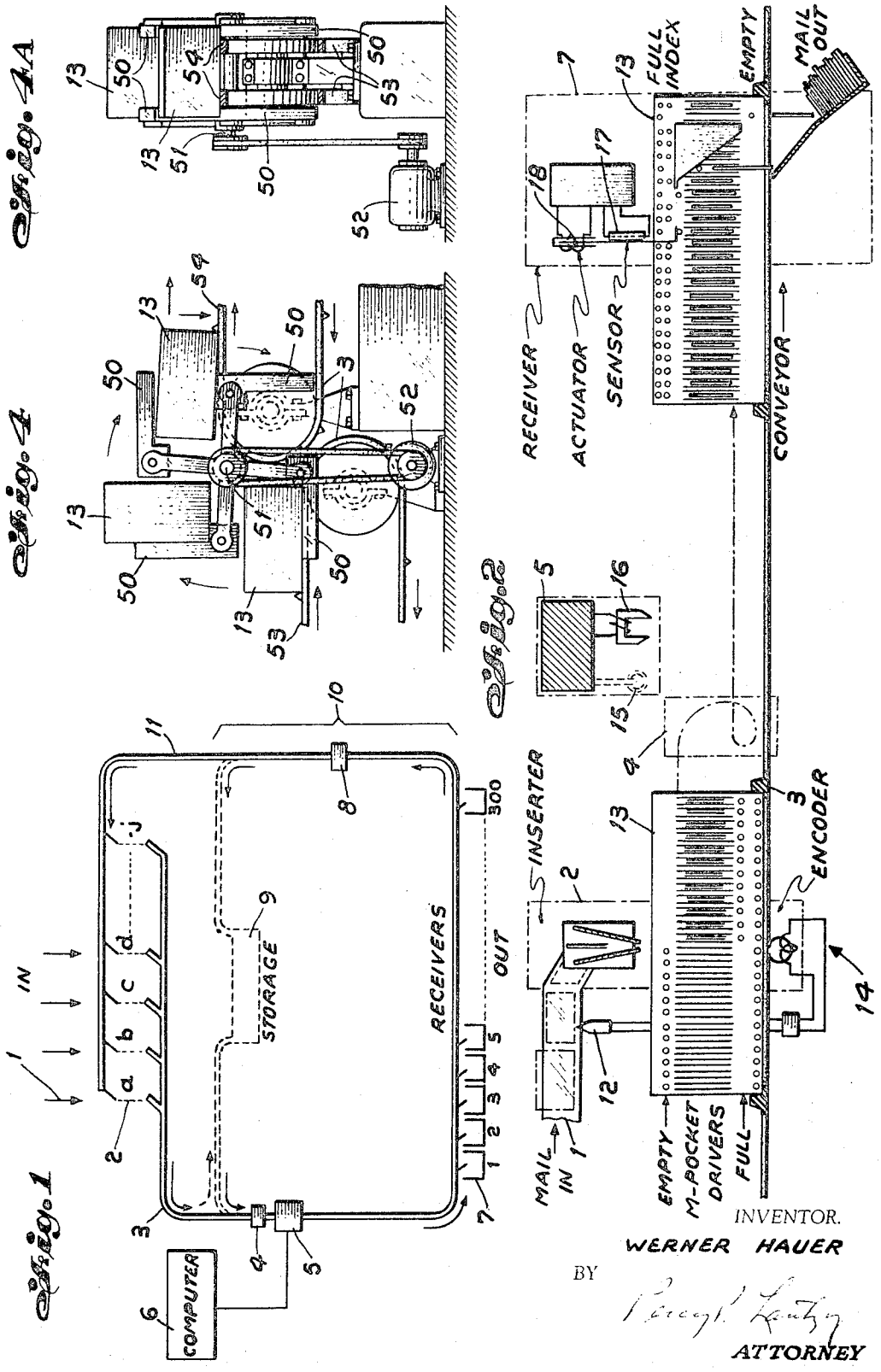
July 1, 1969 W. HAUER 3,452,509

AUTOMATIC SORTING SYSTEM FOR DISCRETE FLAT ARTICLES

Filed April 11, 1966 Sheet 1 of 7



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AUTOMATIC SORTING SYSTEM FOR DISCRETE FLAT ARTICLES

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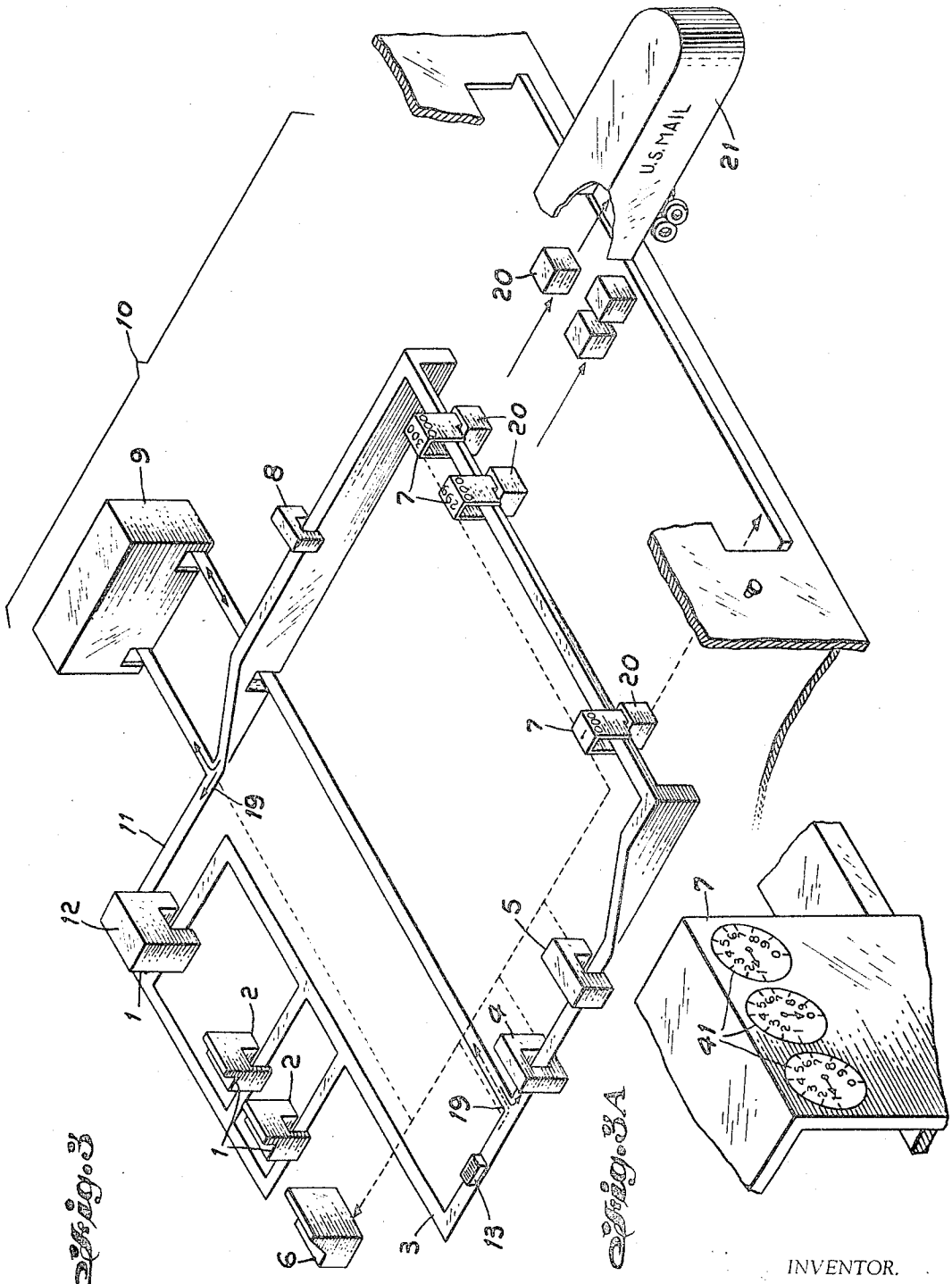


Fig. 3

Fig. 3A

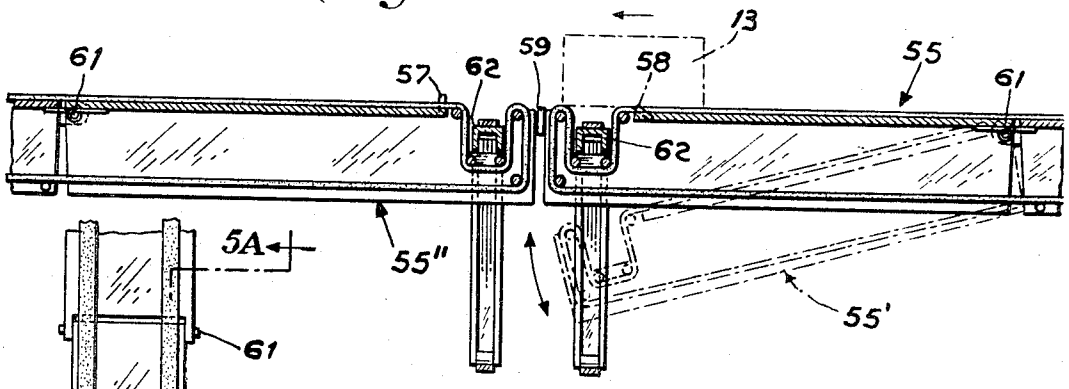
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AUTOMATIC SORTING SYSTEM FOR DISCRETE FLAT ARTICLES

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Fig. 5A



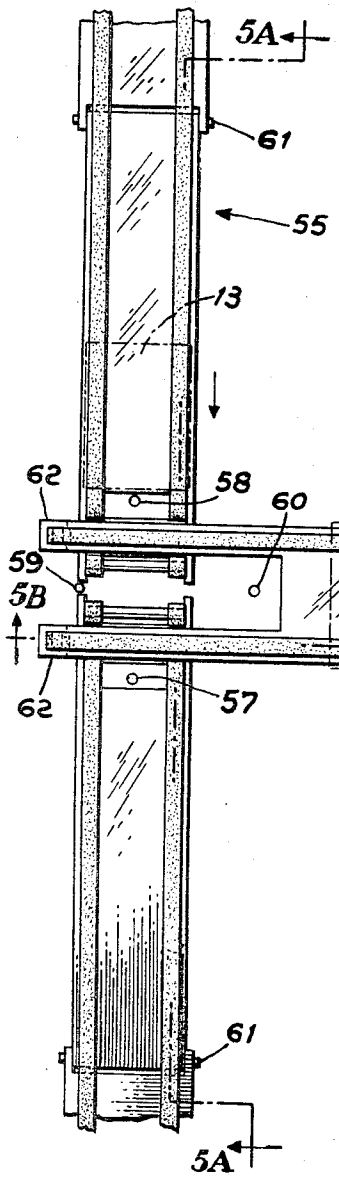


Fig. 5

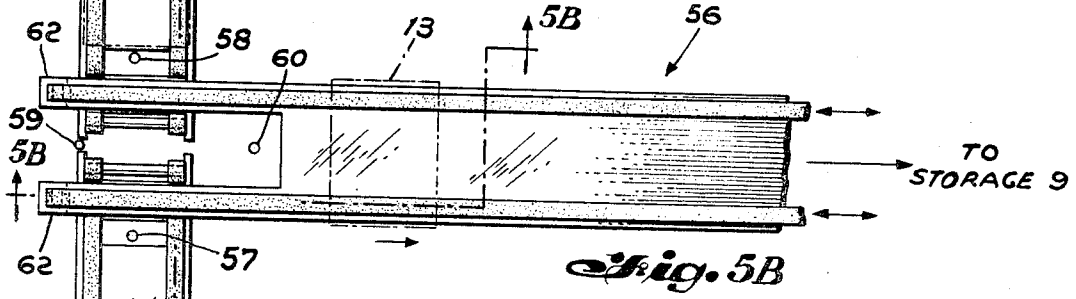
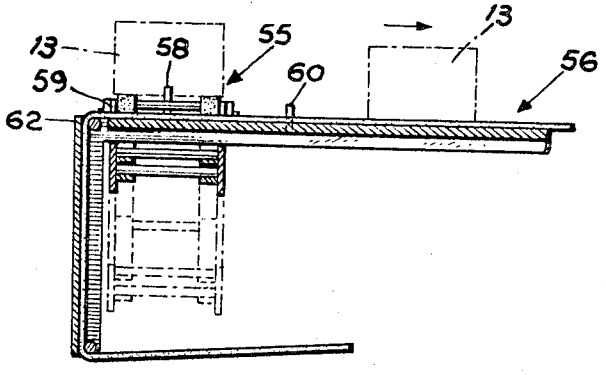


Fig. 5B



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AUTOMATIC SORTING SYSTEM FOR DISCRETE FLAT ARTICLES

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Fig. 7

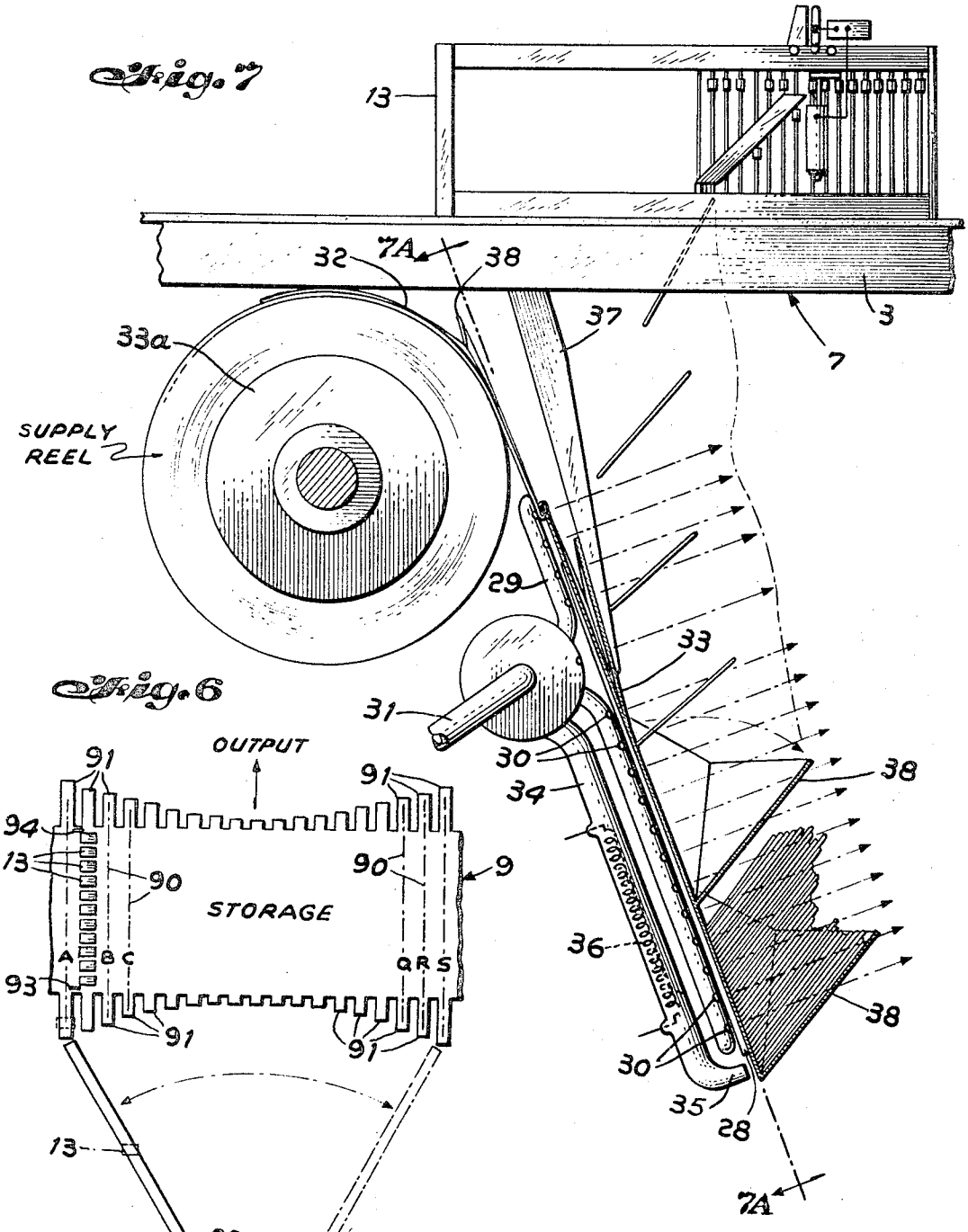


Fig. 6

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AUTOMATIC SORTING SYSTEM FOR DISCRETE FLAT ARTICLES

Fig. 7A

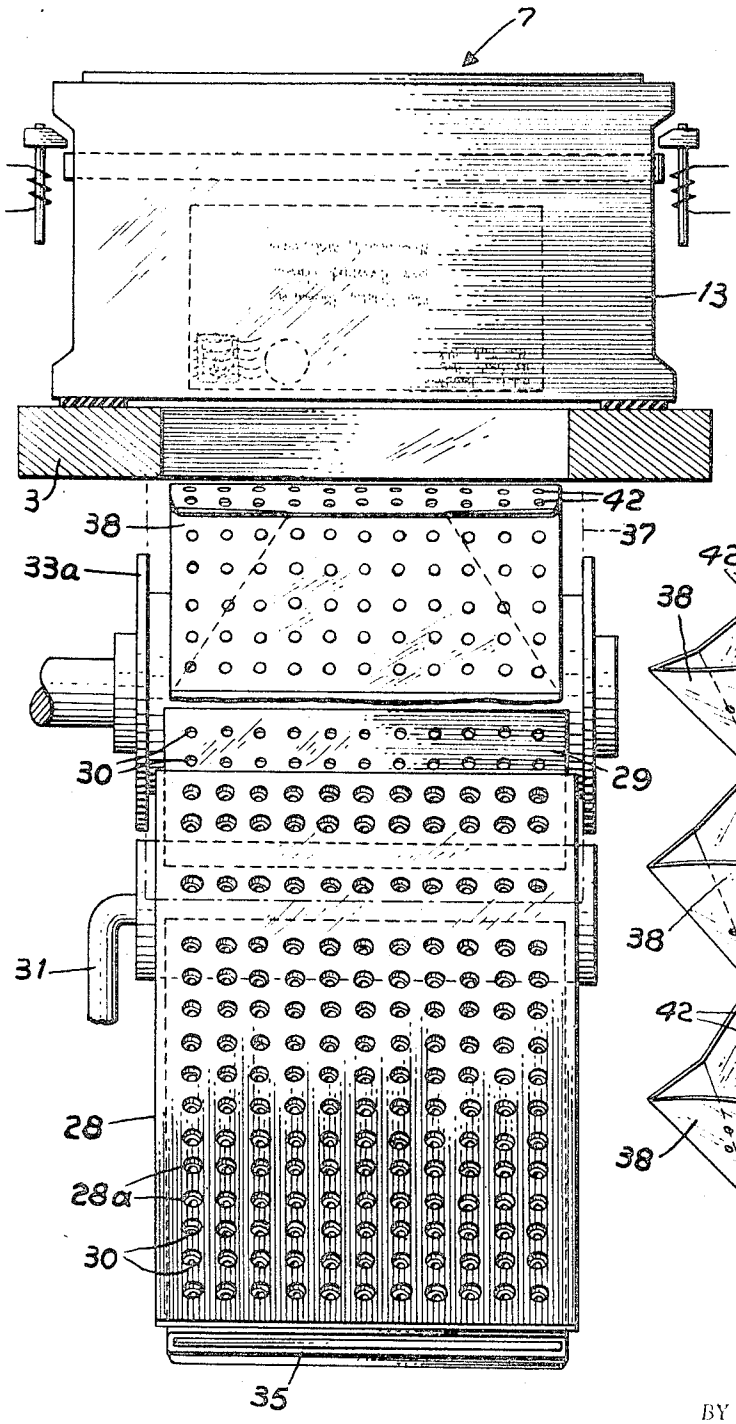
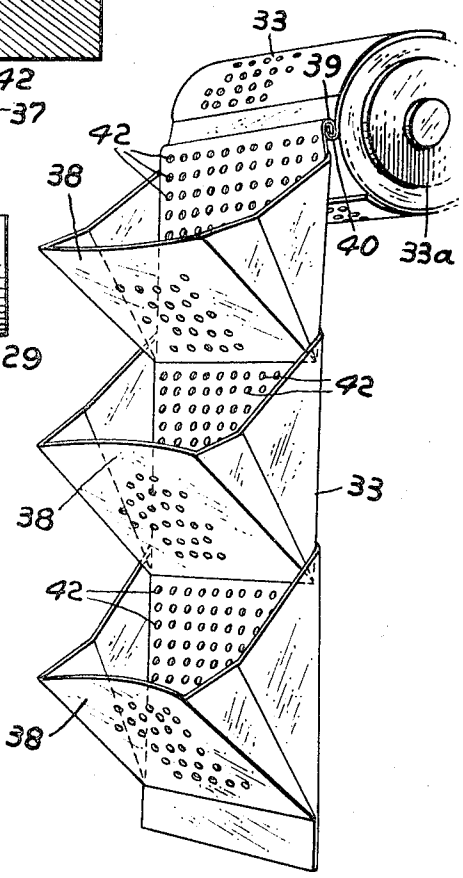


Fig. 8

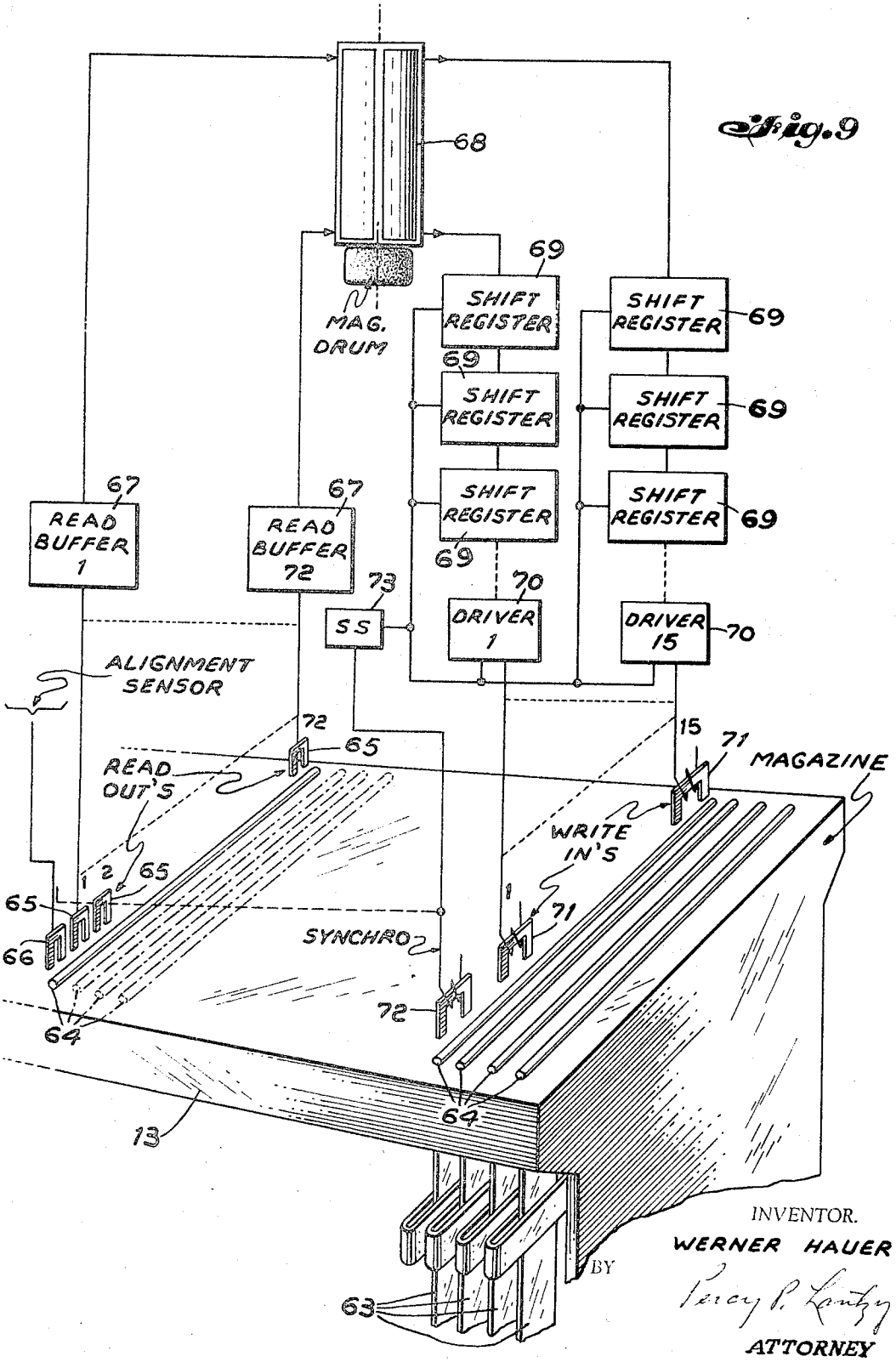


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AUTOMATIC SORTING SYSTEM FOR DISCRETE FLAT ARTICLES

Filed April 11, 1966

Fig. 9



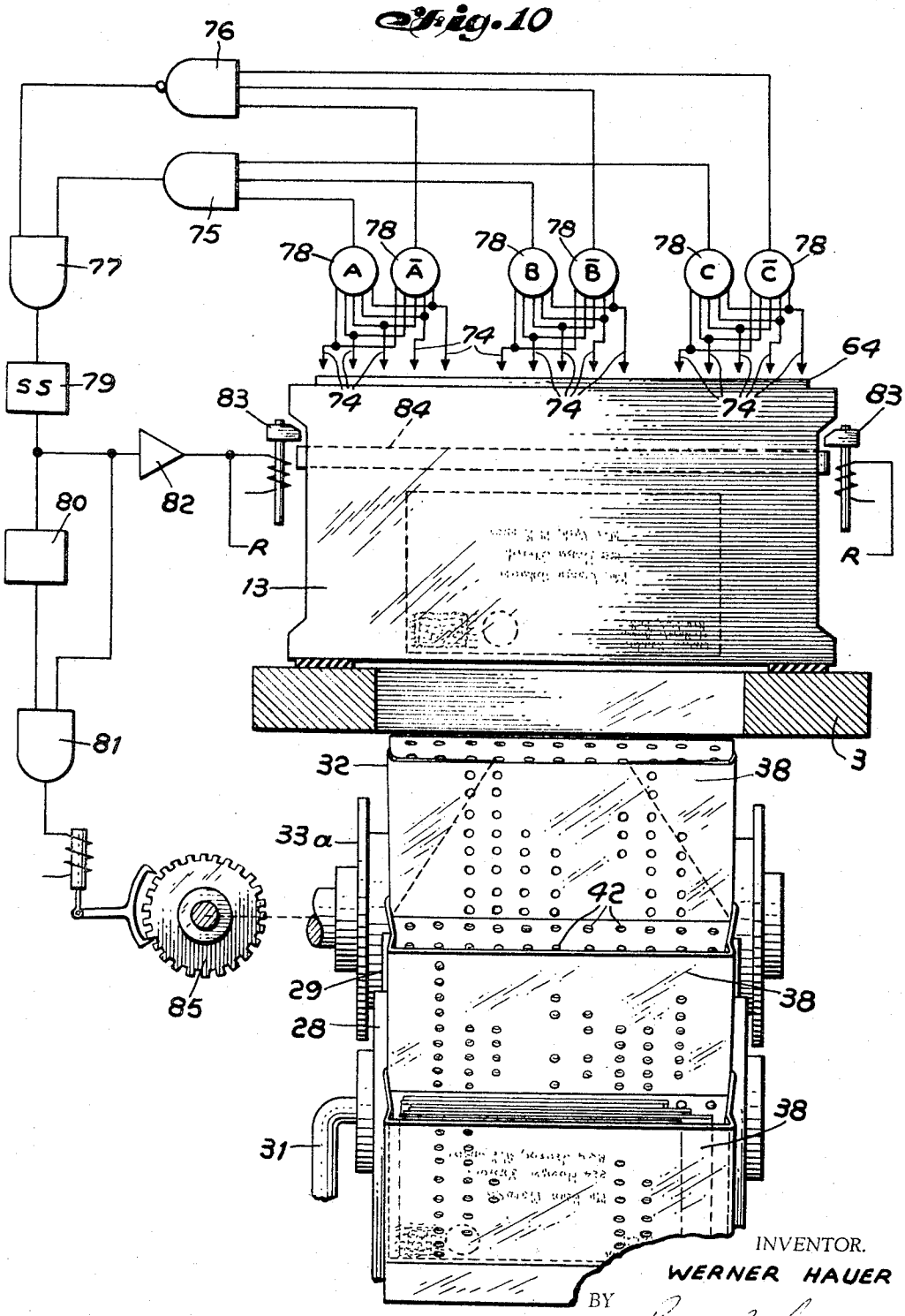
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AUTOMATIC SORTING SYSTEM FOR DISCRETE FLAT ARTICLES

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Fig. 10



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United States Patent Office 3,452,509
Patented July 1, 1969

3,452,509

AUTOMATIC SORTING SYSTEM FOR DISCRETE FLAT ARTICLES

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Filed Apr. 11, 1966, Ser. No. 541,806
Int. Cl. B65b 19/28, 35/30, 35/50
U.S. Cl. 53—52 14 Claims

ABSTRACT OF THE DISCLOSURE

A system requiring only one singulation and encoding of articles comprising a single array of output stations, encoding means, and a storage facility. By use of coding sensing, selected articles are ejected to discrete stations, and non-selected articles are temporarily stored. Subsequently, in successive sortations, all articles are ejected to correct stations as the stations are successively recoded to accept different groups of discrete articles.

This invention relates to systems for sorting discrete flat articles, such as articles of mail, and particularly to an improved recycling sortation arrangement.

Known sortation systems carry mail on conveyor belts, or the like to a plurality of output stations within one installation. In these systems, coding arrangements are used to identify the individual letter destination and to enable ejection of appropriate mail to appropriate output stations. Thus, in a first array of output stations for principal mail distribution centers (i.e., New York city, Boston, Cleveland, Chicago, Newark, Dallas, etc.) mail destined for such enters (or environs thereof) is ejected at the appropriately designated stations. Assuming for the moment that the mail sorting system here discussed is in Philadelphia, a second sortation of the remaining mail would require the mail to be conveyed further over a second and successive array of output stations which may be designated as "out-of-town" distribution centers (i.e., Reading, Scranton, Allentown, Bethlehem, Harrisburg, etc.). Next the mail yet remaining would be conveyed further over a third array of output stations designated as "local" distribution centers, a station for each community within the metropolitan range of Philadelphia (i.e., Elkins Park, Glenside, Drexel Hill, Bristol, Jarrettown, etc.). Finally, the only mail remaining is for Philadelphia proper. This last mail would receive the final sortation, over a last array of output stations, which segregates the letters according to the fifty to fifty-five ZIP Code areas or zones encompassed by the city of Philadelphia.

These known arrangements require a broad expanse of operating areas, to have the mail traverse the successive arrays of sortation stations, or a complicated management to rearrange the output station assignment pattern of the sorting machine after the first sortation and rerun the mail in the now different output station assignment pattern through the same sorting installation. More, the finally sorted and ejected mail must be stacked and bundled by hand or by accessory machinery and conveyed by containers to a central truck and/or train loading platform. Necessarily, the code sensing the mail ejection devices must be provided in a quantity corresponding to the number of discrete sortations—perhaps 250 to 300 for major centers, 100 to 150 for minor out-of-town centers, 50 to 100 for local centers, and 50 to 100 for "in-town" sortations. Thus, as many as 500 identical devices for code sensing and mail ejecting may be required to satisfy the full run of complete sortation. Finally, in some known systems recycled sortation is used where the number of output stations is at least as great as the largest number in one sortation. However, these arrangements require successive singulation and reading processes to set the control numbers of the machine for the successive sortations.

It is an object of this invention to provide an automatic article sorting system which employs but one singulation and one reading of each mail article, and a single array of output stations for a number or sortations which is greater than the number of output stations.

It is another object of this invention to provide an automatic mail sorting system which uses article holding devices and recycles them past a single array of output stations in a series of recurring and successive yet discrete sortations.

Another object of this invention to provide an automatic mail sorting system which accommodates the full sortation of mail in immediate adjacency to the central truck and/or train loading platform.

It is another object of this invention to provide an automatic article bundling means for each output station of the mail sorting system.

Another object of this invention is to provide an automatic mail sorting system which uses electronic memory, control and programming to convert a discrete encoding of articles of mail into an arbitrary encoding which is used to selectively cause mail to be ejected into or withheld from output stations.

A further object of this invention is to provide an automatic mail sorting system with a flexible output station arrangement having mail destination sensing facilities which are selectively alterable so as to accommodate any arbitrary arrival, docking and resultant deployment of mail trucks thereat.

Yet a further object of this invention is to provide an automatic mail sorting system with flexible mail destination sensing facilities which are selectively alterable so as to effect dispatch of mail for "heavy-traffic" destinations to any desired plurality of output stations.

Another object of this invention is to provide an automatic mail sorting system with facilities which respond automatically, in the event of malfunctions of, or overloads at the output stations, to establish substitute output stations.

A feature of this invention is the use of a computer controlled code converter device to "read" first encodings of the article holding device, encodings corresponding to the discrete destination of the articles of mail, and to "write," that is, to super-impose a second encoding on computer instructions. The second encoding is a director encoding which, providing it corresponds with encoding of selectively encoded sensing means at the output stations, will cause the holding device to release the correct mail.

Another feature of this invention is the use of a closed-loop conveyor system which moves the article holding device from the input means and past the output stations in first, second, and third or more successive sortations over the output stations.

Another feature of this invention is the provision of storage means for the holding device for times intervening the successive sortation passes.

Another feature of this invention is the provision of a web of continuous heat-shrinkable pouch strips, and article "lofting" air pressure, to automatically stack and bundle the mail as the pieces thereof are ejected at the individual output stations.

The above-mentioned and other features and objects of this invention will become more apparent by referring to the following description taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a schematic representation of an embodiment of the system in accordance with my invention;

FIGURE 2 is a diagram of the basic sequence of the system in accordance with my invention;

FIGURE 3 is a perspective view of a post office layout employing my invention;

FIGURE 3A is a perspective view of output stations indexing means;

FIGURE 4 is a side elevation view of an inverter used in the inventive system;

FIGURE 4A is an end view of the inverter of FIG. 4;

FIGURE 5 is a top view of a transfer arrangement used in the system;

FIGURE 5A is a front elevational view of the transfer arrangement of FIG. 5;

FIGURE 5B is a side elevational view of the transfer arrangement of FIG. 5;

FIGURE 6 is a top view of the storage means for the system;

FIGURE 7 is a side elevation view of the automatic bundling means according to the invention;

FIGURE 7A is a front elevation view of the bundling means of FIG. 7;

FIGURE 8 is a perspective view of pouch strips used with the bundling means of FIGURE 7;

FIGURE 9 is a schematic representation of the code converter arrangement; and

FIGURE 10 is a schematic representation of the output station sensing means.

Referring now to FIGURE 1 there is disclosed a sorting system in accordance with my invention. Input **1** denotes the point of influx for the unsorted mail where operators or machine readers at a plurality of parallel positions (*a, b, c, d . . .*) insert the mail into holding devices and perform encoding, as will be discussed subsequently, at **2**. Conveyor means **3** transports the mail to an inverter **4**. Inverter **4** turns the holding devices (containing the mail) upside down and passes them on the code converter **5** under the control of computer **6**. For reasons to be explained subsequently, code converter **5** performs further encoding and passes the mail on to the output stations **7** represented by numerals 1 through 300. There, selected articles of mail are ejected from the holding devices. Next the holding devices with the non-ejected mail are conveyed on to inverter **8**, which returns them to the originating upright position, and then they pass on to storage **9**. The closed-loop conveyor system is represented by index numeral **10**, while the return line is shown at **11**.

While my inventive system can be used with different types of mail transporters, and can be adapted for use with still other types, the embodiment presented here, only by way of example, will assume the use of an article holding and dispensing magazine such as that disclosed in my U.S. Patent No. 3,140,767 for High Speed Automatic Mail Sorting Systems, issued July 14, 1964. More, while various encoding, inserting and ejecting arrangements for mail and transporters are known and can be employed with my invention, the manner of encoding, inserting, ejecting mail disclosed in my earlier-mentioned U.S. patent will be assumed for the ensuing discussion.

Synoptically, the devices, and operation of the systems disclosed in Patent No. 3,140,767 are as outlined below. This outline should facilitate an understanding of the present disclosure.

The patented High Speed Automatic Mail Sorting Systems teach the use of articles holding and dispensing magazines. The magazines are assemblies of plastic pockets, arrayed in parallel, the magazines having means for varying the depth of the pockets. Below each individual pocket is fixed a magnetic coding bar. Each magazine, with its pockets and coding bars, is maintained in a tray. Further, the magazines have "drivers" for each pocket which are cooperative with output station ejectors to discharge selected articles of mail from the pockets. The systems routine is as follows.

Empty magazines are conveyed to a postal clerk/operator who, after noting the addresses of the incoming mail inserts successive pieces in the successive pockets. The operator uses a keyboard to encode the coding bars to signify the destination addresses of the corresponding pocketed mail articles. The mail-laden magazines are moved to an inverter which turns the magazine upside down and positions the now-encoded coding bars at the top. The inverted magazines are moved to output stations where there are arrayed discrete sensors and ejectors for each different receiver bin. As a magazine passes through the output stations, the sensors there arrayed "read" the encoding on each bar of each pocket. When there occurs a correspondence between the encoded destination for a particular article of mail and a destination for which the sensor of a particular receiver bin is set, the magazine "driver" will be actuated. The actuated "driver" then cooperates with the ejectors to dispatch the mail article from the pocket.

The present disclosure, then, teaches an improved automatic sorting system, one embodiment of which is drawn from the utilization of at least the magazines, coding bars, magazine "drivers," and output sensors and ejectors of my prior, patented High Speed Automatic Mail Sorting Systems (U.S. Patent No. 3,140,767).

FIGURES 2 and 3, respectively, present the basic operation of my invention, and an arrangement of the system in a post office facility. Input **1** feeds the mail to machine readers or manual operators **2**. The culling, facing, reading and inserting of mail in the magazines and the encoding of the magazines, can be done by any of several known means; an example of such means is taught in my U.S. Patent No. 3,140,767. The operator, uses a keyboard to magnetically impress a binary code of low level magnetization (40 gauss) on the coding bar for each pocket of the magazine in accordance with the ZIP Code address of the letter inserted therein. Thus, coding bars for a letter addressed to a Baltimore, Maryland ZIP Code of 21218 will be encoded in binary-decimal:

0010 0001 0010 0001 1000 (=21218)

Obviously the operator can impart any binary code representations, successively, for successive pockets of a magazine for differing ZIP Codes for different destinations: 10022, New York city; 01546, Shrewsbury, Mass.; 01881, Wakefield, Mass.; 10538, Larchmont, N.Y., etc.

Assuming the post office to be in, say, Dallas, Tex., postal clerks will require that a first sortation extract only long distance mail (i.e., mail for remote and major distribution centers), leaving mail otherwise addressed for subsequent sortations. Thus, an efficient system must be able to discern and select only mail encoded for addresses in or near New York City, Chicago, Los Angeles, San Francisco, Detroit, etc. and to leave untouched mail addressed to "out of town" (i.e., Fort Worth, Waco, Wichita Falls, San Antonio, etc.), "local" (i.e., Euless, Irving, Grapevine, Coppell, Balch Springs), and "in town" mail. According to my invention, this discernment and selection is accomplished as follows. The magazines are transported to an inverter **4** where they are turned upside down. Detailed discussion of the inverter mechanics will be given subsequently.

While this inversion is not necessary to the essence of my invention, it is a necessary procedure to subsequently effect mail ejection from the magazines being considered in this discussion. These are the magazines disclosed in my U.S. Patent 3,140,767. Of course, other mail transporters having different means of ejection which obviate any need for inversion could be used in my inventive sortation system.

Following inversion the magazines are moved to a code converter **5**. Code converter **5** has "read" and "write" heads, which function in a manner well known in the art, and is coupled to computer **6** from which it receives instruction. The computer device can be any such having random read-write access of sufficient capability, as the PhD–170 by Bryant Computer Products

Division of the Ex-Cell-O Corporation, Walled Lake, Mich. By employing the memory of the computer and the digital logic of its arithmetic subsystem, the inventive system arrangement has the converter **5** read the 40 gauss binary code on the coding bar of a pocket in a manner which is non-destructive. This data is transmitted to the computer **6**. As the "read" head transmits a binary representation (0001 0000 0101 0011 1000) of ZIP Code 10538 (Larchmont, N.Y.), the computer memory identifies this as synonymous with a arbitrary destination coding (used solely within the post office building) which, by way of illustration, is designated as 101 (New York city). Therefore, the computer **6** instructs the "write" head of the code converter **5** to superimpose the binary representation of 101 on the coding bar with a high-level magnetization (400 gauss). So also, the computer-controlled converter **5** adds the 101 (New York city) code to letters initially encoded as 10036, 500 Fifth Ave., New York, N.Y.; 10462, Bronx, N.Y.; 10016, Madison Avenue, New York, N.Y.; etc. Thus, the computer is programmed to remember that ZIP Codes (i.e. binary representation thereof) 10001 through 10544 call for a "writing" of code 101. Letters thus second-coded will subsequently be ejected to the output station **7** which is designated as "101." Likewise, the computer **6** is programmed to identify ZIP Codes 60101 through 60658 as Chicago (or environs). An arbitrary Chicago designation coding may be "102"; thus, mail for Harvey, Ill., 60426 thru 60428; Bensenville, Ill., 60106; and Wheaton, Ill., 60187; as well as for Chicago itself, 60601 thru 60658, will be second coded "102" and consigned to an output station **7'** so designated. So-called "Los Angeles mail," also, having ZIP Codes 90001 through 90714 will be second-coded "103." An output station **7''** so designated will collect Lennox, Bellflower, Lakewood, etc. mail having ZIP Codes of 90304, 90706, 90712 thru 90714, etc., as well as mail for Los Angeles proper having ZIP Codes of 90001 thru 90071.

The computer **6**, then, will have three or four different stored programs to handle the three or four sortations. In the first sortation, which extracts the mail for the major long distance distribution centers, mail for these centers is second-coded at the converter **5** with arbitrary codes 101, 102, 103 through perhaps 350 to designate it for ejection at "New York city," "Chicago," "Los Angeles," through "Juneau" output stations.

Following code conversion (second coding) the magazines are conveyed to the output stations **7**. In a manner similar to that disclosed in my referenced patent, mail is ejected at correct destination output stations—there being an output station to collect the mail for each one of these arbitrary codes.

In a first sortation, then, all magazines are conveyed past an array of 250 to 300 (as required) output stations and eject only the mail destined for the major national distribution centers. The ejected mail, in a manner to be disclosed subsequently, is automatically bundled and ready for trucking or railroading for delivery. The magazines with the remaining (non-ejected) mail are conveyed on to storage **9** to await a second sortation. Operation of the storage **9** facility will be discussed subsequently. From storage **9** the magazines follow the conveyor means **3** back to the converter **5**. As can be seen in FIGURE 3, the closed loop conveyor path **10** is maintained in this proposed layout of the system.

After all sortations are completed, return path **11** provides a means for the return of the empty magazines to the operators or machine readers **2**. Again, with reference to FIGURE 2, code reader **12** represents such means well known in the art, employed in machine readers. At manual reader stations, code reader **12** would be represented by an operator. The magazines **13** are shown surmounting an encoder **14** which imparts the initial binary equivalent of the ZIP Code. The magazine inverter **4** is shown adjacent to code converter **5**. "Writing" and "reading" heads **15** and **16** are shown within code converter **5**. Sensor **17** and actuator **18** of the output station **7** represents those elements the nature and functioning of which, as disclosed in my referenced patent, are used, respectively, to respond to the high level second encoding on the magazine coding bars and to the eject mail.

Transfer devices **19**, discussed in connection with FIGURE 5 subsequently, and represented in FIGURE 3, can be manually operated to insure a closed-loop traverse by the magazines **13**. Obviously, the transfer devices **19** can also be computer controlled to actuate before and following each sortation program.

Interoffice transport containers **20** collect the ejected and bundled mail for truck **21** or railroad packaging and handling.

FIGURES 4 and 4A represent an embodiment of an inverter used in the system. Pairs of fixed arms **50**, disposed radially about a hub **51**, are revolved in clockwise fashion between adjacent branches of conveyor means **3**. The arms **50** are rotated, by drive means **52**, within parallel belts **53** and **54** of conveyor means **3**. Thus, the inverter accepts successive magazines **13** from parallel belts **53**, lifts them and inverts them, and deposits them on belts **54**. Inverter **8**, shown in FIGURES 1 and 3, operates in similar fashion, except that it accepts inverted magazines **13** and returns them to an upright attitude.

FIGURES 5, 5A and 5B represent an embodiment of transfer devices (**19**, FIGURE 3) used in the system. Conveyor track **55** represents a portion of the major conveying path, and conveyor track **56** represents a shunt path to or from storage **9**. When it is desired to transfer magazines **13** from the conveyor track **55** to storage **9** via conveyor track **56**, it is only necessary to interrupt track **55** and have track **56** take over magazine movement. Thus, position sensors **57–60** (such being well known in conveyor systems art) are used to signal optimum times for track interchange. Sensor **57**, as magazine **13** impinges thereagainst (having travelled in the direction of the arrow shown), will operate a solenoid arrangement (not shown) to drop conveyor limbs **55'** and **55''** about pivot points **61**. Magazine **13**, then, will be resting on the parallel extensions **62** of conveyor track **56** and will be moved to storage **9**. The dropping of conveyor limbs **55'** and **55''** is of timed duration; both limbs return to normal disposition when the magazine **13** directed to storage has cleared the path of track **55**. Sensor **58** is used to interrupt the conveyance of successive magazines until a foremost magazine has traversed the transfer point. Sensor **59**, just contrary to the function of sensor **57**, is used to actuate solenoid means to raise conveyor limbs **55'** and **55''**, to accept a magazine just moved out from storage **9**. Sensor **60** is used to lower limbs **55'** and **55''** until a magazine moving out from storage impinges against sensor **59**. Sensor **60** also interrupts the outward (from storage) conveyance of successive magazines until a foremost magazine has traversed the transfer point.

FIGURE 6 illustrates, in a plan view, an embodiment of a storage arrangement used in the inventive system. Storage facility **9** has a plurality of rows **90** (designated "A" through "S") in which a number of magazines **13** can be stored between mail sortation cycles. Conveyor ramps **91** are arrayed across either sides of the storage facility **9** to receive (or dispatch) magazines **13** from (or to) slewable conveyor arms **92**. Sensors **93** and **94** serve to signal drive means (not shown) for arms **92** when it is timely to move the arms from one row **90** to another. In accordance with means well known in the art, sensors **93** and **94** are coupled to sense a filled capacity for row **90**; in this, sensor **93** serves a counting function. Sensor **94** has means to subtract from the count to sensor **93** when, as will sometimes be necessary, it is required to pass all or some magazines **13** directly through the storage facility **9** without halt. Thus, the count of sensor **93** will not reach "capacity" and the row **90** will

be presented as an open passageway. Finally, sensor **94** has stop means to halt conveyor belt movement in row **90** unless an arm **92** is addressed to and interfaced with output ramp **91** of the row.

The automatic bundling means of output stations **7** is illustrated in FIGURES 7 and 7A. There is shown ramp **28**, disposed beneath an output station number **7**, with orifices **28A**. Air rack **29**, with ports **30** receives pressured air from source **31**. A web **32** of heat-shrinkable perforated pouch strips **33** is fed over both said air rack **29** and ramp **28** from reel **33***a*. Air line **34** is joined to source **31** and vents out nozzle **35** at the bottom of ramp **28**. Heating means **36** are contained in the air line **34**. As articles of mail are ejected from the magazine **13**, air forced through the ports **30**, orifices **28A**, and perforations **42** in the pouch strips **33**, causes each piece to "loft" downward in an attitude perpendicular to ramp **28**. A guide **37** holds the pouches **38** closed until preceding pouches are sufficiently filled and have moved downward toward the containers (**20**, FIGURE 3). As each successive pouch **38** falls open, lofted mail comes to rest therein and collect. As the loaded pouches **38** pass nozzle **35**, the flow of heated air from air line **34** causes the material of the pouch **38** to shrink and securely clasp the mail enclosed therein. As can be seen in FIGURE 8, the upper end **39** of each pouch strip **33** is interfolded with the lower end **40** of each succeeding pouch strip. Thus, as one pouch strip **33** moves downward via means discussed in connection with FIG. 10, it unreels the succeeding pouch strip.

FIGURE 9 schematically illustrates the means for conversion of the low-level (40 gauss) magnetic encoding of ZIP Code addresses into high-level (400 gauss) magnetic encoding of an arbitrary code for selective mail article ejection. The inverted magazine **13** with parallel, mail article pockets **63** is shown with coding bars **64** for each pocket. Read-out devices **65**, which utilize Hall effect substrates (indium antimonide), are components of the code converter (**5**, FIGS. 1, 2, 3). Alignment sensor **66** detects correct orientation of magazine **13** under devices **65** and energizes the read-out process at the correct instant. As many as seventy-two bits can be read out, as seventy-two read-out devices **65** are there arrayed along the coding bars **64**. Normally a maximum of twenty-five data bits (viz, 00110 00000 00110 00001 00011, for ZIP Code 60613, Chicago, Ill.) for example will have to be read out. The extra coding area on the coding bar can be used to enter more extensive encoding when and as mail traffic warrants, or can be used to enter more extensive encoding (than the five decimal ZIP Code requires) for checks, vouchers, etc., when the inventive system here described is used in banking, insurance, warehousing, etc. applications rather than in post offices.

The read-out bits of data are acquired by and stored in the read buffers **67** and offered to the magnetic drum **68** of the computer (**6**, FIGS. 1, 3). The program (stored on the drum under which the computer is controlled—1st, 2nd, or 3rd sortation program, etc.) will determine the processing instruction for the mail article being read. If, as earlier suggested, the post office is in Dallas, Tex., the computer will, on a first sortation, set forth instruction for an extraction of all mail having ZIP Codes which do not commence with the numeral seven. Therefore, on reading a ZIP Code of 10022 (New York city), the computer (via its magnetic drum **68**) will translate this into binary bits 00001 00000 00001 (i.e., arbitrary code "101") and uses shift registers **69** and drivers **70** to induce this code, via high-level magnetization (400 gauss), onto the coding bar **64** for that New York city mail article when the magazine has moved to where the pocket **63** and coding bar **64** for that mail article is directly beneath the write heads **71**. Sensor **72**, like sensor **66**, serves an alignment function; cooperative with single-shot multivibrator **73**, it enables the writing function only when the coding bar is properly aligned under the write heads. The read buffers **67**, shift registers **69**, drivers **70**, write heads **71**, multivibrator **73**, and sensors **66** and **72** are, like read heads **65**, components of the code converter (**5**, FIGS. 1, 2, 3). In this embodiment, fifteen write heads **71** are used, these being adequate to encode the binary representation of the 3-digit arbitrary codes (101—New York city, 102—Chicago, etc.) for the output stations (**7**, FIGS. 1, 2, 3).

FIGURE 10 schematically illustrates the means for the output station (**7**, FIGS. 1, 2, 3) code sensing ejection, and pouch supply web movement. Coding bar **64** carries the 3-digit arbitrary code which read-out sensors **74** will discern. As each digit of the arbitrary code will have five binary bits, a total of fifteen sensors **74** are provided. Each group of five is coupled to an AND gate circuit **75** and a NAND gate circuit **76** as well, the outputs of both circuits being coupled to another AND gate circuit **77**. The redundancy of AND and NAND read-outs is provided, as is commonly done in digital logic art, to insure that a logic "one" or "zero" is correctly discerned. Dial switches **78** can be of any known electro-mechanical means to facilitate the alteration of the sensors arrangement—to enable responses for altered coding. Normally, each output station will be set up for and maintained at one arbitrary code (101, 102, 407, or 269, etc.). However, when mail loading requires it, output station arbitrary codes can be changed, switched, or voided by dialing different coding (for sensing) or by dialing three zeroes; this feature is discussed further in following text.

The output of AND gate circuit **77** is coupled to single shot multivibrator **79**. The output pulse multivibrator **79** is coupled to counter **80**, AND gate circuit **81** and amplifier **82**. The output of amplifier **82** enables the solenoid driven actuators **83** (on each side of magazine **13**), causing the actuators **83** to move the "driver" **84** downward to a lower position within the pocket (preparatory to ejection of the mail article). The recurring outputs of multivibrator **79** to AND gate circuit **81** are of no effect until one such output coincides with an output from counter **80**. Counter **80** can be set for 25, 30, 35 inputs before providing an output. The setting thereof will be determined by the capacity of the pouches (**38**, FIGS. 7, 8) for articles of mail. Coincidence of counter **80** and multivibrator **79** outputs will cause AND gate circuit **81** to "step" the web escapement **85**. Stepping of the web escapement **85** causes the pouch supply web **32** to further unwind from reel **33A**.

As discussed earlier, magazines **13** are conveyed to storage **9** after a first sortation. The storage means can be of a type such as that discussed in connection with FIG. 6, or it can be any of several types well known to those skilled in the art, types having racks and elevators and appropriate drive and moving means. Also, the release of all magazines **13** from storage **9** for successive sortation runs can be manually controlled or controlled by the computer **6** with initiation of the successive sortation programs. Additionally, the conveyor means **3** has an interruptable drive which can be operator- or computer-controlled.

My system permits the dispatch of all sorted mail at one loading platform. Thus, trucks **21** (FIGURE 3) will pick up "New York city" mail at the output station **7** designated "101," "Chicago" mail at the output station designated "102," etc., after the first sortation, receiving the bundled mail in containers **20**. (Obviously the movement of the containers **20** can be automated in response to timing means or the effects of a given weighted capacity.)

So also, other trucks **21** will pick up "out of town" (Texas) mail for Lubbock, Fort Worth, Waco, Beaumont, Wichita Falls, etc., at the same output stations **7**, after the second sortation. This time a station designated "101" will have Lubbock mail, and "102" Fort Worth mail, and so on. This is so because on the second sortation the second program of the computer **6** instructs the con-

vertor 5 to second encode the magazines, on reading discrete ZIP Codes, as follows:

79401 through 79416=101 (Lubbock);
76101 through 76135=102 (Fort Worth);
76701 through 76711=103 (Waco);
77701 through 77708=104 (Beaumont); etc.

Thus, mail for large "out of town" distribution centers will be sorted out in the second sortation. Mail ZIP coded 75060 thru 76501 will not be sorted out. This is a ZIP Code group for Dallas proper and its surrounding communities. Mail for those surrounding communities (Euless, Irving, Grapevine, etc.) this being "local" mail, will be sorted out at the third sortation. Second coding for these may be as follows:

76039=101 Euless;
75060=102 Irving;
76051=103 Grapevine; etc.

Final sortation of mail for Dallas proper, mail ZIP coded 75201 thru 75247, will exhaust the magazines **13**. It is then that the magazines are conveyed along return path **11** (FIGURE 3) for the collection and subsequent sortation of the next influx of mail.

It will be evident that the sensing means of the output stations **7** and the ejecting means responsive thereto can be set once to the arbitrary codes 101 through 350 (or more as required), and left unaltered. Also, it is evident that these means can be alterable to inhibit them, to void codes 101, or 127, or 265 or whatever, as when mail destined therefore is inordinately heavy. Setting and alteration of the setting is accomplished by indexing means **41** (FIGURE 3) (including dial switches **78**, FIG. 10) at output station **7**; indexing means **41**, shown indexed to arbitrary code 101, is connected to sensor **17** (FIGURE 2) to control the response thereof. Indexing means **41** can be manually or computer-controlled to set or alter the indexing thereof. Then a separate sortation can be run for the 101, 127, 265 mail, using ten, twenty, or more output stations for these destinations, by further dividing the ZIP Code destinations. In this, using the computer capability in an unscheduled program the converter **5** would second encode the magazines as follows:

79401 through 79404=101, Lubbock;
79405 through 79408=102, Lubbock;
79409 through 79412=103, Lubbock;
79413 through 79416=104, Lubbock;
76101 through 76105=105, Fort Worth; etc.

In this manner, four, ten, or twenty times the normal volume of mail for given destinations can be handled with an even outflow at the output stations. More, the subdivision of the basic ZIP Code group facilitates subsequent distribution of the mail.

The foregoing discussion is predicated on the use of a plurality of computer programs to effect a plurality of sortations. Thus, in a first sortation, mail articles properly selectable for ejection are processed. Mail articles not selectable for ejection in the first sortation are passed over. The former are second-coded and set up for dispatch from the magazines **13** in the first sortation; the latter are simply "read" and nothing further is done with them. The nonselectable mail articles remain in the magazines **13** during the first sortation. Under subsequent computer programs, in subsequent sortation, each mail article is processed for ejection into the correct output station **7**. The following chart of disposition of random pieces of mail having varying ZIP Code addresses, shows the processing effected in four successive sortations in a Dallas, Tex., post office.

ZIP Code	Mail address	Sortation 1st	2nd	3rd	4th	Output station: Arbitrary code	Output station: Distribution center
82002	Cheyenne, Wyo	X				171	Cheyenne.
13225	Hancock Field, N.Y	X				117	Syracuse.
19045	Jarrettown, Pa	X				105	Philadelphia.
97223	Tigard, Oreg	X				213	Portland.
90304	Lennox, Calif	X				180	Los Angeles.
13215	Onondago, N.Y	X				117	Syracuse.
76705	Bellmead, Tex		X			117	Waco.
79097	White Dear, Tex		X			118	Amarillo.
75145	Kleberg, Tex			X		127	Kleberg.
75127	Fruitdale, Tex			X		101	Fruitdale.
75223	Dallas, Tex				X	101	Dallas.
76689	Valley Mills, Tex		X			117	Waco.
97148	Yamhill, Ore	X				213	Portland.
92373	Redlands, Calif	X				180	Los Angeles.
75019	Coppell, Tex			X		119	Coppell.
82050	Albin, Wyo	X				171	Cheyenne.

Obviously, the computer **6** capability affords my inventive system a wide flexibility. For instance, in the event that long-haul truck and railroad facilities are delayed, and arrive untimely to receive "long-distance" and "out-of-town" (1st and 2nd sortations) mail, the postal operators can call up 3rd and 4th sortation computer programs. Thus, "local" and "intown" mail can be processed, and dispatched via short-haul trucking, while the delayed facilities (which are normally given priority) are awaited. So too, in the event of output station malfunction or overload, the indexing means (**41**, FIGURE 3A) of the affected output station, where such are computer controlled, can be voided and spare output stations substituted therefor.

It will be evident that the inventive system here disclosed can be used with a single computer program to effect all sortations. In such an application all mail, regardless of ultimate destination, will be "read" and second-coded in the initial run through the code converter **5**. In this arrangement, the first digit of the second coding (the arbitrary code) will signify the sortation during which the ejection of the mail is to be effected. An explanation of this is best understood with reference to the preceding chart. The first three digits of the ZIP Code will signal to the appropriately programmed computer **6** that the article so addressed in long distance, out-of-town, local, or in-town mail. Thus, it will cause the code converter **5** to second-code the coding bar for each article with an initial digit signifying the sortation; the other two digits of the second coding will signify the output station **7**. Therefore, mail for Albin, Wyo. ZIP coded 82050 will be second-coded: 171. The initial "1" will signify the first sortation, and that digit, together with "71" will signify output station "171" (Cheyenne, Wyo.); mail for Bellmead, Tex. (ZIP Code 76705) will be second-coded 217; the "2" will signify the second sortation; joined with the "17" it will signify output station "217" (Waco). Finally ZIP Code 75019 will evoke a second-code of 519 in this the "5" signifies the 3rd sortation, and that together with 19 denotes output station "519" (Coppell, Tex.); ZIP Code 75223 will evoke a second-code of 701, where 7 signifies the 4th sortation; joined with 01, it will signify output station "701" (Dallas).

In a Dallas, Tex. post office, then, the system computer **6** will be programmed to evoke an initial digit for the second-coding of "0" or "1" (for a first sortation) on discerning an initial ZIP Code digit of 0 through 6 and 8 through 9. These initial ZIP Code numerals signify

long-distance, hence, first sortation mail. In the manner already discussed, the code converter **5** and the computer **6** will cooperate to discern the correct output station **7** for such articles by "reading" the remaining discrete digits of the ZIP Code. On discerning an article ZIP coded with initial digit of 7, the computer **6** will be programmed to recognize this as other than long distance mail. Therefore, the code converter **5** will "read" successive digits of these ZIP Codes. On reading a 76XXX, or 79XXX, or 77XXX, or 78XXX, or 74XXX, etc., by the code converter **5** the coding bar of the article concerned will be given a sortation digit (i.e., the first digit of the second coding) of "2." Articles thus second coded will be sorted out in the second sortation. Code converter "reading" of 751XX, or 753XX, or 754XX, etc., will evoke a sortation coding of "3." ZIP Codes of 75201 to 75247 is mail for Dallas proper. Thus, articles of mail thus ZIP-coded will be given a sortation digit of "4."

In this usage of the inventive system, use of a single computer program to effect all sortations, it may be desirable to transpose the positions of inverter **4** and code converter **5**. With reference to FIGURE 1, then, code converter **5** would be more proximate to the operators or machine readers **2**, and inverter **4** would be placed beyond the code converter **5**. Both the code converter **5** and inverter **4** would be out of the closed-loop system **10**, being disposed in advance thereof. Also inverter **8** would be placed beyond the closed-loop system **10**, being disposed along return line **11**. With reference to FIGURE 2, the code converter **5** would be at the left and would be disposed below conveyor means **3**, and inverter **4** would be at the right. The purpose in this repositioning would be to avoid the necessity of first inverting and then righting the magazines **13** on each successive sortation. This rearrangement, facilitated by the code-conversion of all mail articles prior to the first sortation, allows the one-time inversion of the magazines **13** and accommodates their maintenance in this attitude throughout all sortations and storage; thus, possible damage to the magazines from excessive or repeated inversion and re-righting can be avoided.

Any sortation digits, or combinations thereof, can be used, such as "0" and "1" for a first sortation, "2," "3," and "4" for a second sortation, "5," and "6" for a third, and "7," "8," and "9" for a fourth. The computer **6** can remotely alter the indexing means **41** (FIGURE 3), with the initiation of each successive sortation, or the re-setting can be done manually, to change the indexing from 001 through 199 (for a first sortation), to 201 through 499 (for a second sortation), etc.

I have described two methods for the use of computer-controlled code conversion in my inventive system.

It will be evident, however, that, in lieu of a flexible, dynamic computer, the ends of the inventive system can be effected with less complex arrangements having known and appropriate digital logic. In this embodiment, direct employment of the ZIP Code is made. That is, the low-level binary encoding of the ZIP Code address is not converted to an arbitrary output station binary encoding. Rather, the binary representation, initially encoded on the coding bar of mail for, by way of example, Chicago, Ill., ZIP coded as 60613 (binary, low-level coding: 00110 00000 00110 00001 00011) will be retained in processing through the code converter (**5**, FIG. 1). After passage through the code converter, the coding bar will have the same ZIP Code number binary encoding, but now it will be a high-level (40 gauss) encoding.

In this embodiment of my inventive system, the digital logic devices are coupled to the output station read-out devices (**65**, FIG. 9) and will be configured to discern significant digits of the high-level, ZIP-Code number, binary encoding. In a first sortation, then, the logic devices are responsive to binary representations of ZIP Codes having initial digits of 0 through 6 and 8 and 9. The output station dial switches (**78**, FIG. 10) are coupled to the logic devices to establish their response, to establish output station sensing codes 000 through 699 and 800 through 999. Thus, an output station, perhaps the 116th in an array of two hundred or more, will have a sensing code of 606. This, then, is the output station that will receive the Chicago mail ZIP-Coded 60613.

Following the first sortation the output station dial switches (**78**, FIG. 10) are manually or remotely changed to establish output station sensing codes complementary to the second sortation. These second sortation codes also are direct extractions of successive digits of the ZIP Codes for out-of-town mail (the long-distance, major cities' mail having been ejected from the magazines). These sensing codes, for Fort Worth, Waco, Wichita Falls, San Antonio, etc. mail, are 000 through 499 and 700 through 999. This is so because 3rd and 4th sortation mail is ZIP-Coded 75060 through 76501 (Dallas proper, and surrounding communities). The digital logic and the output station switching means is configured to ignore the initial ZIP-Code digit "7," now, because all mail remaining in the magazines is so identified. The digit "7," then, doesn't help the subsequent discernment. The second, third, and fourth ZIP-Code digits, now, are significant. As the Dallas-area mail embraces the significant second, third, and fourth Zip-Code digits 506 through 650, output stations will not have sensing codes for 500 through 699 in this second sortation.

Third and fourth sortations follow the same principles. In the third sortation, the sensing codes at the output stations are 500 through 519 and 530 through 699. This sortation will extract 76039 (Euless), 75060 (Irving), 76051 (Grapevine), etc., mail and leave only mail for the city of Dallas in the magazines. In the fourth and final sortation mail ZIP-Coded 75201 through 75247, the Dallas mail, will be accepted from the magazines by means of the once more re-established or changed output station sensing codes which, in the final sortation, look for encodings of 200 through 299. Here the last three digits of the ZIP Code are significant, for all the mail in the magazines, all Dallas mail, has "75" as initial ZIP Code digits. As these do not contribute to discriminating sortation, they are neither sensed nor used in the final sortation.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that the description is made only by way of example and not as a limitation to the scope of my invention, as set forth in the objects thereof and in the accompanying claims.

I claim:

1. An automatic article sorting system comprising;
means for the input of the articles;
output stations for the receipt of sorted articles; means intermediate said input means and said output stations to handle the articles therebetween, said handling means having
means to move the articles from said input means said output stations in sortation passes,
means cooperative with said output stations to release only selected articles to said output stations during each sortation pass, and
storage means for the storage of other than selected articles following each sortation pass;
said handling means further including article holding magazines, said magazines having article destination coding devices; and said input means comprising
means to stack input articles,
means to single out successive topmost articles,
means for inserting said topmost articles into said article holding magazines, and
means for initial encoding of said coding devices so as to signify thereby the discrete nature or destination of the articles inserted in said magazines.

2. An automatic sorting system, according to claim **1**, wherein:
said output stations are less in number than the number of sortations.

3. A sorting system, according to claim 1, wherein:
said output stations have means to sense which of the articles are correctly receivable therein.

4. A sorting system, according to claim 1, wherein said magazines further have
means for ejecting articles held therein, said ejecting means being cooperative with said releasing means to discharge said selected articles from said magazines to said output stations.

5. A sorting system, according to claim 1, wherein said moving means comprise
a conveyor system, said conveyor system defining a closed-loop path from a given point removed from said input means, along said output stations, and back to said given point.

6. A sorting system, according to claim 5, wherein said handling means further have
code converting means, positioned adjacent to said conveyor system and intermediate said given point and said output stations, to discern the initial encoding of said coding devices and to add a second encoding thereto.

7. A sorting system, according to claim 6, wherein said handling means further have
control means, remote from and coupled to said code converting means, to cause said code converting means to add said second encoding to said coding devices as a discrete coding having a correspondence to the discrete nature of the articles.

8. A sorting system, according to claim 7, wherein:
said control means causes said code converting means to add said second encoding to said coding devices as a discrete coding having in part a coding symbol signifying in which of the sortation passes the articles are to be discharged from said magazines.

9. A sorting system, according to claim 7, wherein:
said control means causes said code converting means to add said second encoding to said coding devices only on discernment by said code converting means of a first range of said initial encoding of said coding devices, and causes said code converting means to add said second encoding only on discernment of successive ranges of said initial encoding.

10. A sorting system, according to claim 1, wherein:
said output stations further have means for the automatic bundling of articles there ejected, said bundling means including
means for aerodynamically lofting said articles in free fall,
means for stacking the lofted articles,

means to envelop successive groups of the stacked articles,
means to tighten said enveloping means about said successive groups, and
means to release said tightly enveloped groups to receptacles.

11. A sorting system, according to claim 10, wherein said stacking means comprise
a ramp disposed beneath said output station, said ramp having ports defined therein along the length thereof to permit the passage of air therethrough;
an air rack, disposed along and adjacent to that surface of said ramp which is opposite said output station, said air rack having orifices defined therein, along the length thereof, on that surface most proximate to said ramp, said orifices being disposed immediately opposite said ports; and
a source of pressured air joined to said air pipe.

12. A sorting system, according to claim 11, wherein:
said enveloping means comprise a supply web of heat-shrinkable pouch strips, and a reel secured at the upper end of said ramp on which said supply web is maintained and from which reel said supply web of pouch strips is fed downward over the surface of said ramp which is opposite said air pipe.

13. A sorting system, according to claim 12, wherein:
said tightening means comprise an air line connected to said source of pressured air at one end and venting across the lower end of said ramp at the opposite end, and means for heating the air passed through said air line.

14. A sorting system for discrete, flat articles, according to claim 13, wherein:
said pouch strips on said reel are interfolded, at mating ends thereof, to insure the down feeding of successive pouch strips in a continuous supply web as foremost pouch strips disengage, due to the weight of an adequate capacity of articles, and fall into receptacles.

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