ABSTRACT: A paper-handling machine with slitters and a rotary knife cutter for cutting traveling webs of papers has opposing conveyor belts to move sheets of paper downstream from the cutter to a collection area. A reject section is located upstream of the piling section and conveyors are positioned to move the cut sheets to either the piling section or the reject section responsive to a signal received from a sensing device or other switch. Either the reject section and/or the piling section includes a conveyor capable of attracting and holding a cut sheet of paper properly charged with static electricity. Each cut sheet of paper has an electrical charge imparted to it by an electrical charge element positioned adjacent a conveyor belt downstream from the rotary knife. A charge element is signalled to impart a charge to selected paper sheets as the latter pass the device. A charge can be imparted to one side of a cut sheet so that the sheet is shunted to reject section. If a sheet overlap with conveyor belt receptive to an electrical charge is included in the piling section, a second charge element can also be placed adjacent the conveyor belt on the side opposite from the first charge element to charge the opposite side of selected moving paper sheets. The leading edges of the cut sheets being moved to overlap are attracted upwardly to the overhead conveyor and thereafter slowed down and moved over the trailing edges of preceding sheets so that succeeding sheets overlap one another. A static eliminator device is positioned to neutralize the charges imparted to the sheets as they are collected.
Fig. 9
3,612,270

CUTTER PILER WITH ELECTROSTATIC LAYBOY

The present invention is a mechanism for processing and handling paper sheets in which the sheets are cut and then conveyed to a collection area. More specifically, the subject machine includes a slitter and a rotary knife cutter for slitting and cutting moving paper webs into sheets. Thereafter, a conveyor system is arranged to move the cut sheets downstream from the cutter to a piling section. A reject section is included in the conveyor system upstream of the piling section so that selected, defective or defective sheets, or samples, can be automatically shunted to the reject section collecting area. The other sheets are conveyed to a piling section where the sheets are collected to be packaged. In the machine described, electrostatic charges are used to attract and move cut sheets to the collection area.

An electrical charge element is positioned downstream from the cutter to impart an electrical charge to selected paper sheets. The charge element can be positioned to impart a charge to one side of a selected paper sheet destined for the reject collection area. The charge element is triggered to impart a charge to the entire length of a rejected paper sheet being shunted to reject section.

If desired, the machine's reject section can be designed for electrostatic paper handling and a conventional overlap system in the layboy. But it is preferred to position charge elements on both sides of the moving cut sheets so that charges are imparted to either side of the moving paper sheets depending on the destination (reject section or piling section) of the sheets. In this latter embodiment, an upper charge element can be positioned above a conveyor in the layboy and paper charged by the upper charge element is automatically moved to a reject section. A lower charge element is positioned on the opposite sides of the moving sheets so that the sheets are conveyed past the reject section entrance onto a piling section.

The conveyor system leading to the piling section includes an overlap arrangement of conveyors in which the leading edges of the sheets are raised and moved over the trailing edges of preceding sheets and this is accomplished by transferring the cut sheets to a slower moving conveyor belt. If the sheets traveling on a course to the piling section are charged, the electrical charge can be imparted only to the leading edges of the sheets so that the leading edges are attracted and raised towards an overhead conveyor located above the course of travel of the paper sheets. The sheets are then conveyed past the reject entrance to a knockdown device and a sensing device energizes a third charge element which imparts an electrical charge to the trailing edges of each sheet so that the trailing edges are attracted to a relatively slower moving piler conveyor positioned beneath the course of travel. As the charged sheets reach a collection area, a static electricity eliminator removes the charge.

From the description given herein, it will be seen that imparting an electrical charge to moving paper sheets offers a way to exercise superior control over sheets being processed and conveyed than previous methods and equipment. Currently, control over the sheets being rapidly moved to a collection area is accomplished by vacuum, air pressure or by nipping the sheets with tapes or other mechanical means. The disadvantages of known layboy equipment are, chiefly, the equipment is too expensive and subject to malfunction. For instance, the use of vacuum or air pressure to control the cut sheets necessitates ductwork, pipes and, in the case of air pressure, risks the introduction of contaminants. Mechanical devices are generally a source of maintenance problems and do not control the rapidly moving sheets sufficiently well at high speeds.

It is an object of the present invention to provide a system for controlling rapidly moving paper sheets that is relatively inexpensive and more effective than presently used devices and techniques. These and other objects will be apparent from the description below.

FIG. 1 is a side view showing the preferred arrangement of cutter and layboy with conveyors leading to reject and piling sections.

FIG. 2 is a front elevation of charge bars positioned above and below the conveyors which move the cut sheets from the cutter section.

FIG. 3 is a bottom plan view of a charge bar with wiring and charge points.

FIG. 4 is a diagrammatic illustration of the electrical charges on a sheet and conveyor which are polarized by a charge bar.

FIG. 5 is a side elevation of the electrostatic overlap shown in part.

FIG. 6 is a side elevation view of the static elimination bar with parts broken away.

FIG. 7 is a side elevation of the layboy showing the conveyor arrangement omitting some parts.

FIG. 8 is a top plan view of the knockdown rolls of the layboy of FIG. 7 taken along the lines VIII--VIII.

FIG. 9 is a diagram of the circuit for the charge elements.

In FIG. 1, a paper train W of single or multiple webs is drawn from one or more unwind devices (not shown) over an adjustable lead-in roll 1 and through slitters 2, by draw roll 3 and squeeze roll 4. The slit webs are then fed between rotary knife 6 and bed knife 5 so that they are cut to length by the action of rotating knife 6 against bed knife 5. The webs have thus been reduced by slitting and cutting to a plurality of continuous, side-by-side packs of paper sheets which are conveyed to one or more collection areas. A source of air from a manifold adjacent bridge 8 assists to move the paper sheets from the cutter to the conveying arrangement of a layboy. As mentioned above, a single web of paper can be processed but the usual practice is to draw two or more paper webs together so that the webs overlie one another before being slit and cut as a single multi layer web. Also, the slitters can be removed as desired. After slitting and cutting, the paper sheets are moved as small packs by the conveyor assembly in the layboy. The foregoing elements are conventional and well known in the trade. For a clearer understanding, the drawings only show two webs being processed, but three or more webs can be handled according to conventional practice.

The cut sheets are moved to a piling section or shunted to a reject section by a series of conveyors, preferably tapes or belts, known as a layboy. The conveyer system is shown in some detail in FIG. 7 and includes rolls 7 and pulleys 16 which drive, support and guide the conveyor elements. Drivebelt 7A is arranged to drive both conveyors 17 and 18. The upper conveyor 17 is formed by a plurality of side-by-side tapes which extend almost the entire length of the layboy. The first lower conveyor 18 is of similar structure to conveyor 17 and both conveyors are normally driven at slightly over web speed. The forward rolls 7 act as nip rolls and the tapes of opposing conveyors 17 and 18 are offset relative to one another so that the cut sheets are pinched between the tapes of conveyors 17 and 18. The second lower conveyor 19 is similar in structure to elements 17 and 18 but is driven at a relatively lower speed to allow the leading edges of the cut sheets to overlap the trailing edges of preceding cut sheets after transfer from the high-speed conveyors to the slower second lower conveyor. The two lower conveyors 18 and 19 are each provided with takeup units 15 for tensioning the conveyors which units include a revolving roll journaled in a movable block as shown in FIG. 7. Between lower conveyors 18 and 19 is the entrance to reject section, with conveyor 18 leading downwardly to the reject collection area. Sheets destined for the piling section are transferred over air bridge 30 (similar to 8) to the slower conveyor 19 and after passing the reject entrance, the cut sheets are moved to a piler section to be stacked on lift platform 27 against back stop 26. The lift platform 27 lowers incrementally as the cut sheets are being piled while jogger finger 24 and side jogger blade 25 guide the sheets to insure sheet alignment. Copending application Ser. No. 684,423 filed Nov. 20, 1967, describes an operative cutter piler system with conveyors that can be included in the layboy described herein.
The above-described arrangement is generally conventional for moving cut sheets to a piler with a layboy. Normally, reject is automatically accomplished by opening a gate responsive to a signal from a pinhole detector, such as a light bulb 32 and phototronic eye 34, positioned before the web passes through the knives 5 and 6. The signal for reject in this system would trigger a mechanical gate such as that seen in FIG. 5 of U.S. Pat. No. 3,216,296. The electric eye scanner is shown monitoring one web but normally each web will have its respective scanner and if each web is being slit into three segments, three scanning devices are used. Also, other defect monitoring devices can be used to accomplish reject.

In the machine disclosed herein, charge elements are used to impart an electrical charge to the paper sheets as the sheets approach the entrance to the reject section.

Downstream from the cutter and before the entrance to the reject section, an electrical charge device is positioned with upper charge element 10 and lower charge element 9 each located in a housing 42 above and below the cut sheets of paper being moved between conveyors 17 and 18.

Each charge element 9 and 10 is preferably an applicator bar 40 which spans the width of the conveyors in the path of the moving cut sheets. In FIG. 2, charge elements 9 and 10 in charging bar 40 hold to a line 41 mounted on support arms 42 above and below conveyors 17 and 18. Each of the conveyors 17 and 18 is formed by a series of endless tapes that are offset relative to one another as seen in FIG. 2.

In FIG. 3, charge bar 40 has rows of aligned charge points 45 which are spaced apart in rows. The rows are spaced so that when assembled above the tapes of conveyors 17 and 18, the upper element 10 has points 45 in line with the tapes of conveyor 18 and the bottom element 9 has its points 45 in line with the tapes of conveyor 17. The points 45 are sharp so that ionization of the air adjacent the conveyors readily takes place during operation. The bars 40 can be spaced about 1 inch above and below the moving cut sheets and tapes. A power cable 46 supplies about 10,000–70,000 volts DC usually about 30,000 volts, and the points 45 can be charged to generate negative or positive ions as desired. The cable 46 is segmented into several sections insulated from one another so as to be charged above a particular pack or clip of sheets which have been slit and cut. In other words, only one of the side-by-side clips of sheets can be rejected while the other clips are moved to the piler.

As the sheets are moved past an activated charge bar 40, the high voltage applied to the bar causes ionization of the air and the exposed sides of the paper sheets develop the same charge as found on the points 45. Thus, if a positive charge is imparted to upper charge points 45, the upper surfaces of the sheets, that is, those surfaces nearest the points, become positively charged (FIG. 4). The opposite, or unexposed, surfaces develop an opposite or negative charge. Each of the paper sheets in a clip becomes polarized responsive to the charged points 45 and the ionization which takes place. By reason of the polarized charges developed by the paper sheets, the sheets in turn cause a similar polarization to take place in the conveyors and the sheets and conveyor belts are attracted to one another. When two or more superimposed paper sheets are cut and processed, each sheet becomes polarized as a separate layer.

In order to insure that good attraction is developed between the cut sheets and the conveyors, the use of conveyor tapes or belts having a substantially nonconductive material, at least at its outer surface, is preferred. It has been observed that charged paper sheets, being only semiconductors, will usually bond to practically any conveyor material, even highly conductive materials. In the case of paper sheets, being non-conductive material such as nylon, rayon, polyester materials or cotton, the degree of humidity does not appreciably affect the strength of the bond between the sheets and conveyors.

As mentioned above, most conveyor materials are operative, but it is preferred to make the conveyors with a substantially nonconductive top surface and the under surface with a conductive material such as a metallized flexible belt material which can be grounded. FIG. 4 shows the charge developed by the paper and conveyor under the influence of a positively charged charge bar 40 and negatively charged charge bar 40 with the charge of the upper surface being positively charged and its lower surface being negatively charged. The conveyor has an upper, nonconductive layer and a lower conductive layer that is grounded. The upper layer polarizes in a manner similar to the paper P and thus the paper P is strongly attracted to the conveyor. The conveyor, during operation, controls and moves the paper sheets to the appropriate collection area.

The upper charge element 10 is activated when cut sheets are to be shunted to reject section. Webs or sheets with defects can be detected as with a pinhole-sensing device (FIG. 1) which includes a light source 32 and a photoelectric eye device 34. The sensing device can be located upstream of the lead-in roll after which the webs are grouped together to form a single multilayered web W. Normally a sensing device is used for each single web and the sensing device arrangement as well as the circuitry shown in the drawings are for illustrative purposes only.

A manual switch is also provided to activate the upper charge element 10 so that samples can be shunted to reject. When charge element 10 is activated, a relay maintains the circuit until the entire length of the paper sheet has been charged. The charged sheet will then lie flat on the lower conveyor 18 as the latter's path leads down to a static elimination air bar 13 (FIG. 6) and then to a sheet stripper 28 located adjacent the lower roll 7. It will be appreciated that instead of a reject collection area, an alternative piler platform can be installed to collect sheets while the primary piler is being unloaded. Also, the reject section can be arranged overhead if desired.

The above-described reject section structure together with upper charge element 10 can be used with or without an electrostatic overlap. The conventional overlap usually has a slowdown conveyor and means to move the leading edges of the cut sheets over the trailing edges of preceding sheets. The overlap can be accomplished by air vacuum or simply by positioning the slower conveyor below the end of the more rapidly moving conveyor so that the cut sheets fall on top of one another.

Cut sheets are frequently delivered to the piler section at speeds of 150–250 feet per minute. A rotary cutter can be operated at speeds greater than 1,000 feet per minute and slowdown of the cut sheets takes place in the layboy as they are transferred to conveyor 17. The conveyor components are arranged to prevent the edges of the cut sheets from colliding head-to-tail with one another. While conventional layboy overlap systems can be used in combination with an electrostatic reject system, it is preferred to use an electrostatic overlap such as shown in FIGS. 1, 5 and 7 to insure positive control over the moving cut sheets and to minimize jamming. The normal operation of the electrostatic overlap is to periodically charge lower charge element 9 so that only the leading edges of the cut sheets are charged as the sheets are moved past the reject section entrance. The charged leading edges are attracted upwardly to conveyor 17 and moved across the reject entrance and bridge 30. The trailing edges of the sheets are moved to the second conveyor 19 which is traveled over rolls 7 at a lower speed than conveyors 17 and 18.

As the sheets are moved across the gap between conveyors 18 and 19, photoelectric eye assembly 12 senses the trailing edges of sheets and triggers a third charge bar 11 which is located in a housing above the sheets. Only the trailing edges of the cut sheets are charged for overlap and thus, the trailing edges of the cut sheets are attracted to the relatively slow speed conveyor 19 as the leading edges of the cut sheets are pulled by high-speed conveyor 17 to overlap preceding sheets. Almost immediately after overlapping occurs, the static charges on the leading edges of the cut sheets is eliminated by air bar 13 and the leading edges of the cut sheets are knocked down from conveyor 17 by grooved roll 14.
Roll 14 is journaled in supports 14C which are adjustable along tracks 14A when handles 14B are turned. The roll 14 is positioned within the tapers of conveyor 17 so that the tapers ride within the grooves of the roll 14. The grooves are deeper than the tapers' thickness and the roll 14 idles, being turned to some extent by the movement of the tapers through the grooves. Roll 14E is also journaled in supports 14C and functions as a support for roll 14. As seen in FIG. 1, the distance between eye assembly 12 and the axis of roll 14 is the same as one sheet length. When the length of the cut sheets is varied, movement of roll 14 is made along tracks 14A to compensate for the change. The switch on the rotary knife 6 is a photoelectric eye 103 which monitors each revolution of a slot 101 in a disc mounted on the rotary knife's axle. In copending application Ser. No. 684,423, the slot 101 is used to count the sheets cut by knife 6, whereas in the instant application the width of the slot in the disc corresponds to the width of the charge elements 9, 10 and 11. Thus, eye 103 pulses or closes the circuit through phasing switch 205 during the time the slot 101 is scanned closing switch 205. The slotted disc is actually a rotating cam and a magnetic detector can also be used with a cam instead of photoelectric eye 103.

The grooved roll 14 flattens the leading edges of the sheets down overlap and operates as a nip roll in cooperation with conveyor 19 immediately below. Other knockdown devices can be used instead of roll 14 and pulsating air showers above, or vacuum below, as well as pulsating fingers and rotating cams are known to the trade.

The static elimination air bar 13 is shown in FIG. 6 as a hollow metal tube 51 with holes 52 fitted within a larger metal tube 53 with holes 52 fitted within a larger metal tube 53 with relatively large holes 54. Tube 53 is grounded and separated from tube 51 by an insulated spacer 56 at each end. Adjacent holes 52 are a series of charge points 55 which ionize the air when connected to an AC source. About 5,000 volts AC current can be supplied continuously through cable 57 attached to tube 51 and air is circulated through the tube 51 to be ionized as it passes out holes 52 and then larger holes 54 centered over points 55. The tube 53 can be positioned 12 inches or more but preferably is located about one-half inch from the traveling cut sheets and the conveyor tapes to extend across the entire width of the layboy and neutralize the static charges on the cut sheets and conveyors. As seen in FIG. 1, an air bar 13 is located downstream of the charge elements to purge static charges from the sheets in both reject and overlap.

After the cut sheets are knocked down and moved by conveyor 19 past the end of conveyor 17, a kickoff conveyor 22 and sheet separator 21 are positioned to prepare the sheets for piling on lift platform 27. Back jogger fingers 24, side jogger blades 25, one on each side, and back stop 26 all serve to align the sheets as they are piled. A series of static eliminator air nozzles 20 are positioned to protrude through the tapes of conveyor 19 and blow a continuous stream of ionized air from manifold 26a through adjustable valves 26b. Instead of manifold 26a, a bar similar to air bar 13 can be used with the tubes 20 being the outlets from the bar 13 rather than holes 54.

As the cut sheets approach the piler, the upper conveyor 17 terminates and kickoff conveyor 22 with endless tapes is housed at the end of the layboy. Conveyor 22 is driven by belts 22A and 22B with a reversing pulley arrangement and conveyor 19 is driven by motor 18 as seen in FIG. 7 at a relatively lower rate of speed. Sheet separator 21 is positioned adjacent conveyor 22 and is an inverted V-shaped member with each outside edge extending about 2 inches higher than the center so that the individual sheets are corrugated as the kickoff conveyor propels the sheets on piler platform 27.

In FIG. 9, the circuitry for reject is shown. As the leading edge of a sheet is entering between charge elements 9 and 10, a pulse is generated through switch 205 so that it is initiated to stay on for the duration of the length of slot 101 or a magnetic cam length only.

The slot or cam length in linear inches is equivalent to the width of the charge units whereby the leading or trailing edges of a particular sheet only are charged. Each sheet travels with a charged edge until it reaches reject or overlap. When destined for overlap, a sheet trips a scanning device, photoeye 12, to open the circuit to charge element 11. The position of photoeye 12 is such that when the sheet reaches the grooved knockdown roll 14 the scanner path is clear and charge element 11 is energized, charging the trailing edge of the sheet so that it is attracted downward.

Static eliminator air bar 13 is on continuously, and in the position of the bar 13 shown in FIG. 1, it will neutralize the leading edge of a sheet prior to the sheet reaching the knockdown roll 14 whereupon overlap is assured since conveyor 19 is moved at a lower rate of speed than the upper conveyor 17.

Under normal conditions, straight through flow prevails, and the pulse generator is phased in through switch 205 with the leading edge of each sheet being charged for overlap. Charge element 10 is in the same relative position as element 9 and when selector switch 201 is turned to reject manually, the circuits to relay 203 are closed while the circuit to charge element 9 is opened.

When the phasing switch 205 closes, it energizes relay 203 locking in charge element 10 at 203C. It also closes the circuit through 203A.

Charge element 9 can be opened by the manual turning of selector switch 201 and 201A (which is part of switch 201). When reject is to stop, the selector switch 201 (and 201A) is then manually turned to original position, closing the circuit to 203A. The circuit through switch 203A was previously closed when the phasing switch 205 closed relay 207. Pulsing relay 207 opens the circuit through 203C, and closes the circuit through 203B thereby energizing charge element 9 and then normal overlap occurs.

Relays 203 and 207 above are coils of a two coil latching relay. When 203 is pulsed, contacts 203A, 203B and 203C change condition (i.e., 203A and 203C from normally open to closed and vice versa for 203B), then when relay 207 is pulsed, these same circuits return to their original condition.

For automatic reject responsive to photoeye 34, selector switch 201 is replaced by a set of contacts normally open at the contacts for switch 201 and normally closed contacts at 201A. When the photoeye 34 signals a defect, the circuit through 201 is closed and through 201A opened. Otherwise, the same sequence would occur as previously described above.

The length of the sheet is determined by the r.p.m. of the cylinder 6, relative to the speed of the web and the web speed is controlled by the draw roll 3 which is mechanically geared to the knife cylinder 6.

What is claimed is:

1. A paper-handling machine comprising means for traveling a web of paper to a cutter, conveyor means for moving cut paper sheets from the cutter, electrical charge means being positioned adjacent said conveyor means downstream of said cutter, said conveying means comprising opposing upper and lower conveyors which define a course of travel for said cut sheets, said charge means including a charge element positioned adjacent the travel course of said conveyors, means for supplying an electrical charge to said charging element responsive to a signal whereby an electrical charge is selectively imparted to said charge element and to the cut sheet adjacent said charge element, said conveying means having a surface capable of developing a polarized static charge similar to that imparted to said cut sheet by said charge element so that said sheet is then attracted to said conveyor means and moved to a collection area.

2. The machine of claim 1 wherein said collection area includes a reject section and a piling section, said conveyor means including an upper conveyor belt, and a lower conveyor belt leading to the reject section, said upper and lower conveyor belts opposing one another over part of their lengths to define a course of travel for the cut sheets.
3. The machine of claim 2 wherein a further lower conveyor belt is located downstream from said first-mentioned lower conveyor belt, said further conveyor belt leading to the piling section.

4. The machine of claim 2 wherein a reject-sensing means is associated with said charge element whereby a moving cut sheet is charged by said element and then attracted to said lower conveyor belt leading to the reject section.

5. A paper-handling machine comprising means for traveling a web of paper to a cutter, conveyor means for moving cut paper sheets from the cutter, static electricity charge means being positioned along said conveyor means downstream of said cutter, said conveying means comprising a plurality of adjacent conveyor elements which define alternative paths for the cut sheets, a first path leading to an overlap piling section and a second path leading to a reject section, said charge means having an upper charge element and a lower charge element respectively positioned above and below the travel course of the cut sheets, means for selectively charging one of said upper and lower charging elements responsive to a signal as selected cut sheets are moved adjacent said elements to impart a charge to said sheets, said conveying elements comprising surfaces capable of developing a polarized static charge similar to that imparted to said selected paper sheets by said charge means whereby the charged cut sheets are attracted to one of said conveyor elements to follow one of said paths.

6. The machine of claim 5 wherein said cutter is a rotary knife and a timing switch is associated with said knife to signal the upper charge element of said charge device as the leading edge of a selected cut sheet is moved adjacent said upper element responsive to the revolutions of said knife whereby only a portion of the cut sheet is exposed to a charge.

7. The machine of claim 5 wherein said conveying means includes an upper conveyor leading to the overlap section and a lower conveyor belt leading to the reject section.

8. The machine of claim 7, wherein said lower charge element is signalled to impart a charge to the leading edge of a cut sheet and said upper conveyor belt attracts said leading edge to move same to the overlap section, said further conveyor belt being spaced from said first-mentioned conveyor belt whereby a gap is formed, sensing means adjacent said gap to detect overlap sheets being moved to said overlap section, said sensing means being connected to activate a third charge element whereby the trailing edges of the overlap sheets are charged by said third charge element.

9. The machine of claim 6, wherein static eliminator means is located adjacent said conveyor means downstream of said charge device to eliminate the static charges imparted to the paper sheets by said device.

10. The machine of claim 6 wherein said conveyor means includes at least one tape conveyor, the tapes of said conveyor comprising at least one laminated member with a lower conductive layer and an upper, substantially nonconductive layer, said conductive layer being grounded.