ABSTRACT

A right angle transfer conveyor and its frame are mounted for vertical movement toward and away from the elevation of sheet discharge at the end of a corrugator. The frame for the transfer conveyor supports a carriage movable horizontally toward and away from the discharge end of the corrugator. The position of the carriage and the elevation of the conveyor are correlated whereby vertical adjustment of the conveyor frame is simultaneous with horizontal adjustment of the carriage. The carriage supports a plurality of devices for arresting movement of sheets whereby the direction of movement of the sheets changes 90° via said transfer conveyor.

12 Claims, 4 Drawing Figures
SHEET TAKE OFF APPARATUS

BACKGROUND

This invention relates generally to sheet handling apparatus and, more particularly, to apparatus for handling sheets of corrugated paperboard as they are discharged by the conveyor of a corrugator downstream from the cut-off machine. The apparatus arrests the forward motion of the sheets and causes the sheets to travel in a direction perpendicular to the previous direction. Apparatus for accomplishing this general purpose has been proposed heretofore. For example, see U.S. Pat. Nos. 2,498,061 and 3,658,322.

Sheets are discharged from a corrugator at a high rate of speed and at a high volume. In the case of a sheet which is only 2 feet long, the production rate may exceed 300 sheets per minute. These sheets must be removed from the point of discharge from the corrugator and stacked for further processing. Removal of the sheets by a conveyor which transports the sheets in the direction of their discharge from the cut-off machine would require excessive floor space and greatly extend the overall length of the corrugator.

When long sheets are being produced it is desirable that the leading edge of the sheets ejected from the corrugator be prevented from commencing movement on the transfer conveyor until the sheets are completely free of the corrugator conveyor. The trajectory of long sheets is such that the leading edge tends to fall onto the conveyor first. Should the leading edge of a long sheet touch the transfer conveyor before the trailing end is free of the corrugator conveyor the sheet will be skewed. The sheets then advanced on the transfer conveyor will not be aligned and the resulting stack will be unsatisfactory. Short sheets tend to float downward onto the transfer conveyor with equally unfavorable results since the rate of delivery of sheets may exceed the time required for the sheets to fall. These and other problems are solved by this invention.

It is desirable that the sheets be brought under compression on the transfer conveyor as soon as possible so that frictional forces between the sheets and the conveyor be constant. This insures that the sheets will advance at a uniform rate on the transfer conveyor.

The preferred practice is to arrest the flow of sheets as close to the point of discharge from the corrugator as practical, and then change the direction of flow of the sheets 90°. Apparatus of this nature has been subject to jams, the sheet arresting devices have not been completely reliable, the apparatus required excessive set up and adjustment time, and lacked means to automatically adjust the height of the transfer conveyor and sheet arresting devices at the sizes of the sheets change due to a change in the production run.

DISCLOSURE OF INVENTION

In accordance with the present invention, the frame for the transfer conveyor is movable in a horizontal direction toward and away from the discharge point on the corrugator. The conveyor frame is also adjustable vertically. One or both of these adjustments is necessary as the sizes of the sheets change from one production run to another production run.

The conveyor frame supports a carriage for reciprocal movement toward and away from the discharge point of the corrugator. The carriage supports a plurality of sheet arresting devices. The arresting devices are preferably in the form of relatively hard, wear-resistant cone-shaped members resiliently mounted. Movement of the carriage toward and away from the discharge point of the corrugator is integrated with vertical adjustment of the frame for the transfer conveyor whereby the most effective location may be attained for the sheet arresting devices. In this regard, location of said devices relates to the elevation of said devices as well as the distance between said devices and the discharge point of the corrugator.

It is an object of the present invention to provide a novel sheet take-off apparatus for use in conjunction with sheets fed thereto in a manner whereby the sheets must be caused to make a 90° change in direction.

It is another object of the present invention to provide a sheet take-off apparatus having sheet arresting devices and a transfer conveyor which are simultaneously adjustable.

It is another object of the present invention to provide an apparatus and method to maintain the ratio between the vertical movement of a take-off conveyor versus the distance of sheet arresting devices from the discharge point of a corrugator substantially constant.

Other objects will appear hereinafter.

For the purpose of illustrating the invention, there is shown in the drawings a form which is presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

FIGS. 1A and 1B illustrate a side elevation view of the apparatus of the present invention.

FIG. 2 is a top plan view of the apparatus of the present invention.

FIG. 3 is a sectional view taken along the line 3—3 in FIG. 2.

Referring to the drawing in detail, wherein like numerals indicate like elements, there is shown in FIG. 1 a sheet take-off apparatus in accordance with the present invention designated generally as 10. The apparatus 10 is positioned at the discharge end of a corrugator 18. The discharge end of the corrugator 18 generally is in the form of a conveyor downstream from the cut-off machine and partially shown at the left end of FIG. 1A. The corrugator conveyor discharges sheets horizontally in the direction of movement of the web through the corrugator 18.

The apparatus 10 includes a transfer conveyor frame defined by parallel side frame members 12 and 14 coupled at their ends by end frame members 16 and 17 thereby defining a frame designated generally as 19. As will be apparent from FIG. 1A, end frame member 16 is the closest to the discharge point of sheets from the conveyor of corrugator 18. As will be apparent from FIGS. 1A and 1B, the end frame members 16 and 17 are mounted perpendicular to and on top of the side frame members 12 and 14. The frame 19 supports the transfer conveyor which for the purposes of the present disclosure is in the form of power driven rollers 20,20'. It is within the scope of the present invention to use belts instead of rollers. Sheets to be handled by the apparatus 10 discharge from the corrugator 18 in the direction of arrow 22 and subsequently are caused to be discharged by the rollers 20,20' of a transfer conveyor in the direction of arrow 24. See FIG. 2.

The rollers 20,20' are parallel to one another and parallel to the direction of arrow 22. As shown in FIG.
2, the distance across the rollers 20,20' in the direction of arrow 24 is greater than the distance between the side frame members 12 and 14. Each of the rollers 20,20' is supported on the frame 19 in the same manner. Hence, the manner in which the rollers 20,20' are supported on the frame 19 will be described only in connection with one such roller, namely a roller 20' which is one of the last three rollers adjacent the discharge end of the transfer conveyor.

As shown more clearly in FIGS. 1A and 1B, roller 20' has one end supported by end frame member 16 in a bearing 26. The other end of roller 20' is supported in a bearing 28 on end frame member 17. The end of roller 20' adjacent the end frame member 17 terminates in a sprocket 30. The sprocket on each roller 20, such as sprocket 30, is meshed with an endless chain 32.

One of the rollers 20 has an extension 34. See FIGS. 1B and 2. A sprocket 36 on extension 34 is meshed with a chain 38 extending around a sprocket driven by an adjustable speed reducer 40 which in turn is driven by a variable speed motor 42. The speed reducer 40 and motor 42 are mounted on a bracket 43 supported by the frame 19. The sprockets on the rollers 20,20' and the sprocket 36 as well as the chain 32 are encased within a safety housing 44.

The three rollers 20' farthest downstream on the transfer conveyor are provided with smaller diameter sprockets than the rollers 20 whereby rollers 20' are caused to rotate at a faster speed. The purpose of the greater speed of the three outer rollers 20' will be described hereinafter.

The frame 19 supports a carriage 46 mounted for movement toward any away from the discharge point of the corrugator 18. The carriage 46 includes side walls 48 and 50 mounted on wheels 52 and 54 respectively. The wheels 52 ride on the side frame member 12 while the wheels 54 ride on a side frame member 14.

The side frame members 12 and 14 rotatably support shafts 56 and 58 extending therebetween. The ends of a chain 60 are connected to front and rear portions of the carriage 46 adjacent side frame member 12. The chain 60 extends around sprockets on the shafts 56 and 58. The ends of a chain 62 are connected to a front and rear portions of the carriage 46 adjacent the side frame member 14. The chain 62 extends around sprockets on the shafts 56 and 58. Hence, rotation of either shaft 56 or 58 will cause the carriage 46 to move in a horizontal direction toward and away from the discharge point of the corrugator 18.

Idler sprockets 64 are provided at suitable locations for each of the chains 60 and 62. The sprockets 64 are supported by a suitable support 65 mounted in depending relation from the side frame members 12 and 14.

The carriage 46 includes a beam 66 extending between and connected to the side walls 48 and 50. A shaft 68 is supported by the side walls 48 and 50 parallel to the beam 66. A plurality of cone-shaped sheet arresting devices 70 are supported by the shaft 68. Each arresting device 70 is mounted on a stub shaft on which it may freely rotate about its longitudinal axis and with each stub shaft being supported as a cantilever from the shaft 68.

The contour of each arresting device 70 converges generally toward the discharge point of the corrugator 18 and is mounted so as to form a guide in conjunction with the rollers 20 for the discharged sheets. Each arresting device 70 is made from a relatively hard, wear resistant material such as nylon or steel. Each arresting device 70 is supported for rotation about the longitudinal axis of shaft 68. The effective weight of the arresting devices 70 is adapted to be adjusted suitably.

The stub shaft for each arresting device 70 is connected to a support member 72 rotatably mounted on the shaft 68. A discrete lever arm 74 is connected to each member 72 to effect rotation of the same about the axis of shaft 68. The free end of each arm 74 is pivotally connected to a piston rod which in turn is connected to a resilient counter-balancing means such as a piston disposed within a cylinder 76. Each cylinder 76 is pivotally connected to a bracket on beam 66. Each of the cylinders 76 is connected to a single source of motive fluid such as compressed air whereby the cylinders 76 may be actuated simultaneously.

A deflection plate 78 is supported by the side walls 48 and 50 at an inclination of about 30°. As shown more clearly in FIG. 1B, the deflection plate 78 is disposed at a location between the arresting devices 70 and the discharge point of the corrugator 18.

Referring to FIG. 2, sheets are transmitted by the transfer conveyor in the direction of arrow 24. To maintain the sheets flat or in shingled relationship, a wheel 102 applies pressure on the sheets so that there will be positive movement of the sheets by the transfer conveyor. The wheel 102 is rotatably supported by an arm 104. Arm 104, as shown more clearly in FIG. 1B, is connected to a shaft 106. Shaft 106 is rotatably supported by bearings mounted on the side wall 48 of the carriage 46. A torsion spring 108 has one end connected to a retainer 110 on shaft 106 and its opposite end connected to a bracket 112 on the side wall 48. As the sheets tend to cause wheel 102 to move upwards and pivot about the axis of shaft 106, the spring 108 maintains a uniform pressure on the wheel so that the sheets remain in intimate contact with the driven rollers 20 of the transfer conveyor.

The frame 19 is provided with downwardly extending leg members 86 and 88 on one side of the frame. Comparable leg members are provided on the opposite side of the frame. Leg member 86 rotatably supports a wheel 90 which rides on track 98 having an upwardly inclined ramp 94. Leg member 88 rotatably supports a wheel 97 which rides on track 100 having an upwardly inclined ramp 96. The ramps 94, 96 are inclined at an angle of about 30° and extend upwardly toward the discharge point of the corrugator 18. Hence, as the frame 19 moves from right to left on tracks 98, 100 in FIGS. 1A and 1B, the ramps 94, 96 change the elevation of the transfer conveyor and the elevation of the arresting devices 70.

The means for causing the frame 19 to move up the ramps 94 and 96 includes a motor 114 suitably supported by brackets on the frame 19. The output from motor 114 is geared to shaft 56. Shaft 56 is connected to aligned stub shaft 116 and 118 by gears or sprockets. The stub shaft 116 and 118 are supported by the side frame members 12 and 14 respectively. Each of the shafts 116 and 118 is coupled to one of identical jacks 122, 124 in the same manner. Hence, only the coupling associated with shaft 116 will be described in detail.

Shaft 116 is coupled to an input shaft 120 by a chain and sprockets. Input shaft 120 is part of the jack 122. Jack 122 is preferably of the worm gear-screw type. See FIG. 3. Input shaft 120 has thereon a worm 126 meshed with gear teeth on the outer periphery of gear.
128. Gear 128 has threads in its bore meshed with threads on a screw 130. The longitudinal axis of screw 130 is parallel to the ram 96. The jack 122 includes a housing 132 having a tubular shield 134 surrounding the screw 130. The gear 128 is provided with bearings 136 and 138 on opposite sides thereof for transmitting loads to the housing 132. Housing 132 is supported by a bracket from frame 19 and coupled to the corresponding housing associated with jack 124 by means of a brace 140.

Screw 130, at the end remote from the jack 122, is pivotally connected to a bracket 142 which in turn is bolted to a part of the frame 144 of the corrugator 18 adjacent the discharge point for sheets. The screw for jack 124 is similarly coupled to the frame 144 of the corrugator 18. Thus, the motor 114, by way of the shafts and sprockets described above, causes the housings of jacks 122 and 124 to move along the longitudinal axis of the stationary screws 130 and 130'. Although the screws 130 and 130' may pivot with respect to their support on the corrugator 18, they are otherwise stationary.

The operation of the apparatus 10 is as follows: sheets are discharged from the corrugator 18 in the direction of arrow 22 and contact arresting devices 70. If the discharge angle is high, the leading edge of the sheets may glance off the deflector plate 78 and then contact the arresting devices 70. The inertia of the sheets causes the free end of the arresting devices 70 to be raised slightly whereby the leading edge of the sheet moves under the arresting device 70. The resilient force exerted by the cylinders 76 causes the arresting devices 70 to pivot downward thereby pinching the sheets against the rollers 20. The inertia of the sheets is thereby dissipated and movement of the sheets in the direction of arrow 22 is stopped. Friction between the sheets and the arresting devices 70, after the sheets have been arrested and are being moved in the direction of arrow 24 by rollers 20, is minimized by the ability of the arresting devices 70 to rotate about their longitudinal axes.

The transfer conveyor defined by the driven rollers 20 causes the sheets to move in the direction of arrow 24 whereby the sheets are now travelling in a direction which is 90° with respect to their previous direction of travel. The speed of the transfer conveyor defined by rollers 20 is correlated with respect to the discharge speed of the sheets from the corrugator 18 in a manner well known to those skilled in the art whereby various degrees of shingling of sheets may be attained. In this regard, the variable speed motor 42 may be coupled to the motor drive for the corrugator 18 so as to maintain the desired relationship between the speeds of the corrugator 18 and the transfer conveyor defined by rollers 20. Wheel 102 maintains the sheets in contact with the rollers 20 due to the effect of spring 108.

If the corrugator 18 discharges sheets cut from the full width of the web, the sheets will be arranged on the rollers 20 in partially overlapping or shingled relationship. In large corrugators where the width is about 96 inches, it is more conventional to slit the corrugated web before it is cut into discrete sheets. This causes the corrugator 18 to discharge more than one sheet simultaneously. "Multiple outs," two, three, or more sheets being directed simultaneously against the arresting devices 70. The speed of the transfer conveyor defined by the rollers 20 is correlated with the sheet discharge speed so that rather than shingling, stacking of sheets may be attained. Thus, in the case of three out, the transfer conveyor may advance the sheets progressively so that incoming sheets are successively deposited in overlying relationship so that stack comprising three sheets each are discharged from the transfer conveyor.

If stacks are formed on the transfer conveyor, the stacks advance in abutting relationship. As a stack moves over the rollers 20', that stack is accelerated since rollers 20' are rotating at a higher speed than rollers 20. The leading stack is thereby advanced causing a gap between it and the successive stack.

When a change is made from one production run to another whereby the length of sheets being cut changes, it is necessary to change the position of the arresting devices 70 with respect to the discharge point of the corrugator 18 as well as the elevation of the arresting devices 70. As sheets get shorter in length, it is necessary to move the carriage 46 closer to the discharge point of the corrugator 18 and elevate the devices 70 so as to approach the elevation of the discharge point for sheets from the corrugator 18. As the length of the sheets being handled increases, the reverse is true. That is, the carriage 46 should be moved farther from the corrugator 18 while lowering the elevation of the support for arresting devices 70.

The ratio between the elevation of rollers 20 on the transfer conveyor versus the distance between the devices 70 and the discharge point on the corrugator 18 is maintained substantially constant. In this regard, the motor 114 drives the jacks 122 and 124 by way of shaft 56. Shaft 56 is coupled to the conveyor 46 by means of the chains 60 and 62. Thus, as shaft 56 rotates in one direction, the carriage 46 moves toward the corrugator 18 while at the same time the jacks 122 and 124 cause the frame 19 to move up the ramps 94 and 96.

The use of ramps 94 and 96 as well as the jacks 122 and 124 constitute a preferred means for selectively elevating frame 19. Other equivalent devices may be used as desired.

It is to be noted that the forward momentum of discharged sheets is arrested substantially instantly and that the sheets are aligned on the transfer conveyor without the use of a backing. The design and manner of loading of the arresting devices 70 permits them to stop sheets precisely without undesirable rebound. The stopping of the sheets by the arresting devices 70 results from an equality achieved between the momentum of the sheets on the one hand and the combined effects of friction and inertia of the arresting devices 70 in accordance with known mathematical principles.

I have found that for average conditions prevailing in the corrugated paperboard industry, a preferred ratio between the vertical movement of the transfer conveyor and the horizontal movement of arresting devices 70 is about 1 to 18–20. Thus, for every inch of vertical movement of the transfer conveyor, the arresting devices 70 move horizontally 18 to 20 inches.

By way of example and not by way of limitation, assume the sheet is 120 inches long. The transfer conveyor would be about 7 inches below the elevation of the discharge point of the conveyor on the corrugator 18 and the arresting devices 70 would be 130 inches from said point. If sheet size is changed to a 25 inch sheet, the transfer conveyor would be elevated vertically to a position about 2 inches below the elevation of the corrugator discharge point and the arresting de-
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services 70 would simultaneously move horizontally about 98 inches toward said discharge point on the corrugator 18.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims rather than to the foregoing specification as indicating the scope of the invention.

It is claimed:

1. Apparatus for handling sheets discharged successively from a processing machine comprising a transfer conveyor for conveying sheets in a first horizontal direction, a carriage, means supported by said carriage above the elevation of the conveyor for arresting the motion of discharged sheets, means supporting the carriage for movement in a second horizontal direction which is substantially perpendicular to said first direction, and means for moving said arresting means in said second direction while simultaneously changing the elevation of both said arresting means and said conveyor.

2. Apparatus in accordance with claim 1 wherein said arresting means includes a plurality of sheet arresting devices and means on said carriage for simultaneously adjusting the force exerted by each said device on a sheet therebelow.

3. Apparatus in accordance with claim 2 wherein said means supporting the carriage includes a frame on which said conveyor is supported.

4. Apparatus in accordance with claim 3 wherein said means for changing the elevation of said arresting means and conveyor includes structure for moving said carriage along an inclined plane.

5. Apparatus in accordance with claim 1 wherein said last mentioned means is constructed and arranged for maintaining the ratio between vertical movement of the conveyor versus the horizontal distance between said arresting devices and a predetermined location from which sheets are discharged substantially constant.

6. Apparatus for handling sheets of paperboard comprising a corrugator having a conveyor means for discharging sheets in a first direction, a transfer conveyor for receiving sheets as the sheets move in said first direction and for conveying the sheets in a second direction perpendicular to said first direction, a plurality of devices disposed above the conveyor for arresting the movement of sheets travelling in said first direction, means supporting said devices for simultaneous movements toward and away from said corrugator in a manner so that the elevation of the devices increases as the devices move toward said corrugator and descend as said devices move away from said corrugator.

7. Apparatus in accordance with claim 6 wherein said last mentioned means also causes the transfer conveyor to move upwardly as said devices are moved toward said corrugator and causes said transfer conveyor to descend as said devices are moved away from said corrugator.

8. Apparatus in accordance with claim 7 wherein the ratio of vertical movement of said transfer conveyor versus the horizontal distance between said devices and the discharge point of said conveyor means is 1 to 18-20.

9. Apparatus in accordance with claim 6 wherein each of said arresting devices is rotatable about an axis inclined with respect to said first direction, a shaft extending parallel to said second direction, each of said arresting devices being pivotally supported by said shaft, and a separate power cylinder connected to each arresting device whereby the effective weight of each said device may be adjusted simultaneously.

10. Apparatus in accordance with claim 6 wherein said transfer conveyor includes means for accelerating one sheet so that a gap is produced between said one sheet and a succeeding sheet.

11. In a method of handling sheets discharged successively from a conveyor means at the discharge end of a processing machine in a first direction toward arresting devices disposed above the elevation of a transfer conveyor comprising compensating for changes in sheet length between production runs including moving said devices horizontally in said first direction while simultaneously moving said transfer conveyor in a vertical direction so that the ratio of vertical movement of the transfer conveyor versus the horizontal movement of said devices is substantially constant.

12. In a method of handling sheets in accordance with claim 11 wherein said ratio is 1 to 18-20.

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