JAM DETECTION SYSTEM FOR SORTING APPARATUS

ABSTRACT: An improved control and jam detection system for an apparatus for sorting documents including transport means, a plurality of modules, each module having a plurality of trays for storing documents, each tray having an inlet located along the document path and a deflector member associated therewith and adapted when actuated to route said documents from said transport means into the tray. The system comprises program means to actuate an individual one of said deflector members to route said documents into a selected tray in predetermined sequence, sensing means for sensing presence and absence of a document at predetermined locations along said document feed path and providing corresponding presence and absence indicating signals, and circuit means coupled to said transport means including a timing means responsive to said signals and providing an input to control the transport means whereby upon the occurrence of a jam the transport of documents into each of the modules is stopped and the document input supplied to an overflow tray until another signal from said program means is received at which time the apparatus is shutdown.
JAM DETECTION SYSTEM FOR SORTING APPARATUS

This invention relates to a system for sorting documents, and more particularly, to an improvement in jam detection and shutdown of sorting apparatus including a plurality of modular tray assemblies.

Document sorters provide in effect a plurality of alternate document routes or paths to individual document receptacles or trays whereby the documents may be separated from one another in the manner desired. Inasmuch as the time required by the sorter to handle documents is directly related to the speed at which documents move through the sorter, high document speeds are necessary if sorter operating time is to be minimized. Additionally, where the sorter input comprises a high-speed document-generating machine such as a copier-duplicator, the speed of the sorter must at least match that of the input machine if the full potential of the input machine is to be realized.

Where documents such as paper sheets are to be sorted, high sorter speeds with corresponding high document velocities are difficult to maintain. As can be appreciated, these types of documents are susceptible to bending, buckling, tearing, etc. The failings, which are exaggerated by increased document velocities, have rendered developments of reliable high-speed document sorters without the occurrence of a jam almost impossible. As a result, there has been a demand for an associated jam detection system which is highly reliable yet minimizes the down time of a machine upon the occurrence of a jam.

It is a principal object of the present invention to improve the detection of document misfeeds.

It is a further object of the present invention to enable the rapid location of a misfeed in a multiple modular sorting apparatus to minimize machine down time.

It is an object of the present invention to provide a document sorter system capable of accommodating a wide range of degree of misfeeds and enable the rapid location thereof.

Other objects and advantages will be apparent from the ensuing description and drawings in which:

FIG. 1 is a schematic view of document-sorting apparatus showing first and second sorter modules;

FIG. 2 is an end view with parts broken away of a sorter module;

FIG. 3 is an end view showing the document input transport of the first sorter module;

FIG. 4 is an enlarged view with parts broken away showing the document deflector mechanism of the sorting apparatus shown in FIG. 1;

FIG. 5 is an enlarged view with parts broken away of the document guide means of the sorting apparatus shown in FIG. 1; and

FIG. 6 is a schematic side view of the sorting apparatus illustrating the location of the sensing devices;

FIG. 7 is a block diagram of the jam detection system according to the present invention.

The jam detection system of the invention desirably is for use with a high-speed sorting apparatus for sorting documents comprising in combination a plurality of modules each having a plurality of spaced traylike document receiving receptacles, the receptacles being parallel with one another and inclined upwardly. A document transport adjacent the lower side of the receptacles is adapted to feed documents upwardly into the receptacles, the documents moving first in a substantially upward direction in the receptacles under the impetus of the transport and thereafter moving in a substantially downward direction in the receptacles under the influence of gravity.

Documents are fed to the next module by a second transport and so on until as many trays as necessary are utilized. Upon the occurrence of a jam, the sorting operation is ceased and the machine shutdown after a predetermined interval.

Referring particularly to FIG. 1 of the drawings there is shown document-sorting apparatus 10 typical for use with the present invention. In the exemplary showing of the drawings, sorting apparatus 10 includes series connected first and second sorter modules 12, 14, respectively, arranged to receive documents to be sorted from a suitable document-producing apparatus such as a copying machine (not shown). The document input to sorting apparatus 10 normally comprises conventional paper sheets usually rectangular in shape and of various size, weight, and thickness. Other types of documents such as film, cards, etc. are, however, contemplated. It will be understood that additional sorter modules may be added to obtain requisite sorter capacity but that two are sufficient for purpose of explaining the present invention.

Sorter modules 12, 14 each have a document transfer section 15 and a separating or receiving section 16. In sorter module 12, transfer section 15 includes input transport 18 for receiving documents discharged by the document-producing apparatus with which sorting apparatus 10 is used, intermediate transport 20, and discharge transport 22. In sorter module 14, input transport 18 is omitted with the documents entering sorter module 14 at the bottom thereof between intermediate transport conveyor 54 and pinch rolls 34. Separating section 16 includes a plurality of upwardly inclined trays or receptacles 24 for receiving and holding documents. It will be noted that trays 24 are canted slightly to enhance document registration.

Sorter modules 12, 14 each include a base 25, top 26, plural side frame member 27 at one end, and sidewall 28 at the opposite end thereof. Crossmembers 29 project between frame members 30 and wall 28 parallel to and slightly above base 25. Additional frame members 30 extend parallel to frame members 27 between crossmembers 29 and top 26. To facilitate moving sorter modules 12, 14 wheels 31 may be attached to base 25 thereof. Input transport 18 of first sorter module 12 comprises a belt-type conveyor 33 with cooperating pinch rolls 34. Conveyor 33 includes plural feed belts 36 supported on rolls 37. Rolls 37 are carried by shafts 38 journaled in sides 40 of conveyor 33. Conveyor sides 40 may be suitably secured to pinch roll side supports 42 which in turn are secured to module frame members 27, 30. Roll carrying shaft 38 is extended to carry conveyor drive pulley 44. Drive belt 45 operably connects motor 46 with pulley 44 to drive conveyor 33. Pinch rolls 34 are releasably held in contact with conveyor feed belts 36 at spaced points along the working surfaces thereof by wirelike members 49 supported on cross legs 48. Fingerlike document deflectors 52 are supported on shaft 53 journaled for limited rotation in sides 46 of conveyor 33. Deflectors 52, shown in dotted lines in the raised position, route documents downwardly, when lowered, to intermediate transport conveyor 54.

Intermediate transport 20 includes a belt-type conveyor 54 with cooperating pinch rolls 34 spaced along the outer downwardly moving side and at the base thereof, and cooperating pinch rolls 57 spaced along the inner upwardly moving side thereof. Conveyor 54 includes roll support shafts 61 journaled in sides 60 of conveyor 54. Rolls 62 on shafts 61 support conveyor feed belts 63. Lower shaft 61 of conveyor 54 is extended and drive pulley 64 is mounted thereon. Drive belt 65 connects pulley 66 with motor 66. Outer pinch rolls 34 for conveyor 54 are arranged in slotlike openings 68 in longitudinal channels 69. Rolls 34 are resiliently held and journaled in contact with feed belts 63 by means of support members 49 attached to frame crosslegs 71. Channels 69 are curved at 69' to define, in cooperation with feed belts 63, a transition path to turn the documents carried by conveyor 54 from a vertical to a horizontal direction. The upper portions of channels 69 are curved at 69' curved channel portions 69' cooperate with deflectors 52 when depressed to form a transition path for routing documents from input conveyor 22 to conveyor 54. Lower pinch rolls 34, which contact belts 63 of intermediate conveyor 54 adjacent the bottom thereof are similarly journaled by members 49 attached to discharge transport frame 86.

Inner pinch rollers 57 are rotatably supported in document guides 74 adjacent the inlet to each document tray 24. As will appear more fully, rollers 57, which are biased and journaled
Movable fingerlike deflectors 73 (FIG. 4) are provided adjacent the bottom of conveyor 54 to control the routing of documents into separating section 16 or onto discharge transport 22 for transport to a subsequent sorter module. Deflectors 73 are carried by shaft 75 journaled for limited rotation in frame support 86. Deflectors 73, when in the raised position, route documents conveyed by conveyor 54 upwardly to module separating section 16. When depressed, deflectors 73 permit documents conveyed by conveyor 54 to pass onto discharge conveyor 79. Discharge transport 22 includes a belt-type conveyor 79 and cooperating pinch rolls 34. Discharge transport 22 is disposed between base 25 and crossmembers 29. Shafts 84, journaled in sides 85 of conveyor 79, carry support rolls 83 for feed belts 87. Pinch rolls 34 are rotatably supported in contact with feed belts 87 of conveyor 79 at spaced points along the working surface thereof by supports 49 attached to frame 86. Roll support shaft 84 of conveyor 79 is extended and drive pulley 94 is secured thereto. Drive belt 65 drives pulley 94 from motor 66.

Document trays 24, which may be formed from a suitable sheetlike material, are substantially rectangular in shape with one side 93 upturned to serve as both a document stop and register. Trays 24 are supported at one end in document guides 74 while the other end is attached to wall 28. Document guides 74 (FIGS. 2 and 5) comprise a troughlike part suitably secured to frame members 30 in parallel spaced relation to one another. The inside wall 95 of each guide 74 has an inclined slotlike opening 96 therethrough the adjacent the lower portion thereof adapted to receive the lower end of document tray 24. Documents are fed between adjacent guides 74 onto trays 24, wall 95 of guides 74 serving both as a document stop to prevent documents from sliding backwardly out of trays 24 and as a document register. Base 95 of guides 74 has a plurality of spaced fingers 99 projecting therefrom. Document deflectors 80, mounted on shafts 81 are arranged adjacent each tray 24. Deflector support shafts 81 are journaled for limited rotation in sides 60 of conveyor 54. Deflectors 80, when moved to document intercepting position, cooperate with fingers 99 and pinch rollers 57 to route documents through the space between adjacent guides 74 into the tray 24 associated therewith. The uppermost deflectors 80, which are fixed in a document intercepting position, route any document remaining on conveyor 54 into tray 24 to obviate possible carryover of documents by conveyor 54.

The angle of inclination of trays 24 is critical, it being understood that where the angle of inclination is too great, the documents, which are normally sheet paper, may sag or buckle, or may not completely pass between guides 74 into the trays. Where, however, the angle of inclination is too small, documents may not slide sufficiently to contact the guide 74 and registration is not completed. The velocity at which documents are fed into trays 24, static electric charges on the documents themselves which tend to cause the documents to stick to one another, and the weight of the documents also affect the choice of tray angle inclination. To forestall document sag and buckling while assuring document registration at relatively high document velocities, trays 24 are inclined at an angle of substantially 35° to the horizontal. Trays 24 are additionally tilted or canted downwardly in a plane substantially perpendicular to the plane of tray inclination toward upstanding side 93. Documents fed onto trays 24 accordingly tend to move angularly across trays 24, first in a generally upward direction under the impetus of conveyor 54 and thereafter in a generally downward direction under the influence of gravity until the lower side and bottom edges of the document contact wall 94 of tray 24 and guide 74, respectively. Through this arrangement, an adjacent side and bottom edge of the documents in each tray are brought into common registration with one another.

Solenoids are provided to move deflectors 52, 73, respectively, one solenoid serving when energized to rotate shaft 53 and depress deflectors 52 while solenoid 103 serves, when energized to rotate shaft 74 and raise deflectors 73. Shafts 81 carrying deflectors 80 are each provided with a suitable rotation limiting means, as for example, slot and pin means 105, 106, respectively. Springs 108 bias shafts 81 in a counter-clockwise direction as seen in FIG. 4 to hold deflectors 80 thereof retracted. Solenoids 110 serve, when energized, to rotate the shaft 81 associated therewith in a clockwise direction against the bias of spring 108 to place deflectors 80 thereof in a document intercepting position. Slot and pin means 105, 106 cooperate to limit rotation of deflectors 80 to a predetermined arc.

In accordance with the present invention, a photoelectric sensing unit comprising a plurality of photocell sensing devices S1, S2, S3, S4, S5, S6, etc., with accompanying light sources are positioned in the document transport path at locations shown in FIG. 6 to detect jams and supply signals to a jam detection control and indicator circuit of the sorting apparatus. Referring now to FIG. 7 of the drawings, there is shown in block diagram from the control and jam detection for sorter apparatus 10. A programmer 115 automatically preset through internal logic to an initial condition controls the operation of motors 46 and 66 through a motor drive control 120 and solenoids 102, 103 and 119 under normal operations.

With programmer 115 preset to obtain desired document-sorting motors 46, 66 are energized to drive input transport 18, and intermediate and discharge transports 20, 22 respectively. At the same time, programmer 115 energizes the intermediate and discharge transport drive motor 66 of each of the modules. Motor 46 preferably drives input transport 18 at a speed which is substantially equal to the velocity at which documents are discharged by the machine with which sorting apparatus 10 is used to facilitate transfer of documents to the sorting apparatus 10. Motor 66 preferably drives intermediate transport 20 and discharge transport 22 at the relatively high design speed of sorting apparatus 10, which is normally greater than the speed at which input transport 18 is driven. This arrangement facilitates coupling of sorting apparatus 10 with document producing machines of various types and speeds by requiring only that the speed of input transport 18 be changed as needed to match the operational speed of the machine with which sorting apparatus 10 is used.

With operation of transports 18, 20, 22 of sorter module 12, input transport 18 carries documents to the sorter module. Where documents are not sorted, programmer 115 holds solenoid 102 inoperative and deflectors 52 thereof retracted. Transport 18 accordingly carries the documents to unsorted document tray 24.

To sort documents in module 12 or in second sorter module or modules 14, programmer 115 triggers solenoid 102 whereby deflectors 52 are moved downwardly to a document-intercepting position to route documents carried by input transport 18 onto intermediate transport conveyor 54. Documents are accordingly carried by belts 63 of conveyor 54 downwardly toward base 25 of module 12. Programmer 115 triggers solenoid 103 to raise deflectors 73 and route documents carried by conveyor 54 upwardly toward trays 24 of separating section 16 thereof. Solenoids 110 are individually triggered by programmer 115 through interruption of sensing device S3 in the first module and sensing device S5 in the second module to temporarily move the deflectors 80 associated therewith into a document intercepting position whereby an individual or series of documents are isolated from conveyor 54 into a selected tray 24. It is understood that on termination of the triggering signal from programmer 115, the actuated deflectors are retracted by spring 108. Where solenoids 110 are inoperative, fixed deflectors 80' route documents from conveyor 54 into tray 24'. Where additional sorter modules are employed, the document deflectors 80 thereof are similarly regulated by programmer 115 to obtain desired sorting of the documents therewithin.
Under normal operating condition when the last document is transported through the machine processor unit an output signal 180 from programmer 115 is supplied to the motor drive control to deenergize drive motors 46 and 66. At the same time the deflector solenoids 102, 103, and 110 are repositioned to the starting position. In the event that the machine processor unit has been shut down due to a malfunction therein, it is desirable that programmer 115 not reposition the deflectors so that upon correction of the malfunction, operation can be resumed. To accomplish this, output signals from certain sensing devices S1, S3, S5 are combined with a signal 187 from a processor malfunction control 185 to programmer 115 to maintain the deflectors in their present position.

In accomplishing jam detection, the present invention utilizes the photocell sensing devices S1, S2, S3, S4, S5, and S6, with accompanying light sources to provide input signals to programmer 115 and also to a jam detection circuit as will be described more fully hereinafter. Upon detection of a document malfunction in the system an output signal is supplied to motor drive control 120 which serves to deenergize drive motor or motors 46 depending on the number of modules in the sorting apparatus. Drive motor 46 is allowed to continue until such time as succeeding copies are safely exited from the machine processor. At the same time that drive motors 66 are deenergized, a signal is received to solenoid 102 to actuate deflector 52 so as to enable the documents to be transported to tray 24.

The operation of the jam detection circuit may best be understood in connection with a description of the FIG. 7. A signal 202 from sensing device S1 is supplied to a flip-flop 220 which then initiates a timer 230 which starts a timing cycle. The next sensing device in the document path S2 senses the arrival of the document to supply a signal 204 to reset flip-flop 220 thereby terminating the timing cycle of timer 230. At the same time, signal 204 sets a flip-flop 221 initiating a timing cycle in timer 231. In similar fashion, a sensing device S3 supplies a signal 205 to reset flip-flop 221 thereby terminating timer 231 and also set flip-flop 222 which in turn initiates a timer 232. A jam is detected if, in this example, the sensing device S3 failed to detect arrival of a document in sufficient time to prevent timer 231 from timing out to its limit and producing a jam signal 300 to “or” gate 240. In similar fashion, signals are supplied from a sensing device S4 to set flip-flop 223 which initiates a timer 233 and a sensing device S5 to reset flip-flop 223 and set flip-flop 224 which initiates a timer 234. Output signals from all of the timers 230 through 234 are then supplied to “or” gate 240 which produces an output pulse 307 which is supplied to the motor drive control 120 and also is one input into “and” gates 250, 251, 252 which correspond to the number of modules being used in the sorting apparatus. The second input to the “and” gates 250, 251, 252 are from the programmer 115 indicating the particular module being addressed. A coincidence of the signals arriving at any one of these “and” gates provides an output to one of the indicator lamps 260, 261, 262 which locates the specific particular module where the jam has occurred. By this arrangement, the jam is indicated immediately and correctable through removal of only the damaged copy so that a minimum downtime of the machine is accomplished.

While there has been described and illustrated herein a preferred form of the invention, it will be apparent to those skilled in the art to change the modifications may be made thereto without departing from the spirit and intent thereof which is to be limited only by the scope of the following claims.

What is claimed is:

1. An improved control and jam detection system for apparatus sorting documents including document transport means, a module having a plurality of trays for storing documents, each tray having an inlet located along the document path and a deflector member associated therewith and adapted when actuated to route said documents from said transport means into the tray, the improved system comprising program means to actuate individual ones of said deflector members to route said documents into a selected tray of the module in predetermined sequence, sensing means for sensing the presence and absence of a document at predetermined locations along said document feed path and providing corresponding presence and absence indicating signals, circuit means coupled to said transport means including a timing means responsive to said signals and providing an input to control the transport means whereby upon the occurrence of a jam the transport of documents into each of the trays in the module is stopped and the document input supplied to an overflow tray until another signal from said program means is received at which time the apparatus is shut down, wherein said circuit means includes bistable storage means having set and reset positions operatively connected to said sensing means and said timing means to be set when a first sensing signal occurs and to be reset when a subsequent sensing signal is received, said timing means being sufficiently long to extend beyond the interval of said subsequent signal only in the case of a jam to enable the reset position of bistable storage means to render said timing means inoperative.

2. An improved control and jam detection system for apparatus sorting documents including document transport means, a module having a plurality of trays for storing documents, each tray having an inlet located along the document path and a deflector member associated therewith and adapted when actuated to route said documents from said transport means into the tray, the improved system comprising program means to actuate individual ones of said deflector members to route said documents into a selected tray of the module in predetermined sequence, sensing means for sensing the presence and absence of a document at predetermined locations along said document feed path and providing corresponding presence and absence indicating signals, circuit means coupled to said transport means including a timing means responsive to said signals and providing an input to control the transport means whereby upon the occurrence of a jam the transport of documents into each of the trays in the module is stopped and the document input supplied to an overflow tray until another signal from said program means is received at which time the apparatus is shut down, and jam-sensing means positioned in a processor unit to supply signals to said program means to shut down said apparatus when a malfunction in the processor unit occurs and maintains deflector members in their present position.

* * * * *