(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 572 805 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
27.03.2013 Bulletin 2013/13

(51) Int Cl.:
B07C 1/02 *(2006.01)* ***B65H 29/66*** *(2006.01)*

(21) Application number: **12185556.3**

(22) Date of filing: **21.09.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **23.09.2011 IT TO20110851**

(71) Applicant: **SELEX ELSAG S.P.A.**
Genova (IT)

(72) Inventors:
- **Casazza, Roberto**
16016 COGOLETO (IT)
- **De Leo, Guido**
16134 GENOVA (IT)
- **De Poli, Stefano**
16142 GENOVA (IT)

(74) Representative: **Jorio, Paolo et al**
Studio Torta S.p.A.
Via Viotti, 9
10121 Torino (IT)

(54) **Method and system for conveying and merging two or more groups of shingled mail items**

(57) A method of conveying and merging, at a relative intersection zone (CZ_i), at least one (i-1)th group (2) of shingled mail items with an ith group (2') of shingled mail items, the method including the step of :
a) conveying the (i-1)th and ith groups (2, 2'), as of a start time (t_{START}), along respective paths to the intersection zone (CZ_i);
the method also including the steps of :
b) determining, for each group (2, 2') of shingled mail items to be conveyed and merged, at least the position ($P_{(i-1)0}$, P_{i0}) of its head (2H, 2H') at the start time (T_{START}) ; and
c) controlling start-off of each group (2, 2') to the intersection zone (CZ_i) on the basis of at least the position ($P_{(i-1)0}$, P_{i0}) of its head (2H, 2H') at the start time (t_{START}).

There is also described a conveying and merging system designed to implement the above method.

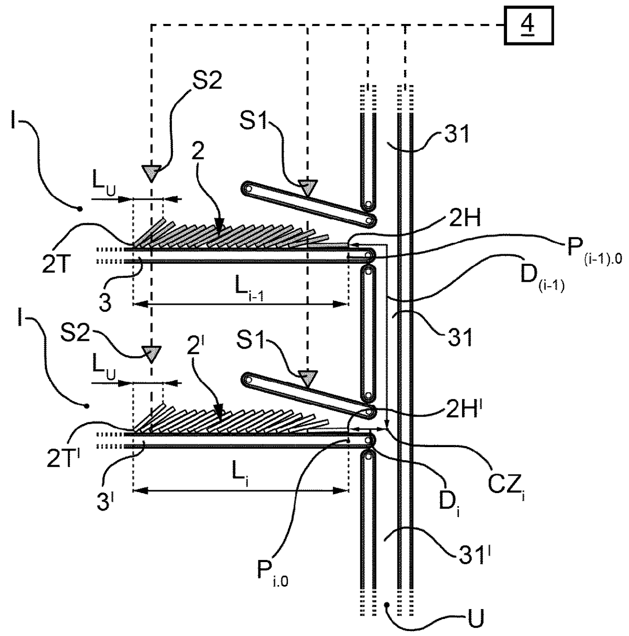

FIG. 1A

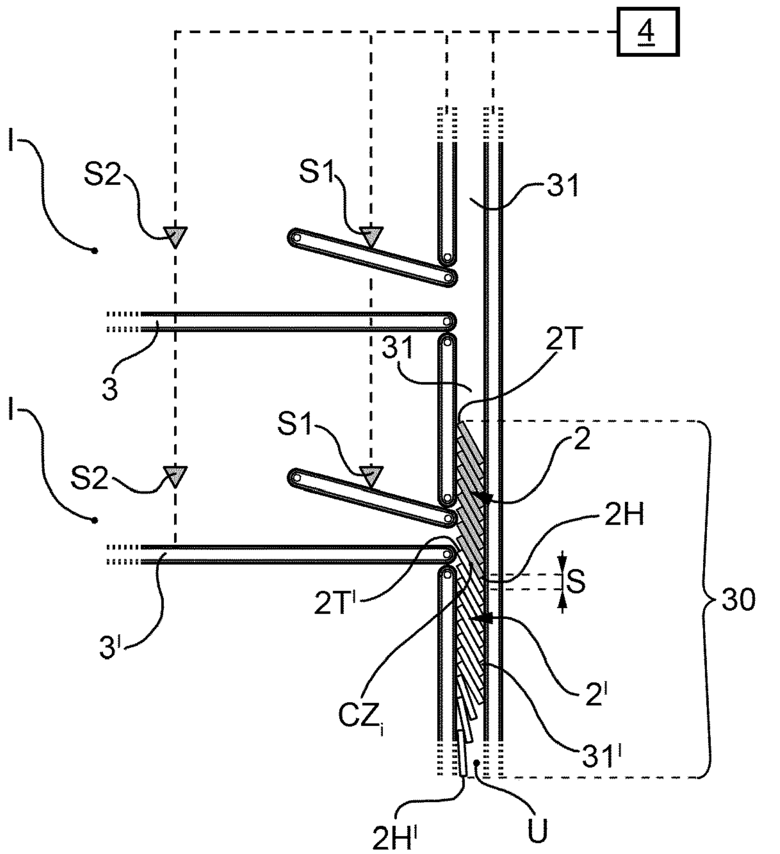

FIG. 1C

Description

[0001] The present invention relates to a method and system for conveying and merging two or more groups of shingled mail items.

[0002] Forming and conveying groups of shingled items is known, i.e. groups of items aligned in a preferably straight direction, partly overlapping and with respective edges spaced a constant or variable distance apart.

[0003] Shingled groups are typically conveyed by means of conveyor belt systems with either one single belt defining a supporting surface for the shingled groups or a pair of opposite belts, which exert pressure on opposite sides of the shingled groups.

[0004] To merge two shingled groups, the groups are normally fed along respective separate conveyor belt systems, and made to converge at an area common to both systems and at which merging of the two into one is obtained.

[0005] For example, Figures 1A and 1B show consecutive stages in the operation of a conveying system for moving groups of shingled mail items along respective advancement paths. More specifically, each advancement path comprises a number of segments, each at least partly defined by a respective one- or two-belt conveyor system.

[0006] As in the example shown, two-belt systems are normally used along segments of an advancement path arranged vertically or, however, steeply sloping.

[0007] When dealing with groups of shingled mail items, it is normally necessary to merge two groups into a larger one. In practice, then, two or more paths converge at a given intersection zone, and therefore are, from that point on, coincident, regardless of the geometry of the paths. In any case, the converging-path axes being incident, at least one of the groups of shingled items invariably has to travel along a curved path or, at any rate, along a path involving a change in the advancement direction.

[0008] In particular, merging of groups of shingled items is made necessary by processing requirements, e.g. by the presence, along the advancement path, of mail processing (e.g. sorting) devices, or particular conveying or direction-change devices, which demand that the incoming supply of mail items be as constant and homogeneous as possible, so as to both ensure steady operation of the individual devices and, more generally speaking, to achieve high throughput of the conveying system as a whole.

[0009] Merging two groups of shingled mail items poses, on a practical level, various potential problems.

[0010] The group resulting from the merging of two groups of shingled items may, for example, end up being thinner, at the area where the two groups are joined, with respect to the average thickness of either group of shingled items (see Figure 2).

This is to be avoided at all cost, because it may eventually result in the merged group parting altogether, e.g. as it is transferred to another part of the conveyor system, and especially in the event of two consecutive path segments at different levels. Moreover, the merged group being longer than it should be (by sagging at the join) may impair the efficiency of the conveyor system as a whole. Finally, the unevenness described above may impair overall performance of the mail processing (e.g. sorting) devices, thus resulting in errors in the mail conveying and handling sequence.

[0011] Conversely, the area in the merged group where the two groups join may swell with respect to the average thickness of either group of shingled items (as shown in Figure 3).

[0012] This too is to be avoided, as it results in distension of the retaining surfaces (i.e. the opposite surfaces of the two-belt conveyor system between which the group travels). When the retaining surfaces move apart, contact between the retaining surfaces and the thinner portions of the group may be lost, with the result that the mail items in these portions collapse and are no longer conveyed steadily and in controlled manner by the conveyor belt system.

[0013] Consequently, the correct sequence of the mail items in the merged group is no longer guaranteed, i.e. items originally in the second group may be located further forward than items originally in the first group. Furthermore, the type of unevenness described above may cause a blockage of the mail processing (e.g. sorting) devices.

[0014] Another factor affecting the merging of two groups of shingled mail items is a direct consequence of at least one of the groups having to travel along a curved path or, at any rate, change direction on its way to the intersection.

[0015] Each group of shingled mail items is fairly thick, so, as it travels along a curve or changes direction, the surface of the group on the inside of the curve travels at a different speed (speed v_i) from the surface on the outside of the curve (speed v_e) as shown in Figure 4.

[0016] This difference in speed has the effect of altering, i.e. increasing or decreasing, the mean spacing of the mail items in the group, depending on the geometry of the conveyor system and relative paths.

[0017] Because this change in spacing is not normally fully corrected when the group gets back onto a straight course, a slight increase or decrease in the length of the group is often observed. If not compensated for, this group length alteration may impair the accuracy with which the longer/shorter group merges with the other group.

[0018] A simple, effective method is therefore needed to compensate for this group stretching/contracting effect as the group travels along a curved path or, at any rate, a path involving a change in direction.

[0019] Demand therefore exists within the sector for a method and system of conveying and merging converging groups of shingled mail items, which makes it possible to eliminate, in general, the above drawbacks.

[0020] More specifically, a need is felt for a system of conveying and merging groups of shingled mail items of the type comprising a number of conveyor belt systems defining one or more advancement paths for the groups, which provides for effectively merging the groups with no sagging or swelling, and, when necessary, compensates for any stretching or contraction of the groups.

[0021] It is therefore an object of the present invention to provide a simple, low-cost method and system of conveying and merging groups of shingled mail items, which enables achieving at least one of the above demands.

[0022] The above object is achieved by the present invention, in that it provides a method of conveying and merging groups of shingled mail items as claimed in Claim 1, and a system as claimed in Claim 8.

[0023] A preferred, non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figures 1A, 1B and 1C show schematics of a system for conveying groups of shingled mail items at three consecutive stages;

Figures 2 and 3 show schematics of two phenomena (sagging and swelling of a group formed by merging two groups of shingled mail items) which the method according to the present invention is designed to eliminate;

Figure 4 shows a schematic of a disturbance phenomenon (stretching/contraction of a group of shingled mail items) which the method according to the present invention is designed to compensate;

Figures 5A, 5B, 5C show schematics of three consecutive stages in merging more than two groups of shingled mail items using the method according to the present invention;

Figure 6 shows one embodiment of the method of conveying and merging groups of shingled mail items according to the present invention.

[0024] Number 1 in Figures 1A, 1B and 1C indicates as a whole a system for conveying and merging groups 2, 2' of shingled mail items at consecutive operating stages.

[0025] Each group 2, 2' comprises a number of mail items aligned in a preferably straight direction, partly overlapping, with respective edges spaced a constant or variable distance apart. More specifically, each group 2, 2' has a head 2H, 2H' (or front portion in the travelling direction of the group), and a tail 2T, 2T' (or rear portion in the travelling direction of the group); and the total distance between the head and tail of each group 2, 2' defines its length.

[0026] System 1 is, in particular, designed to move groups 2, 2' of shingled mail items - formed in known manner - along respective advancement paths, each at least partly defined by one or more powered, one- or two-belt conveyor systems 3, 3', 31, 31'.

[0027] System 1 typically comprises a number of conveyor belt systems 3, 3', 31, 31', which extend between respective end pulleys arranged to define supporting surfaces, on which the shingled groups travel at a speed v from respective inputs I to a shared output U. Along vertical or steeply sloping path segments, system 1 preferably comprises two-belt systems 31, 31'.

[0028] The known electric motors and transmissions powering conveyor belt systems 3, 3' are not shown for the sake of simplicity.

[0029] More specifically, system 1 is configured to merge at least one $(i\text{-}1)^{th}$ group 2 of shingled mail items with an i^{th} group 2' of shingled mail, at an intersection zone CZ_i, to which the (*i*-1)th and ith groups 2, 2' are conveyed along respective paths.

[0030] In the Figure 1A example, system 1 conveys an (i-1)th group 2 of length L_{i-1}, whose head 2H is initially located at a point $P_{(i-1)0}$ on a first conveyor belt system 3; and an ith group 2' of length L_i, whose head 2H' is located at a point P_{i0} on a second conveyor belt system 3'.

[0031] At the time to which Figure 1A refers, to reach intersection zone CZ_i, the (i-1)th group 2 must travel along a path portion of length $D_{(i-1)}$ and which involves a change in direction. So, in addition to first system 3, on which it is located at the start time shown in Figure 1A, the (i-1)th group 2 will therefore also be conveyed by a first two-belt conveyor system 31 adjacent to first system 3 and extending in a substantially vertical direction.

[0032] Similarly, to reach intersection zone CZ_i, the ith group 2' must travel along a path portion of length D_i followed by a change in direction. So, in addition to second system 3', on which it is located at the time shown in Figure 1A, the ith group 2' will therefore also be conveyed by a second two-belt conveyor system 31' adjacent to second system 3' and extending in a substantially vertical direction.

[0033] System 1 advantageously comprises first sensor means S1, e.g. photocells, laser sensors, proximity sensors, etc., located along the paths of the (i-1)th and ith groups 2, 2' to detect passage of heads 2H, 2H'.

[0034] The exact initial positions $P_{(i-1)0}$, P_{i0} of groups 2, 2' may thus conveniently be determined using motion models (e.g. space motion vs time equations), preferably on the basis of signals from sensor means S1 upon passage of heads 2H, 2H'.

[0035] The exact lengths L_{i-1}, L_i of groups 2, 2' may conveniently be determined on the basis of known parameters (means size, mean spacing, etc.) of the mail items in the groups.

[0036] System 1 preferably also comprises second sensor means S2, e.g. photocells, laser sensors, proximity sensors, etc., located along the paths of groups 2, 2' to detect passage of tails 2T, 2T'.

[0037] On the basis of signals from sensor means S2 indicating passage of tails 2T, 2T', and signals from sensor means S1 indicating passage of heads 2H, 2H', and given the travelling speed v of groups 2, 2' along respective conveyor belt systems 3, 3', the exact length L_{i-1}, L_i of each group 2, 2' can be determined at any time.

[0038] System 1 preferably also comprises further sensor means (not shown), e.g. optical barriers, photocells, laser sensors, etc., for determining the length L_U of the last mail item in each group 2, 2'. Alternatively, the length L_U of the last mail item in each group may be assumed substantially constant and equal to a predetermined value.

[0039] System 1 advantageously comprises a control unit 4 connected functionally to at least first sensor means S1 and the respective drive means (not shown) of conveyor belt systems 3, 3', 31, 31', and which is designed to start and stop conveyor belt systems 3, 3', 31, 31' on the basis of at least the initial positions $P_{(i-1)0}$, P_{i0} of heads 2H, 2H', and the lengths L_{i-1}, L_i of the (i-1)th and ith groups 2, 2' of shingled mail items, so that the leading edge of the (i-1)th group 2 at least overlaps the trailing edge of the ith group 2' in a single merged group 30 of shingled mail items at relative intersection CZ_i. Control unit 4 preferably also starts and stops conveyor belt systems 3, 3', 31, 31' on the basis of lengths $L_{U(i-1)}$, L_{Ui} of the respective last items in the (i-1)th and ith groups.

[0040] Control unit 4 is preferably also connected functionally to second sensor means S2.

[0041] The target condition, in which two groups of shingled mail items are overlapped and merged perfectly as described above, is shown in Figure 1C.

[0042] Similarly, Figure 5C shows the target overlap and merge condition of a number of groups of shingled mail items into one merged group 30 substantially comprising adjacent groups 2, 2', 2" merged two by two, with the leading edge of the (i-1)th group at least overlapping the trailing edge of the ith group. Generally speaking, each group is characterized by a length L_i and an initial position P_{i0} of its head, and is initially separated by a distance D_i from a relative intersection CZ_i with the (i-1)th group.

[0043] As will be obvious from the following description, by applying the method according to the invention to ultimately adjacent pairs of groups of shingled mail items, it is possible to form a multiple merged group 30 of the type shown in Figure 5C.

[0044] Figure 6 shows in greater detail the operations performed by control unit 4 to convey two or more groups 2, 2' of shingled mail items to respective intersections zones CZ_i, i.e. to control starting and stopping of group conveyor belt systems 3.

[0045] Firstly, block 100, control unit 4 determines at least the initial position P_{i0} of the head 2H' of each i^{th} group of shingled mail items to be conveyed and merged, and accordingly determines the length L_i of the i^{th} group and the distance D_i from the relative intersection CZ_i with a respective (i-1)th group.

[0046] Similarly, control unit 4 preferably determines the actual initial position of tail 2T', and accordingly also calculates length L_i.

[0047] In other words, groups 2, 2' are assumed to be initially motionless on the respective conveyor belt systems.

[0048] Next, block 101, the control unit temporarily zeroes the start-off time t_1 of the first group.

[0049] In other words, block 101 basically assumes that the first group in the sequence of groups to be merged is the one to be set in motion first. As explained below, the method according to the invention provides for (indirectly) determining the truth of this assumption, and, if it is disproved, for correcting the sequence in which the various groups are set in motion.

[0050] Next, block 102, control unit 4 sets a counter *i* to 2, and, at block 103, resolves, with respect to variable t_i, a motion equation of the ith and (i-1)th groups, which defines the conditions by which, at a given following time t_{merge}, to overlap/merge the two groups at intersection CZ_i as shown in Figure 1C (or Figure 5C in the case of more than two groups). For which purpose, control unit 4 takes into account the values of the variables determined at block 100.

[0051] The groups to be conveyed and merged are preferably imposed a target overlap/merge condition, in which the head 2H of the (i-1)th group overlaps the tail 2T' of the ith group in such a manner as to trail behind the head of the last mail item in the ith group by a distance S equal to the mean spacing of the shingled mail items in each group.

[0052] This relationship is expressed mathematically by the equation :

$$P_{(i-1)\_merge} + S = P_{i\_merge} \qquad (1)$$

where :

- $P_{(i-1)\_merge}$ is the position of the head of the (i-1)th group at the merge time;
- p_{i_merge} is the position of the tail of the ith group at the merge time;
- S is the mean spacing (known beforehand) of the shingled mail items in each group.

[0053] Equations for calculating the position of the head/tail of each group at the merge time may be substituted in equation (1).

[0054] This gives the following motion equation of the (i-1)th and ith groups :

$$P_{(i-1)0} - D_{(i-1)} + v(t_{merge} - t_{(i-1)}) + S = P_{i0} - L_i + L_{Ui} - D_i + v(t_{merge} - t_i) \qquad (2)$$

where :

- $P_{(i-1)0}$ is the initial position of head 2H of the (i-1)th group;
- $D_{(i-1)}$ is the initial distance between head 2H of the (i-1)th group and the intersection zone CZ_i with the ith group;
- $t_{(i-1)}$ is the start-off time of the (i-1)th group;
- P_{i0} is the initial position of the head 2H' of the ith group;
- L_i is the length of the ith group;
- $L_{U(i-1)}$ is the length of the last item in the (i-1)th group;
- D_i is the initial distance between head 2H' of the ith group and the intersection zone CZ_i with the (i-1)th group;
  t_i is the start-off time of the *i*th group;
- v is the travelling speed of conveyor belt systems 3, 3';
- S is the mean spacing of the shingled mail items in groups 2, 2'.

[0055] The mean spacing of the shingled mail items in groups 2, 2' may normally be used for S, but, in some cases - for example, when groups 2, 2' also contain particularly thick items - this may prove inaccurate and impair the efficiency of the method.

[0056] To prevent this, an alternative embodiment imposes a target overlap/merge condition, in which the head 2H of the (i-1)th group overlaps the tail 2T' of the ith group in such a manner as to trail behind the head of the last mail item in the ith group by a distance S* based on measured dimensions (typically length and thickness) of the two items eventually contacting directly at the join. Accordingly, system 1 may advantageously comprise third sensor means (not shown) for determining the actual thickness of head 2H, 2H' and/or tail 2T, 2T' of the (i-1)th and ith groups.

[0057] It should be noted that the term $P_{i0} - L_i + L_{Ui}$ in equation (2) expresses the initial position of the head of the last item in the ith group.

[0058] The $t_{(i-1)}$ value being imposed or calculated beforehand, and all the other quantities being known (i.e. imposed beforehand as operating parameters of system 1, or measured by the sensors described, or calculated/estimated on the basis of acquired quantities), equation (2) is easily resolvable with respect to variable t_i.

[0059] In other words, each t_i represents the start-off time of an ith group, determined with respect to the previously determined start-off time t_{i-1} of the (i-1)th group, i.e. the absolute algebraic difference between them represents the time lag with which the ith group must start off with respect to start-off of the (i-1)th group to merge the two groups correctly as designed by the present invention.

[0060] When the advancement path of the ith group involves a change in direction, equation (2) is preferably modified (see equation (3) below) by inserting a correction term to compensate for stretching, as typically occurs when a group changes direction. In which case, the initial position of tail 2T' of the ith group is given, not by $P_{i0} - L_i + L_{Ui}$, but by a respective modified term $(P_{i0} - L_i + L_{Ui})_{MOD}$.

[0061] Mathematically, the modified initial position value of a direction-change ith group can be calculated using the equation :

$$(P_{i0} - L_i)_{MOD} = P_{i0} - (L_i - L_U).K_S \qquad (3)$$

where :

- L_i is the initial length of the ith group;
- L_{Ui} is the length of the last item in the *i*th group;
- K_S is the group stretch/contraction coefficient.

[0062] The value of group stretch/contraction coefficient K_S substantially depends on the geometry of system 1 and the thickness of the group. For example, a coefficient K_S value of roughly 1.05 - 1.10 may be assumed when the geometry of system 1 causes the group to stretch.

[0063] At block 104, the control unit determines whether there are any other groups for conveying and merging. This is done in known manner, e.g. using an optoelectronic sensor (S1) defining an optical path that is interrupted by any mail items.

[0064] In the event of an affirmative response, block 104 goes on to a block 105, where control unit 4 increments counter i by one unit, and then returns to block 103.

[0065] Conversely, in the event of a negative response, control unit 4 goes on to a block 106, where it searches for the minimum start-off time t_{i_MIN} of all the start-off times t_i determined.

[0066] At the next block 107, control unit 4 subtracts the minimum start-off time t_{i_MIN} from each start-off time t_i to calculate corrected start-off times t_i* according to the equation:

$$T_i^* = t_i - t_{i\_MIN} \qquad (4)$$

[0067] It should be noted that each start-off time t_i may be greater than, less than, or equal to zero. More specifically, t_{i_MIN} may be greater than, less than, or equal to zero, so the operation performed in block 107 is an algebraic subtraction (which takes into account the sign of t_{i_MIN}).

[0068] In other words, if start-off times t_i are all positive or zero, block 107 leaves them unchanged, i.e. each $t_i^* = t_i$.

[0069] Alternatively, if at least one of start-off times t_i is negative, control unit 4 determines the negative start-off time with the highest absolute value, and subtracts it algebraically from all the start-off times to 'normalize' them. In other words, after block 107, all the start-off times t_i are 'corrected' so that none have a negative sign. In fact, the minimum start-off time t_i determined is replaced with a corresponding zero start-off time t_i, and the group of mail items associated with this start-off time is moved first, as explained below.

[0070] Finally, at block 108, control unit 4 carries out the conveying and merging procedure by moving each ith group off at the corrected start-off times t_i* calculated in block 107. In other words, each ith group is started off with a time lag, equal to the respective modified start-off time t_i*, with respect to the start time t_{START} of the conveying and merging procedure.

[0071] In other words, the control unit starts a number of timers, each associated with starting off an *i*th group of shingled mail items.

[0072] Accordingly, control unit 4 moves conveyor belt systems 3, 3' along respective paths to respective intersections with respective time lags, equal to corrected start-off times t_i*, with respect to the start time of the conveying and merging procedure.

[0073] It should be noted that, in the example described with reference to the drawings and motion equations (1) and (2) - possibly with the correction in equation (3) - conveyor belt systems 3, 3' move respective groups of shingled mail items all at the same constant speed v.

[0074] However, equations (1) and (2) may obviously be corrected to allow for movement at a non-constant speed.

[0075] For example, the constant v term in equations (1) and (2) may be replaced with a predetermined function $v_i(t)$ describing, or at least approximating, the speed-time pattern of head 2H' of each ith group, to take into account acceleration and deceleration of the group along the respective path.

[0076] In the above description, all the path portions - each defined by one or more powered, single- or two-belt conveyor systems 3, 3', 31, 31' - are assumed free at the start of the actual conveying and merging procedure, whereas, in actual fact, this is obviously not always so, i.e. quite often, at least one of powered systems 3, 3', 31, 31' is temporarily inaccessible, by already being engaged by another group in transit, or an intersection CZ_i is temporarily occupied.

[0077] This can be taken into account in a variation of the method according to the invention, in which an access time lag r_i is added to the corrected start-off times t_i* calculated in block 107, depending on the engaged/free status of a relative path portion, i.e. of a corresponding powered, single- or two-belt conveyor system 3, 3', 31, 31'.

[0078] In other words, each group, particularly the one with the lowest corrected start-off time t_i*, is set in motion with a time lag r_i with respect to the relative corrected start-off time, to allow the relative path to clear.

[0079] Accordingly, system 1 according to the invention may advantageously comprise access sensor means (not shown), e.g. photocells, for instantly determining the engaged/free status of critical path portions, and which are preferably located at the intersections CZ_i defined by system 1.

[0080] The advantages of the conveying and merging method and system according to the invention will be clear from the above description.

[0081] In particular, the method according to the invention clearly provides, in a simple, low-cost manner, for merging two or more groups of shingled mail items into one with a high degree of precision, reliability and repeatability, as typically required in the mail processing sector.

[0082] Moreover, because the groups of shingled mail items to be merged are set in motion in a start-off time sequence that takes into account at least the initial position and actual length of the groups, the method according to the invention prevents sagging and swelling of merged groups at the join, as frequently occurs in less precise systems.

[0083] Another important point to note is how the conveying and merging method and system according to the invention also take into account the geometry of system 1, and in particular any change in direction and consequent stretching of the groups, which may conveniently be compensated by adapting the motion equation of the groups to the actual characteristics of the respective paths.

[0084] Clearly, changes may be made to the conveying and merging method and system as described and illustrated herein without, however, departing from the protective scope of the accompanying independent Claims.

Claims

1. A method of conveying and merging, at a relative intersection zone (CZ_i), at least one (i-1)th group (2) of shingled mail items with an ith group (2') of shingled mail items, the method comprising the step of :

a) conveying said (i-1)th and ith groups (2, 2'), as of a start time (t_{START}), along respective advancement paths to said intersection zone (CZ_i);
the method being **characterized by** comprising the steps of :
b) determining, for each group (2, 2') of shingled mail items to be conveyed and merged, at least the position ($P_{(i-1)0}$, P_{i0}) of its head (2H, 2H') at said start time (t_{START}), and the length L_i of the ith group (2'); and
c) controlling start-off of each group (2, 2') to said intersection zone (CZ_i) on the basis of at least said position ($P_{(i-1)0}$, P_{i0}) of its head (2H, 2H') at said start time (t_{START}), and said length L_{i-1}, L_i so that a leading edge of said (*i-1*)th group (2) overlaps at least partially a trailing edge of said *i*th group (2') to form a single merged group (30) of shingled mail items at said intersection zone (CZ_i).

2. A method as claimed in Claim 1, wherein step c) of controlling start-off of each group (2, 2') to the intersection zone (CZ_i) comprises the steps of :

d) calculating (103) a start-off time (t_i) for each group (2, 2') at least on the basis of said position ($P_{(i-1)0}$, P_{i0}); and
e) starting off each group (2, 2') with a time lag (t_i*), with respect to said start time (t_{START}), calculated on the basis of said start-off time (t_i).

3. A method as claimed in Claim 1 or 2, wherein, to merge the groups, said step a) comprises the step of overlapping the head (2H) of the (i-1)th group (2) on the tail (2T') of the ith group (2'), so that said head (2H) trails behind the head of the last mail item in the ith group (2') by a distance (S) equal to the mean spacing of the shingled mail items in each group.

4. A method as claimed in Claim 1 or 2, wherein, to merge the groups, said step a) comprises the step of overlapping the head (2H) of the (i-1)th group (2) on the tail (2T') of the ith group (2'), so that said head (2H) trails behind the leading edge of the last mail item in the ith group (2') by a distance (S*) based on the measured dimensions of the head (2H) of the (i-1)th group (2) and the tail (2T') of the ith group (2').

5. A method as claimed in any one of Claims 2 to 4, wherein said start-off time (t_i) of the ith group is also calculated on the basis of :

- the position ($P_{(i-1)0}$) of the head (2H) of the (i-1)th group at said start time (t_{START}) ;
- the distance $D_{(i-1)}$, at said start time (t_{START}), between the head (2H) of the (i-1)th group and said intersection zone (CZ_i) with the ith group;
- the start-off time ($t_{(i-1}$) of the (i-1)th group;
- the distance D_i, at said start time (T_{start}), between the head (2H') of the ith group and said intersection zone (CZ_i) with the (i-1)th group;
- the travelling speed (v) of said groups along their respective paths; and
- the mean spacing (S) of the shingled mail items in each group (2, 2').

6. A method as claimed in Claim 5, wherein said respective start-off times (t_{i-1}, t_i) of said (i-1)th group and said ith group (2, 2') are related by the equation :

$$P_{(i-1)0} - D_{(i-1)} + v(t_{merge} - t_{(i-1)}) + S = P_{i0} - L_i + L_{Ui} - D_i + v(t_{merge} - t_i)$$

where t_{merge} represents the instant in which said (i-1)th group and said ith group (2, 2') merge at the intersection zone (CZ_i).

7. A method as claimed in any one of Claims 2 to 6, wherein said step e) of starting off each ith group comprises the steps of :

f) determining the minimum start-off time (t_{i_MIN}) of all the start-off times (t_i) calculated; and
g) calculating a corrected start-off time (t_i*) for each $_i$th group by subtracting said minimum start-off time (t_{i_MIN}) algebraically from the relative start-off time (t_i).

8. A method as claimed in any one of Claims 2 to 7, wherein said step e) of starting off each group (2, 2') commences with a time lag r_i with respect to the relative corrected start-off time (t_i*), so as to allow the relative path to clear.

9. A method as claimed in any one of Claims 1 to 8, wherein, for each ith group whose path involves a change in direction, the value of said position (P_{i0}) of the head (2H') of the ith group at said start time (t_{START}) is corrected on the basis of a stretch coefficient K_S of the group.

10. A conveying and merging system comprising :

- a number of conveyor systems (3, 3'; 31, 31') for conveying at least one (i-1)th and one ith group (2, 2') of shingled mail items along respective paths, and merging them at a relative intersection (CZ_i);
- first sensor means (S1) located along the paths of said groups (2, 2') to detect passage of the respective heads (2H, 2H') of the groups (2, 2') and determine the respective positions ($P_{(i-1)0}$, P_{i0}) of the heads at a start time (t_{START}) ; and
- a control unit (4) connected functionally to at least the first sensor means (S1) and to drive means of the conveyor systems (3, 3'; 31, 31'), and programmed to control travel of each group (2, 2') to said intersection (CZ_i) using the method as claimed in any one of Claims 1 to 9.

11. A system as claimed in Claim 10, and comprising second sensor means (S2) located along the paths of said groups (2, 2') to detect passage of the respective tails (2T, 2T') of the groups (2, 2').

12. A system as claimed in Claim 10 or 11, and comprising third sensor means located along the paths of said groups (2, 2') to determine the thickness of the respective tails (2T, 2T') and/or heads (2H, 2H') of the groups (2, 2').

13. A system as claimed in Claim 10 or 12, and comprising access sensor means located along the paths of said groups (2, 2') to instantly determine the engaged/free status of relative portions of said paths.

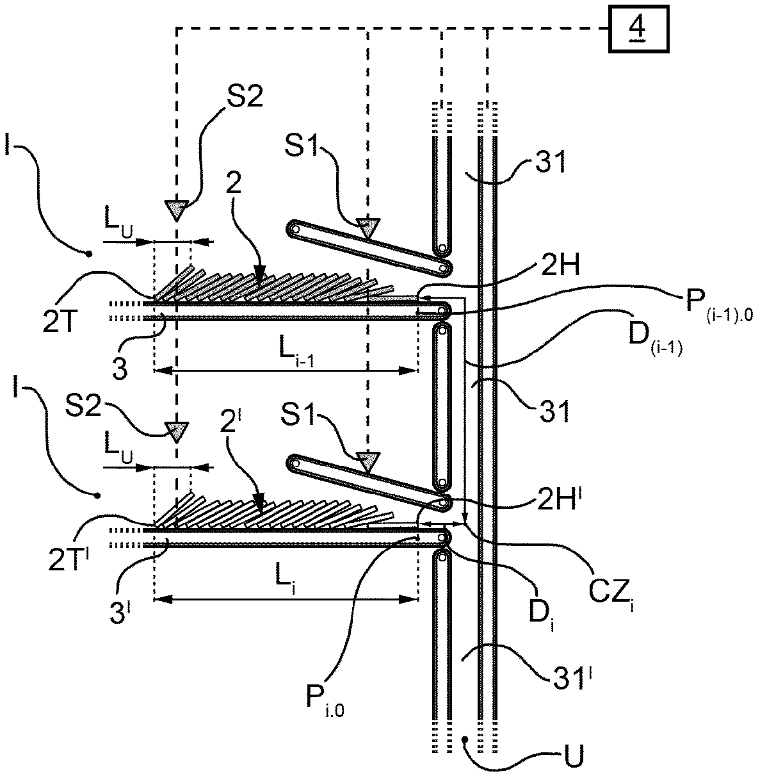
4
S2
S1
31
I
2
L_U
2H
P_(i-1).0
2T
D_(i-1)
3
L_i-1
I
S2
31
S1
2^I
L_U
2H^I
2T^I
CZ_i
3^I
L_i
D_i
31^I
P_i.0
U

FIG. 1A

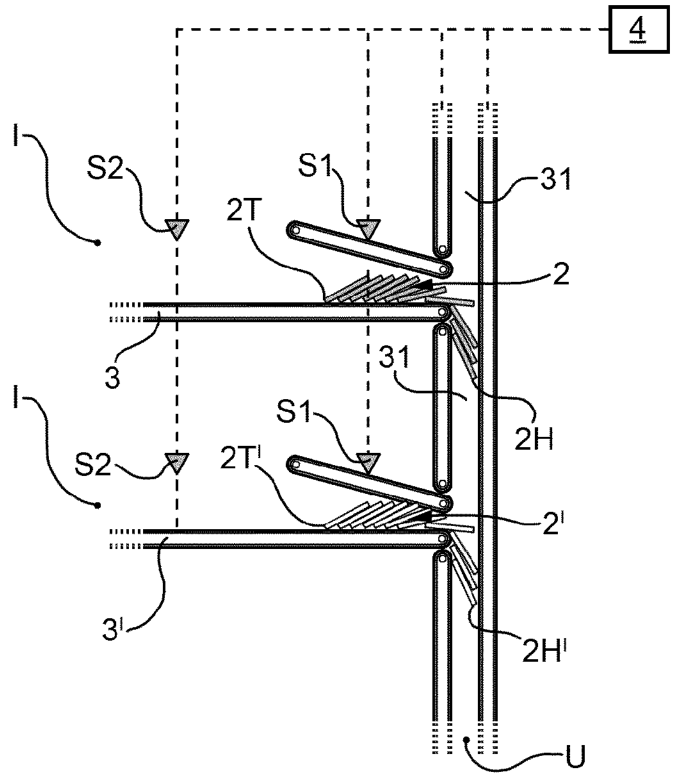
4
I
S2
S1
31
2T
2
3
31
2H
I
S1
S2
2T^I
2^I
3^I
2H^I
U

FIG. 1B

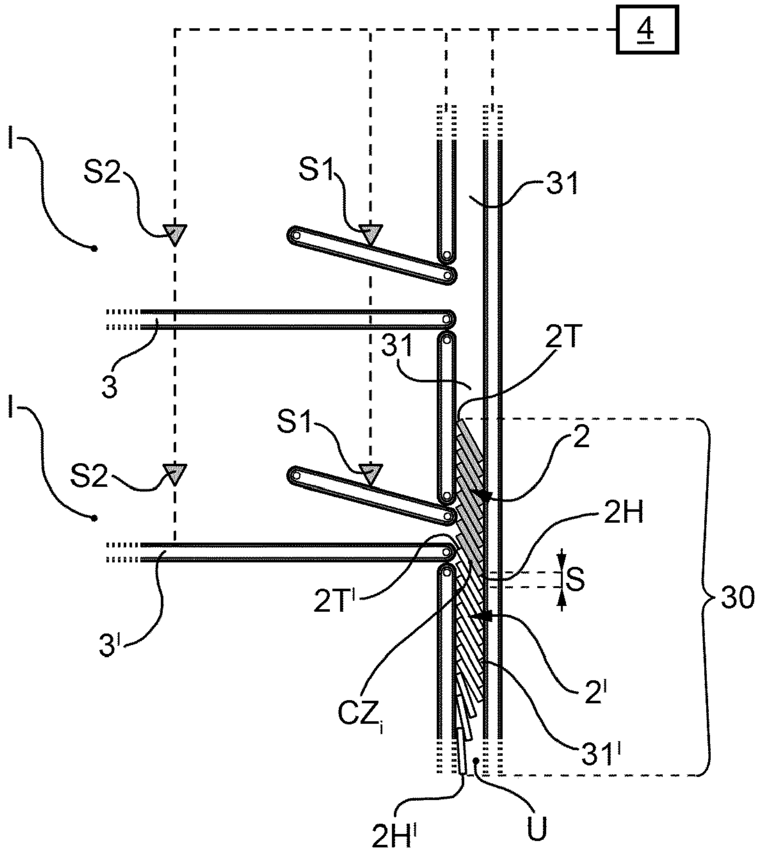

FIG. 1C

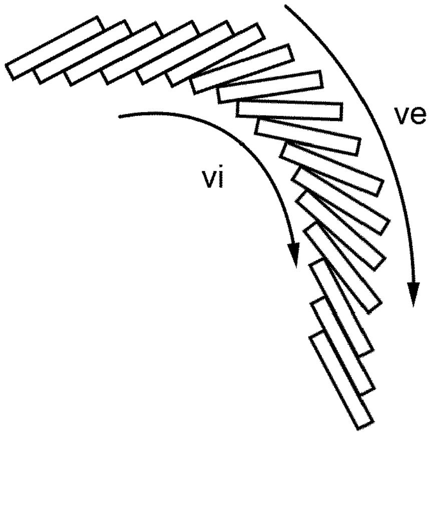

FIG. 4

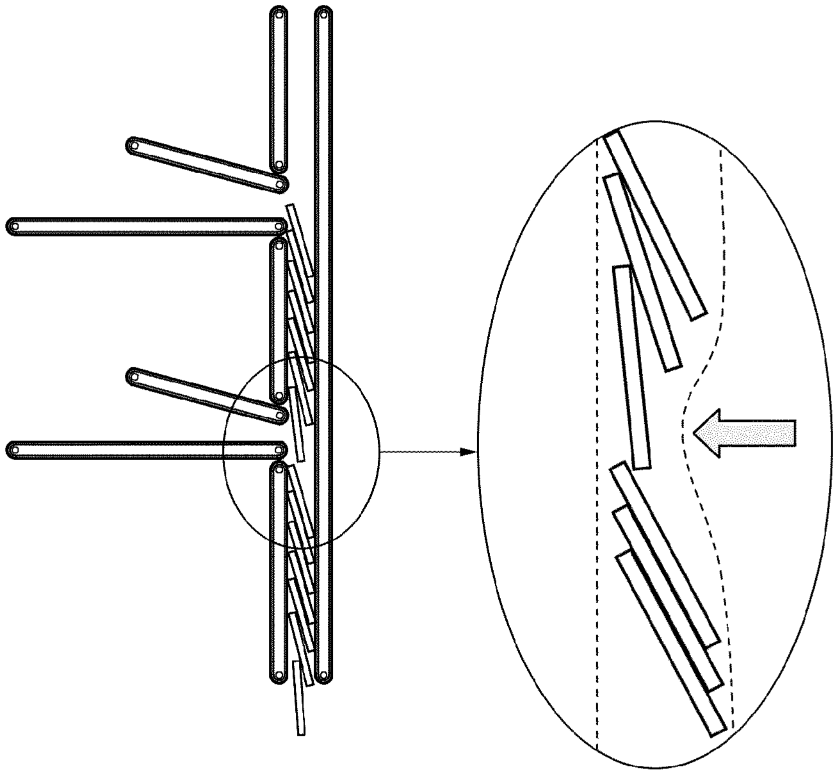

FIG. 2

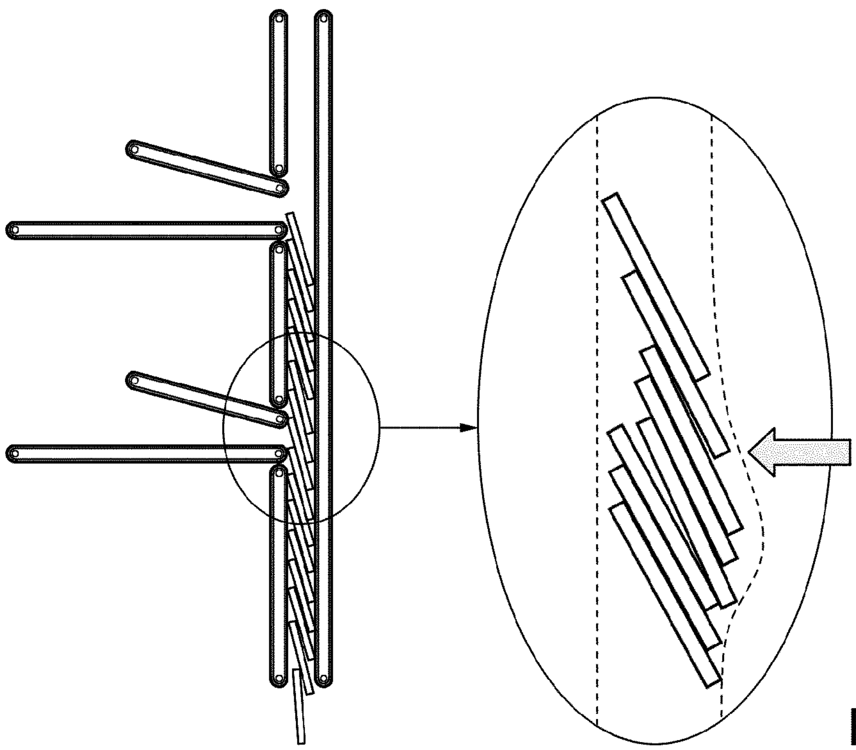

FIG. 3

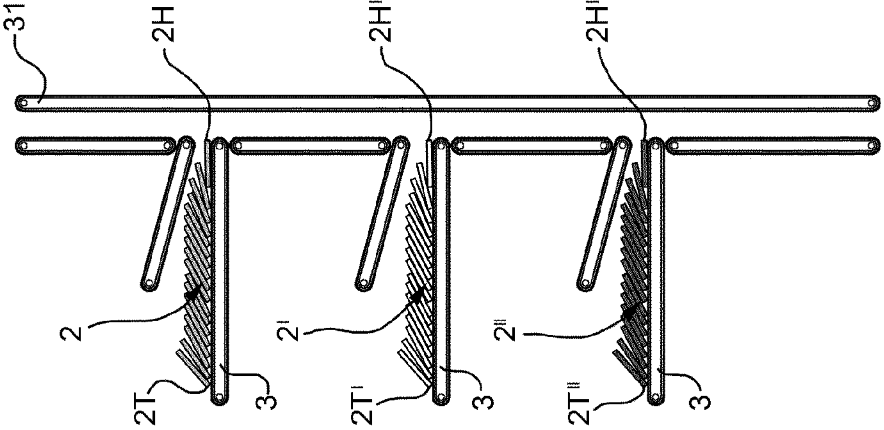

FIG. 5A

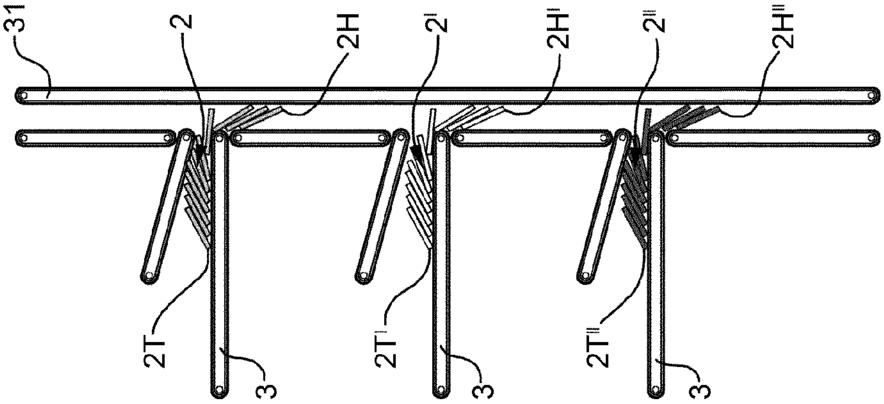

FIG. 5B

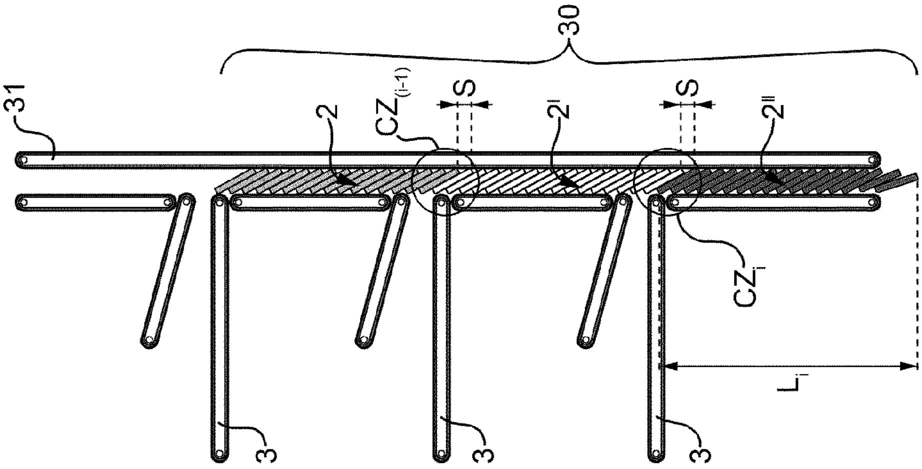

FIG. 5C

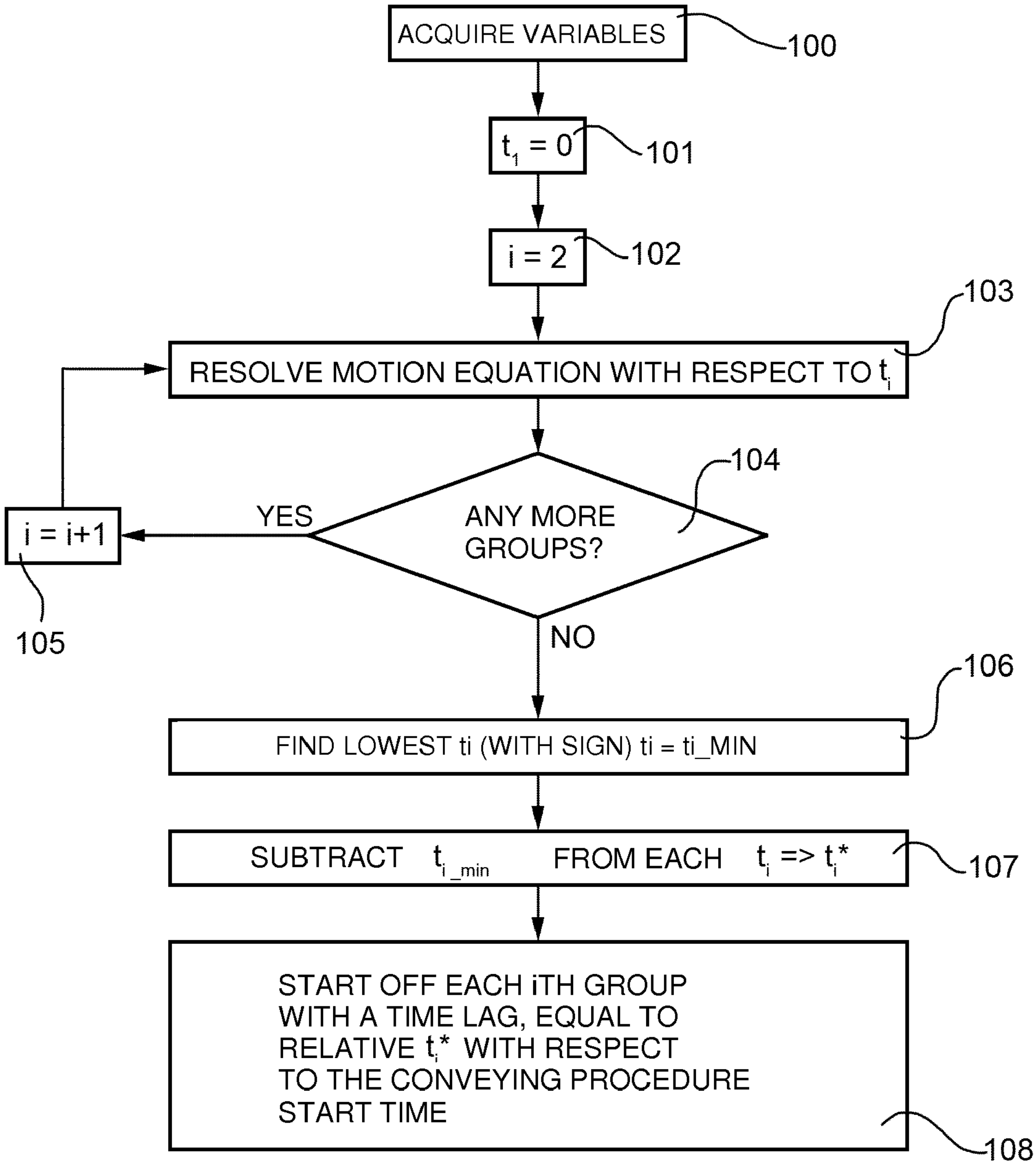
ACQUIRE VARIABLES
100
t1 = 0
101
i = 2
102
103
RESOLVE MOTION EQUATION WITH RESPECT TO ti
104
ANY MORE GROUPS?
YES
i = i+1
105
NO
106
FIND LOWEST ti (WITH SIGN) ti = ti_MIN
SUBTRACT ti _min FROM EACH ti => ti*
107
START OFF EACH iTH GROUP WITH A TIME LAG, EQUAL TO RELATIVE ti* WITH RESPECT TO THE CONVEYING PROCEDURE START TIME
108

FIG. 6

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 12 18 5556

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 0 923 997 A2 (ELSAG SPA [IT]) 23 June 1999 (1999-06-23) * paragraphs [0010] - [0013], [0017] - [0024], [0029] - [0030]; figures *	1,10	INV. B07C1/02 B65H29/66
A	EP 0 804 975 A2 (FINMECCANICA SPA [IT] ELSAG SPA [IT]) 5 November 1997 (1997-11-05) * column 1, lines 35-56 * * column 3, lines 14-20 * * column 4, lines 4-8 * * column 4, line 36 - column 6, line 27; figures *	1,10	
A	US 5 433 325 A (LEVARO MAURO [IT] ET AL) 18 July 1995 (1995-07-18) * column 5, lines 48-68; figures *	1,10	
A	EP 2 213 603 A2 (PITNEY BOWES INC [US]) 4 August 2010 (2010-08-04) * paragraphs [0032] - [0037] *	3,4	
			TECHNICAL FIELDS SEARCHED (IPC)
			B07C B65H

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	3 October 2012	Lemmen, René

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 18 5556

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

03-10-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0923997 A2	23-06-1999	CA 2256151 A1	17-06-1999
		DE 69822768 D1	06-05-2004
		DE 69822768 T2	10-02-2005
		EP 0923997 A2	23-06-1999
		IT 1296655 B1	14-07-1999
		JP 4101961 B2	18-06-2008
		JP 11236144 A	31-08-1999
		US 6366828 B1	02-04-2002
EP 0804975 A2	05-11-1997	DE 69716990 D1	19-12-2002
		DE 69716990 T2	24-07-2003
		EP 0804975 A2	05-11-1997
		IT TO960358 A1	03-11-1997
		JP 10071368 A	17-03-1998
		US 5908116 A	01-06-1999
US 5433325 A	18-07-1995	CA 2110446 A1	02-06-1995
		DE 69326617 D1	04-11-1999
		DE 69326617 T2	13-01-2000
		DK 654309 T3	21-02-2000
		EP 0654309 A1	24-05-1995
		ES 2137219 T3	16-12-1999
		NO 934904 A	03-07-1995
		US 5433325 A	18-07-1995
EP 2213603 A2	04-08-2010	EP 2213603 A2	04-08-2010
		US 2010194025 A1	05-08-2010

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82