United States Patent

Hunter et al.

[15] **3,674,143**

[45] **July 4, 1972**

[54] TRANSPORT AND SORTING MECHANISMS FOR AN AUTOMATIC CONVEYOR SYSTEM

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[22] Filed: **Dec. 28, 1970**

[21] Appl. No.: **101,526**

[52] **U.S. Cl.** **209/74,** 271/64

[51] **Int. Cl.** **B07c 3/06**

[58] **Field of Search** ..... 209/72, 73, 74, DIG. 1; 271/9, 271/64; 270/5 B

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[57] **ABSTRACT**

This disclosure relates to a transport and sorting mechanism for an automatic conveyor system for mail pieces and the like wherein the articles to be sorted are moved along a smooth surface by means of a transport belt or linkage having pairs of studs or arms to impart a horizontal motion to the articles. The smooth surface along which the articles are conveyed is formed of the top surfaces of partitions between various destination receptacles and rotatable gates over the respective receptacles which gates when closed are in alignment with the top surfaces of the partitions. Letters and other pieces of mail of various sizes are placed in the conveyor system by the operator who records the destination of each article so inserted and the article is conveyed along the smooth surface until it reaches its destination receptacle at which time the rotatable gate is opened to allow the article to be received by the corresponding receptacle. Two or more receptacles can be served by a single belt or linkage and means are provided to merge the contents of such pairs of receptacles and place them on a separate conveying transport for further processing.

5 Claims, 9 Drawing Figures

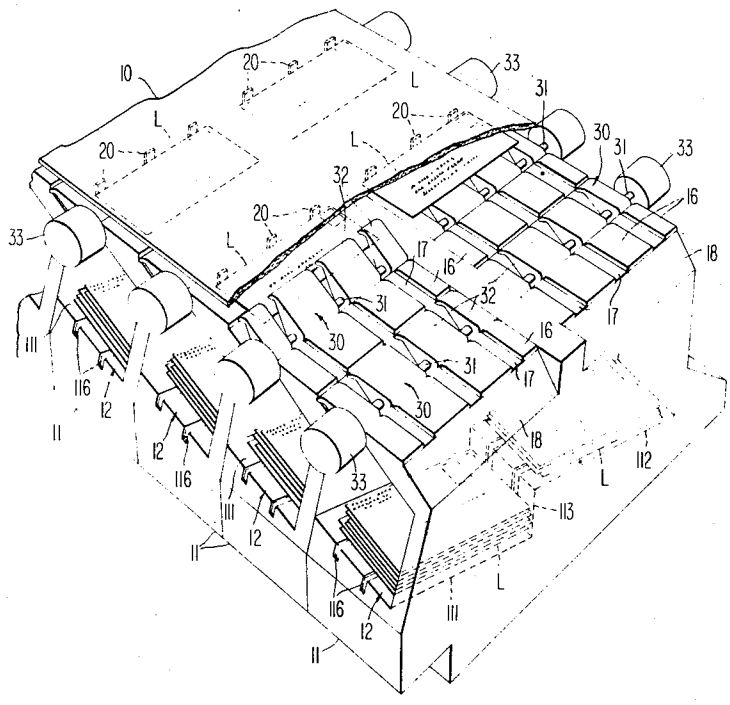
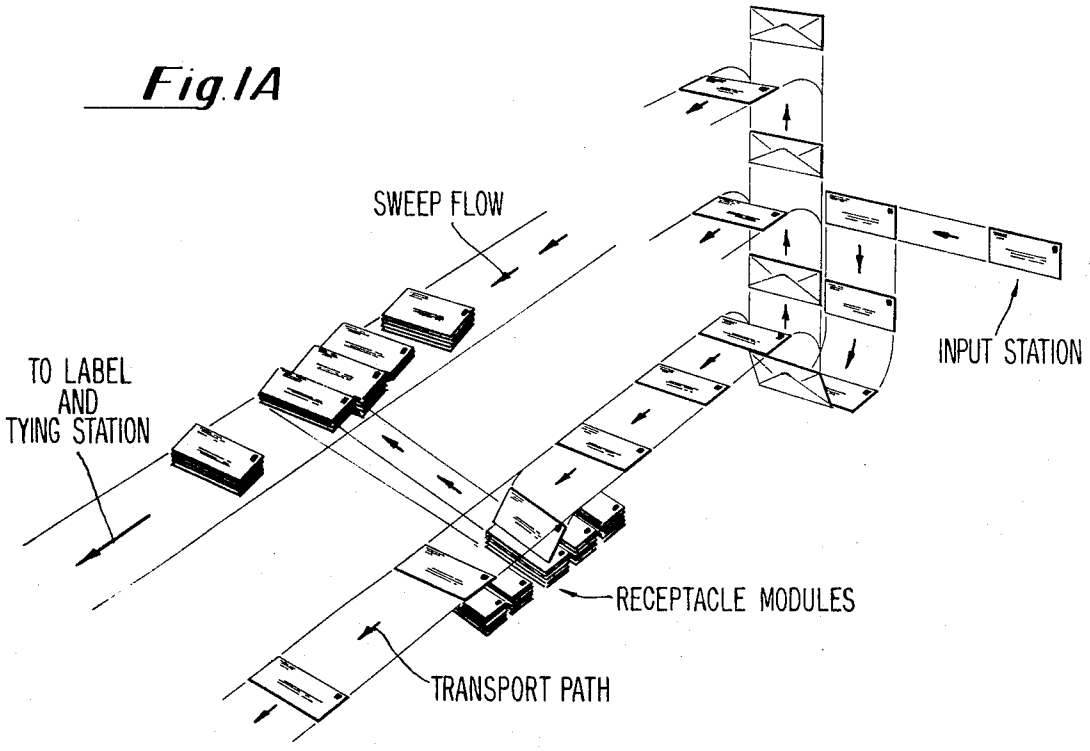


Fig. 1A



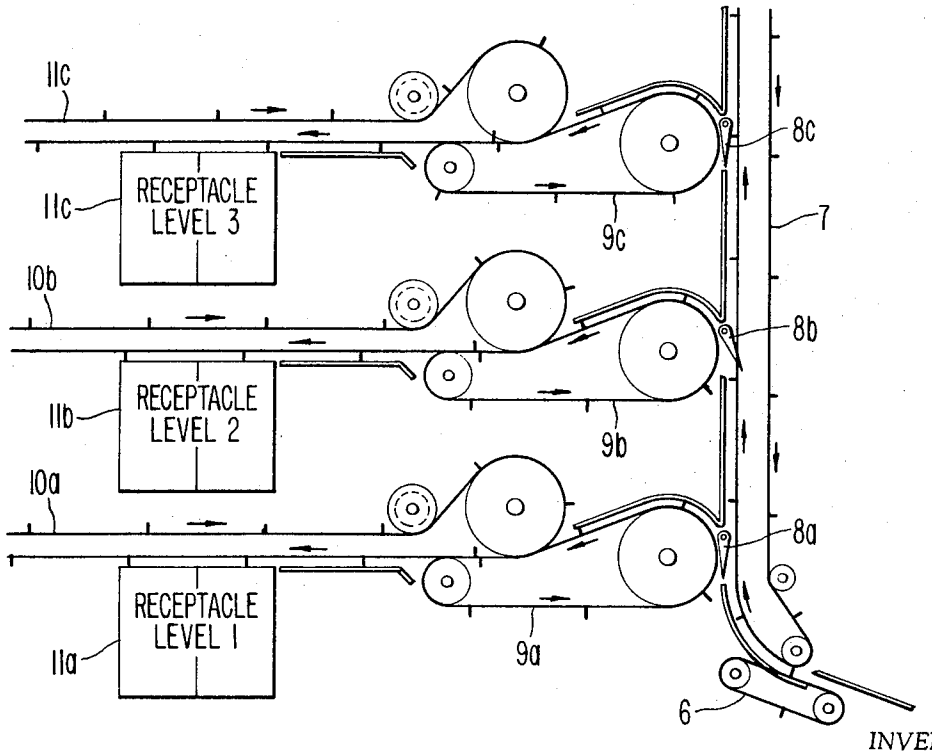


Fig. 1B

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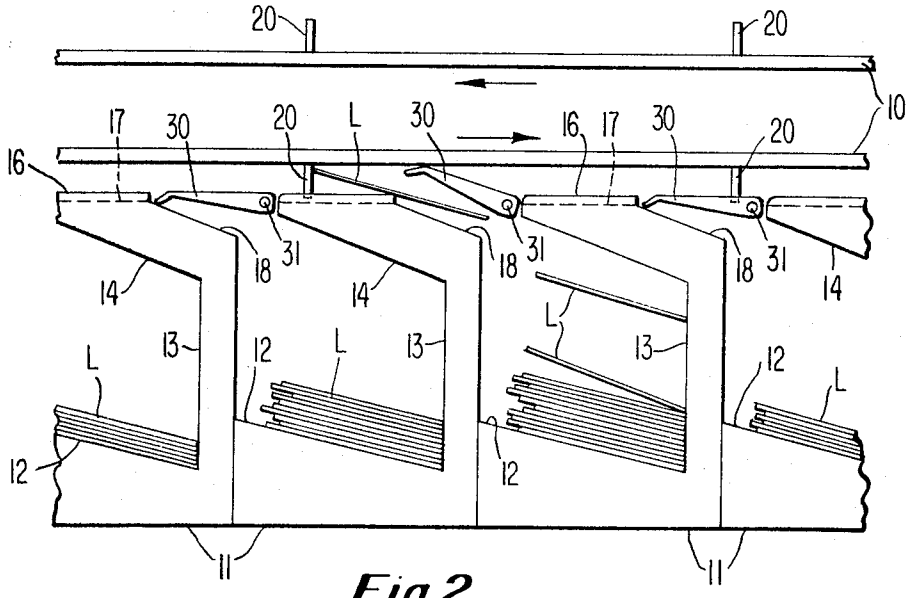

20
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30
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L
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31
18
31
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31
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13
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13
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L
L
12
12
11
11

Fig.2

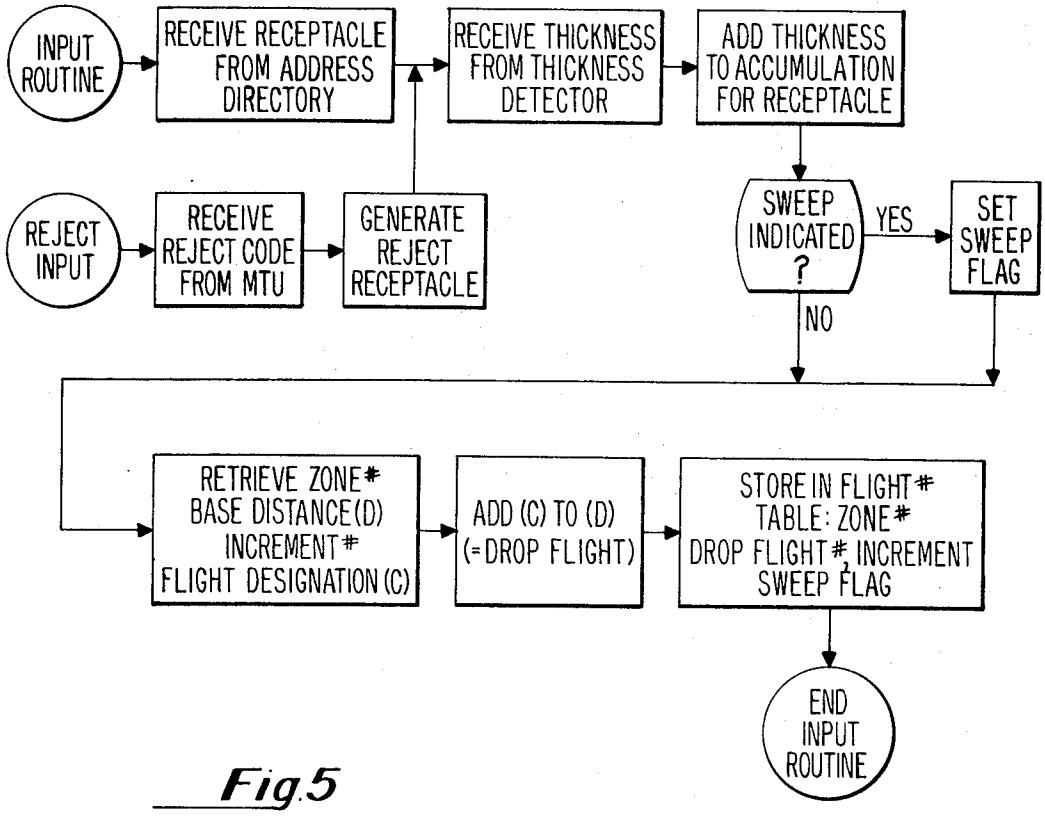

INPUT ROUTINE
RECEIVE RECEPTACLE FROM ADDRESS DIRECTORY
RECEIVE THICKNESS FROM THICKNESS DETECTOR
ADD THICKNESS TO ACCUMULATION FOR RECEPTACLE
REJECT INPUT
RECEIVE REJECT CODE FROM MTU
GENERATE REJECT RECEPTACLE
SWEEP INDICATED ?
YES
SET SWEEP FLAG
NO
RETRIEVE ZONE# BASE DISTANCE(D) INCREMENT# FLIGHT DESIGNATION (C)
ADD (C) TO (D) (=DROP FLIGHT)
STORE IN FLIGHT# TABLE: ZONE# DROP FLIGHT#, INCREMENT SWEEP FLAG
END INPUT ROUTINE

Fig.5

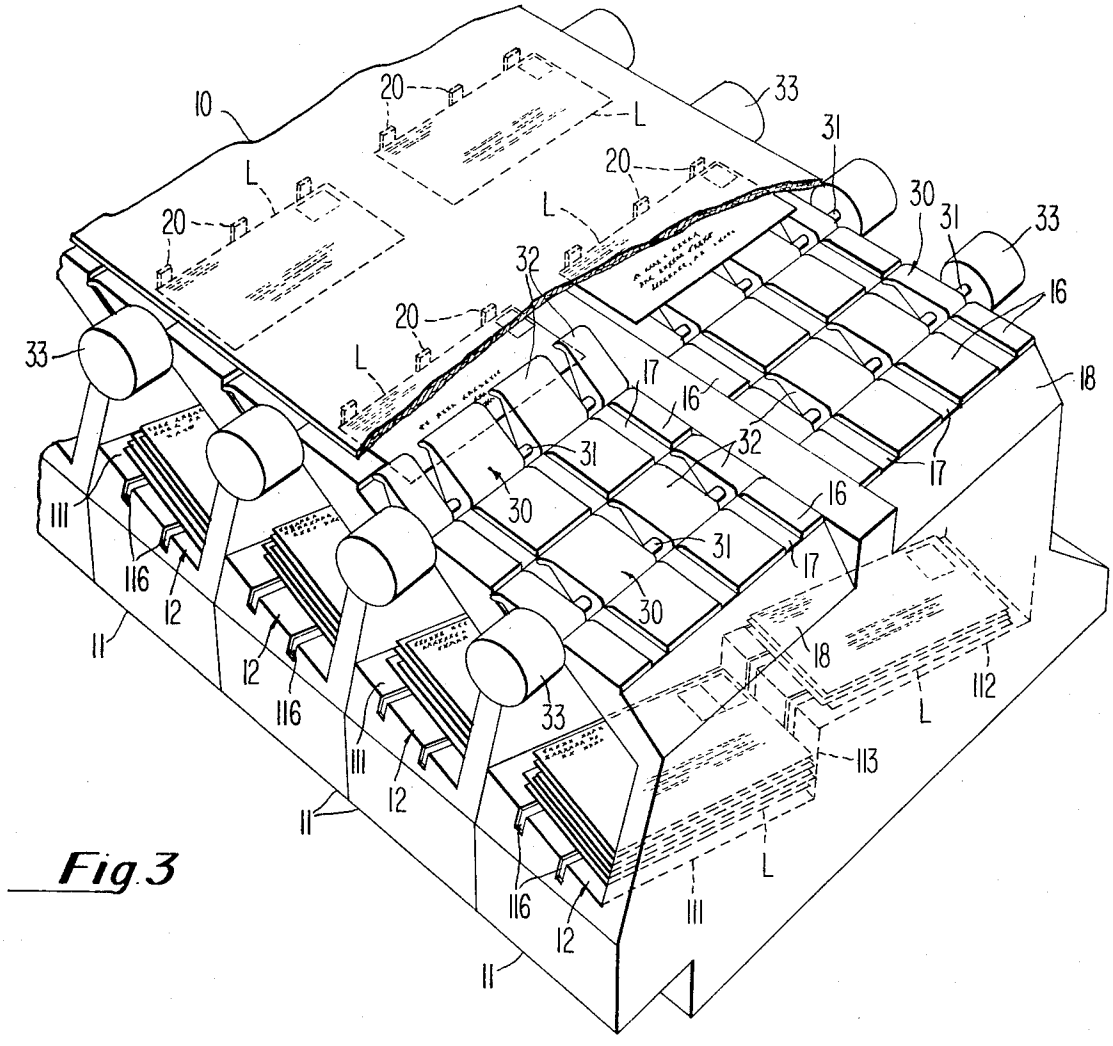

10
20
L
33
31
30
32
16
17
18
111
116
12
11
112
113

Fig. 3

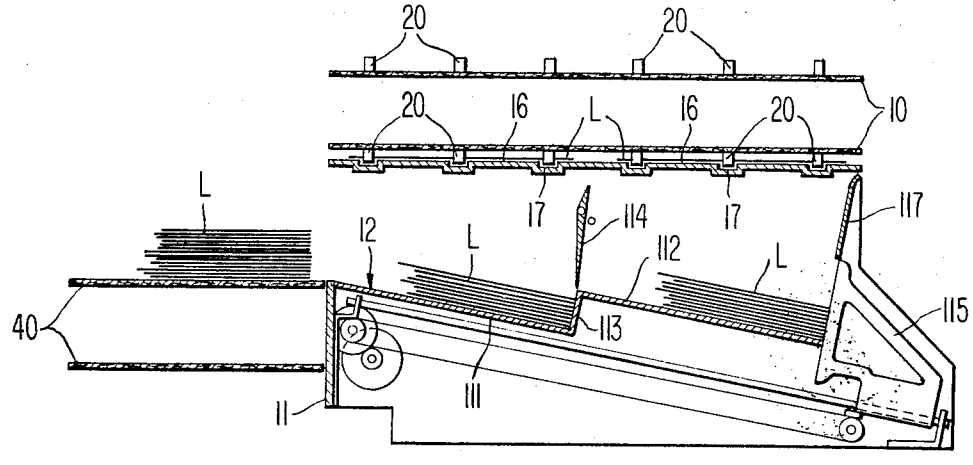

20
16
L
10
17
114
117
12
112
115
40
113
111
11

Fig. 4

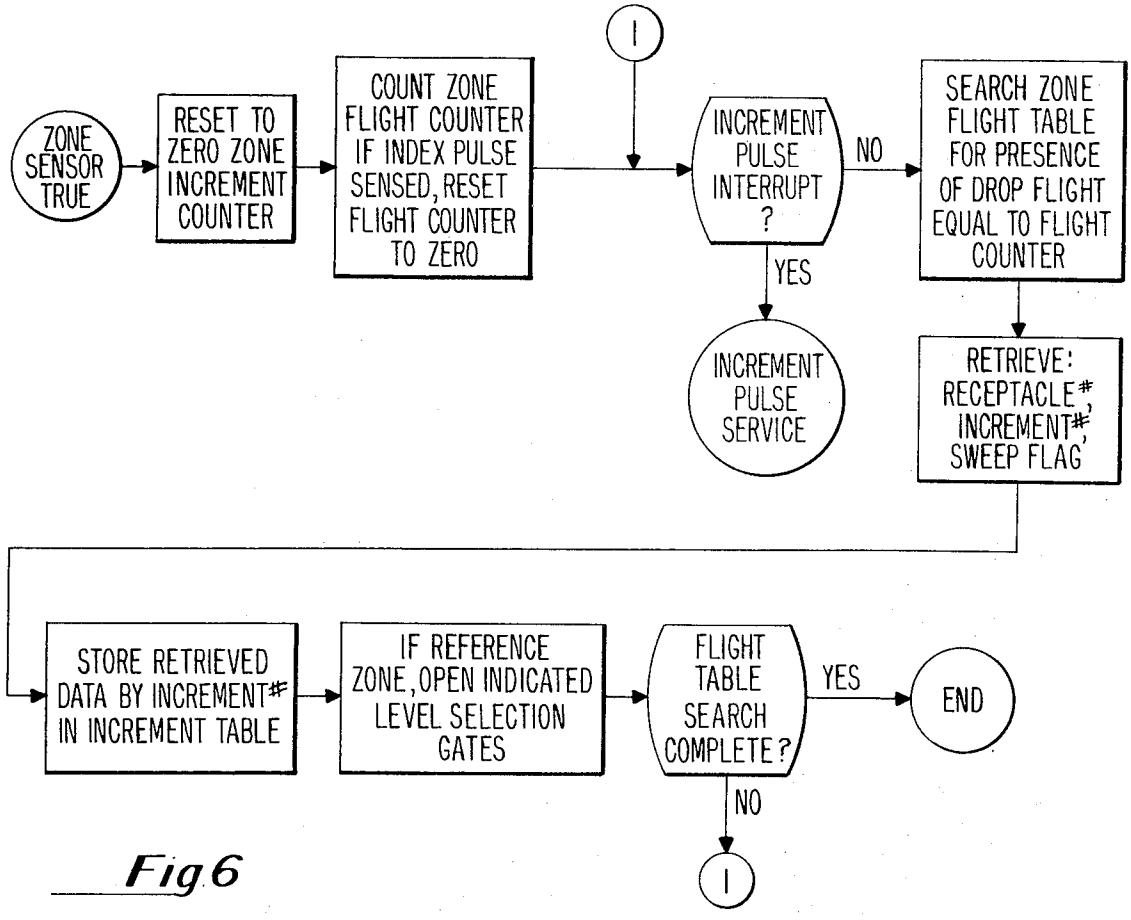

ZONE SENSOR TRUE
RESET TO ZERO ZONE INCREMENT COUNTER
COUNT ZONE FLIGHT COUNTER IF INDEX PULSE SENSED, RESET FLIGHT COUNTER TO ZERO
1
INCREMENT PULSE INTERRUPT ?
NO
YES
INCREMENT PULSE SERVICE
SEARCH ZONE FLIGHT TABLE FOR PRESENCE OF DROP FLIGHT EQUAL TO FLIGHT COUNTER
RETRIEVE: RECEPTACLE#, INCREMENT#, SWEEP FLAG
STORE RETRIEVED DATA BY INCREMENT# IN INCREMENT TABLE
IF REFERENCE ZONE, OPEN INDICATED LEVEL SELECTION GATES
FLIGHT TABLE SEARCH COMPLETE?
YES
END
NO
1

Fig 6

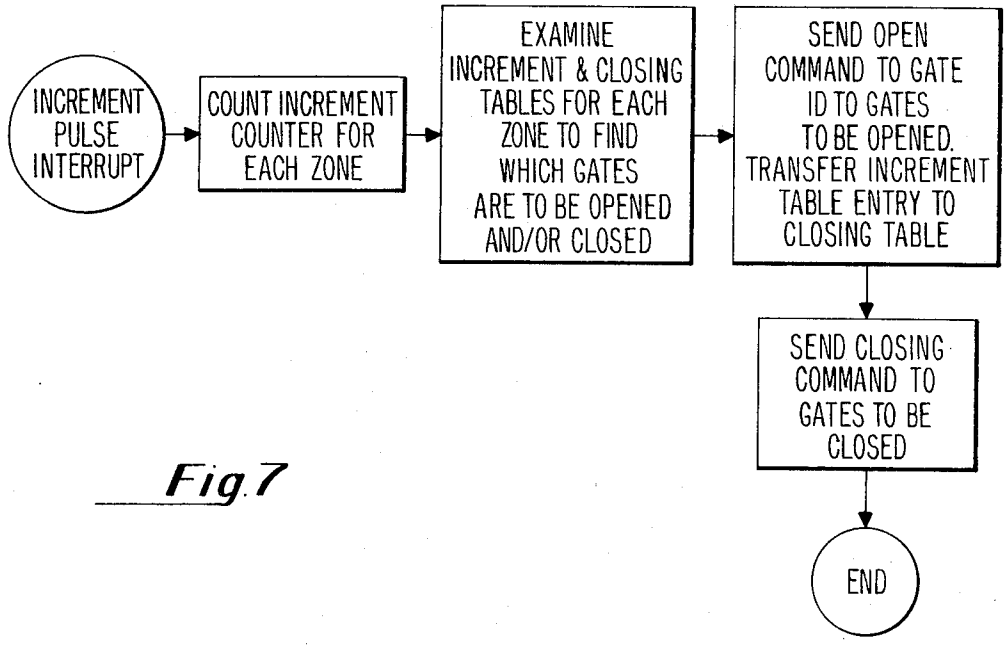

INCREMENT PULSE INTERRUPT
COUNT INCREMENT COUNTER FOR EACH ZONE
EXAMINE INCREMENT & CLOSING TABLES FOR EACH ZONE TO FIND WHICH GATES ARE TO BE OPENED AND/OR CLOSED
SEND OPEN COMMAND TO GATE ID TO GATES TO BE OPENED. TRANSFER INCREMENT TABLE ENTRY TO CLOSING TABLE
SEND CLOSING COMMAND TO GATES TO BE CLOSED
END

Fig 7

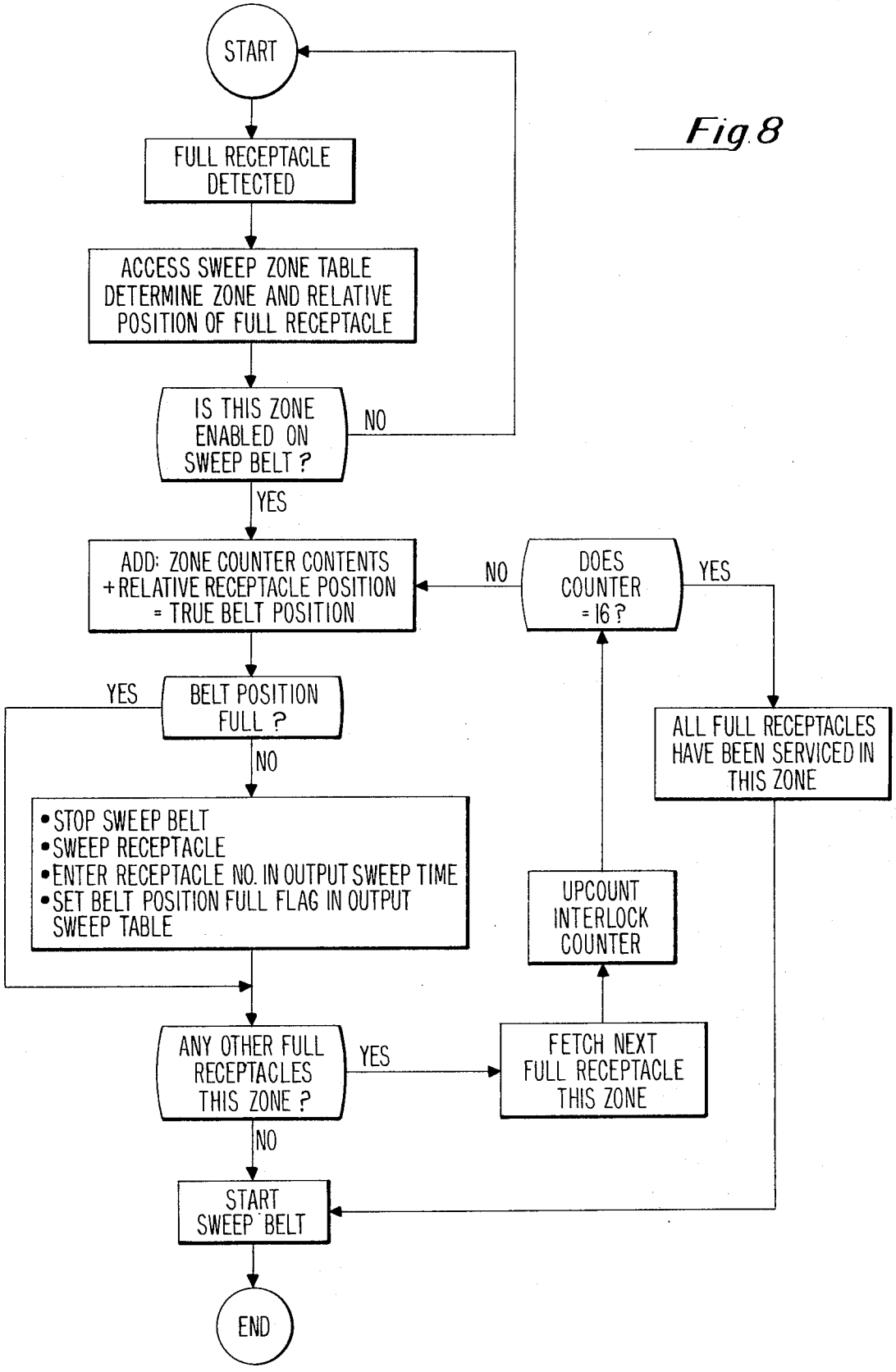

START
FULL RECEPTACLE DETECTED
ACCESS SWEEP ZONE TABLE DETERMINE ZONE AND RELATIVE POSITION OF FULL RECEPTACLE
IS THIS ZONE ENABLED ON SWEEP BELT ?
NO
YES
ADD: ZONE COUNTER CONTENTS + RELATIVE RECEPTACLE POSITION = TRUE BELT POSITION
NO
DOES COUNTER = 16 ?
YES
YES
BELT POSITION FULL ?
NO
ALL FULL RECEPTACLES HAVE BEEN SERVICED IN THIS ZONE
• STOP SWEEP BELT
• SWEEP RECEPTACLE
• ENTER RECEPTACLE NO. IN OUTPUT SWEEP TIME
• SET BELT POSITION FULL FLAG IN OUTPUT SWEEP TABLE
UPCOUNT INTERLOCK COUNTER
ANY OTHER FULL RECEPTACLES THIS ZONE ?
YES
FETCH NEXT FULL RECEPTACLE THIS ZONE
NO
START SWEEP BELT
END

Fig. 8

TRANSPORT AND SORTING MECHANISMS FOR AN AUTOMATIC CONVEYOR SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to transport and sorting mechanisms for the sorting of mail and other similar objects and more particularly to such mechanisms which are adapted for volumne sorting.

Various pneumatic systems have been developed for high-speed sorting of checks, Hollorith punch cards and the like. Such systems are quite efficient when the objects being sorted are of uniform size and characteristics; however, these systems are not practical for the sorting of items of variable sizes where the uniformity of characteristics cannot be closely maintained. In the case of such nonuniform items, increased throughput is obtained by systems adapted to handle increased volumne rather than in systems adapted to operate at increased speeds. In fact, in such systems, the slower the speed of the mechanical transport, the more reliable the system becomes.

Mechanical sorting apparatus employed in the current state of the art for sorting mail includes a conveyor upon which a plurality of carts are mounted which carts are provided with a releasable bottom such that the contents of each cart can be dropped into a particular selected one of a plurality of receptacles mounted beneath the conveyor. With such a system, the conveyor can pass a number of input stations and articles destined for certain preselected receptacles are placed in an appropriate cart. After the respective carts have passed all of the contributing stations, the carts are then passed over the plurality of destination receptacles and the contents of each cart are deposited in the corresponding preselected or addressed receptacle. In order to determine the time at which each of the respective carts has been aligned over its corresponding destination receptacle, each cart is provided with a plurality of code wheels mounted on a single axis and adapted to be placed in one of two positions, in essence, to form a binary code or address corresponding to the particular destination receptacle. Each receptacle, in turn, is provided with a plurality of grooved tracks over which the code wheels ride and each of the grooved tracks can be oriented in one of two positions corresponding to the binary code or address associated with the receptacle. For this arrangement, the code wheels for a particular cart will ride above the grooved tracks until such a time as the code wheel configuration corresponds to the grooved track configuration, whereupon the code wheel axis will be allowed to drop slightly and this motion can be utilized to release the bottom of the tray to deposit its contents into the corresponding receptacle.

Such state of the art letter sorters are a distinct improvement over manual sorting. However, improved throughput can only be achieved by increasing the size of the system to obtain greater volumn throughput. Because of the mechanical nature of such a system increase in the size thereof to accommodate a greater number of input stations and a greater number of destination receptacles results in a proportionate increase in the number of mechanical parts involved with a resultant increase in the number of mechanical failures that can occur. Thus, an increase in the size of the system is accompanied by a proportionate decrease in the reliability of the system.

Certain measures may be taken to reduce the number of mechanical components involved in such a large system. For example, the mechanical code wheels which are currently employed in state of the art letter sorters can be replaced by an automatic sensing and computational system such as disclosed in the Hunter et al. patent application, Ser. No. 37,629, filed May 14, 1970 and assigned to the same assignee of the present invention. Such an automatic system employs a plurality of sensors to detect the position of the conveyor carriers so that the difference between a computed carrier position and its actual position will be less than the maximum tolerable error due to wear, stretch or slack in the conveyor belt or chain. At the

time an article or parcel is placed in the conveyor system, its carrier designation and the position of the destination receptacle are stored in a memory. During each incremental time period, the contents of the memory are scanned and compared with counters associated with each position sensor. When a comparison is achieved, a signal is sent to the appropriate receptacle to actuate the corresponding carrier to unload its contents.

Such an automatic sensing and addressing system eliminates a number of the mechanical parts employed in current state of the art sorting mechanism. However, the transport system itself is still subject to decreased reliability as the size of the system is increased as was explained above and such systems are in general bulky in terms of space required for their operation and also noisey due to wear and mechanical interaction during the operation of the system.

It is, therefore, an object of the present invention to provide an improved conveyor system for the sorting of various sized objects such as mail.

It is another object of the present invention to provide an improved conveyor system having a reduced number of mechanical parts.

It is still a further object of the present invention to provide an improved conveyor system for the sorting of mail and the like which system requires a minimum amount of space for its operation.

SUMMARY OF THE INVENTION

As was described above, current state of the art conveyor systems for sorting mail and like objects include a conveyor upon which a plurality of carts are mounted, which carts are provided with a releasable bottom such that the contents of each tray can be dropped into a particular selected one of a plurality of receptacles mounted beneath the conveyor. In order to eliminate the number of mechanical linkages and the like which form such a system with releasable cart bottoms and also form the connections of the carts to the conveyor, the present invention is adapted to move the articles to be sorted along a smooth surface by means of a transport belt having pairs of studs or arms to impart a horizontal motion to the letter or other article. The smooth surface along which the article is conveyed is formed of the top surfaces of partitions between various destinations receptacles and rotatable gates over the respective receptacles which gates, when closed, are in alignment with the top surfaces of the partitions. In this manner, letters and other pieces of mail of various sizes can be placed in the conveyor system by the operator who records the destination of each article so inserted and that article is conveyed along the smooth surface until it reaches its destination receptacle at which time the corresponding rotatable gate is opened to allow the article to be received by the receptacle.

A feature, then, of the present invention resides in a conveyor system including a transport belt or linkage having sets of transport arms extending transversely from the lower surface thereof and a plurality of receptacles mounted below the belt which receptacles are closed at their upper portions by rotatable gates which, when closed in a horizontal position, comprise a smooth surface along which an article can be conveyed by the pusher members or arms. The respective rotatable gates are provided with slots arranged radially from the axis of rotation to receive the pusher members so as to insure contact between the pusher members and the articles to be conveyed.

Other features of the present invention reside in a second conveying system to reside adjacent to the sorting conveying system and means to eject the articles thus sorted from the various receptacles onto the second conveying system for transport to an appropriate bundling and labeling station.

DESCRIPTION OF THE DRAWINGS

The above described objects, advantages and features of the present invention will become more readily apparent from a

review of the following specification when taken in conjunction with the drawings wherein:

FIGS. 1A and 1B are diagrams of the flow of letters and other articles as they are sorted by apparatus employing the conveyor system of the present invention;

FIG. 2 is an elevational cross-sectional view of the apparatus of the present invention which view is taken normal to the direction of motion of the transport belt;

FIG. 3 is a perspective view of the mechanisms of the conveyor system of the present invention;

FIG. 4 is an elevational cross-sectional view of the mechanism of FIG. 3 which view is taken along the direction of motion of the transport belt of the present invention;

FIG. 5 is a flow diagram illustrating the steps employed in the input information processing as employed with the present invention;

FIG. 6 is a flow diagram illustrating the steps of the zone information processing as employed with the present invention;

FIG. 7 is a flow diagram illustrating the increment pulse processing as employed with the present invention; and

FIG. 8 is a flow diagram illustrating the steps of the sweep operation as employed with the present invention.

GENERAL DESCRIPTION OF THE CONVEYOR SYSTEM

The function of the system which employs the present invention is illustrated generally in FIGS. 1A and 1B. FIG. 1A is a perspective flow diagram illustrating the paths which the letters or other articles take during a sorting operation. At the input station, the destination of each piece of mail is entered by the operator into an addressing system which is of a type described in the above-referred-to Hunter et al. application and the letter is carried by an insertion conveyor to one of a number of levels of transport conveyors only one of which is illustrated in FIG. 1A. The letter then moves along the path of particular selected transport level until it reaches the destined receptacle module as determined by the above-referred-to addressing system. In this manner, the letters or other articles are stored in the individual receptacle modules in accordance with their address destination. As an individual receptacle becomes full, the contents thereof are moved to a sweep conveyor as illustrated in FIG. 1A by which they are transported to an appropriate labeling and tying station.

The mechanism by which the mail or other articles are conveyed along their respective transport paths is illustrated generally in FIG. 1B. With reference to that figure, mail or other articles is placed on input conveyor **6** for transportation to level selection conveyor **7** by which the article is conveyed vertically to the particular selected transport level as determined by its ultimate destination. When it reaches the appropriate level, one of the level selector gates **8***a*, **8***b*, or **8***c* is opened to deflect the article onto one of the corresponding insertion conveyors **9***a*, **9***b* or **9***c* which in turn inserts the particular article into the transport path of corresponding one of transport conveyors **10***a*, **10***b* or **10***c*. The article is then conveyed along its respective transport path until it reaches the particular destination receptacle corresponding to the ultimate destination address.

As thus described, the system for which the present invention is adapted is one for automatically receiving, transporting and sorting mail and other articles according to their destination address. Except for the particular transport and sorting mechanisms which are only generally illustrated in FIG. 1B, the system so far described does not differ markedly from current state of the art mail sorting systems. The particular transport and sorting mechanisms of the present invention will be described below.

DETAILED DESCRIPTION OF THE SYSTEM

The basic transport and sorting mechanism of the present invention is illustrated in FIG. 2. As shown therein, mail or other articles L are to be sorted into a plurality of receptacle modules **11**. To this end, the individual articles are moved along surface **16** and over receptacle gates **30** by transport conveyor **10** which is provided with a plurality of transport arms **20** to engage and convey the transport motion to the respective articles. As illustrated in FIG. **2**, transport conveyor **10** is a continuous conveyor that moves along and slightly above surface **16** and the receptacle gates **30** in one direction (from left to right in FIG. **2**) and returns (from right to left in FIG. **2**) at a greater height above the respective surfaces and gates in order to complete the conveyor loop. To insure engagement with the respective articles L, the respective transport arms **20** extend below the transport surfaces **16** which is provided with grooves **17** to accommodate arms **20**. Receptacle gates **30** are also designed for such accommodation in a manner which will be discussed below.

When the individual mail pieces being conveyed along the transport surface approach the particular designated one of receptacles **11**, as determined by the addressing control which is not a part of the present invention, the corresponding receptacle gate **30** is rotated upwardly to intercept the mail pieces and deflect them into the designated receptacle as illustrated in FIG. **2**. In this manner, a transport and sorting system can be formed of that number of receptacles modules as required for any particular application.

A more detailed representation of the transport and sorting mechanism of the present invention is illustrated in perspective form in FIG. 3. In that embodiment, the respective receptacle modules are extended in a direction transverse to the transport conveyor so as to accommodate parallel transport paths. Since the components of the extended portion of each module are identical to the original portion, only those components of the extended portion will be discussed. FIG. 3 illustrates the particular manner in which the transport surface is grooved to receive the respective transport arms that extend downwardly from conveyor **10**. Thus, the top portions of the individual receptacle modules **11** are formed of a plurality of transport support surfaces **16** separated by recess surfaces **17** and also a plurality of rotatable gating fingers **32** mounted on a rotatable shaft **31** to be driven in rotation by motor **33**. Gating finger **32** form gate **30** as represented in FIG. **2** but are in fact spaced apart fingers to accommodate transport arms **20** of conveyor belt **10** even when the gate is in an open position to receive a mail piece. That is to say, since the transport arms are in engagement with the transported mail piece up until the time that it is deposited into a particular designated receptacle, the gates for the individual receptacles must be able to pass transport arms **20** when these gates are in an open position. It will be noted in both FIGS. **2** and **3** that the top portions of each of the receptacle modules **11** is provided with an inclined surface **18** which resides below a substantial portion of gating fingers **31** which form gate **30** so as to form an entrance into the next succeeding receptacle.

The manner in which the sorted mail pieces are removed from the respective receptacles is best illustrated in FIG. **4** which is a transverse cross section of the mechanism of FIG. **3**. FIG. **4** also better illustrates the embodiment of the present invention where the transport conveyor is employed to supply two series of receptacles in parallel. As illustrated therein, the bottom of the floor of the dual receptacle module is formed of two slanting or inclined support members **111** and **112** which are parallel to one another and separated by an almost vertical support member **113**. Support member **113** also serves as an almost vertical support for the mail pieces in one portion of the dual receptacle module. Further support for one portion of the module is provided by rotatable partition **114** which when in its vertical position rests against support member **113** to form a substantially vertical wall. When it is desired to empty the respective portions of the receptacle module, eject arm **115** is activated to move in a direction along the respective inclined support members **111** and **112** to push the mail pieces resting on support member **112** under rotatable partition **114** which rotates upwardly to accommodate this motion. Eject arm **115** then also engages the mail pieces resting on support member **111** so as to move the stack thus formed out

of the module onto sweeping conveyor **40**. As illustrated in FIG. **3**, the respective support members are provided with slots **116** to accommodate the movement of the respective eject arms **115**. As was described in relation to FIG. 1A, the mail pieces or articles thus sorted are conveyed by sweeping conveyor **40** to a tieing and labeling station for further disposition.

SYSTEM OPERATION

In order to provide a better understanding of the system employing the present invention, the operations of that system will now be described with references to FIGS. **5–8** which are flow diagrams illustrating the various routines. FIG. **5** is a flow diagram of the input information processing routine by which the destined receptacle number of a particular piece of mail is received from the address directory of the control system and translated into the flight (group) and increment numbers required to control the opening of the respective receptacle gate. As explained in detail in the above-referred-to Hunter et al. application, the timing for the opening of the respective receptacle gates is controlled by counters which in essence are counts stored in the memory of the control system at a memory location corresponding to the particular receptacle and zone in which the receptacle resides. As indicated in FIG. **5**, this routine also keeps a running account of the total thickness of mail pieces deposited in each receptacle so as to indicate when each receptacle is full and requires the ejectment of its contents onto the sweep conveying portion of the system as was described above. The thickness of each letter is measured by a special sensor as it is entered into the system. When the input information has been processed, it is stored in the memory of the control system. As indicated in FIG. **5**, the system is also able to indicate when a piece of mail proves to be unreadable or has an invalid code configuration, and the like, in which case that particular mail piece is to be deposited in a separate reject receptacle.

The manner by which the zone or particular transport path level is detected so as to open one of the particular level selection gates is illustrated in FIG. **6**. The opening of a particular level selection gate to deflect the mail piece into its proper transport conveyor was described in relation to FIG. 1B. The routine illustrated in FIG. **6** is initiated upon the sensing of the mail pieces as they enter level selection conveyor **7** of FIG. 1B.

Once the individual mail piece has been entered into the transport path of a particular selected level, the corresponding destination receptacle and time required for the mail piece to reach that receptacle are determined from appropriate information received from the control memory and this information is employed to activate the corresponding receptacle gate according to the routine illustrated in FIG. **7**.

As was indicated above, the transport and sorting mechanism of the present invention is adapted to have its individual receptacles emptied and transported by a sweep conveyor for the further processing of the mail pieces. Furthermore, the mechanism of the present invention is adapted to convey mail pieces along parallel transport paths for parallel sorting and the corresponding parallel receptacles can have their contents merged during the sweep operation. The routine by which the sweep operation is controlled is illustrated by the flow chart in FIG. **8**. The sweep operation can be initiated by any one of a number of different conditions such as the setting of a sweep flag during the input information processing routine of FIG. **5**, or by a manual request by the operator. Note in the flow chart of FIG. **8** that when a full receptacle is detected before the sweep belt is stopped, the absolute belt position is checked to insure that it is empty. The sweep belt is stopped only if there is a belt position available to receive the mail pieces from a particular receptacle. Thus the starting and stopping of the sweep belt is minimized by only stopping it when there is an empty position available to receive mail and then holding the belt stopped until all full receptacles within the zone or level are unloaded. An interlock is provided so that if the belt has been stopped and there is no space available on the sweep belt or any remaining full receptacles, the belt will be restarted automatically. This is accomplished by upcounting an interlock counter in the controller each time a fetch for a full receptacle in the same zone is attempted. If this counter reaches **16**, indicating that it has been attempted to sweep all receptacles in the zone or level without complete success, the belt is automatically restarted.

EPILOGUE

As thus described, the present invention is directed toward a transporting and sorting mechanism for an automatic conveyor system that may be employed to sort mail pieces and other articles of nonuniform size and characteristics. The mechanism employs a minimum number of mechanical parts when compared to current state of the art mail sorting systems. Upon insertion into the system, the individual mail pieces are transported along a smooth surface by an over head conveyor belt or linkage to which are attached transport arms that engage individual mail pieces and impart motion thereto. The individual mail pieces are moved over a plurality of receptacles each of which is provided with a rotatable gate that may be opened to intercept the mail piece destined for that receptacle. The transport conveying belt may be adapted to supply two or more series of receptacles in parallel and the individual stacks of mail thus sorted can then be merged and ejected onto a sweep conveyor for transportation to other processing stations.

While only particular embodiments of the present invention have been thus described, it will become apparent to those skilled in the art that changes or modifications may be made therein without departing from the spirit and scope of the invention as claimed.

What is claimed is:

1. A transport and sorting apparatus for the sorting of various sized articles, said apparatus comprising:

a plurality of receptacles parallely arranged in at least a first and second sequence along a transport path, each of said receptacles having a top portion which partially encloses the receptacles and a rotatable gate which when closed completes the enclosure of said receptacle, said top portion and said gate, when closed, forming a smooth surface; and

a transport linkage mounted above said pluralities of receptacles and adapted to convey said articles along said smooth surfaces of said first and said second transport paths in parallel, said rotatable gates being adapted to be opened to allow individually selected receptacles to receive those articles destined therefor, a separate conveying means oriented in the direction of said transport paths and mounted adjacent to one of said sequences of receptacles to receive therefrom the articles thus sorted for conveyance to further processing stations, and

a plurality of ejectment members, one for each pair of corresponding receptacles from the each of said sequences of receptacles, said members being adapted to move through each receptacle of its respective pair to merge the contents thereof for ejectment onto said separate conveying means.

2. A receptacle clearing device for merging the contents of a plurality of corresponding receptacles of adjacent sequences of receptacles comprising a plurality of ejectment members, one for each plurality of corresponding receptacles from the each of said sequences of receptacles, said members being adapted to successively move through each receptacle of its corresponding plurality to merge the contents thereof for ejectment from said corresponding receptacles.

3. The device as set forth in claim **2** including stacking means, wherein the plurality of ejectment members in moving through each receptacle of said corresponding plurality of receptacles, stacks the contents of successive receptacles one upon the other.

4. A method according to claim 3 including the steps of merging the articles from corresponding ones of each successive pair of sequences of receptacles.

5. The device as set forth in claim 3 including a further transport linkage means for receiving the final stacked contents merged from all of said successive receptacles.

* * * * *