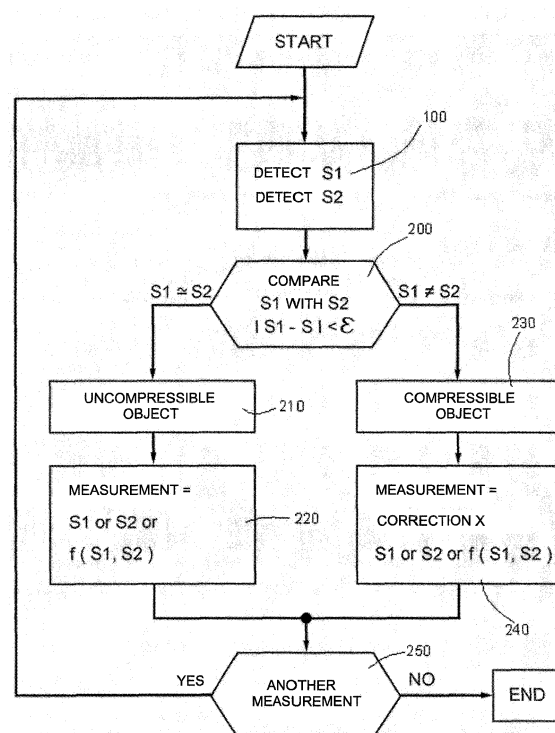


Fig.4

Description

[0001] The present invention relates to a device and a method for measuring the thickness of postal objects.

[0002] In order to treat in an appropriate way the postal objects before the sorting and/or sequencing process, it is necessary to know their physical characteristics in so far as many sorting and/or sequencing devices can work properly only when the postal objects fed at input thereto have pre-set physical characteristics.

[0003] For example, the patent application No. PCTWO9725162 describes the combined use of a thickness sensor set in a rectilinear region of a conveyor belt and a stiffness sensor set in a position corresponding to a curved region of the conveyor belt and used for measuring bending of the postal objects being conveyed. The thickness sensor is of a laser, ultrasound, or else infrared type. An evaluation device determines the stiffness of the postal objects on the basis of the information supplied by the sensors.

[0004] There is moreover felt the need to provide a device designed to detect - in a simple and effective way — the characteristics of compressibility of the postal objects.

[0005] There exist in fact some postal objects that are substantially incompressible (for example, postcards, return receipts) in so far as they consist of a single sheet that is unlikely to undergo deformation by forces applied perpendicularly to the faces of the postal object, whilst other objects (for example, envelopes containing a number of sheets set on top of one another and folded) are compressible, i.e., their original uncompressed thickness can be reduced following upon application of the aforesaid forces.

[0006] The aim of the present invention is to provide a device designed to detect the thickness by distinguishing between the two aforesaid physical conditions.

[0007] The above aim is achieved by the present invention in so far as it regards a **device** for measurement of the thickness of plane rectangular postal objects comprising: a first conveying system designed to convey postal objects in a direction of advance; and a second conveying system communicating with the first conveying system and designed to convey the postal objects received from the first conveying system in a direction of advance; the first conveying system is configured for conveying postal objects keeping them in an uncompressed state in which no forces are applied on the opposite faces of the postal object; the second conveying system is configured for conveying postal objects, keeping them in a compressed state in which forces are applied on the opposite faces of the postal object so as to reduce the original thickness of the postal object, the device being **characterized in that it comprises:**

- a first thickness-measuring device configured for detecting the thickness of the postal objects coming from and/or travelling along the first conveying system; said first thickness-measuring device carries out a first step of measurement of the thickness of the uncompressed postal object, detecting a first thickness value;
- a second thickness-measuring device that detects the thickness of the postal objects travelling along the second conveying system; said second thickness-measuring device carries out a second step of measurement of the thickness of the compressed postal object, detecting a second thickness value; and
- processing means designed to determine the thickness of the postal object on the basis of said first thickness value S1 and/or said second thickness value S2.

[0008] The present invention moreover regards a method for measuring the thickness of plane rectangular postal objects, **characterized in that** it comprises the following steps:

- performing a first step of measurement of the thickness of a postal object being conveyed, in which the postal object is in an uncompressed condition where no force is applied on the opposite faces of the postal object, detecting a first thickness value S1;
- performing a second step of measurement of the thickness of the postal object in which the postal object is in a compressed condition where a force is exerted on opposite faces of the postal object, detecting at least one second thickness value S2;
- comparing said first thickness value S1 with said second thickness value S2 for detecting postal objects that may be compressed considerably and postal objects that are substantially incompressible;
- using the first thickness value S1, the second thickness value S2, or a combination of the first value and of the second value as measurement of thickness of the postal object in the case where the postal object has been detected as being substantially incompressible; and
- using the result of the multiplication between a compression factor k and the first thickness value S1 or else the second thickness value S2 or else a mathematical function f calculated on the basis of the first thickness value S1 and the second thickness value S2 in the case where the postal object has been detected as being considerably compressible.

[0009] The invention will now be illustrated with reference to the attached figures, which illustrate a preferred non-

limiting embodiment thereof and in which:

- Figure 1 is a top plan view of a device for measuring the thickness of postal objects provided according to the teachings of the present invention in a first operative position;
- Figure 2 is a top plan view of the device for measuring the thickness of postal objects in a second operative position;
- Figure 3 is a perspective view of the device of Figure 1; and
- Figure 4 illustrates the operations performed by the device according to the present invention.

[0010] Figures 1 to 3 illustrate a device designed to measure the thickness of postal objects, which comprises:

- a first conveying system 3, designed to convey plane rectangular postal objects 7 in a preferably rectilinear direction of advance D1; and
- a second conveying system 8, communicating with the first conveying system 3 and designed to convey the postal objects 7 received from the first conveying system 3 in a preferably rectilinear direction of advance D2.

[0011] According to the present invention, the first conveying system 3 is configured for conveying the postal objects 7 keeping them in an uncompressed state, i.e., in a state in which no forces are applied on the opposite plane rectangular faces of the postal object 7. The second conveying system 8 is configured for conveying the postal objects 7 keeping them in a compressed state, i.e., in a state in which forces are applied on the opposite faces of the postal object 7 in order to reduce the original thickness of the postal object 7.

[0012] There exist in fact some postal objects that are substantially incompressible (for example postcards, return receipts, cards) in so far as they are formed by a single sheet that is unlikely to undergo deformation by forces applied in a direction perpendicular to the faces of the postal object, whereas other objects (for example, envelopes containing a number of sheets set on top of one another and folded) are compressible, i.e., their original uncompressed thickness can be reduced following upon application of the aforesaid forces.

[0013] In greater detail, in the example of embodiment illustrated, the first conveying system 3 comprises a pair of belts 10, 11, which extend between end pulleys 12, 13 (only one of said pulleys is represented) and have facing plane portions 10a, 11a set apart from one another by a distance D (Figures 1 and 2) that is generally constant (or slightly decreasing in the direction of motion, example 15 mm at input, 12 mm at output) for defining vertical side walls of a channel 15 along which the postal objects 7 move. The minimum width of the channel, which is, for example, 12 mm, exceeds the usual maximum thickness of the postal objects 7 normally sorted.

[0014] The end pulleys 12, 13 have vertical axes 12b, 13b parallel to one another, and the postal objects 7 move along the channel 15 with planes of lie that are substantially vertical.

[0015] The first conveying system 3 comprises a third belt 17, which extends between end pulleys 18 (only one end pulley is represented) having axes 18b perpendicular to the axes 12b, 13b. The third belt 17 defines a horizontal plane portion 18a that constitutes a bottom portion of the channel 15 on which a bottom rectilinear edge of the postal object 7 rests. In this way, the motion of the third belt 17 enables advance of the postal object 7, and the synchronous motion of the belts 10, 11 accompanies the object 7, which is contained laterally between the two belts 10, 11.

[0016] The elements illustrated above are carried by a plane rectangular wall 20, which defines the top portion of a bench (not illustrated) and has a rectangular groove 22, housed within which is the plane portion 18a, which is coplanar to the plane rectangular wall 20.

[0017] Once again with reference to the non-limiting example of embodiment illustrated, the second conveying system 8 comprises a pair of motor-driven belts 24, 25 carried by a plurality of respective pulleys 26, 27 having axes parallel to the axes 12b, 13b.

[0018] The belts 24, 25 have plane portions 24a, 25a that come into contact with one another in a nipping area 28 defining the inlet of the second conveying system 8 and extend for a stretch of superposition where they are in contact with one another in order to press on opposite faces of the postal objects 7 fed to the inlet 8, set between the belts 24, 25 and mobile along the second conveying system thanks to the movement of the belts 24, 25.

[0019] In greater detail, a pulley 27a set alongside the pulley 13 provides a return for the belt 25 that extends from the pulley 27a to a pulley 27b providing a rectilinear stretch 251, which forms an acute angle α with respect to the direction D1.

[0020] A pulley 26a set alongside the pulley 12 provides a return for the belt 24 that extends from the pulley 26a to the pulley 27b providing a rectilinear stretch 241 that converges into the stretch 251 in a position corresponding to the nipping area 28 that is tangential to the pulley 27b.

[0021] The rectilinear stretches 241 and 251 provide a lead-in stretch for entry of the postal objects into the second conveying system 8.

[0022] According to the present invention, a first thickness-measuring device 30 is provided, which detects the thickness of the postal objects 7 coming from and/or travelling along the first conveying system 3; said first thickness-measuring

device 30 carries out a first step of measurement of the thickness of the uncompressed postal object to which no force is applied on its opposite faces. A first value S1 of thickness is thus detected corresponding to an uncompressed condition of the postal object 7.

[0023] According to the present invention a second thickness-measuring device 35 is moreover provided, which detects the thickness of the postal objects 7 travelling along the second conveying system 8; said second thickness-measuring device 35 carries out a second step of measurement of the thickness of the compressed postal object 7 on which, by means of the action of the belts 24 and 25, a force is applied on its opposite faces. A second thickness value S2 is thus detected corresponding to a compressed condition of the postal object.

[0024] In greater detail, the first thickness-measuring device 30 can comprise a first measuring laser-beam emitter 36 and a second measuring laser-beam emitter 37 (of a known type), which are set on opposite sides of the channel 15 and emit respective laser beams 361, 371, which impinge upon the opposite faces of the postal object 7 that comes out of the channel 15 and sets itself between the pulleys 13, 27a and 12, 26a. In the example of embodiment illustrated the laser beams 361, 371 extend perpendicular to the direction D1 respectively between the pulleys 13, 27a and 12, 26a. By means of known triangulation methods, it is possible to trace back to the position of the points of impact of the laser beams 361, 371 on the opposite faces of the postal object 7 and hence to the thickness of the uncompressed postal object 7.

[0025] Likewise, the second thickness-measuring device 35 can comprise a first measuring laser-beam emitter 38 and a second measuring laser-beam emitter 39 (of a known type), which are set on opposite sides of the belts 24, 25 set in contact with one another and emit respective laser beams 381, 391, which impinge upon the opposite faces of the compressed postal object 7 between the belts 24 and 25. In the example of embodiment illustrated the laser beams 381, 391 extend transverse to the direction D2. By means of known triangulation methods it is possible to trace back to the position of the points of impact of the laser beams 381, 391 on the opposite faces of the postal object 7 and hence to the thickness of the compressed postal object 7.

[0026] The measurements of thickness are fed to an electronic unit 40 (represented schematically), which performs the operations described hereinafter.

[0027] The operations performed by the electronic unit 40 are illustrated in Figure 4 and comprise:

- detection of the first thickness value S1 and of the second thickness value S2 (block 100);
- comparison between the first thickness value S1 and the second thickness value S2 (block 200 following upon block 100).

[0028] In the case where the first thickness value S1 and the second thickness value S2 are substantially similar, i.e., $S1 \approx S2$, a substantially incompressible postal object is detected (block 210 following upon block 200).

[0029] In the case where the first thickness value S1 and the second thickness value S2 are considerably different, i.e., $S1 \neq S2$, a compressible postal object is detected (block 230 following upon block 200).

[0030] Preferably, the operations of comparison of block 200 are performed by calculating the absolute value of the difference between S1 and S2 (i.e., $|S1-S2|$) and comparing said absolute value with a threshold value ϵ detected experimentally:

$$\begin{aligned} |S1-S2| < \epsilon &\rightarrow \text{uncompressible object; and} \\ |S1-S2| > \epsilon &\rightarrow \text{compressible object.} \end{aligned}$$

[0031] In the case where the object is detected as being uncompressible, selected as result of the measurement (block 220 following upon block 210) is the first thickness value S1 or else the second thickness value S2 or else a mathematical function f (typically, the average, i.e., $(S1+S2)/2$) calculated on the basis of the first and second thickness values; namely,

$$\text{Measurement} = S1 \text{ or } S2 \text{ or } f(S1, S2).$$

[0032] In the case where the object is detected as being compressible, selected as result of the measurement (block 240 following upon block 230) is the result of the multiplication between a compression factor k and the first thickness value or else the second thickness value or else a mathematical function f (typically the average i.e., $(S1+S2)/2$) calculated on the basis of the first and second thickness values; namely,

$$\text{Measurement} = k * (S1 \text{ or } S2 \text{ or } f(S1, S2))$$

where k is a function of the second thickness value calculated.

[0033] Typically k is a tabulated value obtained experimentally on the basis of the purpose for which the thickness is used; for example, in the case where the thickness-measuring device is used on a sorter with passive stackers, i.e., a sorter in which the sorted objects are withheld pressed in a container by elastic means, k can assume a single experimental value in the region of 1.3 to 1.4, and the thickness is used for estimating the condition of filling of the stacker.

[0034] In the case where the thickness-measuring device is used on a sorter with active stackers (i.e., a sorter in which the objects sorted are withheld pressed in a container by motor-driven pressure means) the value k can be variable and be a function of the measured thickness S1 (for example, k = 1.2 for S1 comprised between 0.5 mm and 1 mm, k = 1.3 for S1 comprised between 1 mm and 2 mm, k = 1.5 for S1 comprised between 2 mm and 3 mm, k = 1.4 for S1 comprised between 3 mm and 5 mm, k = 1.4 for S1 comprised between 5 mm and 6 mm, k = 1.3 for S1 comprised between 6 mm and 8 mm, k = 1.2 for S1 comprised between 8 mm and 10 mm)

[0035] From blocks 220 and 240 control passes to a block 250 in which a check is made to verify whether there exists another postal object 7 of which the thickness is to be measured: if so, control returns to block 100; otherwise, the procedure terminates.

[0036] The advantages of the thickness-measuring device according to the invention are outlined in what follows.

[0037] The fact of knowing that a postal object is uncompressible enables use of the measurement of the thickness without correction factors k (in order to take into account the expandability of the object, normally measured in the compressed state) and hence optimization of filling of the stackers (if a postcard measuring 0.5 mm in thickness is stacked, the paddle of the stacker shifts by 0.5 mm, whereas it would shift by 0.65 in the case where k were equal to 1.3; hence, in this latter case, with a homogeneous lot of 300 postcards, instead of there being an advance of 150 mm, there would be an advance of 195 mm, i.e., 45 mm more than what is necessary; consequently, with active (motor-driven) stackers, the system would not function in so far as it would leave an excessive empty space; i.e., the postcards would begin to tilt and would not remain vertical).

[0038] Another example regards the case of stations with mail set shingled where the pitch of advance is a function of the thickness; in the absence of any knowledge on the state of compressibility of the objects (hence having to apply always the factor k) shingled mail with just postcards would assume a lower height in so far as it would be necessary to envisage a larger pitches owing to the oversizing on the thickness that it is necessary to take into account; in the final analysis the station could house fewer postcards than would be housed if the state of compressibility were known and the measurement were used without the correction factor k.

Claims

1. A device for measurement of the thickness of plane rectangular postal objects comprising:

- a first conveying system (3) designed to convey postal objects (7) in a direction of advance (D1); and
 - a second conveying system (8) communicating with the first conveying system (3) and designed to convey the postal objects (7) received from the first conveying system (3) in a direction of advance (D2);
- the first conveying system (3) is configured for conveying postal objects keeping them in an uncompressed state, in which no forces are applied on the opposite faces of the postal object (7); the second conveying system (8) is configured for conveying postal objects keeping them in a compressed state in which forces are applied on the opposite faces of the postal object so as to reduce the original thickness of the postal object,

said device being characterized in that it comprises:

- a first thickness-measuring device (30) configured for detecting the thickness of the postal objects (7) coming from and/or travelling along the first conveying system (3); said first thickness-measuring device (30) carries out a first step of measurement of the thickness of the uncompressed postal object, detecting a first thickness value S1;
- a second thickness-measuring device (35) that detects the thickness of the postal objects (7) travelling along the second conveying system (8); said second thickness-measuring device (35) carries out a second step of measurement of the thickness of the compressed postal object, detecting a second thickness value S2; and
- processing means (40) designed to determine the thickness of the postal object on the basis of said first thickness value S1 and/or said second thickness value S2.

2. The device according to Claim 1, wherein said first conveying system (3) comprises a pair of belts (10, 11) that have facing portions (10a, 11a) set apart from one another by a generally constant distance D for defining vertical side walls of a channel (15) along which the postal objects (7) contained in the channel itself move;
said first conveying system (3) comprises a third motor-driven belt (17) that defines a horizontal plane portion (18a),
which constitutes a bottom portion of the channel (15) on which a bottom rectilinear edge of the postal object (7) rests; the motion of the third belt (17) provides advance of the postal object (7), and the synchronous motion of the pair of belts (10, 11) accompanies the object (7) that is contained laterally between said belts (10, 11).
3. The device according to Claim 1 or Claim 2, wherein said second conveying system (8) comprises at least one pair of motor-driven belts (24, 25), which define plane portions (24a, 25a) that come into contact with one another in a nipping area (28) defining the inlet of the second conveying system (8); said motor-driven belts (24, 25) extend for a stretch of superposition where they are in contact with one another in order to press on opposite faces of the postal objects fed to said inlet, set between said motor-driven belts (24, 25) and mobile along the second conveying system thanks to the movement of the motor-driven belts (24, 25) themselves.
4. The device according to Claim 2, wherein said first thickness-measuring device (30) comprises a first measuring laser-beam emitter (36) and a second measuring laser-beam emitter (37) set on opposite sides of said channel (15) and emitting respective laser beams (361, 371) that impinge upon the opposite faces of the uncompressed postal object (7); there being provided processing means designed to calculate said first thickness value S1 by means of triangulation methods on the basis of the detected position of the points of impact of the laser beams (361, 371) on the opposite faces of the postal object.
5. The device according to Claim 3, wherein said second thickness-measuring device (35) comprises a first measuring laser-beam emitter (38) and a second measuring laser-beam emitter (39) set on opposite sides of the stretch of superposition and emitting respective laser beams (381, 391) that impinge upon the opposite faces of the uncompressed postal object (7); there being provided processing means designed to calculate said second thickness value S2 by means of triangulation methods on the basis of the detected position of the points of impact of the laser beams (381, 391) on the opposite faces of the postal object.
6. A method for measuring the thickness of plane rectangular postal objects, **characterized in that** it comprises the following steps:
 - performing a first step of measurement (30) of the thickness of a postal object (7) in which the postal object (7) is in an uncompressed condition where no force is applied on the opposite faces of the postal object, detecting a first thickness value S1;
 - performing a second step of measurement (35) of the thickness of the postal object in which the postal object (7) is in a compressed condition where a force is exerted on opposite faces of the postal object (7), detecting at least one second thickness value S2;
 - comparing (200) said first thickness value S1 with said second thickness value S2 for detecting postal objects that may be compressed considerably (210) and postal objects that are substantially incompressible (230);
 - using the first thickness value S1, the second thickness value S2, or a combination of the first value and of the second value as measurement (220) of thickness of the postal object in the case where the postal object has been detected as being substantially incompressible; and
 - using the result of the multiplication between a compression factor k and the first thickness value S1 or else the second thickness value S2 or else a mathematical function f calculated on the basis of the first thickness value S1 and the second thickness value S2 in the case where the postal object has been detected as being considerably compressible.
7. The method according to Claim 6, wherein in the case where the absolute value of the difference between the first thickness value S1 and the second thickness value S2 is less than a threshold value a postal object is detected as being substantially incompressible.
8. The method according to Claim 6 or Claim 7, wherein said combination of the first value S1 and of the second value S2 is given by the average between the first value and the second value.
9. The method according to any one of Claims 6 to 8, wherein said correction term k assumes a single experimental value, for example 1.3 to 1.4.

10. The method according to any one of Claims 6 to 8, wherein said correction term k is variable and is a function of the first measured thickness or of the second measured thickness.

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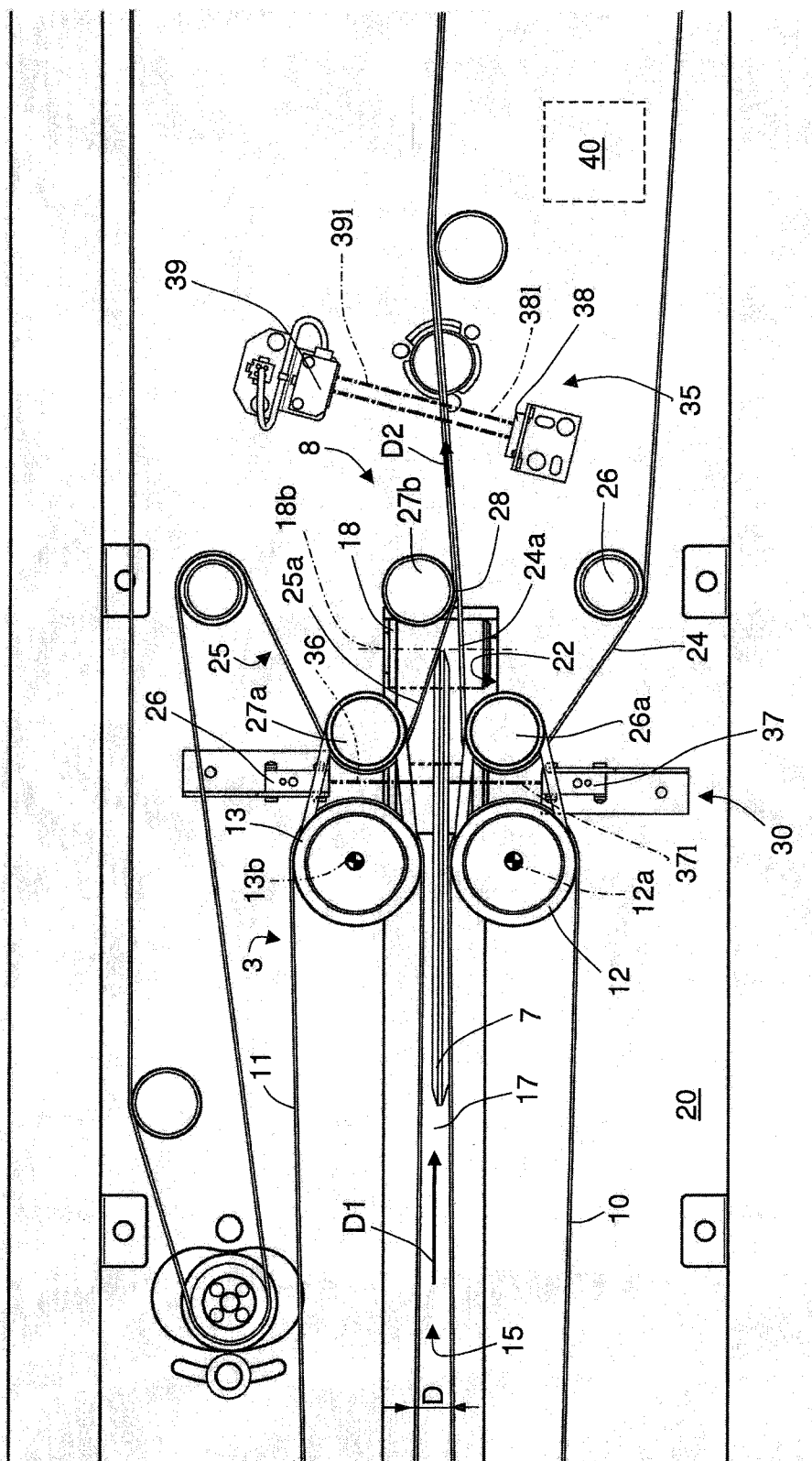


Fig. 1

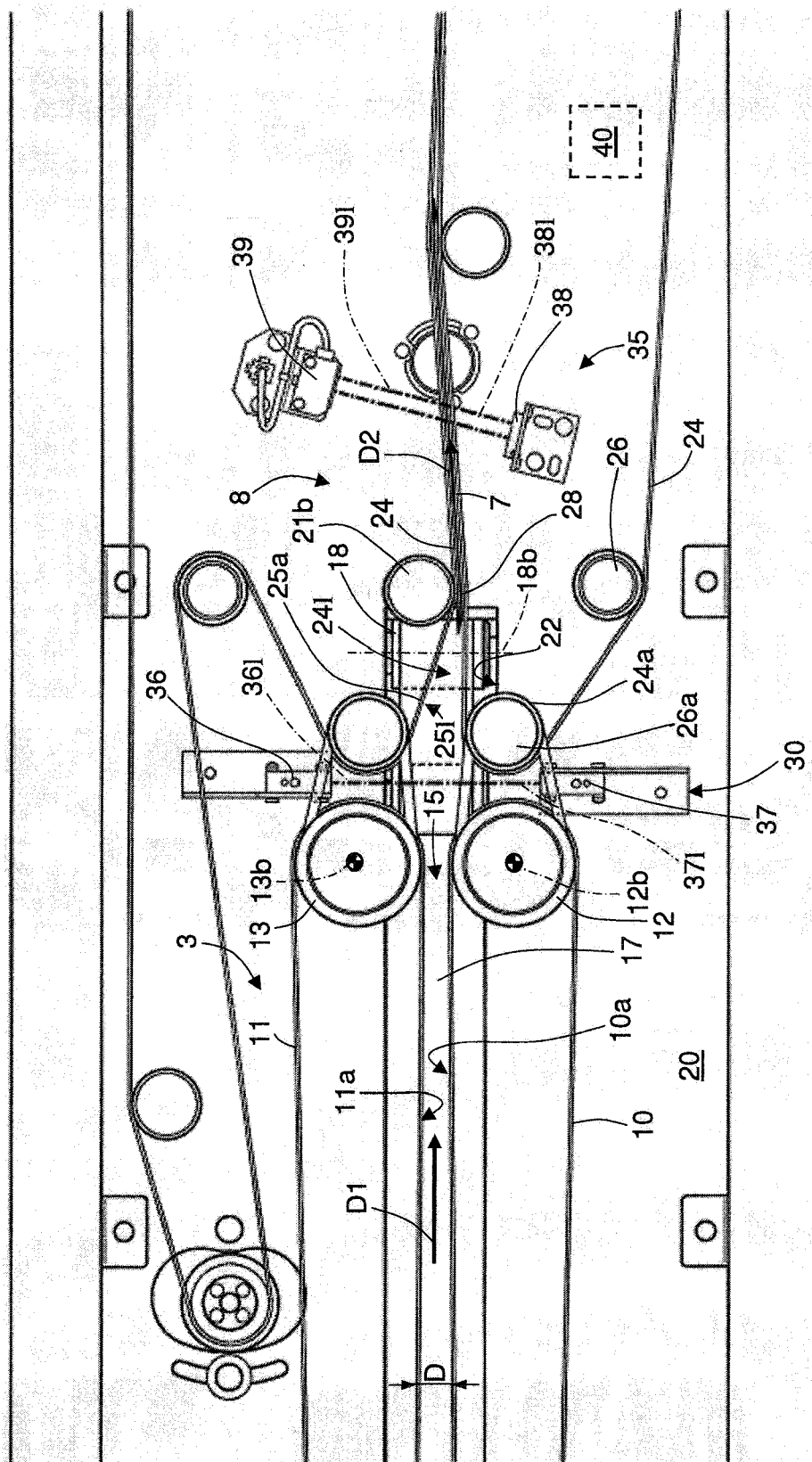


Fig.2

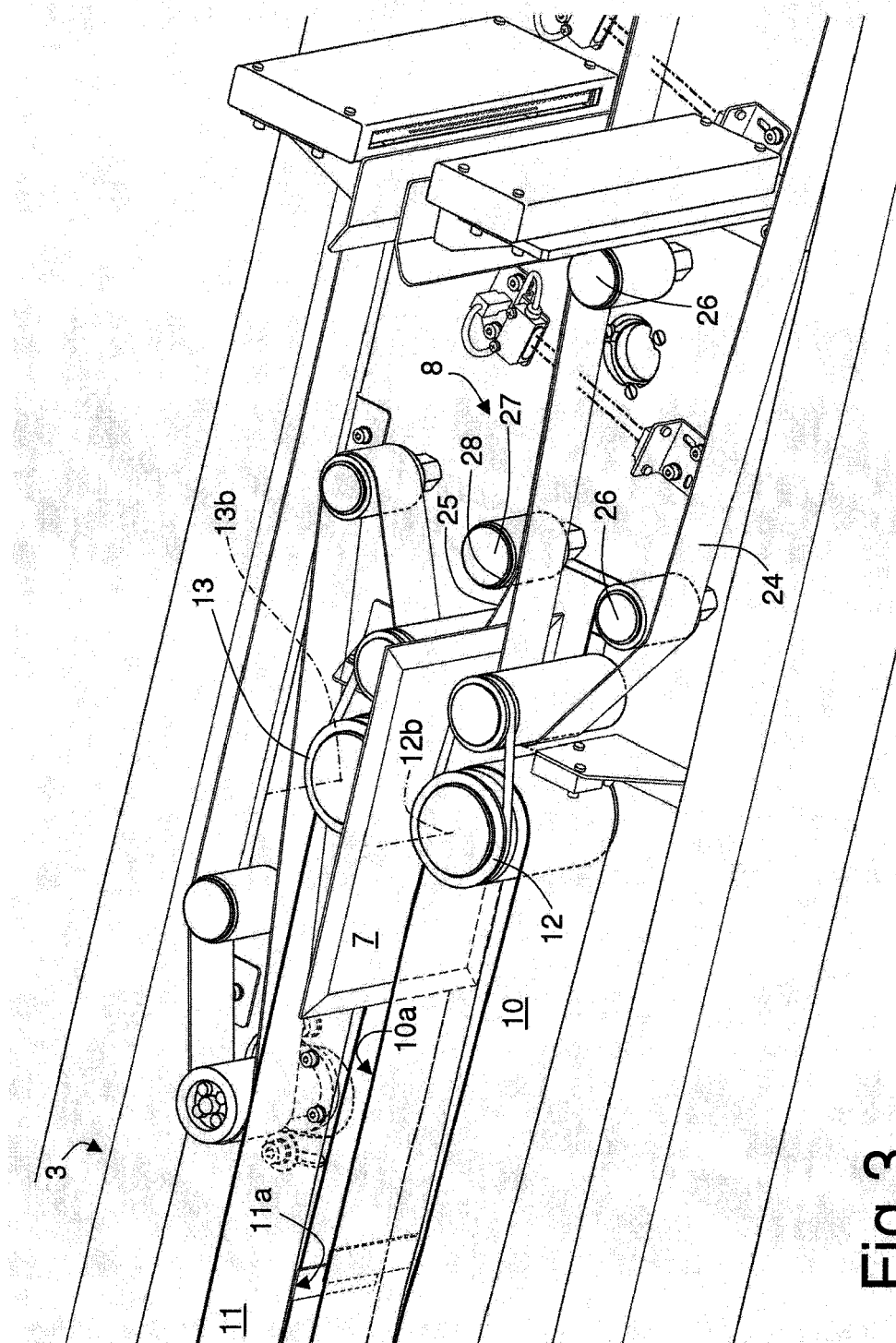


Fig.3

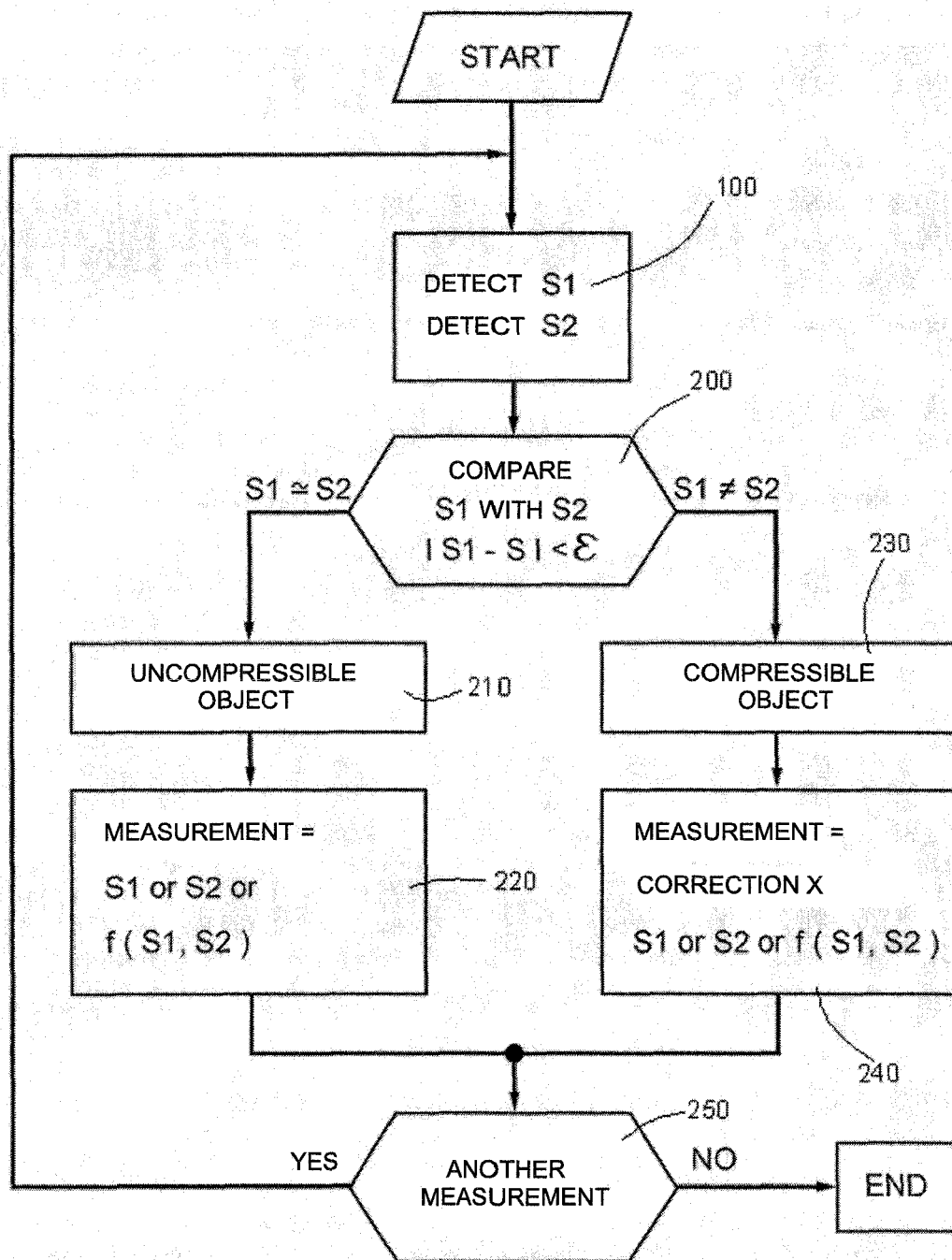


Fig.4



EUROPEAN SEARCH REPORT

Application Number
EP 11 42 5009

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
E	EP 2 298 457 A1 (ELSAG DATAMAT S P A [IT]) 23 March 2011 (2011-03-23) * paragraph [0008] - paragraph [0050] * -----	1-10	INV. B07C1/00
A	EP 1 860 049 A1 (PITNEY BOWES INC [US]) 28 November 2007 (2007-11-28) * paragraph [0026]; figure 5 * * paragraph [0032] * -----	1-10	
			TECHNICAL FIELDS SEARCHED (IPC)
			B07C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 18 May 2011	Examiner Wich, Roland
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 42 5009

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18-05-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2298457	A1	23-03-2011	NONE
EP 1860049	A1	28-11-2007	US 2007273086 A1
			29-11-2007

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 9725162 A [0003]