

SORTING DEVICE AND METHOD

Technical Field of the Invention

5 The present invention relates to a sorting device and method, which is particularly useful for automatically receiving, processing and sorting a library article which has been returned to a library by a borrower.

10 The present invention seeks to provide a sorting device and method which is capable of accepting a returned article, such as, but not limited to, a book, a video tape, an audio cassette or other discrete item such as is normally loaned out to borrower's loan record. The invention also preferably includes means to re-enable any security devices contained on the returned article, sort the returned article into discrete holding areas as determined by the catalogue category of the article, out-sort articles which are
15 on reserve for another borrower, out-sort articles which are for return to another library, print out-sorted article details for inclusion of the print slip into the out-sorted article, and/or deliver to the borrower a printed receipt detailing the articles that have been removed from the borrower's loan record.

Background of the Invention

20 It is an existing practice that articles which are owned by a lending institution, such as a library, and which have been loaned out to a bonafide user of that institution and are now being returned to that institution must undergo a 'loan discharge' sequence which is slow, labour intensive and capable of inflicting repetitive strain injury on that
25 institution's staff.

Typically, the article being returned for loan discharge is dropped in a random fashion into an article return chute where multiples of such articles will be accumulated in a transportable bin sometimes referred to as a 'dump trolley'. A borrower does not
30 usually become issued with a receipt at this point acknowledging that such returned books have been received by the lending institution.

Periodically, institution staff will replace a full bin with an empty bin and take

the full bin to a processing area where the loan discharge activity will take place.

Typically, the articles which are owned by the institution will be identified to that institution by a unique number attached to the article, usually in the form of a bar-coded label placed in a visible location somewhere on that article. Other means of identifying such articles include computer readable character fonts, 'smart' tags which can be activated electro-magnetically and ferro-magnetic strips which contain electro-magnetically recorded information. The continued description of this invention will refer to the bar-coded method in the interests of brevity, but will be equally applicable to the other aforementioned technologies.

The means by which any given article is said to be on loan to a bona fide borrower is in the borrower's computerised loan record containing an entry equal to the unique number of articles on loan as specified by this bar-code. This same unique bar-coded number is a means for the library to further identify this article by its title, author, catalogue category, dewey-decimal number and current borrower number.

To remove this article from a borrower's computerised record it is necessary to recover the unique number from the article and transmit it to the computerised loan system for 'article discharge'. Recovery of this number is typically achieved by institution staff physically locating the bar-coded label then physically taking to that label a bar-code scanning device usually referred to as a 'wand' or 'bar code reader'.

The bar-code on the article is then either swiped by the 'wand' or placed in the path of the 'bar-code read' beam by the institution staff. When the bar-code has been successfully read and decoded and transmitted to the institution's computer, an audible signal will indicate that this particular loan discharge sequence is now complete and the institution staff will physically relocate this article usually into another holding bin in preparation for the next phase of the article return cycle.

Each article being returned to this institution must be handled in a similar fashion.

Institution staff must be continually alert to the fact that any given returned

article could be an exception to normal processing, e.g. any given article could be 'on reserve' for another borrower, or could be for return to another library. In either case this condition is usually signalled by visual display of that condition on a computer display screen and means that such an article must be immediately out-sorted.

- 5 Institution staff must therefore monitor the result of each discharge operation by visually inspecting the computer display screen for each and every transaction.

Typically, articles owned by such institutions will also contain a device known as a security tag, security strip, security marker, etc. Such devices are usually bi-state
10 in that they can be turned into 'active' or 'passive' state through the application of an external influence such as an electro-magnetic field of a specific direction or strength. Articles held in the available collection usually have this bi-state marker held in the 'active' mode while articles which have been legally borrowed by bona fide borrowers will have this marker switched to the 'passive' mode such that when this borrower
15 leaves the institution's premises the security alarm at the exit area will not sound an alarm condition. When this article is returned to the institution for removal from a borrower's record it is necessary to 're-activate' the bi-state device prior to returning this article to the available collection.

20 It is the function of the institution's staff to physically place returned articles into a security tag re-activator by lifting or sliding such articles, then removing them from the re-activator when a visual indication is given that the security tag has been successfully reactivated.

25 Typically, once articles have been processed through the bar code reading and security tag re-activation phases they must then be physically sorted into book trolleys organised by catalogue categories prior to being returned in bulk to the available collection area.

30 There is a growing need to automate this process.

Summary of the Invention

The present invention seeks to provide a device which may be controlled from

an associated personal computer, which will extract returned articles singly from an article return holding area, transport each article through the beam of a bar-code reading device, transmit that bar-code number to an institution 'records' computer, decode the result of the 'discharge' operation so as to determine any exception status, print out a
5 receipt slip for the returning borrower, re-activate any security tags, markers or strips and then sort the article into discrete destination bins according to catalogue number, exception status and/or article types.

In one broad form, the present invention provides a sorting device for sorting
10 books or other articles, comprising:

separating means to receive one or more article(s) and then separate each article;
and,

article sorting means to provide each separate article to a respective destination according to predetermined criteria.

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In a preferred form, said separator means comprises:

receiving means to receive each of said article(s), comprising a substantially downwardly inclined chute or the like; and,

a separation device, comprising a substantially upwardly inclined separate belt
20 means or the like to selectively transport each of said articles, one at a time, from said receiving means to said article sorting means.

In the preferred form, said substantially upwardly inclined separator belt is provided with flukes or the like thereon, acting to increase the frictional forces present
25 between said separator belt and an article provided directly thereon.

Preferably, said separation device further comprises a drag means pivotally supported above said separator belt, to apply frictional drag to an article positioned on said separator belt such that any additional article(s) positioned atop said article is/are
30 prevented from ascending said separator belt.

Also preferably, a first sensor means is provided to identify receipt of an article to said separating means and activate said device.

In a preferred form, said separating means further comprises a reader means to read identifying insignia provided on said article.

In a preferred form, said identifying insignia is utilised to operate a receipt
5 printer to provide a receipt to an operator in response to receiving each article.

In another preferred form, said separating means further comprises a security device activation means to resensitise a security device associated with said article.

10 Preferably, said article sorting means comprises:

a sorting belt to transport each separated article from a first end thereof adjacent to said separating means towards a second end thereof;

at least two receiving locations provided adjacent said sorting belt, to receive respective articles therein according to said predetermined criteria; and,

15 at least one removal mechanism to effect removal of said article(s) from said sorting belt to a selected one of said receiving locations.

In this preferred form, said removal mechanism comprises:

a select belt positioned substantially above said sorting belt, and operable to
20 move in a direction transverse to the direction of said sorting belt;

at least one protrusion extending outwardly of said select belt adapted to contact and push an article positioned on said sorting belt to one of said receiving locations.

In an alternatively preferred form, said select belt is operable to move in a
25 forward or a reverse direction such that said article may be moved to the left or right relative to a longitudinal direction of said sorting belt.

In another preferred form, said removal mechanism comprises a pair of protrusions, extending outwardly of said select belt.

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In various preferred arrangements, said device comprises a plurality of receiving locations provided on one or both of said sorting means.

Preferably, a plurality of sensors are provided along said sorting belt to monitor the position of each respective article as it is transported therealong, and operate a respective removal mechanism according to said predetermined criteria.

- 5 Preferably, one of said receiving locations is adjacent said second end of said sorting belt.

A preferred form of the invention is wherein said articles are books, videos, magazines, letters, parcels or other discrete articles.

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In yet a further broad form of the invention, there is provided a separation apparatus for separating a plurality of discrete articles, comprising:

a substantially upwardly inclined belt means to transport said articles, said belt having flukes or the like thereon; and

- 15 a drag means pivotally supported above said belt, to apply a frictional drag to the upper portion of an article placed on said belt, such that any additional article positioned atop said article is prevented from ascending said belt.

- 20 In yet a further broad form of the invention there is provided a removal apparatus for removing articles from a conveyor belt or the like into discrete locations, comprising:

at least one select belt adapted to move in a direction substantially transverse to said conveyor belt and disposed substantially above said conveyor belt; and

at least one protrusion extending outwardly of said belt adapted to contact and push an article positioned on said conveyor belt to one of said discrete locations.

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In this latter form, preferably said selector belt is adapted to move in a forward or reverse direction such that said article may be moved to the left or right relative to a longitudinal direction of said conveyor belt.

- 30 Preferably, also said removal mechanism comprises a pair of protrusions.

Brief Description of Drawings

The present invention will become more fully understood from the following

detailed description of preferred but non-limiting embodiments thereof, described in connection with the accompanying drawings, wherein:

Fig. 1 shows in a schematic form, the passage of returning articles through the return chute, along the separator belt where the bar-codes are read and security tags re-sensitised, and on to the sorting belt where articles can be sorted right or left or both, with unsorted articles being directed to the reject bin;

Fig. 2 shows in Figs. 2(a) and 2(b), a top and side views, respectively, of the belts in relation to the associated sensors and exit bin locations;

Fig. 3 shows a detailed elevational view of the separator belt in relation to its alignment with the gravity fed return chute;

Fig. 4 shows the sorter bin selector, looking down the length of the sorting belt;

Fig. 5 shows the logic of the tracking algorithm; and,

Fig. 6 shows the self-timing generator by one or more articles travelling along the sorting belt.

Detailed Descriptions of Preferred Embodiment(s)

In Fig. 1 is shown a schematic representation of the device in accordance with the invention. The device will be described in relation to a library institution for lending books and the like, however the invention should be understood not to be limited thereto.

The schematic diagram shows the sorting device, generally designated by the numeral 10, comprising a separation means 11, and an article sorting means 12. Books, videos, magazines, or the like, are supplied via a chute 13 onto the separation means 11. Details of the separation means are shown in Figs. 2 and 3, and particularly Fig. 3 which shows a detailed view of the separation means, whilst details of the article sorting means 12 are shown in Figs. 2 and 4, the details of which will be described more fully

hereinafter.

When books are placed in the return chute 13, due to the downward disposition of the return chute as shown in Fig. 2, the books are supplied, under the forces of gravity to the fluked separator belt. The fluked separator belt, being upwardly inclined and having a plurality of flukes thereon, lead the book towards the sorting means 12. On it's path, the books are optionally passed through a resensitiser 14, and a barcode reader 15, which perform known functions to reactivate a security tag device supplied in the book, and read identifying information or insignia pertaining to the particular book. A sensor 16 may be provided to sense the location of the book being emitted from the separation means. The article sorting means 12 is provided with a plurality of bins 17, 18, 19, 20 and 21, into which various books or other articles may be supplied, depending on predetermined criteria and according to the identifying insignia read pertaining to the particular article by the barcode reader 15. Additional sensors 22, 23, 24 and 25 may be provided along the path of the sorting means, preferably embodied as a conveying belt 26, to sense the location of the articles to be sorted, and to operate other mechanisms in order to supply the articles to be bins 17, 18, 19, 20 or 21. In a preferred form of the invention, the bin 21 is implemented as a reject bin to receive all articles which are not identified with insignia within specific criteria and which are otherwise sorted into the bins 17, 18, 19 and 20.

Depending on the layout of the returns area in a lending institution, the exit bins could be located on both sides of the sorting belt, or on one side or the other as in the book sorter being sited against a wall. Also the number of bins is expandable depending on the length of the sorting belt. The P.C. controller is configurable so that at the institution's discretion, any book can be sorted to any bin. The configuration file contains the possibility of selecting 256 bins with up to 16 blocks of dewey-decimal numbers assignable to each bin, for example, bin 1 could receive books within the following ranges : 100.00-100.99, 250.00-260.99, and 280.00 - 285.99, and bin 2 could receive books having insignia 200.00 - 249.99, etc. It will of course be understood that the invention could be similarly adapted for use in other library classification systems, other than the dewey-decimal systems - for example, the invention may be easily adapted to the Library of Congress Classification system.

Fig. 2 details the sorter block diagram. Articles entering return chute 201 are gravity fed to point 202 where downward progress is stopped by the radius of the separator belt lower roller. If the separator belt is stationary, the article will go no further. Additional articles descending the chute will back-up until such times as the
5 loaning article is extracted from the chute.

The fluked separator belt will turn to extract an article when sensor S'0' Fig. 3 does not see an article at the top of the separator belt. An article can only be extracted from the chute when a fluke extracts its leading edge. This ensures that there will
10 always be a gap between articles ascending the separator belt.

The separator belt will continue to turn until an article reaches the top of the belt 203 and is sensed by sensor S'0' Fig. 3 301. In the process the article is seen by the bar-code reader 212 and the value of its bar-code is transmitted to the associated
15 'records' computer.

When the loan record is successfully discharged by the 'records' computer, a receipt is printed on receipt printer 213 and the to-be-sorted article 214 is loaded on to the sorting belt 205 at the speed of the sorting belt. This is to prevent slippage. The
20 loading sequence will only proceed when logic timing (Fig. 6) indicates that a 'load now' time has occurred.

The sorting belt 205 contains a recessed centre channel 206 in which runs a continuous band of retro-reflective material. Sensors 209 are located at each exit point.
25 If an article cuts the beam from the sensors 209 an 'article present' condition exists. When no article interrupts this beam an 'article clear' condition exists. Fig. 6 shows how the leading edge of the article is determined irrespective of the length of the article.

Any combination of articles travelling along the belt will trigger 'article leading
30 edge' timing conditions within 250Ms of the expected timing interval.

Fig. 3 details the sorter book separator, showing closer detail of the double book preventer. Double book feed is prevented by a combination of the friction of the flukes

driving the lower surface of the ascending article 303, by the gravity feed back and by the two book preventer 302 applying a frictional drag to the top surface of the ascending article 303.

5 Fig. 4 shows the sorter bin selector showing a view down the length of the sorting belt 401 with the recessed trench in the belt containing an endless band 402 of retro-reflective material and sensors S1-Sn being positioned above the retro-reflective material.

10 The selector belt 403 contains two blades 405. The belt 403 is driven either clockwise or anti-clockwise by motor 404.

 If article 406 is to be exited into the left bin the motor 404 turns clockwise and the blade 405 removes article 406 off to the left.

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 The reverse happens for the right bin selection.

 Once activated either right or left the motor 404 will continue to turn until one or the other blades is seen by sensor 407 as being back in the home position. There
20 is no re-set action in this selector so there is no mechanism that must re-set across the path of the next article moving along the belt.

 The bin selector modules can be added at will to increase the number of exit bin points.

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 Fig. 5 shows timing sequence. Timing is controlled by a software register which is configured according to the number of bins. In this sample a system, of 16 bins is presented.

30 Each exit point is given an address 1 - 16. Bins 1 - 7 will exit to the right; Bins 8 - 16 will exit to the left.

 A software register is created at set-up time equal to the number of bins. It is

identified as the 'DR 1 - 16' (destination register 1 - 16). It is a square register.

The 'records' computer will return the dewey-decimal number of a returned article to the return processor and the destination address will be computed according to the set-up of each site. Each article then is given a destination address which is entered into the DR1 register as the article is loaded on to the sorting belt. As the article moves along the belt, each sensor S1 - Sn will trigger a shift pulse which will move the destination addresses along the register in time with articles moving along the belt.

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A blank timing zone will contain a destination address of '0'.

When a destination address reaches a destination register of equal value, the return processor will cause a 'book select' action to occur, and articles will exit the belt to the right of left. When an article exits the belt, its destination address is replaced with the value '0'.

The shift timing (drag shift) is generated by any book on the sorting belt.

20 If the DR 1 - 16 = 0's then the belt is empty and no special timing consideration is required to load an article from the separator.

25 If the DR 1 - 16 $\neq$ 0's then a book is still on the belt and timing is generated by this book or books moving along the belt. An additional book can only be loaded to the sorting belt at a time in which its leading edge timing will coincide with the L.E. timing of books already on the belt.

30 Books moving along the belt will generate pulses each time they pass a sensor S1 - Sn. These pulses are 'OR-ED' and the first to occur will trigger the timing circuit and create a lock-out for half a second of any other book L.E.

The book on the belt which marginally leads the sequence therefore controls the timing. All other books must generate an L.E. condition within 250Ms of this pulse or an

out-of-sync error will occur. Books generating L.E. pulses within 250Ms will therefore be ignored.

When the $DR = DA$, then select timing is finally controlled by the sensor $S1 - S_n$ at
5 the selected exit location.

Fig. 6 shows how the leading edge timing may be implemented. Each book that interrupts the beam of any sensor $S1 - S_n$ will cause that sensor to respond with a signal 601 equal to the length of the book. Differentiator 'D' 603 responds only to the leading edge
10 of the pulse 602 and produces a single 100Ms pulse output 604 in time with leading edge 602.

Articles moving along the belt will generate a spread of timing pulses 610 which are logically 'OR-ED' 611. The first pulse to occur 612 will become the leading edge pulse
15 612 and will trigger a pulse generator 613 which will cause a lock-out of any further S_n pulses for 500Ms.

The article which is physically closest to its logical timing zone on the belt will therefore control overall timing, and any article waiting on the separator belt will load on to
20 the sorting belt according to this timing.

The present invention has been herein described with reference to particular preferred but non-limiting embodiments. It should be noted that numerous variations and modifications the invention will become apparent to persons skilled in the art. All such variations and
25 modifications should be considered to fall within the spirit and scope of the invention as hereinbefore described.

**The claims**

1. A sorting device for sorting books or other articles, comprising:
separating means to receive one or more article(s) and then separate each article; and,
5 article sorting means to provide each separate article to a respective destination according to predetermined criteria.
2. A sorting device as claimed in claim 1, wherein said separator means comprises:
receiving means to receive each of said article(s), comprising a substantially
10 downwardly inclined chute or the like; and,
a separation device, comprising a substantially upwardly inclined separate belt means or the like to selectively transport each of said articles, one at a time, from said receiving means to said article sorting means.
- 15 3. A sorting device as claimed in claim 2, wherein said substantially upwardly inclined separator belt is provided with flukes or the like thereon, acting to increase the frictional forces present between said separator belt and an article provided directly thereon.
4. A sorting device as claimed in claims 2 or 3, wherein said separation device further
20 comprises a drag means pivotally supported above said separator belt, to apply frictional drag to an article positioned on said separator belt such that any additional article(s) positioned atop said article is/are prevented from ascending said separator belt.
5. A sorting device as claimed in any one of claims 1 to 4, wherein a first sensor means
25 is provided to identify receipt of an article to said separating means and activate said device.
6. A sorting device as claimed in any one of claims 1 to 5 wherein said separating means further comprises a reader means to read identifying insignia provided on said article.
- 30 7. A sorting device as claimed in claim 6, wherein said identifying insignia is utilised to operate a receipt printer to provide a receipt to an operator in response to receiving each article.



8. A sorting device as claimed in any one of claims 1 to 7, wherein said separating means further comprises a security device activation means to resensitise a security device associated with said article.
- 5 9. A sorting device as claimed in any one of claims 1 to 8, wherein said article sorting means comprises:
- a sorting belt to transport each separated article from a first end thereof adjacent to said separating means towards a second end thereof;
 - at least two receiving locations provided adjacent said sorting belt, to receive
 - 10 respective articles therein according to said predetermined criteria; and,
 - at least one removal mechanism to effect removal of said article(s) from said sorting belt to a selected one of said receiving locations.
- 10 10. A sorting device as claimed in claim 9, wherein said removal mechanism comprises:
- 15 a select belt positioned substantially above said sorting belt, and operable to move in a direction transverse to the direction of said sorting belt;
 - at least one protrusion extending outwardly of said select belt adapted to contact and push an article positioned on said sorting belt to one of said receiving locations.
- 20 11. A sorting device as claimed in claim 10, wherein said select belt is operable to move in a forward or a reverse direction such that said article may be moved to the left or right relative to a longitudinal direction of said sorting belt.
12. A sorting device as claimed in claim 10 or 11, wherein said removal mechanism
- 25 comprises a pair of protrusions, extending outwardly of said select belt.
13. A sorting device as claimed in any one of claims 1 to 12, wherein said device comprises a plurality of receiving locations provided on one or both of said sorting means.
- 30 14. A sorting device as claimed in claim 13, wherein a plurality of sensors are provided along said sorting belt to monitor the position of each respective article as it is transported therealong, and operate a respective removal mechanism according to said predetermined criteria.



15. A sorting device as claimed in any one of claims 9 to 14, wherein one of said receiving locations is adjacent said second end of said sorting belt.
16. A sorting device as claimed in any one of claims 1 to 15, wherein said articles are
5 books, videos, magazines, letters, parcels or other discrete articles.
17. A separation apparatus for separating a plurality of discrete articles, comprising:
a substantially upwardly inclined belt means to transport said articles, said belt having
flukes or the like thereon; and
10 a drag means pivotally supported above said belt, to apply a frictional drag to the
upper portion of an article placed on said belt, such that any additional article positioned atop
said article is prevented from ascending said belt.
18. A removal apparatus for removing articles from a conveyor belt or the like into
15 discrete locations, comprising:
at least one select belt adapted to move in a direction substantially transverse to said
conveyor belt and disposed substantially above said conveyor belt; and
at least one protrusion extending outwardly of said belt adapted to contact and push
an article positioned on said conveyor belt to one of said discrete locations.
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19. A removal apparatus as claimed in claim 18, wherein said selector belt is adapted to
move in a forward or reverse direction such that said article may be moved to the left or
right relative to a longitudinal direction of said conveyor belt.
20. A removal apparatus as claimed in claim 18 or 19, wherein said removal mechanism
25 comprises a pair of protrusions.
21. A sorting device, a separation apparatus and/or a removal apparatus, substantially as
herein described with reference to the accompanying drawings.