Aug. 10, 1965 A. G. FLINT 3,199,673

APPARATUS AND METHOD FOR HANDLING ARTICLES

Filed April 19, 1962 4 Sheets-Sheet 1

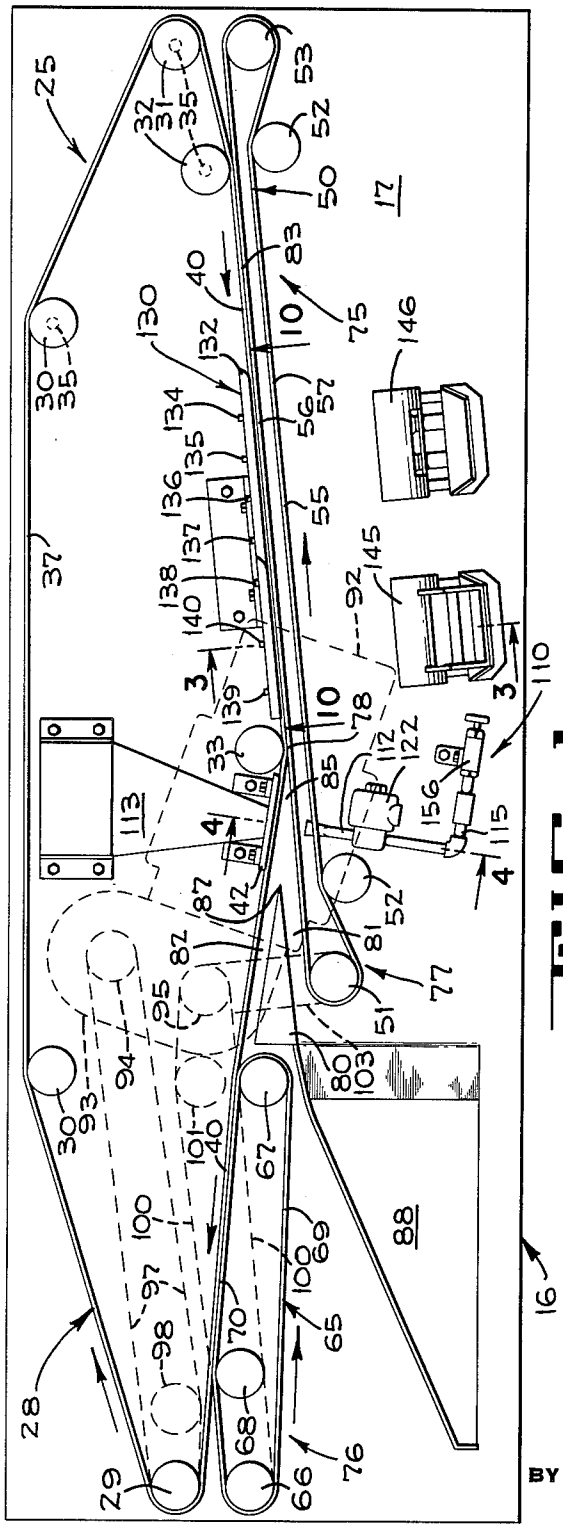


FIG. 1

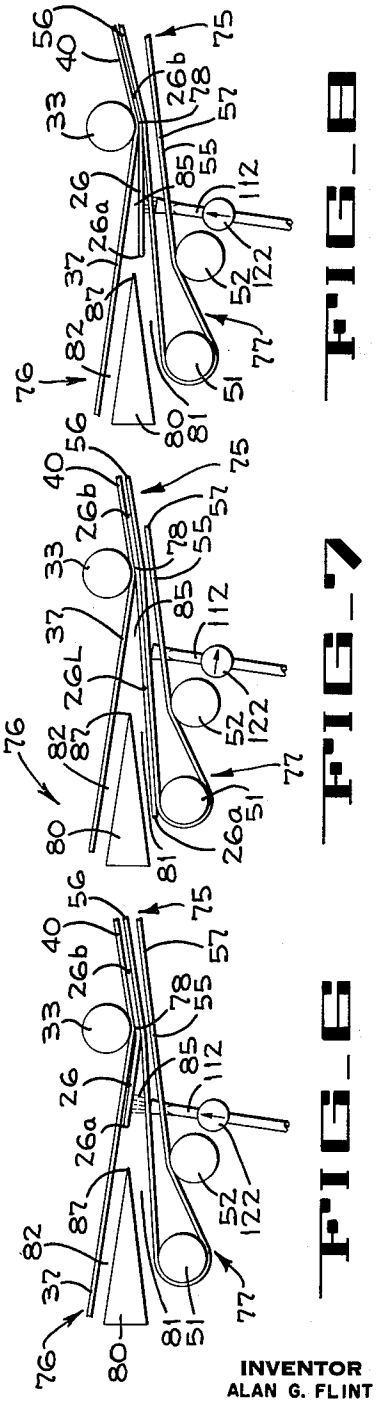


FIG. 7

FIG. 6

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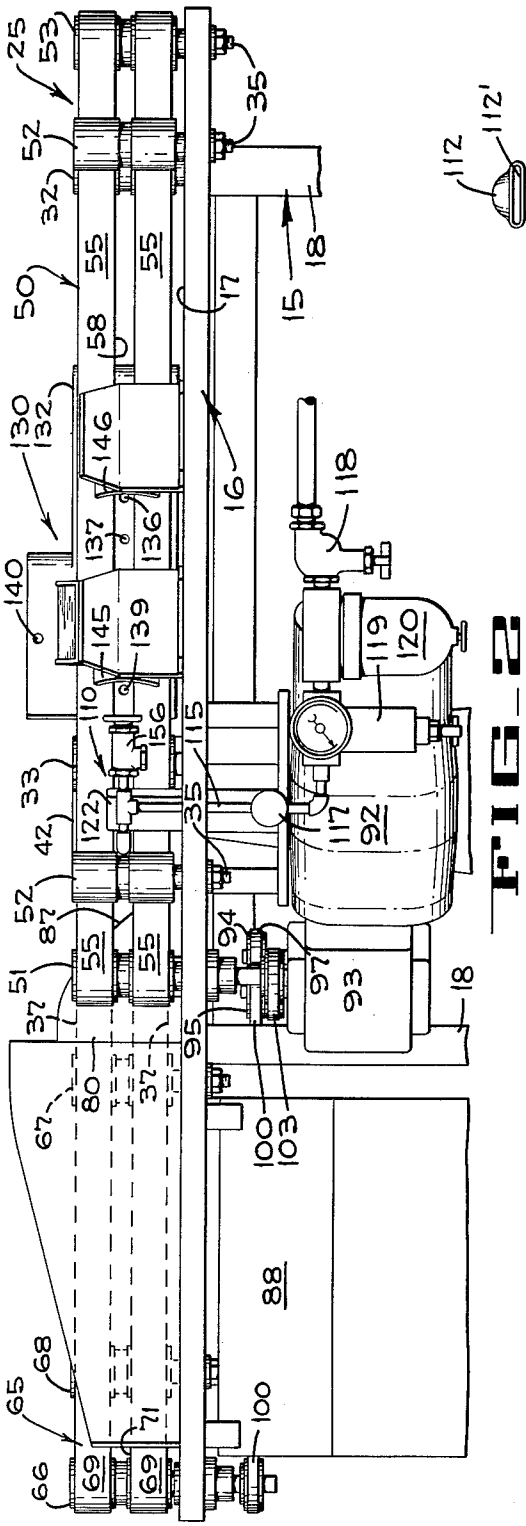


FIG. 2

FIG. 5

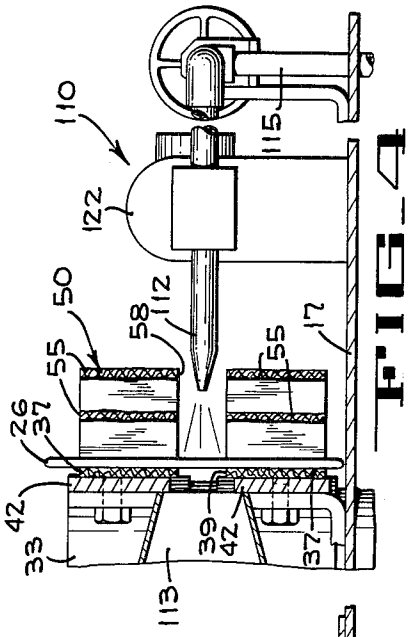


FIG. 4

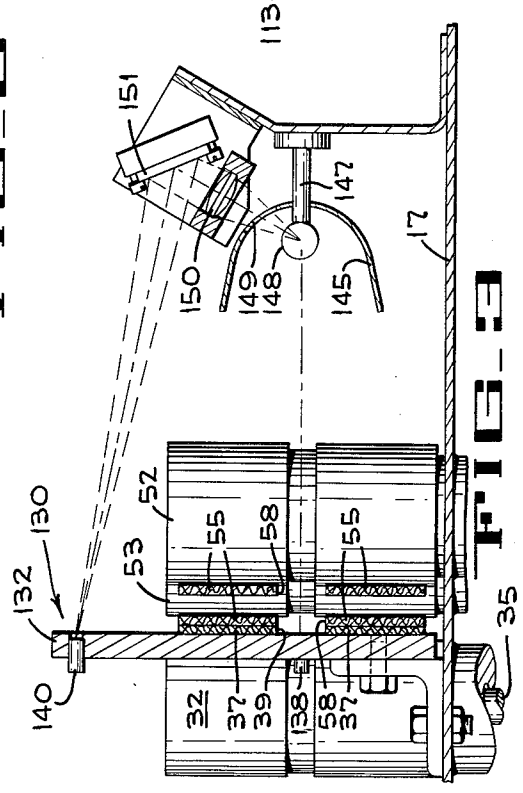


FIG. 3

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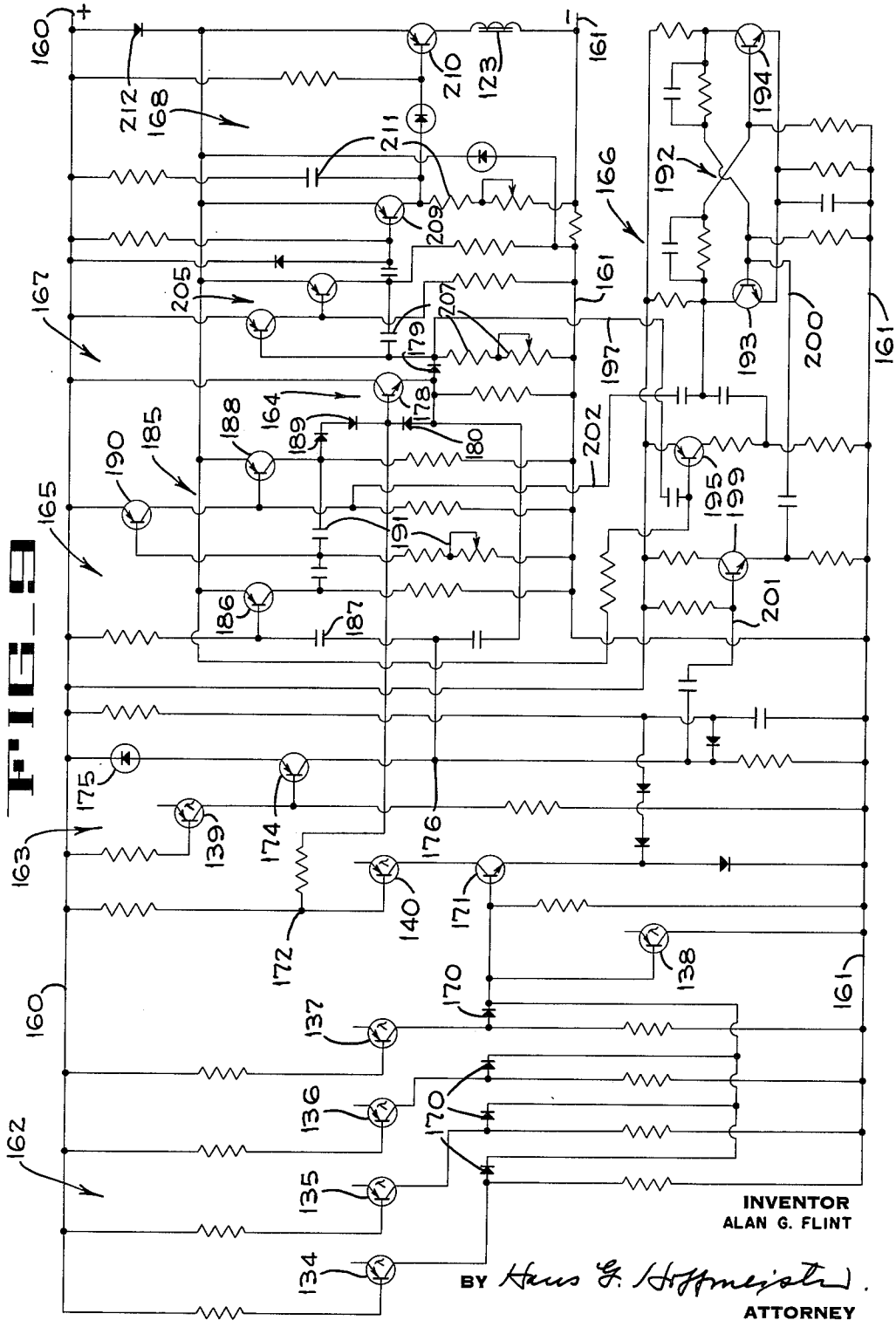


FIG. 9

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FIG_10

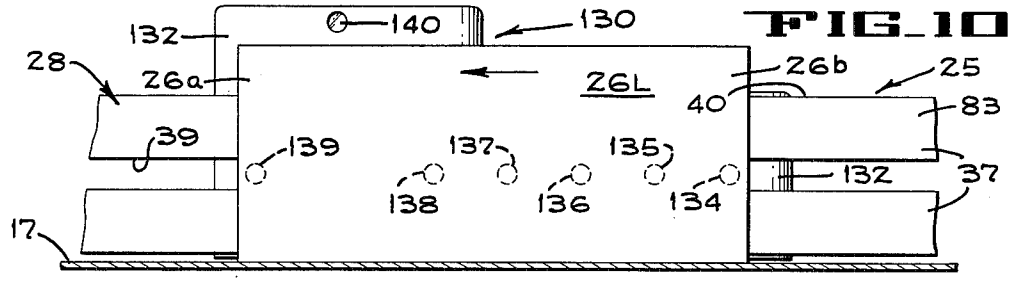


FIG_11

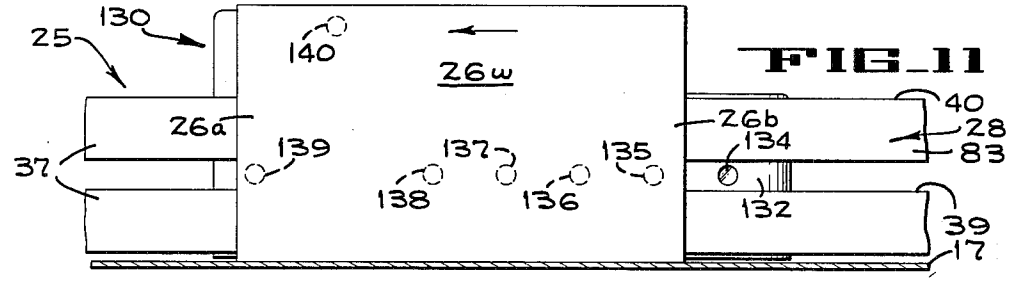


FIG_12

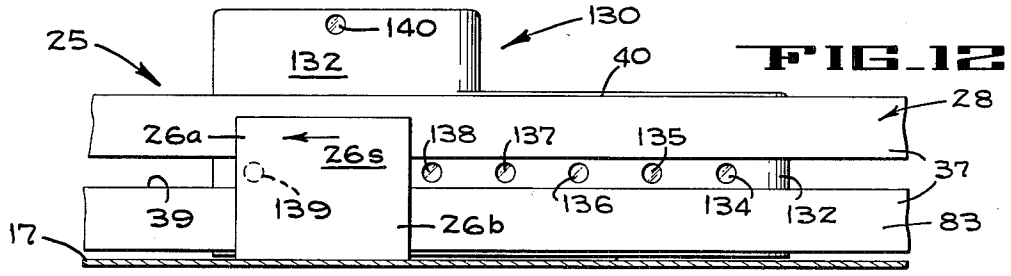


FIG_13

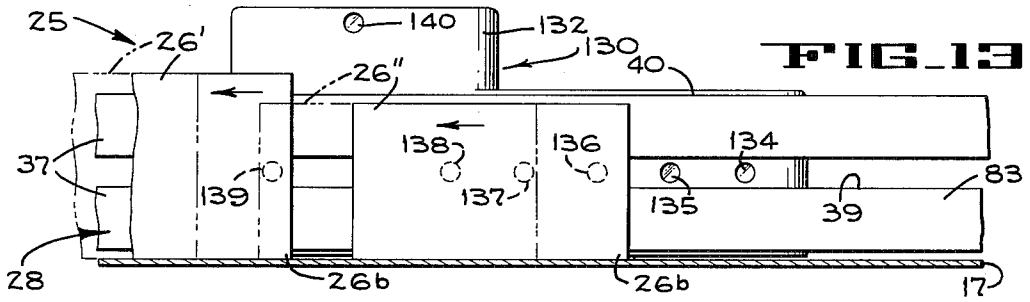
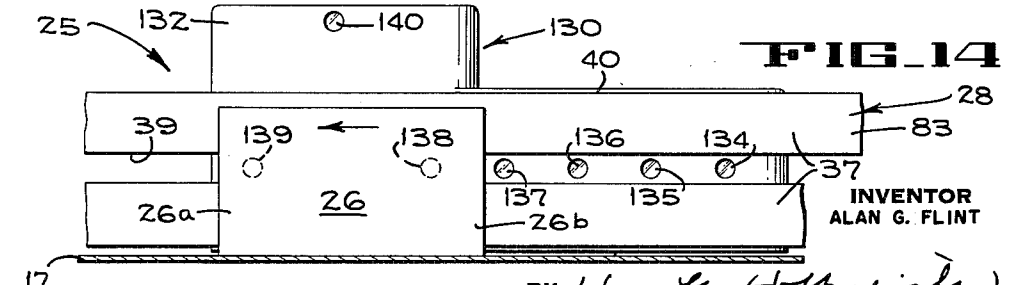


FIG_14



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United States Patent Office 3,199,673 Patented Aug. 10, 1965

3,199,673

APPARATUS AND METHOD FOR HANDLING ARTICLES

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Filed Apr. 19, 1962, Ser. No. 188,800
2 Claims. (Cl. 209—79)

The present invention pertains to an apparatus and method for handling articles, such as letters, and more particularly an apparatus for separating articles by removing from a procession thereof all those articles which have predetermined nonstandard flexibility characteristics.

The apparatus of the present invention has special utility in separating letters for further handling in automatic post office equipment. For example, certain mail sorting equipment will process letters satisfactorily only if they meet certain standards, namely if they are within a range of standard sizes, if they are sufficiently flexible, and if they are spaced far enough apart as they advance through the equipment. The feature of the sorting apparatus that forms the subject matter of the present invention is that of sorting letters in accordance with their flexibility. Parenthetically, the term letter, as used herein, means an envelope and its contents or a post card, but it will be evident as the description proceeds that the principles of the invention are not limited to the separation of letters.

Accordingly, it is an object of the present invention to provide an apparatus for separating articles from a procession thereof into standard and nonstandard groups according to their flexibility.

Another object is to provide an apparatus and method for diverting flexible articles off from a path along which they are traveling.

Another object is to provide an article separating apparatus which separates articles on the basis of flexibility by the use of air pressure and which separates articles on the basis of size and spacing by electronically controlling the presence or absence of air pressure.

Another object is to provide an article separating apparatus which includes a minimum of moving parts.

Another object is to provide an article separating apparatus of the nature described which is particularly useful for separating letters which are nonstandard as to flexibility and which handles a large volume of letters without damage thereto.

These together with other objects and advantages will become apparent upon reference to the following description and accompanying drawings, in which:

FIG. 1 is a plan of an article separating apparatus embodying the present invention.

FIG. 2 is a side elevation of the separating apparatus illustrated in FIG. 1.

FIG. 3 is an enlarged, vertical fragmentary transverse section taken on line 3—3 in FIG. 1 and showing light rays in dashed lines.

FIG. 4 is an enlarged, fragmentary, vertical transverse section taken on line 4—4 in FIG. 1 and showing a letter as it is being deflected by an air blast issuing from a nozzle of the subject apparatus.

FIG. 5 is an enlarged detail end view of the nozzle.

FIGS. 6, 7 and 8 are diagrammatic plans showing various operating conditions of the subject apparatus as letters move through a separating station into either an acceptance channel or a rejection channel.

FIG. 9 is a diagram of an electrical system included in the subject separating apparatus.

FIGS. 10–14 are operational views taken at a position indicated by line 10—10 in FIG. 1 and showing letters passing through the sensing unit of the subject apparatus.

With particular reference to FIGS. 1 and 2, the present article separating apparatus provides a frame 15 including a table 16 having a substantially horizontal supporting surface 17 and being supported by legs 18.

A conveyor assembly, generally indicated by numeral 25, is provided for conveying letters 26 (FIGS. 6–8) through the separating apparatus. This conveyor assembly (FIG. 1) includes a main conveyor 28 having a forward driven roller 29, front and rear outside rollers 30, a rear input roller 31, a rear inner roller 32, and a forward inner roller 33. All of the rollers are dual, that is, have upper and lower portions, as best illustrated in FIG. 2. Furthermore, all of the rollers are mounted on axles 35 which are supported in the table 16 and project up from the supporting surface 17. The main conveyor also provides upper and lower vertical belts 37 respectively guided around the upper and lower portions of the various rollers and in vertically spaced relation to each other so as to provide a horizontal slot 39 which is relatively narrow compared with the width of a letter (FIG. 4). The belts also provide an inner run 40 (FIG. 1) which extends generally longitudinally of the table. Upper and lower backing plates 42 are mounted on the table in front of the forward inner roller 33 for slidable engagement by the upper and lower belts, respectively, of the inner run.

The conveyor assembly 25 also includes a rear auxiliary conveyor 50 (FIGS. 1 and 2) having a forward driven roller 51 (FIG. 1), front and rear outside rollers 52, and a rear input roller 53, all of which are mounted on the table 16 in a manner similar to the rollers 29–33. Furthermore, upper and lower belts 55 circumscribe the input and forward rollers and bear against the outside rollers so as to provide an inner run 56 releasably bearing against the inner run 40 from the roller 32 to the roller 33; a return run 57; and a horizontal slot 58 (FIG. 2), the latter being in the same plane as the slot 39.

Still further, the conveyor assembly 25 includes a forward auxiliary conveyor 65 (FIGS. 1 and 2) providing a forward driven roller 66 (FIG. 1), a rear roller 67, and an intermediate roller 68, all of which are mounted on the table 16 like the rollers 29–33. Upper and lower belts 69 are trained about the forward and rear rollers and bear against the intermediate roller thus providing an inner run 70 releasably bearing against the inner run 40 from the roller 67 to the roller 68 and a horizontal slot 71 coplanar with the slots 39 and 58.

It is significant, therefore, that the described conveyor assembly 25 has a rear section 75 extending along a sensing path 83 from the input rollers 31 and 53 to the forward inner roller 33, a main forward section 76 projecting forward from the forward inner roller 33 in oblique relation to the rear section, an auxiliary forward section 77 projecting forward from the forward inner roller in substantial alignment with the rear section whereby these forward sections diverge forward in predetermined angular relation from a juncture 78 at said forward inner roller 33. Between these forward sections, a triangular separating block or partition 80 is rigidly secured to the table 16 and projects upward from the supporting surface 17 so as to define a rejection channel 81 between the auxiliary forward section and the block, an acceptance channel 82 between the main forward section and the block, and a separating station 85 between the forward sections and between the block and the juncture 78. By providing the block with a rear edge 87 which is upwardly forwardly inclined from the table, the articles move into one channel or the other without interference by this edge. Furthermore, a rejection chute 88 is attached to the table 16 forwardly adjacent to and in alignment with the rejection channel

81 for receiving letters 26 passing through the rejection channel.

For motivating the conveyor assembly 25, a main drive motor 92 (FIG. 1) is mounted under the table 16 and drives main and auxiliary output pulleys 94 and 95 in opposite directions through a gear box 93. A main driving belt 97, which extends around the main output pulley and an idler roller 98, rotatably drives the forward driven roller 29 of the main conveyor. A forward auxiliary driving belt 100, which extends around the auxiliary output pulley and an idler roller 101, rotatably drives the forward driven roller 66 of the forward auxiliary conveyor. Finally, a rear auxiliary driving belt 103 passes around another section of the output pulley 95 and drives the forward driven roller 51 of the rear auxiliary conveyor 50. When the drive motor 95 is energized, therefore, the conveyors are motivated so that their inner runs 40, 56, and 70 all travel in a forward direction at the same speed. In this manner, letters 26 are fed in spaced, single file relation between the inner runs 40 and 56 from the rear inner roller 32 along the sensing path 83 through the juncture 78 and into the separating station 85.

Before considering how the size and spacing between adjacent letters 26 are sensed, a description is given of the manner in which the letters are directed into either the acceptance channel 82 or the rejection channel 81 at the separating station 85. Accordingly, a directing unit, generally indicated by the numeral 110, is provided for this purpose and includes a horizontal air nozzle 112 extending through the slot 58 in the return run 57 in forwardly adjacent spaced relation to the juncture 78. The air nozzle includes a tubular section blending into a flattened section which opens through an outlet slot 112' (FIG. 5) from which air is directed under predetermined pressure across the separating station 85 (FIG. 1) toward the run 40 where it extends along the main forward section 76 of the conveyor assembly 25. A funnel 113, mounted in the table 16, is provided for capturing and discharging the air. The slotted nozzle, as disclosed herein, produces an air blast at the optimum impact force, pressure and spread. That is, it is desirable to obtain a high impact force so as to positively deflect the letters as they enter the separating station, to minimize air pressure so as to conserve air and reduce noise level, and to minimize the angle of air spread so that the air blast or stream readily passes through the narrow slot 39 between the belts 37 into the funnel. The subject nozzle is excellently suited for these purposes.

The air nozzle 112 has an inlet portion 115 in which is connected a solenoid valve 117 which automatically opens and closes with starting and stopping of the motor 92, a manual maintenance valve 118, a manually adjustable pressure regulator 119, and an air filter 120. A high pressure air source, not shown, is connected to the maintenance valve. A solenoid valve 122, including a solenoid 123 (FIG. 9), is also connected in the inlet portion of the air nozzle (FIG. 1) and is electrically opened or closed for providing, or for shutting off, the blast of air across the separating station 85. For the purposes of the present invention, the solenoid valve has just two positions, namely, an open position with the solenoid 123 energized and a closed position with the solenoid deenergized.

When the solenoid 123 is energized and a letter 26 of predetermined flexibility has its leading portion 26*a* (FIG. 6) in the separating station 85 and its trailing portion 26*b* grasped at, and forwardly propelled through, the juncture 78, said letter is deflected into the acceptance channel 82 by the blast of air, whereas a letter of insufficient flexibility (FIG. 8), that is of predetermined stiffness, is not deflected and therefore passes into the rejection channel 81 and thence into the chute 88. The slot 39 is made narrow so that highly flexible letters are not blown through the slot 39; as explained, the described nozzle 112 makes such narrowness possible. When the solenoid valve is in its deenergized condition, a letter (FIG. 7) moving through the separating station continues on into and through the rejection channel even if it is of the required flexibility since there is no blast of air to deflect it.

It is also significant that the present apparatus provides a sensing unit, generally indicated by the numeral 130 (FIG. 1), positioned along the sensing path 83, for sensing the letter size and spacing and for controlling the solenoid valve 122 in accordance with predetermined standards of size and spacing. The sensing unit includes a mounting plate 132 secured to the table 16 and projecting up from the supporting surface 17 on the opposite side of the inner run 40 from the inner run 56. The sensing unit also includes an electrical system (FIG. 9) which includes a row of lower phototransistors 134–139 (FIG. 10) mounted in the plate 132 in the same plane as the slot 39 with the phototransistors being in longitudinally spaced relation along said sensing path 83 (FIG. 1), and an upper phototransistor 140 (FIG. 10) mounted in the plate 132 a predetermined distance above the supporting surface 17, it being noted that the upper phototransistor is also above the belts 37 and 55. The phototransistors 134–138 in said row and the upper phototransistor 140 are hereinafter referred to as conditioning phototransistors whereas the forwardmost phototransistor 134 in the row is hereinafter referred to as the signaling phototransistor since these terms indicate their main functions in the electrical system of FIG. 9.

The sensing unit 130 (FIG. 1) also includes front and rear, generally parabolic reflectors 145 and 146 mounted on the table 16 on the opposite side of the rear section 75 of the conveyor assembly 25 from the mounting plate 132. Lamp holders 147 are mounted within the reflectors (FIG. 3), and light bulbs 148 are supported in the lamp holders. When the bulbs are lighted, light rays are reflected by the reflectors and beamed through the slots 39 and 58 onto the photo-transistors 134–139 in the described lower row thereof. Further, the front reflector has an upper opening 149, and light passes through this opening, then through a double convex lens 150 and is reflected by a mirror 151 across and over the rear conveyor section 75 onto the upper phototransistor 140. Although not shown, it is preferable to enclose the sensing unit 130 and to blow air into such enclosure through a needle valve 156 connected to the inlet portion 115 of the nozzle 112; in this manner dust is minimized in the sensing unit.

It is believed understood, therefore, that when no letters 26 are being conveyed along the sensing path 83, all of the phototransistors 134–140 are illuminated and energized. When a letter moves along the sensing path, however, it interrupts the beams of light and darkens, that is deenergizes, one or more of the phototransistors. The combinations of phototransistors which are darkened and illuminated, and the timing thereof, indicate the size and spacing of the letters. Energization and deenergization of the phototransistors, therefore, is effective through the electrical system of FIG. 9 to shut off the blast of air from the air nozzle 112 whenever a letter should be rejected, as will be explained in detail below.

Referring specifically to the electrical system of FIG. 9, positive and negative lines 160 and 161 are connected to a source of D.C. voltage, for example 25 volts. Connected between these lines are a conditioning circuit 162, a signal circuit 163, a coupling circuit 164, a spacing circuit 165, a nullifying circuit 166, a time delay circuit 167, and an output circuit 168. Briefly considering the significant components of these various circuits, the conditioning circuit includes the conditioning phototransistors 134–138 and 140. The conditioning phototransistors 134, 135, 136 and 137 have their bases connected to the positive line and their collectors connected through diodes 170 to a conditioning transistor 171. The

phototransistor **138** has its base connected to the base of the conditioning transistor and its collector connected to the negative line. The upper conditioning phototransistor **140** has its base connected to the positive line and its collector connected to the collector of the conditioning transistor. The conditioning circuit also has an output terminal **172** at the base of the upper conditioning phototransistor. It will be noted that not all of the circuit components are specifically described and for these, reference is made to FIG. 9.

The signaling circuit **163** includes the signaling transistor **139** which has its base connected to the positive line **160** and its collector connected to the negative line **161**. It is to be noted that none of the emitters of the several phototransistors **134–140** are connected in the outside circuits. The collector of the signaling phototransistor is also connected to a signaling transistor **174** having its emitter connected through a zener diode **175** to the positive line and its collector connected to the negative line. The signaling circuit has an output terminal **176** at the collector of the signaling transistor.

The coupling circuit **164** includes a coupling transistor **178** having its collector directly connected to the positive line **160**, its emmiter connected to the negative line **161**, and its base connected to the output terminal **172** of the conditioning circuit **162**. The emitter of the coupling transistor is also connected to a main coupling diode **179**. The output terminal **176** of the signaling circuit **163** is connected through a diode **180** to the base of the coupling transistor.

The spacing circuit **165** provides a monostable multivibrator **185** and an amplifying transistor **186** connected through an input capacitor **187** to the output terminal **176**. The spacing multivibrator includes an output transistor **188** connected through a pair of diodes **189** to the base of the coupling transistor **178**, an input transistor **190** connected from the collector of the output transistor to the base of the amplifying transistor, and a resistance-capacitance combination **191** for determining the time in which the multivibrator is in its semistable condition.

The nullifying circuit **166** is provided to nullify the effect of the spacing circuit **165** and includes a bi-stable multivibrator **192** having left and right transistors **193** and **194**, and an inverting transistor **195** connected to the main coupling diode **179** by an input line **197** and having an output connected to the left nullifying transistor. An amplifying transistor **199** has its output connected to the left nullifying transistor through line **200**, and an input line **201** connects the base of the amplifying transistor to the output terminal **176** of the signaling circuit **163**. Furthermore, the nullifying circuit **166** has an output line **202** interconnecting the nullifying multivibrator **192** and the base of the output transistor **188** in the spacing multivibrator **185**.

The time delay circuit **167** includes a monostable multivibrator **205** and a resistance-capacitance combination **207** which determines the time in which the time delaying multivibrator is in its semistable condition. The time delay multivibrator has its input connected to the main coupling diode **179**.

The output circuit **168** provides input transistor **209** connected to the output of the time delay multivibrator **205** and a resistance-capacitance combination **211**. The output circuit has an output transistor **210** connected to the positive line through a diode **212** and to the negative line **161** through the air valve solenoid **123**.

The operation of the present separating apparatus is described at this point. In order to place the apparatus in operating condition, the drive motor **92** is energized whereby the valve **117** opens and the runs **40**, **56** and **70** travel forwardly, preferably at a speed of one hundred and ten inches per second, the bulbs **148** are energized to illuminate the phototransistors **134** to **140** inclusive, and D.C. voltage is applied across the positive and negative lines **160** and **161** of the electrical system thereby energizing the solenoid **123** and opening the valve **122** whereby a blast of air issues from the nozzle **112**. The pressure of the air blast is adjusted by the regulator **119**.

When the subject apparatus is used for separating letters **26**, the primary purpose of the apparatus is to remove from a continuous flow of the mixed singulated letters, that is, letters spaced in a single file procession, all those letters which are outside of a predetermined range of sizes, all those letters which are too stiff, and all those letters which are not spaced far enough away from their respective preceding letters. For example, the range of standard sizes may be from 3¾ inches to 11¾ inches long and 2¾ inches to 5¾ inches wide; stiff letters may be defined as those which are not deflected seventeen degrees by an air blast of forty p.s.i. issuing from the air nozzle **112**, and wherein the nozzle is spaced longitudinally from the juncture **78** by a distance of 3⅜ inches; and the standard minimum space between successive letters may be 2¾ inches. It is evident, of course, that the invention is not limited to these specific values, nor to other specific examples given throughout the specification, but that these values and examples are given only to aid in understanding the invention.

Thus, assuming that letters **26** are fed in spaced, single file relation between the input rollers **31** and **53** (FIG. 1), the conveyor assembly **25** moves the letters along the sensing path **83**. Before the letters reach the separating station **85**, the phototransistors **134–140** sense the size and spacing between the letters and shut off the air blast if the letter is too long, too wide, too short, or too close to the preceding letter; letters of standard size and spacing do not turn off the air blast but are subjected to a stiffness test in the separating station. The operation of the electrical system (FIG. 9) under each of these conditions is separately described below. But initially, however, several general statements about the system will aid in understanding how the system operates under these various conditions. With reference to FIGS. 1 and 9, it is first to be noted that the air blast from the nozzle **112** is normally on but is turned off by a reject signal conducted through the main coupling diode **179**, the delay circuit **167** and the output circuit **168**, the latter deenergizing the solenoid **123** in response to the reject signal. Second, as each letter **26** darkens the signaling phototransistor **139**, a positive reject signal or pulse is developed at the output terminal **176**. Third, the nearly positive line voltage at the terminal **172** normally conditions the main coupling diode **179** to conduct such a reject signal. Fourth, this conducting condition of the main coupling diode is not changed by letters of nonstandard sizes so that these letters are rejected. Fifth, a letter of standard size substantially reduces the voltage at the terminal **172** whereby the main coupling diode is reverse-biased so as to block the reject signal.

With these general operational conditions in mind, when a letter **26***l* which is too long (FIG. 10) moves along the sensing path **83**, the row of lower phototransistors **134–139** are all darkened at some instant. Darkening of the phototransistors **134–138** causes the voltage at the base of the conditioning transistor **171** (FIG. 9) to remain low so that this transistor remains in its conducting condition. Also, because the signaling phototransistor **139** is darkened, a reject signal passes from the terminal **176** through the main coupling diode **179** to the delay circuit **167** whereupon the delay multivibrator **205** is driven into its semistable condition. After a predetermined time delay, determined by the R-C combination **207** and sufficient to allow the leading portion **26***a* of the long letter **26***l* to emerge from the juncture **78**, the delay multivibrator returns to its stable condition whereupon it triggers the output circuit **168** which thereby deenergizes the solenoid **123** and turns off the air blast. Therefore, the letter **26***l* is conveyed into the rejection channel **81** (FIG. 7). The output circuit re-energizes the solenoid after a predetermined interval, determined by the R-C combination **211**, sufficient to allow the leading portion **26***a* of the

rejected letter to project between the separating block 80 and the auxiliary forward section 77 of the conveyor assembly 25.

If a letter 26*w* is too wide (FIG. 11), the upper phototransistor 140 is darkened whereupon the previously described conditioning voltage at the output terminal 172 is unchanged so as to maintain the main coupling diode 179 in a signal conducting condition. Therefore, when the signaling phototransistor 139 is darkened by the leading portion 26*a* of the wide letter 26*w*, a reject signal causes such letter to be rejected in the same manner as the letter which was too long, as described above.

When a letter 26*s* is too short, it fails to darken the phototransistors 138 and 139 simultaneously (FIG. 12). With all of the phototransistors 134–138 illuminated, therefore, they are all conducting and place the conditioning transistor 171 in a nonconducting or off condition. Thus, the conditioning voltage at the terminal 172 remains at substantially the positive line voltage whereby the main coupling diode 179 remains in its signal conducting condition. The reject signal generated by the darkening of the signaling phototransistor 139 by the short letter 26*s* is thus conducted through the main coupling diode and the short letter is rejected in a manner now believed understood.

With reference to FIGS. 9 and 13, the operation of the electrical system with regard to spacing control (FIG. 13) is as follows. As the trailing portion 26*b* of each letter 26′ passes beyond, that is forward of, the signaling phototransistor 139, a negative spacing signal or pulse is developed at the output terminal 176. This spacing signal triggers the spacing multivibrator 185 into its semistable condition whereby the main coupling diode 179 is maintained in its signal conducting condition irrespective of the voltage at the terminal 172. The spacing multivibrator remains in its semistable condition for a predetermined spacing time, determined by the R-C combination 191, just short of the time required for a properly spaced succeeding letter 26″ to darken the signaling phototransistor. If such a succeeding letter 26″ darkens the spacing phototransistor within said predetermined spacing time, a reject signal is generated, as before, and is conducted through the main coupling diode to deenergize solenoid 123 and to reject the succeeding letter.

Still considering spacing control, the nullifying circuit 166 is actuated each time a letter 26 is rejected because of length or width, that is the reason for nullifying circuit is to disable the spacing circuit 165 whenever a letter is rejected since the removal of a letter (by rejecting it) from the procession of letters increases the spacing between the two adjacent letters which remain in the procession so that adequate spacing then exists.

The operation of the nullifying circuit 166 is best explained by reference to FIGS. 9 and 13. In FIG. 13, it is to be assumed that the leading letter 26′ will be rejected when it reaches the separating station 85, that the trailing letter 26″ is of standard size, and further, that the distance between the leading letter 26′ and the trailing letter 26″ is less than the predetermined standard, that is, in the present example, less than 2¾ inches. The cycle of the nullifying multivibrator 192 is initiated by the reject signal conducted through the main coupling diode 179 when the leading letter 26′ darkens the signaling phototransistor. When the trailing portion 26*b* of the leading letter 26′ moves forward of the signaling phototransistor and causes it to be illuminated, the spacing signal developed thereby at terminal 176, in addition to being applied to the spacing multivibrator 185, is fed through the amplifying transistor 199 to the nullifying multivibrator whereby the cycle of the nullifying multivibrator is completed and a nullifying pulse is applied to the output transistor 188 of the spacing multivibrator. This nullifying pulse cancels the pulse from the amplifying transistor 186 so that the spacing multivibrator remains in its stable condition and the main coupling diode 179 is not affected by the spacing circuit 165. As will be specifically described below, however, the main coupling diode is reverse-biased by the standard size trailing letter so that when this trailing letter darkens the signaling phototransistor, the reject signal developed thereby is blocked. Therefore, the trailing letter 26″, even though it may have been too close to the leading letter 26′ along the path 83, is not rejected, assuming that it is of standard size and flexibility. It is believed understood that the nullifying multivibrator is reset only when a reject signal is conducted through the main coupling diode.

A standard size letter 26 passing along the sensing path 83 is illustrated in FIG. 14. With such a letter, the signaling phototransistor 139 and at least the forwardmost lower conditioning phototransistor 138 but no more than the four lower conditioning phototransistors 135–138, are simultaneously darkened. The significant effect of a standard letter on the system is that it causes both the conditioning transistor 171 (FIG. 9) and the upper conditioning phototransistor 140 to conduct so that the voltage at the terminal 172 is substantially reduced whereby the main coupling diode 179 is reverse-biased, that is, is in a nonconducting state. Accordingly, the reject signal caused by the standard size letter darkening the signaling phototransistor 139 is not conducted through the main coupling diode and does not cause deenergization of the solenoid 123.

Assuming that a letter 26 is of standard size and is not too closely spaced to a previous letter, it is submitted to a stiffness test at the separation station 85. That is, as the leading portion 26*a* of such a letter moves into the air blast (FIG. 6), the trailing portion 26*b* is still grasped between the belts 37 and 55 at the juncture 78. If the letter is flexible enough, the air blast bends the letter about said grasped trailing portion and forces the leading portion into alignment with the acceptance channel where it is conveyed by the main forward section 76 of the conveyor assembly 25 out of the subject apparatus. If the letter is too stiff (FIG. 8), the air blast is not sufficiently strong to align the leading portion of the letter with the acceptance channel so that the letter remains aligned with the rejection channel into which it is conveyed for discharge into the rejection bin 88. It is understood, therefore, that letters which are acceptable as to size and spacing, but are unacceptable as to the stiffness, are rejected without the necessity of a reject signal from the electrical system.

It will be evident from the foregoing that the subject apparatus separates articles, such as letters, on the bases of at least five different rejectable conditions although using only one diverting unit, that is the solenoid valve, controlling an air blast. Since the air blast is normally turned on, no electrical signal is needed for accepting or rejecting articles for stiffness and the control solenoid is actuated only for articles of non-standard size and spacing. Furthermore, by disabling the spacing circuit when a letter is rejected, the minimum desired article spacing is obtained while preventing undesirable rejections of standard articles. The apparatus is adjustable, has a minimum of moving parts, does not jam or damage articles handled, and can process articles at a high volume, for example up to about 800 letters per minute.

Although a preferred embodiment of the present invention has been shown as described, it will be understood that changes and modifications may be made in the details thereof without departing from the spirit and the scope of the appended claims.

The invention having thus been described, what is believed to be new and desired to be protected by Letters Patent is:

1. Apparatus for sorting flat, flexible articles according to their degree of flexibility comprising a conveyor including a portion for gripping opposite flat sides of the articles and conveying the articles along a delivery path;

an air jet nozzle, said nozzle being spaced downstream of the article gripping portion of said conveying means and at one side of the article delivery path; the spacing of said nozzle from said gripping means being substantially less than the length of the articles, so that when a leading portion of each article is opposite said nozzle, the trailing portion of the article remains gripped by the gripping portion of said conveyor; first and second article receiving channels downstream of said air jet nozzle, said first channel having an article receiving portion that is aligned with said delivery path for receiving relatively stiff articles, said second channel having an article receiving portion that diverges from said delivery path for receiving relatively flexible articles; means for maintaining a normally flowing jet of air through said nozzle for simultaneously testing the flexibility of all artices that pass the air jet nozzle and diverting the relatively flexible articles into said second channel, said jet of air permitting the relatively stiff articles to continue on into said first channel.

2. The method of directly sorting flat, flexible articles in accordance with their degree of flexibility, comprising the steps of simultaneously advancing a train of the articles along a path while gripping the flat sides of the articles, successively laterally freeing one side of the leading portion of each leading article in the train while continuing to grip and advance the trailing portion of the article, and successively subjecting the other side of the leading portion of each article to a laterally directed, continuously flowing jet of air while the trailing portion of the article is gripped, for flexing the leading portions of all of said articles having less than a predetermined stiffness out of their path of advancement.

References Cited by the Examiner

UNITED STATES PATENTS

1,483,059	2/24	Pool.	
2,138,645	11/38	Rey	209—75
3,035,694	5/62	Hirschfeld.	
3,065,850	11/62	Nixon	209—75

FOREIGN PATENTS

1,215,444	11/59	France.

OTHER REFERENCES

German application, 1,062,465, printed July 30, 1959.

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