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(54) Paper sheet pickup apparatus

(57) Mail pieces (P), the rear ends of which are aligned, are picked up one by one by means of a pickup belt (78), and the front end of a first mail piece (P) is detected by a front end detector (87), while it is being picked up. The length of the first mail piece (P) (the position of the rear end of the mail piece (P)) is estimated on the basis of the time elapsed before the first mail piece (P) has been transferred to the front end detector (87). When the first mail piece (P) is transferred to a transfer path (48), the rate of the transfer belt (78) is increased or decreased with reference to the estimated value of the length of the first mail (P) before the first mail (P) reaches to a rear end detector (88), so that a hole 79 can be located at a pickup position to pick up a second mail piece (P). When the first mail piece (P) reaches to the position of the rear end detector (88), the second mail piece (P) is picked up. When the front end of the second mail piece (P) is detected by the front end detector (87), the rate of picking up the second mail piece (P) is increased or decreased to keep the gap between the mail pieces (P) constant.

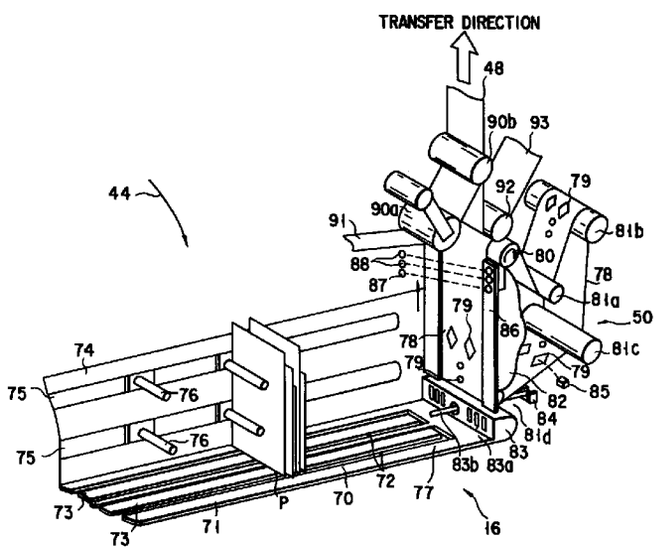

FIG. 3

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Description

The present invention relates to a paper sheet pickup apparatus for use in a paper sheet processing apparatus for processing (e.g., selecting and stamping) paper sheets, such as mails.

In recent years, mail processing apparatuses serving as automatic mail selecting, aligning and stamping apparatuses have been put into practical use, which automatically select, align, stamp and sort mails. A mail processing apparatus comprises an automatic selecting section for selecting standard mails, having predetermined thickness and width, from a number of mails put into the apparatus. It also comprises a buffer section for temporarily storing the standard mails selected by the automatic selecting section. The buffer section includes a mail pickup apparatus which picks up a piece of mail from the mails stored therein and supplies it to an automatic reading section.

In the mail pickup apparatus, for example, while a transfer belt is running, a piece of mail in contact with the belt is adhered to the belt, so that mails can be picked up one by one.

With the above conventional mail pickup apparatus, when mail pieces are to be picked up at regular intervals with the rear ends thereof aligned with each other so that the distance between the rear end of every mail piece and the front end of the subsequent mail piece can be constant, the following method has been employed. First, the rear end of a first picked-up mail piece is detected by a detector, a second mail piece is picked up, and the front end of the second mail piece is detected, so that the distance between the first and second mail pieces is detected. The distance is maintained by switching the rotation rate of the transfer belt for picking up mails between a normal rate and a reduced rate.

However, in the aforementioned mail pickup apparatus, to detect the front and rear ends of mail pieces, it is necessary to pick up mail pieces so that they do not overlap each other, resulting in the problems that the processing speed is low and the distance between mail pieces cannot be narrower than a fixed value. The rate of picking up mails can be increased by increasing the transfer rate of the transfer belt. In this case, however, the size of the apparatus is inevitably large and the driving mechanism of the transfer belt is overloaded.

An object of the present invention is to provide a paper sheet pickup apparatus in which the rear ends of paper sheets are aligned and the paper sheets are picked up one by one at regular intervals, so that the apparatus can be smaller and occupy less space as compared to the conventional apparatus. With the apparatus, the load applied to the driving mechanism is reduced, and the lifetime of the machine is increased. Further, paper sheets can be picked up with less variation and the machine performance can be stable.

According to the present invention, there is provided a paper sheet pickup apparatus comprising:

supply means for supplying first and second paper sheets, rear ends of which are aligned with each other;

pickup means for picking up the paper sheets supplied by the supply means one by one at a pickup rate, a pickup position being preset to a predetermined position and the pickup rate being variable;

detecting means for detecting front ends in a pickup direction of the paper sheets picked up by the pickup means;

estimating means for estimating a length of the first paper sheet based on a detection result concerning the first paper sheet detected by the detecting means;

transfer means for receiving and transferring the first paper sheet picked up by the pickup means;

first control means for altering the pickup rate of the pickup means and moving the pickup position to the predetermined position based on a result of estimation of the length of the first paper sheet obtained by the estimating means, when the first paper sheet is received by the transfer means; and

second control means for altering the pickup rate of the pickup means so as to make a gap between the rear end of the first paper sheet and the front end of the second paper sheet the same as a gap between a rear end of a paper sheet previous to the first paper sheet and the front end of the first paper sheet, when the front end of the second paper sheet picked up by the pickup means is detected by the detecting means.

The present invention also provides a paper sheet pickup apparatus comprising:

supply means for supplying a plurality of paper sheets, rear ends of which are aligned with each other;

pickup means for picking up the paper sheets supplied by the supply means one by one at a pickup rate, a pickup position being preset to a predetermined position and the pickup rate being variable;

detecting means for detecting front ends in a pickup direction of the paper sheets picked up by the pickup means;

calculating means for estimating length of the respective paper sheets based on detection results detected by the detecting means and calculating a detection time in the detecting means;

transfer means for receiving and transferring the paper sheets picked up by the pickup means;

first control means for altering the pickup rate of the pickup means so that the transfer means receives the paper sheets at a fixed time, with reference to the detection time calculated by the calculating means; and

second control means for altering the pickup means so as to move the pickup position to the predetermined position, before a time when the rear end of the paper sheet transferred by the transfer means reaches a fixed position, based on a calculation result of the length of the paper sheet calculated by the calculating means, thereby starting an operation of picking up another paper sheet by the pickup means at the time.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a perspective view showing a schematic structure of a mail selecting, aligning and stamping apparatus according to an embodiment of the present invention;

FIG. 2 is a top view showing a schematic structure of the mail selecting, aligning and stamping apparatus;

FIG. 3 is a perspective view showing a schematic structure of a mail pickup apparatus;

FIG. 4 is a block diagram showing a schematic structure of a mail pickup apparatus;

FIGS. 5 and 6 are flowcharts for explaining a mail pickup operation; and

FIG. 7 is a diagram for explaining timings of transferring a plurality of pieces of mails in the mail pickup operation.

An embodiment of the present invention will be described with reference to the drawings.

The following is a description of the embodiment in which a paper sheet pickup apparatus of the present invention is embodied as a mail pickup apparatus incorporated in a mail selecting, aligning and stamping apparatus.

An outline of the overall structure of the mail selecting, aligning and stamping apparatus will be described. As shown in FIGS. 1 and 2, the mail selecting, aligning and stamping apparatus comprises: a supply section 10 for supplying a number of mail pieces P of various thicknesses and widths to a subsequent stage; a thickness selecting section 12 for selecting mail pieces P having a standard thickness from all the mail piece P supplied to the supply section 10; a width selecting section 14 for selecting mail pieces having a standard width from the mail pieces P having the standard thickness selected by the thickness selecting section 12; a detecting section 22 including a stacker feeder 16 for temporarily storing standard mail pieces P having standard thickness and width and first and second reading sections 18 and 20 for reading information from the mail pieces P; a stamping section 24 for stamping the mail pieces P; and a sorting and storing section 26 for sorting and storing the mail pieces P in accordance with the information read by the first or second reading section 18 or 20.

The mail selecting, aligning and stamping apparatus also comprises, in a central portion, i.e., near the detecting section 22, a main operation panel 28 for supplying various operation instructions to the apparatus and displaying operation modes, operation errors and the like. It further comprises, near the connecting portion between the stamping section 24 and the sorting and storing section 26, a sub-operation panel 30 for displaying operation modes, operation errors and the like.

In addition, the mail selecting, aligning and stamping apparatus includes switches (not shown), so that the thickness selecting section 12, the width selecting section 14 and the detecting section 22 can be activated or stopped individually.

The structures and operations of the respective sections of the mail selecting, aligning and stamping apparatus will be described in detail.

As shown in FIGS. 1 and 2, the supply section 10 has a hopper 32 for collectively receiving a number of mail pieces P and a transfer belt for transferring the mail pieces P upward obliquely to the thickness selecting section 12. The thickness selecting section 12 divides the mail pieces P transferred by the transfer belt 33 into mail pieces P of a standard thickness and mail pieces P of non-standard thicknesses. The mail pieces P of the standard thickness selected by the thickness selecting section 12 are dropped onto a conveyor 34 through a drop path (not shown). The mail pieces P of the non-standard thicknesses are discharged to a reject section 35.

The width selecting section 14 has a stand-up converting section 36 for standing the mail pieces P supplied through the conveyor 34; a transfer path 38 for transferring the mail pieces P stood up by the stand-up converting section 36; selecting portions 40a, 40b, 40c and 40d for selecting mail pieces P of non-standard widths from the mail pieces P transferred through the transfer path 38; and a direction aligning section 42 for aligning edges of the mail pieces P in the longitudinal and lateral directions. The mail pieces P of the non-standard widths selected by the selecting portions 40a, 40b, 40c and 40d are discharged to a reject section through a discharging transfer path and a shooter (not shown). A mail piece p which includes a foreign matter is also rejected by the width selecting section 14.

The detecting section 22 has a transfer path 44 for transferring the standard mail pieces P selected by the width selecting section 14 to the stacker feeder 16 serving as a first storage section. It also has an auxiliary storage section 46 for temporarily storing the mail pieces P transferred from the width selecting section 14, when the stacker feeder 16 is full or a transfer defect occurs (for example, in a case where a gap between successive mail pieces is smaller than a preset value). The stacker feeder 16 includes a first pickup unit 50 for picking up, one by one, the mail pieces P stored in the stacker feeder 16, and supplying them at regular intervals through a transfer path 48 to the first reading section 18.

A local feeder 52 is provided to store standard mail pieces P when the detecting section 22 is directly used without using the supply section 10, the thickness selecting section 12 and the width selecting section 14. The standard mail pieces P taken out of, for example, the auxiliary storage section 46, are put into the local storage section 52. The local storage section 52 includes a second pickup unit 54 for picking up the stored mail pieces P one by one, and supplying them at regular intervals through the transfer path 48 to the first reading section 18.

The first reading section 18 of the detecting section 22 has first to third detecting portions 56a, 56b and 56c to detect objects of detection (e.g., stamps, contrast bars and classifying information) on the mail pieces P transferred through the transfer path 48. A reversing section 58 is provided between the first and second reading sections 18 and 20 to reverse upside down the mail pieces P having detection objects, which have not been detected by the first reading section. If a detection object is detected by the first reading section 18, the reversing operation is not performed. Similar to the first reading section 18, the second reading section 20 has fourth to sixth detecting portions 60a, 60b and 60c to detect objects of detection on the mail pieces P transferred from the reversing section 58.

The mail pieces P passed through the second reading section 20 is stamped in the stamping section 24 and thereafter transferred to the sorting and storing section 26. The sorting and storing section 26 has a plurality of sorting gates 62 driven in accordance with information read by the first or second reading section 18 or 20, and a plurality of partitions 64. The mail pieces P, which have been subjected to the detection and stamping processes, are sorted, for example, depending on destinations, or whether normal mail or express mail. The sorted mail pieces are stored in the corresponding partitions 64.

Referring to FIG. 3, the stacker feeder 16 includes the first pickup unit 50 and a supply section 70 for supplying to the first pickup unit 50 the mail pieces P transferred through the transfer path 44. The supply section 70 comprises a supply base 71, supply belts 73 provided in slits 72 in the supply base 71 so as to be movable toward a pickup belt 78 (to be described later), a side plate 74 stood on the supply base 71, and supply pins 76 arranged at regular intervals in slits 75 formed in the side plate 74 so as to be movable toward the pickup belt 78. The mail pieces P, transferred by the supply belts 73 and the supply pins 76 of the supply section 70, are supplied to a pickup section 77 in a state where the rear (lower) ends are aligned in front of the first pickup unit 50.

More specifically, the first pickup unit 50 comprises a pickup belt 78 extended perpendicular to the direction in which the mail pieces P is transferred by the supply section 70. The pickup belt 78 has a number of sets of holes 79. One hole set has, for example, four holes, and the sets of holes are arranged at regular intervals in the pickup belt 78. The pickup belt 78 is extended over a driving roller 80 and four pinch rollers 81a, 81b, 81c and 81d. When the driving roller 80 is rotated by a driving mechanism (not shown), the pickup belt 78 is moved in a direction indicated by the arrow in FIG. 3, so that the mail pieces P can be transferred in a predetermined transfer direction, i.e., toward the transfer path 48. The pickup belt 78 can be moved at a variable rate by the aforementioned driving mechanism.

In a space surrounded by the pickup belt 78, there is provided a main drawing section 82 drawn by a drawing mechanism (not shown) so as to face the inner surface of the pickup belt 78. An auxiliary drawing section 83 drawn by the drawing mechanism is arranged in a downstream side of the pickup belt 78. The auxiliary drawing section 83 is to prevent the pickup belt 78 from simultaneously picking up two or more mail pieces P. The auxiliary drawing section 83 has drawing holes 83a, and a pressure detecting lever 83b, an end of which is present in the pickup section 77 of the supply section 70. When the mail pieces P are stored in the pickup section 77, the pressure detecting lever 83b is moved by the pressure of the mail pieces, so that the rear end of the pressure detecting lever 83b turns on a pressure detector 84 of transmission type, which is arranged behind the auxiliary drawing section 83. When the mail pieces P are stored in the pickup section 77, the rear end of the pressure detecting lever 83b shades light transmitted from a light emitting element (not shown) to a light receiving element (not shown), thereby turning on the pressure detector 84.

A belt hole detector 85 of transmission type is provided between the pinch rollers 81c and 81d. The belt hole detector 85 detects passage of a hole 79, thereby detecting the transfer position of the pickup belt 78. When light emitted from a light emitting element (not shown) is guided through the hole 79 to a light receiving element (not shown), the belt hole detector 85 is turned on.

A side plate 86 is provided in a front side of the main drawing section 82. Above the side plate 86, there are provided a front end detector 87 of transmission type for detecting the front end (upper end) of a mail piece P picked up by the pickup belt 78 and a rear end detector 88 of transmission type for detecting the rear end (lower end) of the mail piece P picked up by the pickup belt 78. The front end detector 87 is designed so as to be turned on when light emitted from the a light emitting element (not shown) to a light receiving element (not shown) is shaded by the front end (upper end) of the mail piece P. The rear end detector 88 is designed so as to be turned on when light emitted from a light emitting element (not shown) is guided to a light receiving element (not shown) due to the passage of the rear end (lower end) of the mail piece P. The rear end detector 88 may be constituted by either one or a plurality of detector elements.

The mail piece P picked up by the pickup belt 78 is guided to the transfer path 48 after being transmitted through the front end detector 87 and the rear end detector 88.

The transfer path 48 is comprised of a transfer belt 91 extended over rollers 90a and 90b and a transfer belt 93 extended over a roller 92.

A structure the main portion of the above mail pickup apparatus will be described with reference to the block diagram of FIG. 4. A calculating circuit 100 calculates various timings in response to detection signals output from the pressure detector 84, the belt hole detector 85, the front end detector 87 and the rear end detector 88. A mechanism controller 101 performs control in response to a calculation result output from the calculating circuit 100. A driving mechanism 102, controlled by

the mechanism controller 101, drives or moves the supply belts 73 and the supply pins 76. A driving mechanism 103, controlled by the mechanism controller 101, drives the pickup belt 78 at various rates (to transfer or pick up mail pieces).

A drawing controller 104, controlled by a detection signal output from the belt hole detector 85, controls a drawing apparatus 105 connected to the main drawing section 82 and the auxiliary drawing section 83. Drawing operations in the main and auxiliary drawing sections 82 and 83 are performed by means of the drawing apparatus 105.

Calculations performed by the calculating circuit 100 will now be described.

Assume that the rate function of the pickup belt 78 is u (t); the distance between a hole 79 in the pickup belt 78 for drawing a mail piece P and another hole 79 for drawing a subsequent mail piece P is p; the transfer rate of the transfer path 48 is v (which is a constant value, since the transfer path moves at a constant rate); the height of the front end detector 87 above the supply base 71 is x; the height of the position at which the rear end of the previous mail piece P is to be located, at the time when the pickup operation of a next mail piece P is started, is h; the height at which the transfer path 48 receives the mail piece P (the height of the roller 90b above the supply base 71) is y; and the length of the mail piece P is L.

Further, assume that the time at which the pickup operation is started is 0; the time elapsed before the front end of the mail piece P has passed through the front end detector 87 is T1; the time elapsed before the mail piece P has been transferred to the transfer section 48 is T2; and the time elapsed before the rear end of the mail P has passed through the portion at the height h is T3.

In this case, the pickup belt 78 moves at a constant rate during the time between 0 and T1, whereas the moving rate function u (t) of the pickup belt 78 is variable during the time between T1 and T2 and the time between T2 and T3.

As described above, the moving rate of the pickup belt 78 is constant from the start of the pickup operation to the time when the front end of the mail piece P reaches the front end detector 87 (T1). Since T1 is known by the detection of the front end detector 87, the length L of the mail piece P is obtained by the following equation A.

$$\int_0^{T1} u(t)dt = x - L \qquad A$$

$$L = x - \int_0^{T1} u(t)dt$$

Further, the distance in which the pickup belt 78 moves during the period of time between T1 (the time when the front end of the mail piece P is detected by the front end detector 87 and T2 (the time when the transfer path 48 receives the mail piece P) is obtained by the following equation B.

$$\int_{T1}^{T2} u(t)dt = y - x \qquad B$$

The values of y and x are determined in advance, depending on the apparatus, and the time (T1), when the front end of the mail piece P is detected by the front end detector 87, varies in accordance with the length L of each of the mail pieces P. Therefore, the time (T2) when the transfer path 48 receives the mail piece P is kept constant and the rate function u (t) of the pickup belt 78 is controlled so that the front end of the mail piece P reaches the transfer path 48 at the time T2.

Further, the distance in which the pickup belt 78 moves during the period of time between T2 (the time when the transfer path 48 receives the mail piece P) and T3 (the time when the rear end of the transferred mail piece P passes through the height h) is obtained by the following equation C.

$$\int_{T2}^{T3} u(t)dt = p - (y-L) \qquad C$$

The mail piece P is transferred at a constant rate of the transfer rate v of the transfer path 48. In addition, the height h, the front end position of the mail piece P, and the length of the mail piece P are determined. Therefore, T3 can be represented by the following equation D.

$$T3 = ((L+h)-y)/v+T2 \qquad D$$

Because the mail piece P has been transferred by the transfer path 48 since the time T2, and the transfer belt 78 does not transfer the mail piece P during the period of time between T2 and T3, the pickup belt 78 can be driven freely in this period. As described above, since T3 is the timing when a next mail piece is picked up, it is necessary to move the hole 79 in the pickup belt 78 to a predetermined position (at which the mail piece P is picked up) during the period of time between T2 and T3.

The distance in which the pickup belt 78 moves in the period between the time 0 and T2 is obtained as "y-L", from the equations A and B. It is only necessary that the pickup belt 78 is moved by the distance corresponding to the difference between the above distance "y-L" and the distance p between the holes in the pickup belt 78 (p-(y-L)). Therefore, the rate function u (t) of the pickup belt 78 can be obtained from the equation C.

An operation of picking up mail pieces will be described with reference to the above equations A to D, flowcharts of FIGS. 5 and 6, and a timing chart of FIG. 7 showing transfer timings of a plurality of mail pieces P.

When the mail pieces P are supplied to the supply base 70 through the transfer path 44, the rear ends of the mail pieces are aligned with respect to the transfer direction of the transfer belt 78, whereas the positions of the front ends thereof vary depending on the lengths of the mail pieces P. First, the mail pieces P, the rear ends of which are aligned, are arranged on the supply base 70 and supplied to a portion near the pickup belt 78, i.e., to the pickup section 77, by means of the supply pins 76 and the supply belts 73 (Step 1).

When the mail pieces P are supplied in the pickup section 77, the pressure detecting lever 83b is pressed, with the result that the pressure detector 84 is turned on. In other words, the pressure detector 84 detects that the mail pieces P are supplied to a pickup surface of the pickup belt 78 (Step 2).

Then, the driving mechanism 103 is driven by the mechanism controller 101, thereby moving the pickup belt 78 at a constant rate (Step 3).

The belt hole detector 85 detects that the hole 79 is placed at a predetermined position of the mail piece P (Step 4). Thereafter, the drawing apparatus 105 is operated by the drawing controller 104 so as to operate the main drawing section 82 and the auxiliary drawing section 83 at a negative pressure (a pressure lower than one atmosphere pressure) (Step 5).

Thus, a first mail piece P is adhered to the pickup belt 78 by the main drawing section 82 and picked up (Step 6). Note that the pickup time in Step 6 is defined as "0", the pickup start time. In this time, i.e., when the first mail piece P is picked up, a second mail piece P is adhered to the auxiliary drawing section 83, so that two or more mail pieces P may not be picked up simultaneously.

The front end of the first mail piece P, picked up in Step 6, is detected by the front end detector 87 (Step 7).

Next, the pattern of driving the pickup belt 78 is calculated (Step 8). In this step, the value of T2 is fixed as described above, and the rate u (t) of the pickup belt 78 is calculated so that the mail piece P is transferred to the transfer path 48 at the time T2. Based on the value obtained by Step 8, the moving rate of the pickup belt 78, i.e., the transfer rate of the mail piece P, is controlled (Step 9), and the first mail piece P is transferred to the transfer path 48 at the time T2 (the front end of the first mail piece P reaches the transfer path 48) (Step 10).

Since the time T1, at which the front end of the mail piece P passes through the front end detector 87, is obtained on the basis of the timing of detecting the front end of the mail piece P in Step 7, an estimation value of the rear end of the mail piece P is calculated from the equation A, thereby obtaining the length L of the mail piece P (Step 11). The rate u (t) of the pickup belt 78 is obtained as a rate pattern of driving the pickup belt 78 by substituting, for L in the equation C, the length L of the mail piece P obtained from the equation A by the calculating circuit 100 in Step 11 (Step 12). In other words, while the mail piece P transferred to the transfer path 48 by Step 10 is being moved by the transfer path 48 until the time T3, the pickup belt 78, in a free state, controls the rate u (t) so that the hole 79 can be moved to the mail piece pickup position, before the second mail piece P is picked up.

The drive of the pickup belt 78 is controlled at the rate u (t) obtained in Step 12 (Step 13). By Step 13, the second mail piece P can be picked up, when the rear end of the first mail piece P reaches the height h (at the timing of T3).

Since the hole 79 is expected to return to the pickup position by Step 13, the belt hole detector 85 detects whether the hole 79 is located at the pickup position at the time T3 (Step 14). At this time, if the detection timing of the belt hole detector 85 does not coincide with T3, this time is stored as T4.

When it is detected in Step 14 that the hole 79 is located at the pickup position, it is detected whether the rear end of the first mail piece P has passed through the rear end detector 88 (Step 15). In other words, it is detected whether the rear end of the first mail piece P has passed through the position at the height h at the time T3. At this time, if the detection timing of the rear end detector 88 does not coincide with T3, this time is stored as T5. The rear end detector 88 is located at the position of the height h. By the control of the pickup belt 78 based on the above equations A to C, the mail pieces P can be picked up at regular intervals and the hole 79 can be returned to the pickup position before the second mail piece P is picked up. The rear end detector 88 is provided to perform refined adjustment of the deviation of the actual position of the mail piece P from the position obtained by the calculations of the equations A to C, and to suppress variation of the gaps between the mail pieces, in consideration of extension or a slip of the mail piece P by the pickup belt 78.

Based on the detection results in Steps 14 and 15, a rear end correction value is calculated (Step 16). In Step 16, a correction value of an error, which occurs in picking up and transferring the first mail piece, is calculated as follows:

$$L' = (T4-T3) \times v \qquad E$$

$$L'' = (T5-T3) \times v \qquad F$$

The correction values L' and L'' are calculated from the above equations. As mentioned before, "v" is the transfer rate (constant rate) of the transfer path 48.

Thereafter, the second mail piece P is adhered to the pickup belt 78 by the main drawing section 82 and picked up (Step 17). As regards the pickup of the second mail piece, note that the time T3, when the rear end of the first mail piece P passes through the height h, is set as "0", the pickup start time. In this time, i.e., when the second mail piece P is picked up, a third mail piece P is adhered to the auxiliary drawing section 83, so that two or more mail pieces P may not be picked up simultaneously.

The front end of the second mail piece P, picked up in Step 17, is detected by the front end detector 87 (Step 18).

Then, the pattern of driving the pickup belt 78 is calculated (Step 19). In this step, the value of T2 is fixed as described above, and the rate u (t) of the pickup belt 78 is calculated so that the mail piece P is transferred to the transfer path 48 at the time T2, based on the following equation B', taking account of the rate end correction value obtained by Step 16.

$$\int_{T1}^{T2} u(t)dt = y - x + (L'+L'') \qquad B'$$

The rate of transferring the mail piece P by the pickup belt 78 is controlled on the basis of the calculation result of Step 19 (Step 20). The second mail piece P is transferred to the transfer section 48 at the time T2 (the front end of the second mail piece P reaches the transfer path 48) (Step 21).

By the detection of the front end of the second mail piece P in Step 18, the time T1 when the front end of the mail piece P passes through the front end detector 87 is detected. An estimate value of the rear end of the mail piece P is calculated from the equation A, thereby obtaining the length L of the second mail piece P (Step 22). The rate u (t) of the pickup belt 78 is obtained as a rate pattern of driving the pickup belt 78 by substituting, for L in the equation C, the length L of the mail piece P obtained from the equation A in Step 22 (Step 23). In other words, while the rear end of the mail piece P transferred to the transfer path 48 by Step 21 is being moved by the transfer path 48 during the time between T2 and T3, the pickup belt 78, in a free state, controls the rate u (t) so that the hole 79 can be moved to the mail piece pickup position, before the third mail piece P is picked up. The driving of the pickup belt 78 is controlled at the rate u (t) obtained in Step 23 (Step 24).

Then, returning to Step 14, the third and subsequent mail pieces P are processed in the same manner as described above.

As described above, since the pickup belt 78 is controlled such that the mail pieces P are located at the same positions at the times T1, T2 and T3, it is possible to provide a paper sheet pickup apparatus in which the rear ends of paper sheets are aligned and the paper sheets are picked up one by one at regular intervals. The apparatus therefore can be smaller and occupy less space as compared to the conventional apparatus. With the apparatus, the load applied to the driving mechanism is reduced, and the lifetime of the machine is increased. Further, paper sheets can be picked up with less variation and the machine performance can be stable.

In the above embodiment, the mail pickup apparatus of the present invention is applied to the first pickup apparatus in the stacker feeder 16. However, it can also be applied to the second pickup apparatus in the same manner.

Claims

1. A paper sheet pickup apparatus comprising:

   supply means (73, 76) for supplying first and second paper sheets (P), rear ends of which are aligned with each other;

   pickup means (78) for picking up the paper sheets (P) supplied by the supply means (73, 76) one by one at a pickup rate, a pickup position (79) being preset to a predetermined position and the pickup rate being variable;

   detecting means (87) for detecting front ends in a pickup direction of the paper sheets (P) picked up by the pickup means (78);

   estimating means (100) for estimating a length (L) of the first paper sheet (P) based on a detection result concerning the first paper sheet (P) detected by the detecting means (87);

   transfer means (48) for receiving and transferring the first paper sheet (P) picked up by the pickup means (78);

   first control means (100, 101, 103) for altering the pickup rate of the pickup means (78) and moving the pickup position to the predetermined position based on a result of estimation of the length (L) of the first paper sheet (P) obtained by the estimating means (100), when the first paper sheet (P) is received by the transfer means (48); and

   second control means (100, 101, 103) for altering the pickup rate of the pickup means (78) so as to make a gap between the rear end of the first paper sheet (P) and the front end of the second paper sheet (P) the same as a gap between a rear end of a paper sheet previous to the first paper sheet (P) and the front end of the first paper sheet (P), when the front end of the second paper sheet (P) picked up by the pickup means (78) is detected by the detecting means (87).

2. The apparatus according to claim 1, characterized in that the pickup means (78) is constituted by an endless transfer belt (78) and the paper sheets (P) are picked up one by one in a predetermined direction by rotation of the transfer belt (78).

3. The apparatus according to claim 1, characterized in that the pickup means (78) is constituted by an endless transfer belt (78) and drawing sections (82, 83) for drawing the paper sheets (P), and the paper sheets (P) are adhered one by one to the transfer belt (78) by drawing operations of the drawing sections (82, 83), and the paper sheets (P) adhered to the transfer belt (78) are picked up in a predetermined direction by rotation of the transfer belt (78).

4. A paper sheet pickup apparatus comprising:

supply means (73, 76) for supplying a plurality of paper sheets (P), rear ends of which are aligned with each other;

pickup means (78) for picking up the paper sheets (P) supplied by the supply means (73, 76) one by one at a pickup rate, a pickup position (79) being preset to a predetermined position and the pickup rate being variable;

detecting means (87) for detecting front ends in a pickup direction of the paper sheets (P) picked up by the pickup means (78);

calculating means (100) for estimating length (L) of the respective paper sheets (P) based on detection results detected by the detecting means (87) and calculating a detection time (T1) in the detecting means;

transfer means (48) for receiving and transferring the paper sheets (P) picked up by the pickup means (78);

first control means (100, 101, 103) for altering the pickup rate of the pickup means (78) so that the transfer means (48) receives the paper sheets (P) at a fixed time (T2), with reference to the detection time (T1) calculated by the calculating means; and

second control means (100, 101, 103) for altering the pickup means (78) so as to move the pickup position to the predetermined position, before a time (T3) when the rear end of the paper sheet (P) transferred by the transfer means (48) reaches a fixed position (h), based on a calculation result of the length (L) of the paper sheet (P) calculated by the calculating means (100), thereby starting an operation of picking up another paper sheet (P) by the pickup means (78) at the time (T3).

5. The apparatus according to claim 4, characterized by further comprising rear end detecting means (88), arranged at the fixed position (h), for detecting whether the rear end of the paper sheet (P) has passed the fixed position at the time (T3).

6. The apparatus according to claim 4, characterized by further comprising pickup position detecting means (85), arranged at the predetermined position, for detecting whether the pickup position (79) of the pickup means (78) is located at the predetermined position.

7. The apparatus according to claim 4, characterized by further comprising:

rear end detecting means (88), arranged at the fixed position (h), for detecting whether the rear end of the paper sheet (P) has passed the fixed position at the time (T3);

pickup position detecting means (85), arranged at the predetermined position, for detecting whether the pickup position (79) of the pickup means (78) is located at the predetermined position; and

correcting means (100, 101, 103) for correcting control of the pickup means by the first control means (100, 101, 103), based on detection results of the rear end detecting means (88) and the pickup position detecting means (85).

8. The apparatus according to claim 4, characterized in that the pickup means (78) is constituted by an endless transfer belt (78) and the paper sheets (P) are picked up one by one in a predetermined direction by rotation of the transfer belt (78).

9. The apparatus according to claim 4, characterized in that the pickup means (78) is constituted by an endless transfer belt (78) and drawing sections (82, 83) for drawing the paper sheets (P), and the paper sheets (P) are adhered one by one to the transfer belt (78) by drawing operations of the drawing sections (82, 83), and the paper sheets (P) adhered to the transfer belt (78) are picked up in a predetermined direction by rotation of the transfer belt (78).

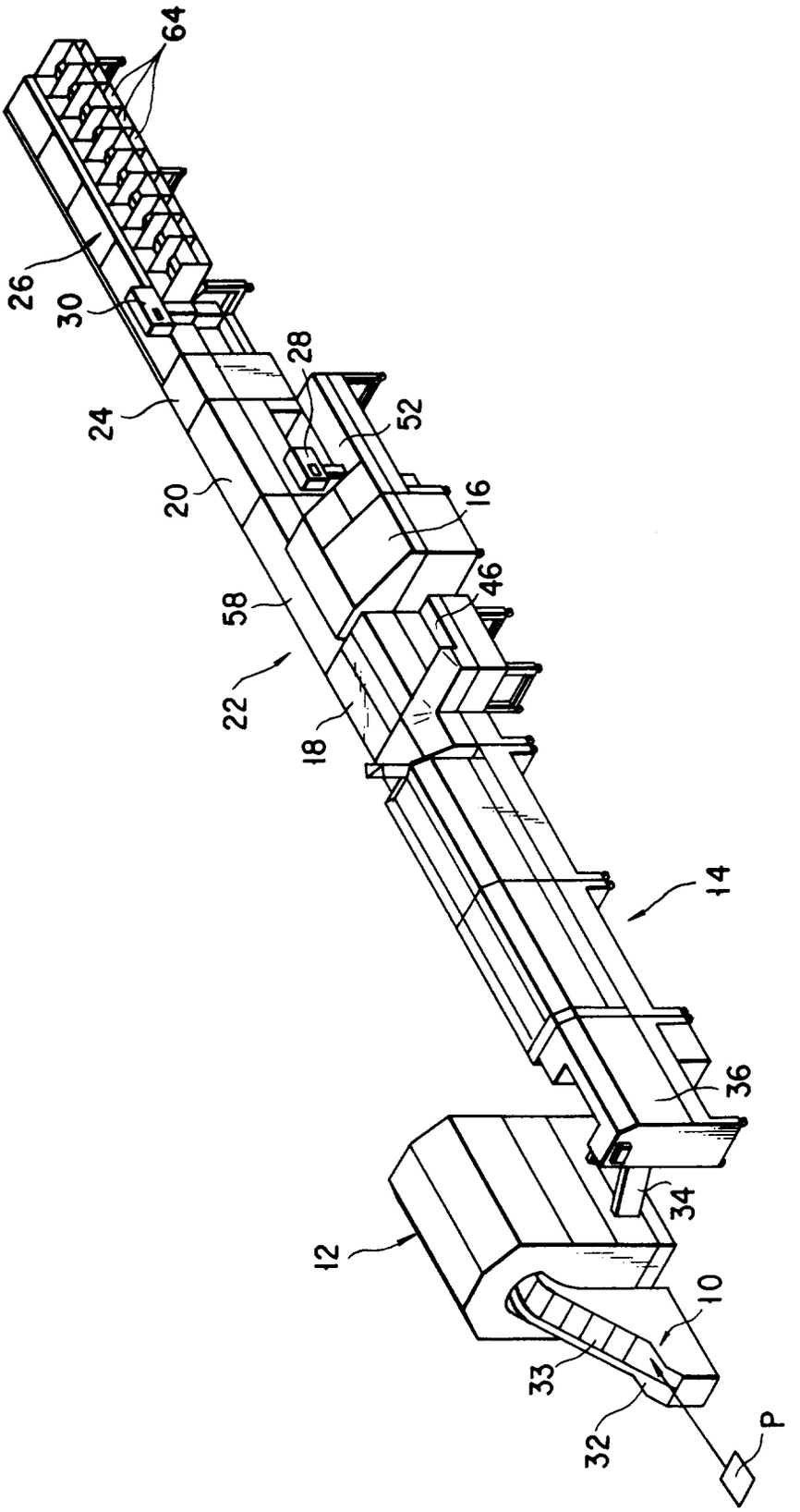

FIG. 1

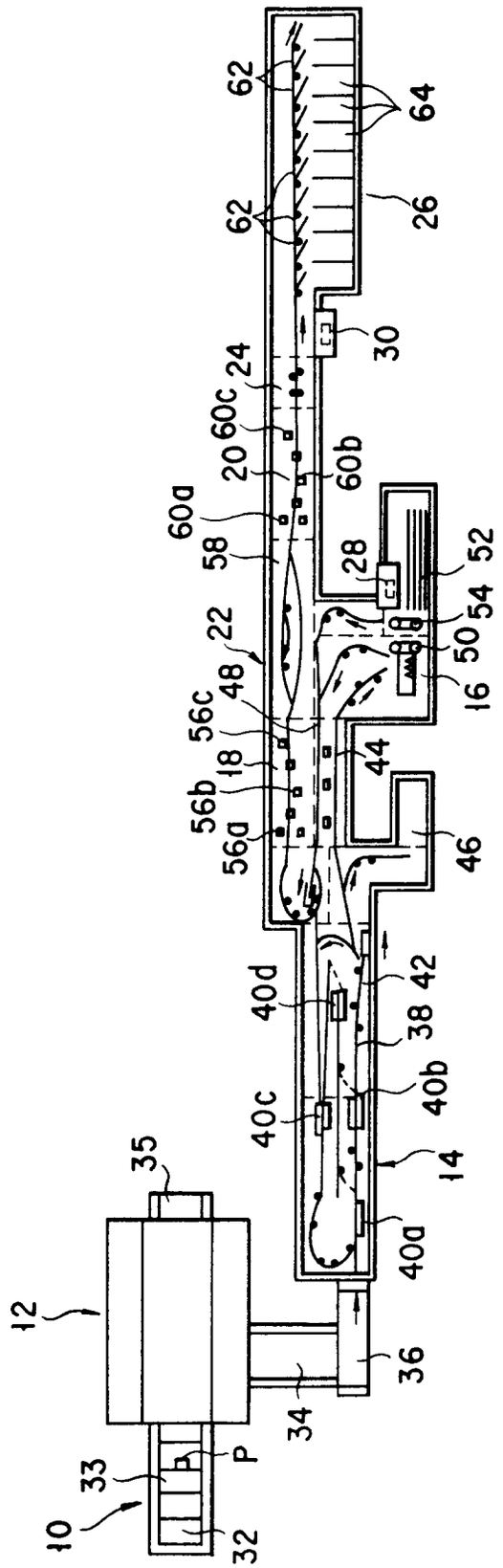
62
64
62
26
30
24
60c
20
60b
60a
58
28
52
54
22
50
48
16
56c
18
44
56b
56a
46
40d
42
38
40b
40c
14
35
40a
12
36
34
P
33
10
32

FIG. 2

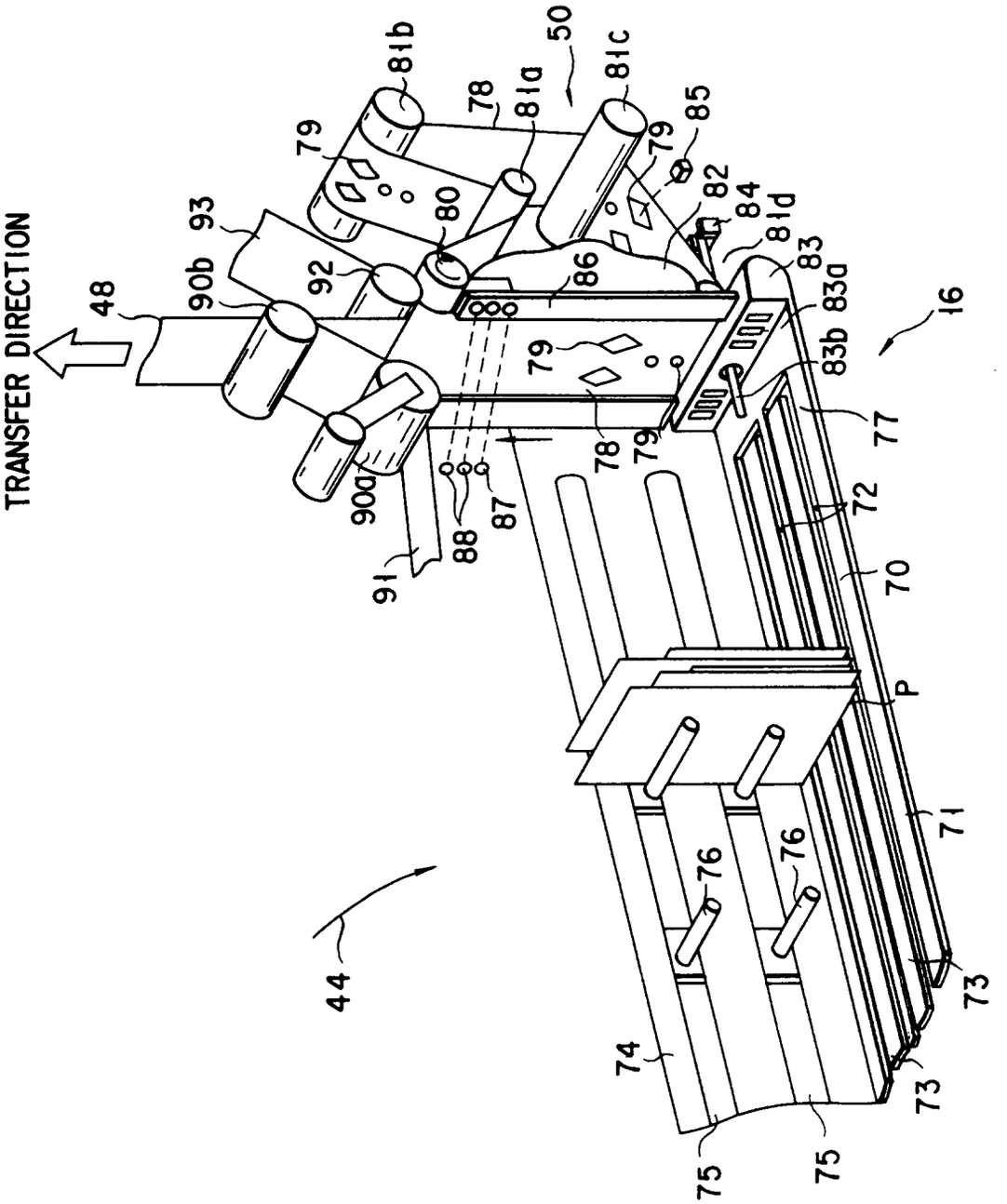
TRANSFER DIRECTION
48
90b
93
92
81b
78
81a
50
81c
85
79
80
82
84
81d
83
83a
83b
16
86
77
72
70
P
71
73
74
75
76
44
87
88
91
90a

FIG. 3

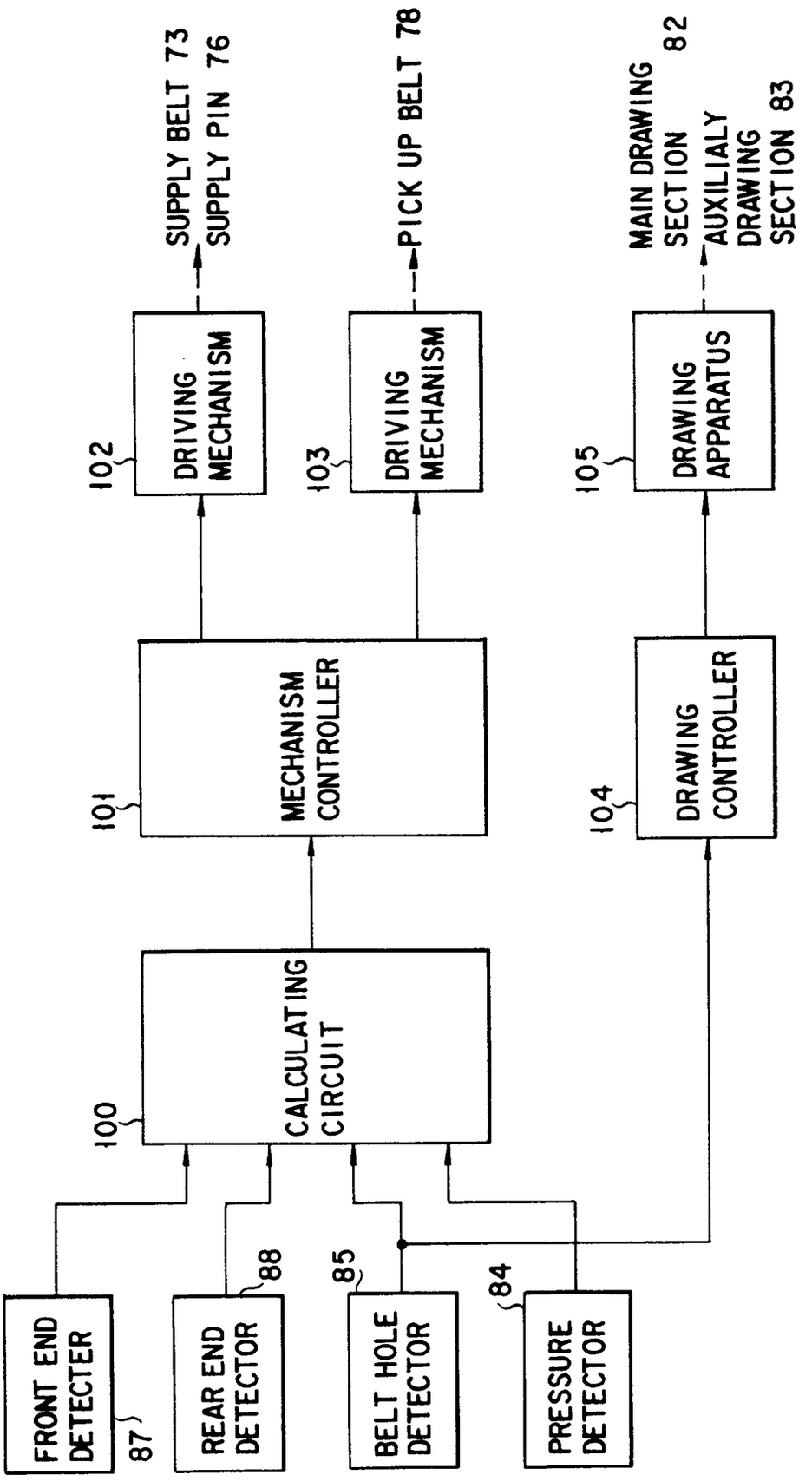
FRONT END DETECTER
87
REAR END DETECTOR
88
BELT HOLE DETECTOR
85
PRESSURE DETECTOR
84
CALCULATING CIRCUIT
100
MECHANISM CONTROLLER
101
DRIVING MECHANISM
102
DRIVING MECHANISM
103
DRAWING CONTROLLER
104
DRAWING APPARATUS
105
SUPPLY BELT 73
SUPPLY PIN 76
PICK UP BELT 78
MAIN DRAWING SECTION 82
AUXILIALY DRAWING SECTION 83

FIG. 4

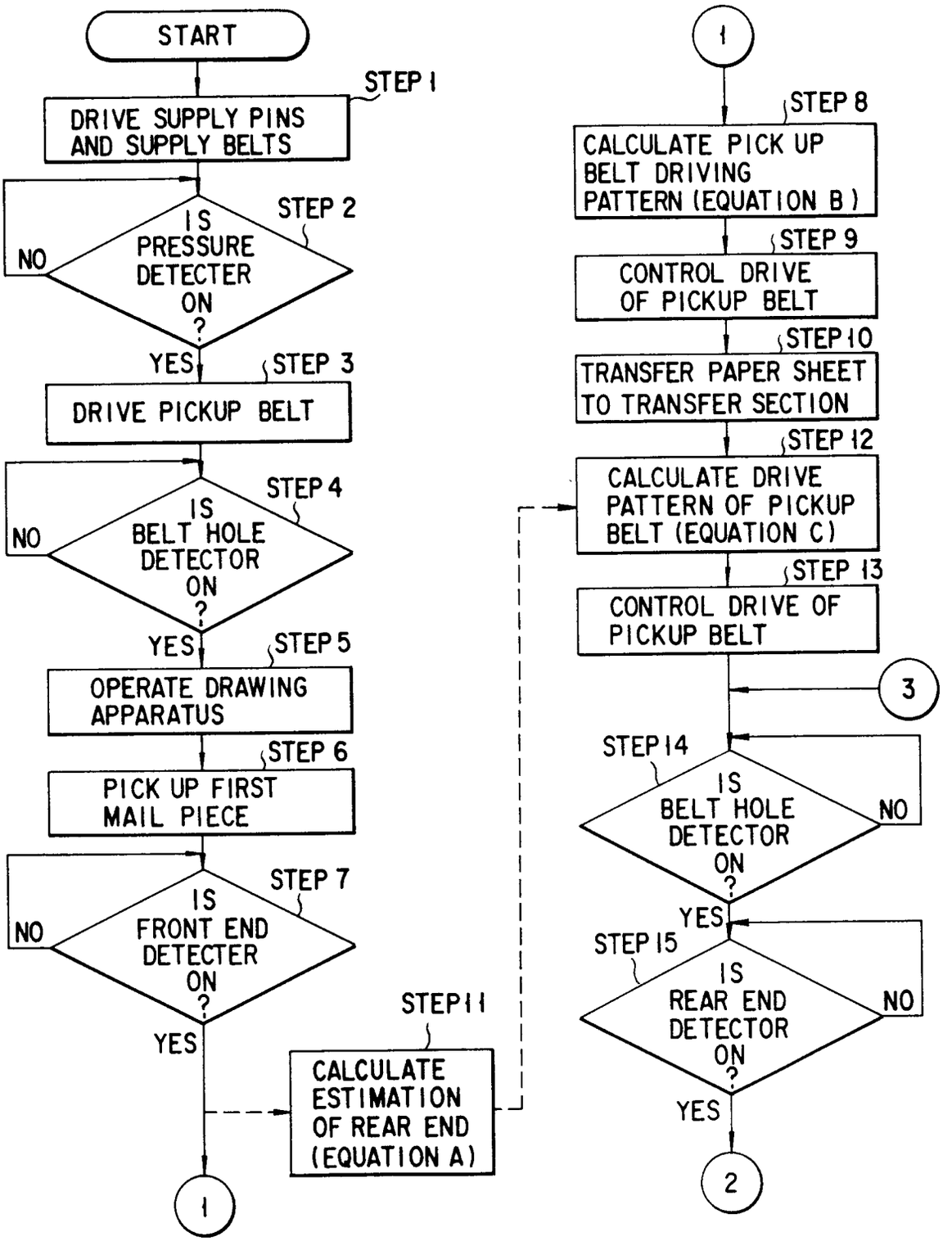
START
STEP 1
DRIVE SUPPLY PINS AND SUPPLY BELTS
STEP 2
IS PRESSURE DETECTER ON ?
NO
YES
STEP 3
DRIVE PICKUP BELT
STEP 4
IS BELT HOLE DETECTOR ON ?
NO
YES
STEP 5
OPERATE DRAWING APPARATUS
STEP 6
PICK UP FIRST MAIL PIECE
STEP 7
IS FRONT END DETECTER ON ?
NO
YES
STEP 11
CALCULATE ESTIMATION OF REAR END (EQUATION A)
1
1
STEP 8
CALCULATE PICK UP BELT DRIVING PATTERN (EQUATION B)
STEP 9
CONTROL DRIVE OF PICKUP BELT
STEP 10
TRANSFER PAPER SHEET TO TRANSFER SECTION
STEP 12
CALCULATE DRIVE PATTERN OF PICKUP BELT (EQUATION C)
STEP 13
CONTROL DRIVE OF PICKUP BELT
3
STEP 14
IS BELT HOLE DETECTOR ON ?
NO
YES
STEP 15
IS REAR END DETECTOR ON ?
NO
YES
2

FIG. 5

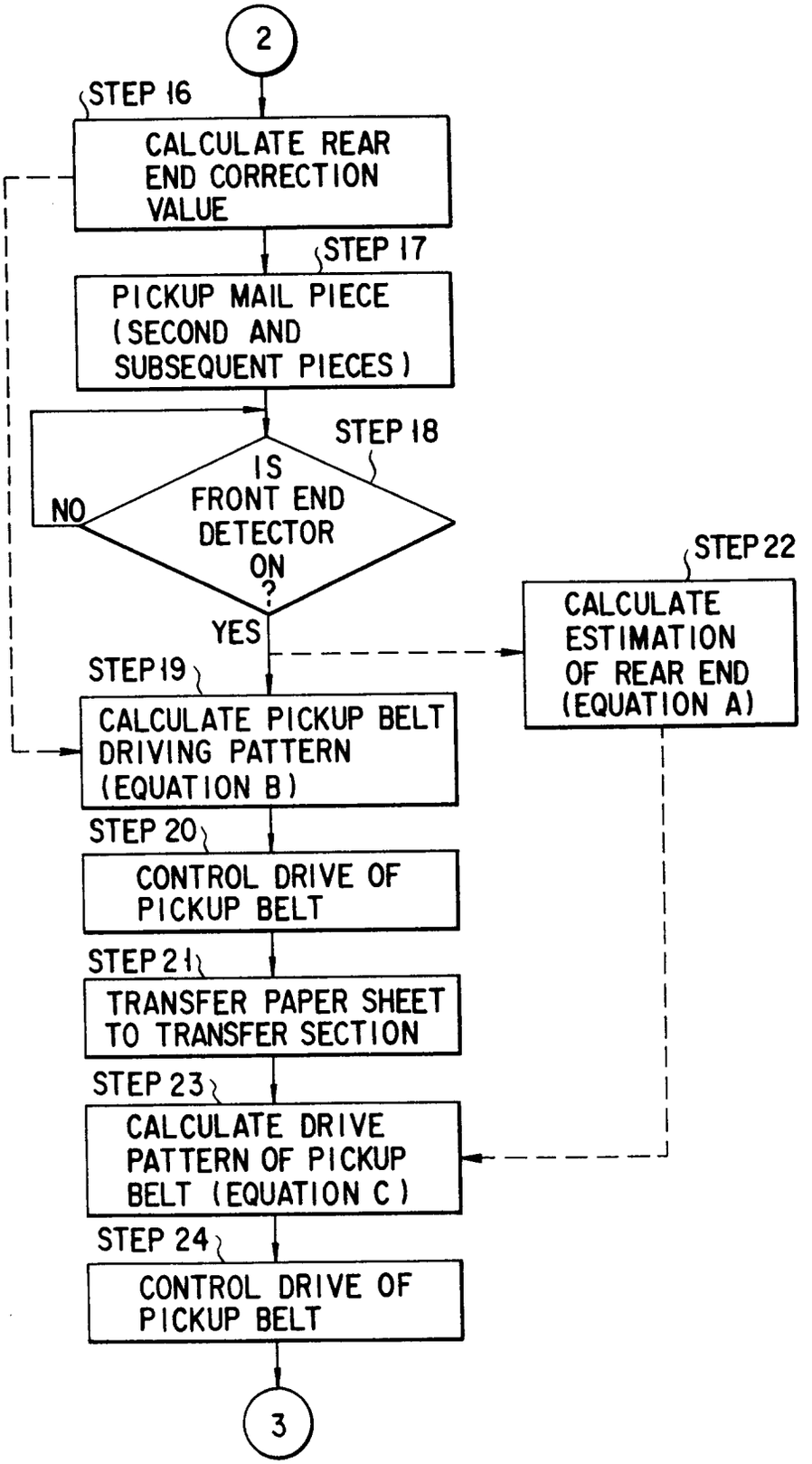
2
STEP 16
CALCULATE REAR END CORRECTION VALUE
STEP 17
PICKUP MAIL PIECE (SECOND AND SUBSEQUENT PIECES)
STEP 18
IS FRONT END DETECTOR ON ?
NO
YES
STEP 22
CALCULATE ESTIMATION OF REAR END (EQUATION A)
STEP 19
CALCULATE PICKUP BELT DRIVING PATTERN (EQUATION B)
STEP 20
CONTROL DRIVE OF PICKUP BELT
STEP 21
TRANSFER PAPER SHEET TO TRANSFER SECTION
STEP 23
CALCULATE DRIVE PATTERN OF PICKUP BELT (EQUATION C)
STEP 24
CONTROL DRIVE OF PICKUP BELT
3

FIG. 6

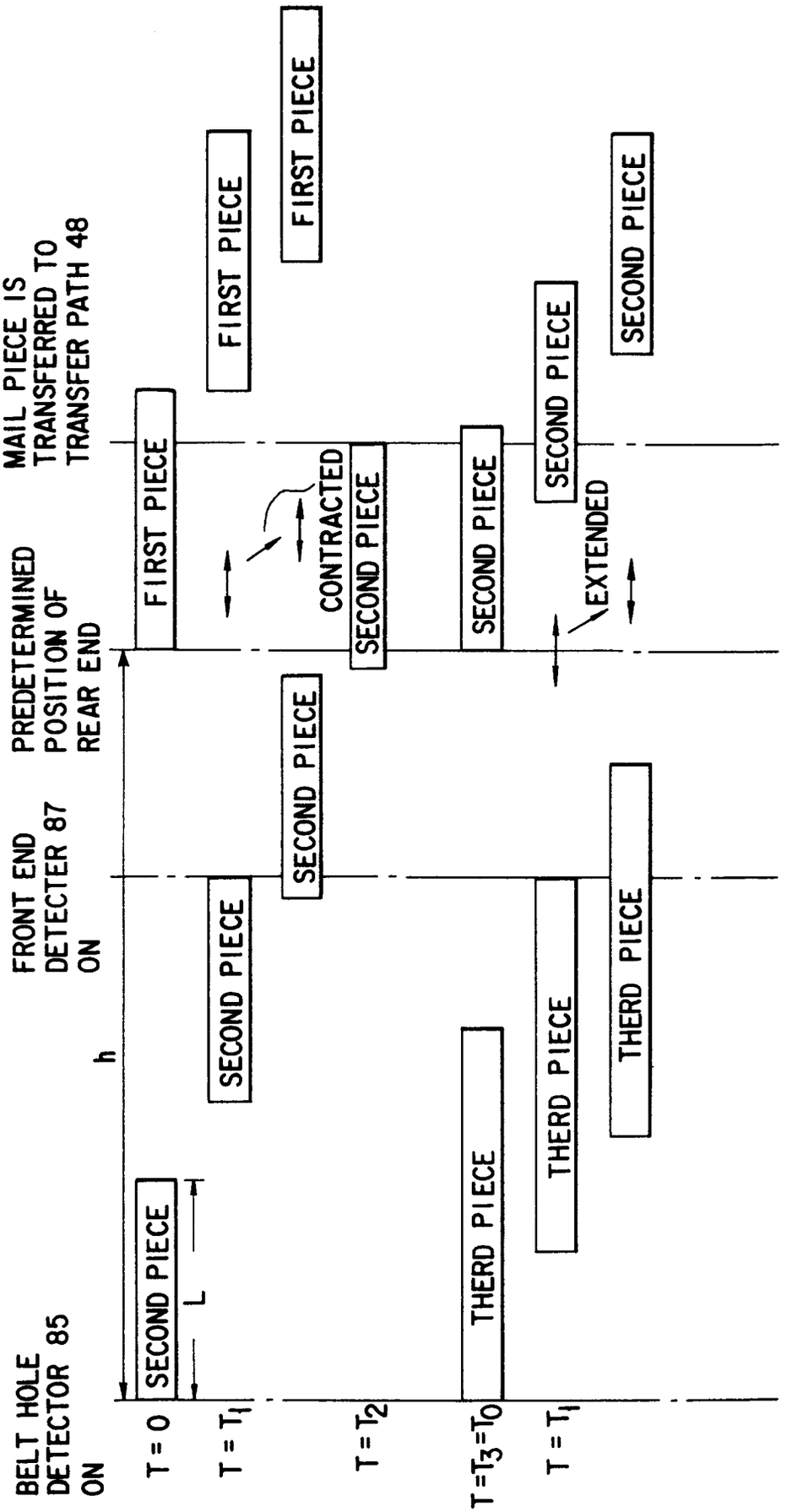
BELT HOLE DETECTOR 85 ON
FRONT END DETECTER 87 ON
PREDETERMINED POSITION OF REAR END
POSITION WHERE MAIL PIECE IS TRANSFERRED TO TRANSFER PATH 48
h
L
T = 0
T = T1
T = T2
T = T3 = T0
T = T1
SECOND PIECE
FIRST PIECE
THERD PIECE
CONTRACTED
EXTENDED

FIG. 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 11 9488

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.6)
A	US-A-4 541 624 (SASAGE ET AL) * the whole document * ---	1-5,8,9	B65H43/00 B65H7/02 B07C1/04
A	WO-A-92 16444 (BELL & HOWELL PHILLIPSBURG COMPANY) * page 3, line 12 - page 16, line 18; figures * ---	1,2,4,5, 8	
A	US-A-4 077 620 (FRANK ET AL) * column 1, line 55 - column 6, line 44; figures 1-3 * ---	1,2,4,5, 8	
A	US-A-4 451 027 (D. D. ALPER) * the whole document * ---	1,4,5	
A	US-A-4 331 328 (H. A. FASIG) * column 1, line 64 - column 8, line 6; figures * ---	1,2,4,5, 8	
A	US-A-4 318 540 (PAANANEN ET AL) * the whole document * ---	1,2,4,5, 8	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B65H B07C
A	EP-A-0 428 922 (IBM CORPORATION) * the whole document * ---	1,4	
A	EP-A-0 060 596 (ELETTRONICA SAN GIORGIO-ELSAG S.P.A.) * page 10, line 25 - page 15, line 27; figures * ---	1,4	
A	EP-A-0 414 623 (IBM CORPORATION) * the whole document * -----	1,4	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 April 1996	Raven, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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