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[54] **CORRUGATED SHEET INVERTING MACHINE**

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[52] **U.S. Cl.** ..... **271/151**, 198/33 AD, 271/76

[51] **Int. Cl.** **B65h 1/22**

[58] **Field of Search** ..... 198/33 AD; 271/DIG. 8, 65, 66, 76, 75, 27, 62 C

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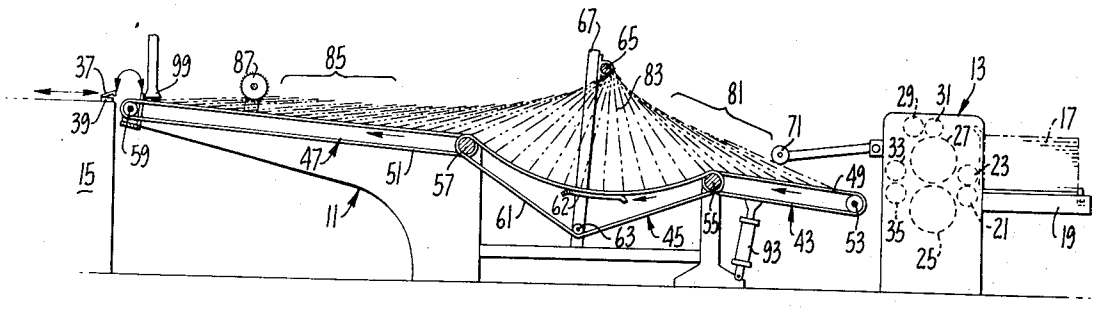
[57] **ABSTRACT**

A technique for reverse shingling a stream of shingled sheets that is especially adapted for feeding corrugated box sheets from a printer to a die press. A slack conveyor belt section pivots the individual sheets about an elongated support roll held stationary above the slack conveyor belt in order to invert the individual sheets.

6 Claims, 7 Drawing Figures



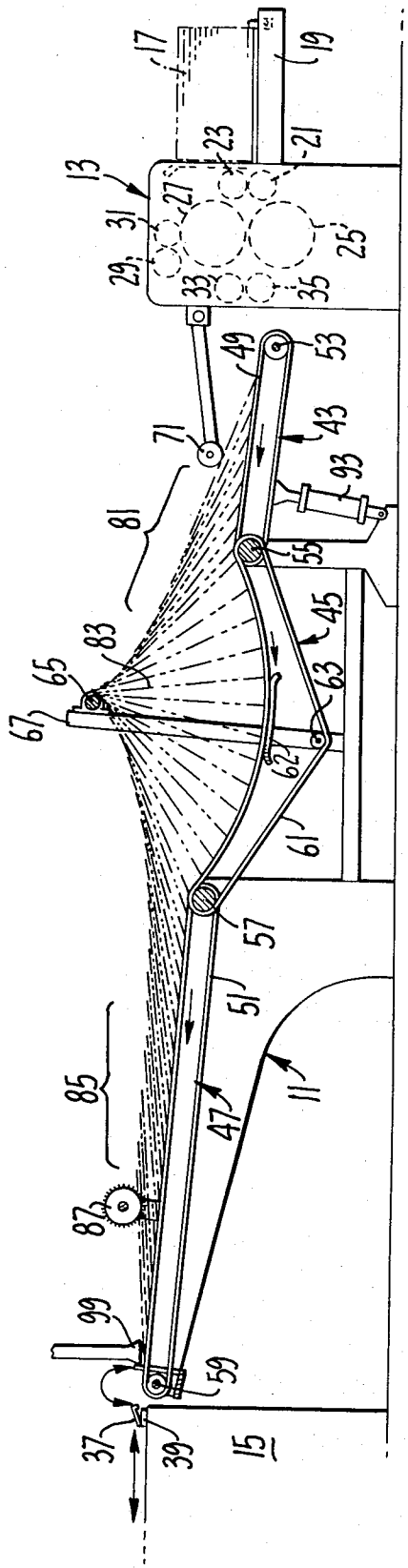


FIG. 1.

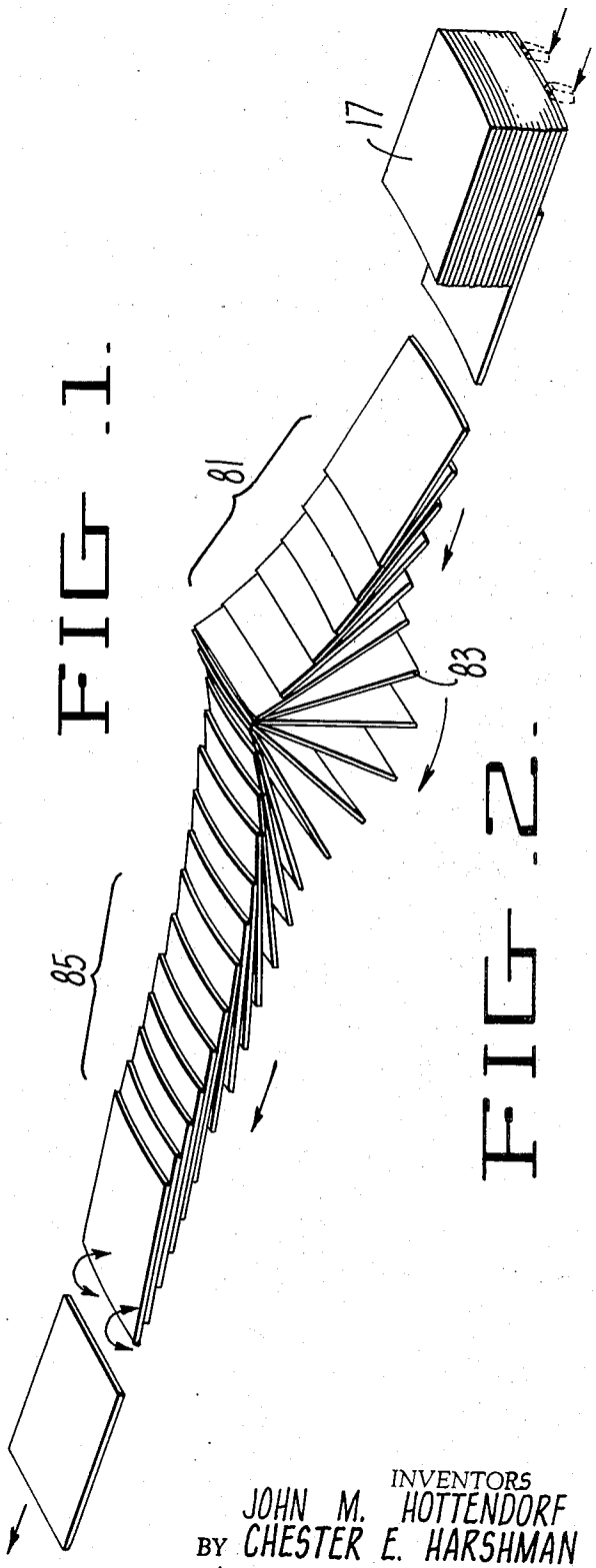


FIG. 2.

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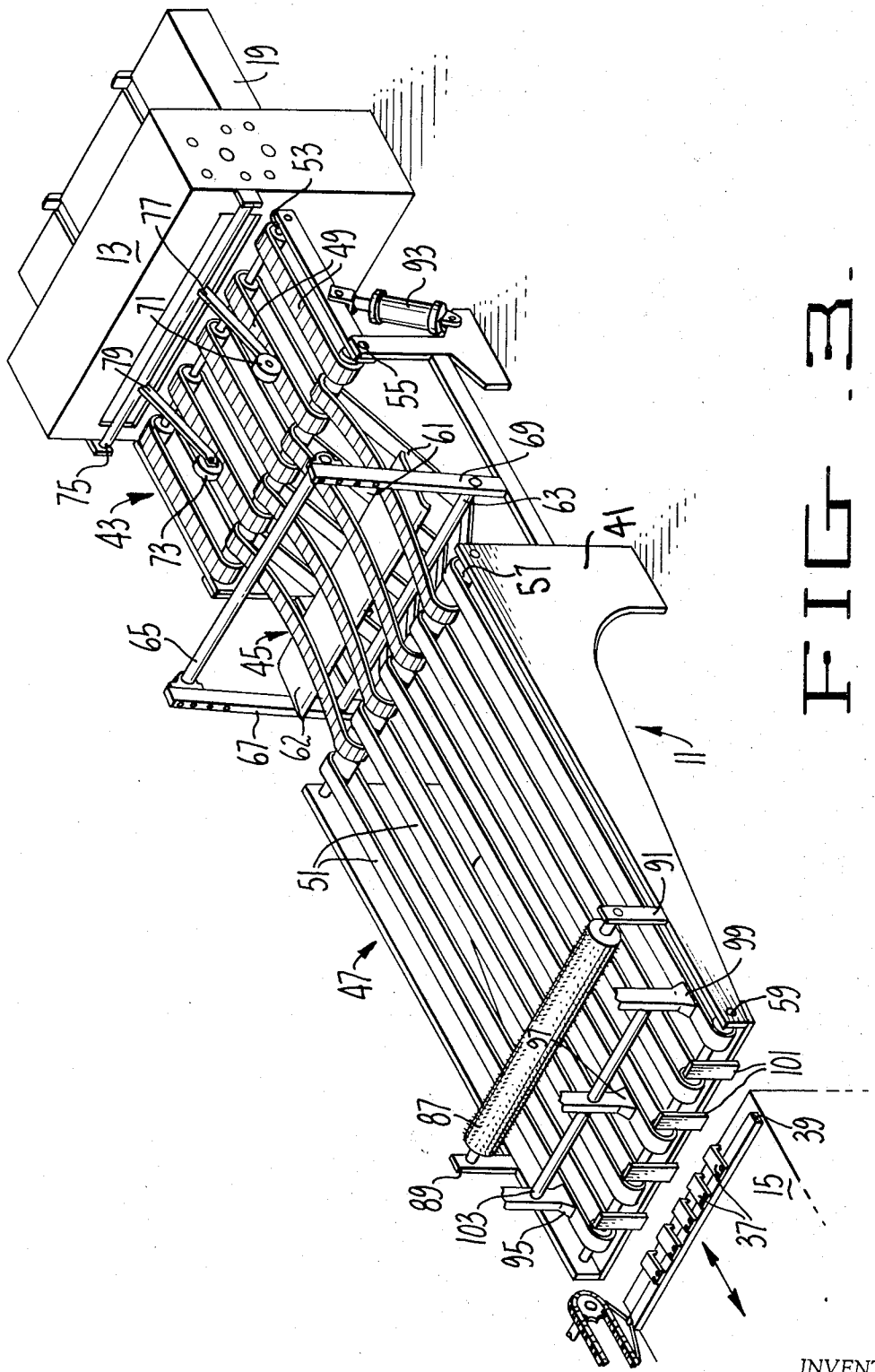

FIG. 3.

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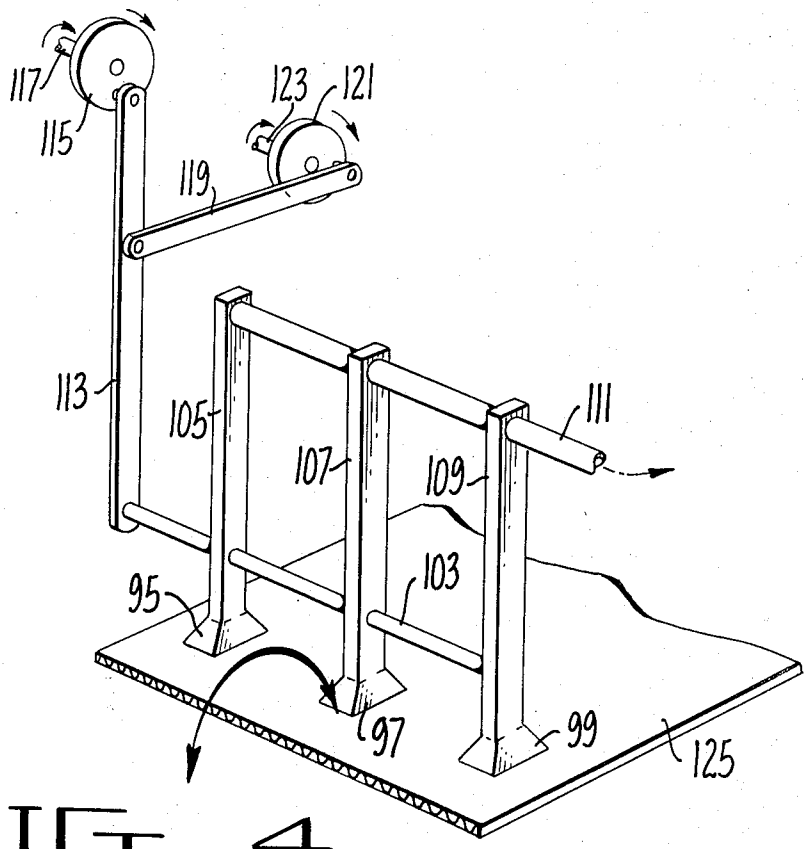

FIG. 4.

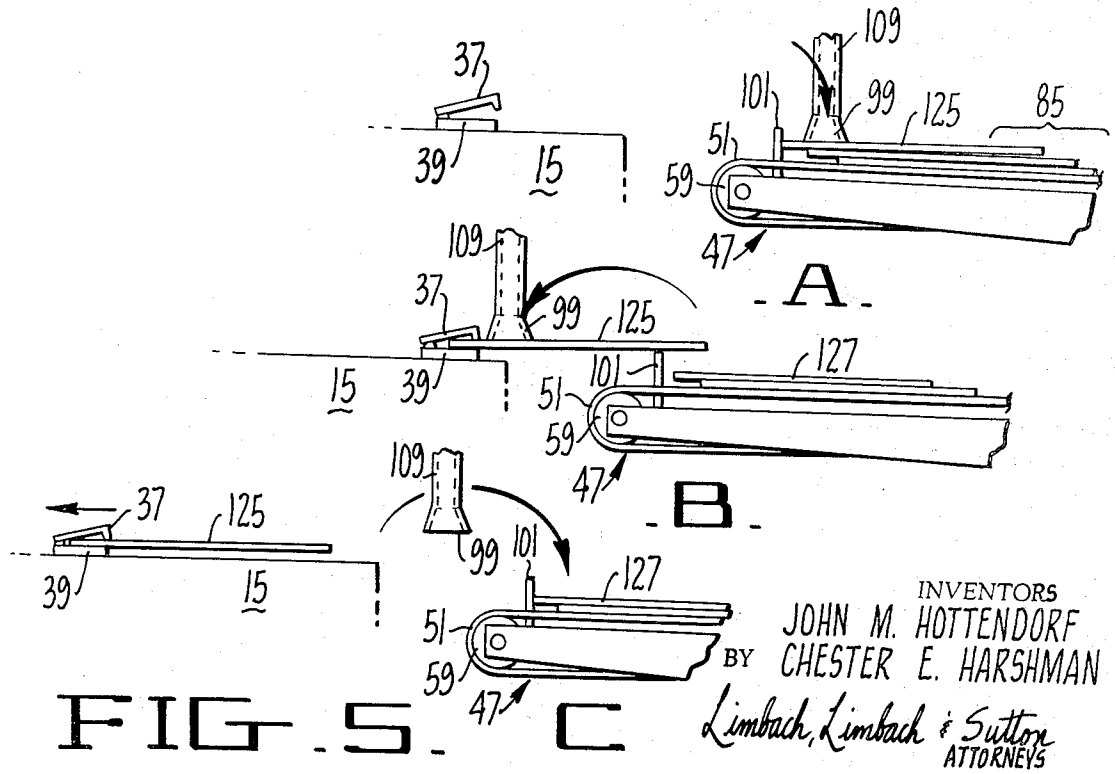

FIG. 5.

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CORRUGATED SHEET INVERTING MACHINE

BACKGROUND OF THE INVENTION

This invention relates generally to the art of inverting sheets while delivering them from one machine to another as part of a process performing sequential operations on these sheets. The various aspects of this invention are especially adapted to handling corrugated cardboard sheets in the process of making corrugated containers.

In a present standard technique of corrugated box making, corrugated cardboard sheets are printed on one side thereof by one machine and subsequently cut by a die press into a form for later folding into the shape of a box. Existing corrugated sheet printing machines operated by printing on the top of sheets fed through them. Top printing is preferred to bottom printing of corrugated sheets for better quality. Existing corrugated sheet die press machines subsequently cut the printed sheet from the bottom side of the sheet presented to it. The cutting is performed from the bottom rather than from the top primarily for reasons of economics of die press machine construction.

It is preferred in the process of making a corrugated box to both print and cut on the same side of corrugated sheet material. Therefore, with the use of existing machines, corrugated sheets must be turned over after they are discharged from the printing machine and before insertion into the die press machine for cutting.

Feeding and turning of corrugated sheets between the printing and die press machines is presently accomplished manually by stacking the sheets discharged from the printer and inverting a stack onto a feed mechanism of a die press. Such a manual operation requires, of course, a certain amount of additional labor that would not be required if the operation could be performed automatically.

An existing machine for automatically feeding and turning the sheets between a printer and die press is sometimes used. This machine includes two conveyor belt sections disposed between the printer and die press for transporting corrugated sheets therebetween. Between the two conveyor belt sections is a rotating drum-like structure. The first belt section delivers a corugated sheet from the printer to the rotating drum-like structure. As the drum rotates, the sheet is gripped thereby and turned over onto the second conveyor belt section at which time the sheet is released from the drum. The second conveyor section then delivers the sheets to a die press. Such a machine is rather comples and expensive to manufacture and use.

Machines utilized in forming corrugated boxes, including a printer and die press, usually have feeding mechanisms which insert individual sheets one at a time into their respective machines from the bottom of a stack of sheets placed on a feeding mechanism. The bottom sheet is generally fed into a machine by pushing from its rear edge. This creates a problem in certain machines especially in a die press, since the corrugated sheets are subject to warping in various directions. Existing die presses have a row of grippers with narrow openings for receiving the leading edge of a corrugated sheet and pulling it into the machine for performance of the cutting operation on the sheet. Since the existing feeders for a die press deliver the leading edge of the corrugated sheet to the grippers by pushing the sheet from its trailing edge, any significant warpage in the corrugated sheet causes it not to be aligned with the openings of the grippers. This necessitates stopping the die press and requires additional labor time to clear the machine and start its operation again.

The use of the same type of feeding mechanism on a printing machine is not such a problem since the leading edge of each corrugated sheet is gripped between a pair of rotating feed rollers. Therefore, the usual corrugated sheet printing machine can operate with more warpage in the leading edge of the sheets than can a die press when the sheets are fed into these respective machines by pushing their trailing edge.

It is a primary object of the present invention to provide a method and apparatus for inverting sheets that is simple and inexpensive to build.

It is another object of the present invention to provide a method and apparatus for transmitting and inverting corrugated cardboard sheets from a printer to a die press.

It is yet another object of the present invention to provide an improved method and apparatus for feeding corrugated cardboard sheets into a die cutting machine.

SUMMARY OF THE INVENTION

These and additional objects are accomplished by a technique according to the present invention in which a plurality of sheets are shingled into a first stack and a second stack of sheets with a reverse shingle is then formed by sequentially inverting one at a time the sheets of the first stack from its bottom and feeding them into the bottom of the second stack of sheets. This permits removal of the sheets from the top of the second stack simultaneously with the second stack being fed with new sheets at its bottom. The techniques of the present invention are especially useful for transferring and inverting corrugated cardboard sheets between a printer and a die press. Removal of inverted corrugated sheets from the top of the second stack has been found advantageous by allowing the feeding of corrugated sheets into a die press in a manner to control warpage of the leading edges of the sheets.

The sheet inversion and reverse shingled stacking thereof is preferably accomplished by a conveyor belt system that may be described in terms of three tandem sections. In a first conveyor belt section, a stream of shingled sheets (first stack) is advanced toward a second conveyor belt section. The second section includes a slack conveyor belt that forms a downward extending loop. An elongated support roll is positioned above the second conveyor belt section and held perpendicular to the direction of travel of the belt. When a new stream of shingled sheets is advanced by the first conveyor belt section to the second section, an operator lifts the leading sheet onto the support roll. Further operation of the conveyor belts causes each sheet to be tipped to a vertical position on the support roll with its bottom edge being advanced thereunder in contact with the slack conveyor belt. This inverts each sheet and forms a reverse shingle (second stack) on a third conveyor belt section that carries away the stream of sheets from the second conveyor belt section. No other elements but the support roll and the slack conveyor section are necessary to invert the sheets. Each sheet after the first of a stream of sheets is guided up onto the support roll by preceding sheets. Such an apparatus is especially useful for delivering a stream of corrugated box sheets from

a printer to a die press, thus saving labor time consumed in manually transferring sheets from a printer to a die press, or in replacement of more complicated and expensive machinery.

A reverse shingle of printed corrugated sheets has the advantage that the sheets may be fed one at a time from the top of the reverse shingled stack into a die press by some means which controls any warpage of the sheets' leading edge. Each of the corrugated sheets may be inserted into the narrow gap of existing die press grippers by pulling the sheet by its leading edge as opposed to existing feed mechanisms that push a sheet along its trailing edge from the bottom of a stack into the die press grippers. A preferred apparatus for advancing the sheets into the grippers is a plurality of suction cups positioned for picking up the sheets by contact with their top along a line near their leading edge.

For additional objects and advantages of the techniques of the present invention, reference should be had to the following description taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of the inverting and conveying machine according to the present invention as disposed between a corrugated sheet printing machine and die press;

FIG. 2 is an isometric view of sheets being advanced through the apparatus of FIG. 1;

FIG. 3 is an isometric view of the apparatus of FIG. 1;

FIG. 4 shows details of a suction cup system for removing sheets from the apparatus of FIGS. 1 and 3;

FIGS. 5A, 5B and 5C show operation of the sheet removal system of FIG. 4 at various different instants of time.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

By way of example, the sheet inverting machine of th present invention is described in its preferred use for solving existing problems in the corrugated box making industry. Referring especially to FIGS. 1 and 3, a corrugated sheet inverting machine 11 is placed between a printing machine 13 and a die cutter 15. The corrugated sheet inverting machine 11 transfers sheets discharged from the printer 13 to the die cutter 15 without the necessity of human intervention.

A stack 17 of blank corrugated cardboard sheets (FIG. 1) is positioned on a feed secion 19 of the printer 13. The sheets of the stack 17 are fed into the printer 13 one at a time from the bottom of the stack 17. A kicker (not shown) advances the bottom sheet of the stack 17 by pushing its trailing edge until the leading edge of the corrugated sheet engages a pair of feed rollers 21 and 23. The feed rollers 21 and 23 advance the sheet to a region between a backup roll 25 and a die cylinder 27. The die cylinder 27 contains an impression of the information to be printed on the box and is supplied ink by ink rollers 29 and 31. A pair of discharge rollers 33 and 35 push the printed corrugated sheets out of the printer 13. The die cylinder 27 is positioned to print the top surface of a sheet passed through the printer 13 because it has been found that this arrangement does a better printing job than if the die cylinder were to be placed in the bottom of the printer 13 for printing the bottom surface of a sheet. This type of printer is well known.

After printing, the corrugated cardboard sheets are fed one at a time into the die press 15. Existing die presses cut from the bottom up against the sheets passed therethrough. Each sheet is positioned with respect to the cutting blades of the die press 15 by a plurality of individual grippers 37 (FIGS. 1 and 3) which are attached to a gripper bar 39 that is caused to slide back and forth by an appropriate mechanical arrangement in the direction of the arrows. The leading edge of each corrugated cardboard sheet passed through the die press 15 is caught between the grippers 37 and the gripper bar 39 and pulled therethrough. The purpose of the corrugated sheet inverting machine 11 is to efficiently transfer sheets discharged from the printer 13 to the die press 15.

The corrugated sheet inverting machine 11 contains generally a frame 41 which supports three conveyor sections in tandem between the printer 13 and the die press 15. A first conveyor section 43 is positioned with one end adjacent the printer 13, a second conveyor section 45 is positioned adjacent the first conveyor section 43, and a third conveyor section 47 is positioned between the second conveyor section 45 and the die press 15. The first conveyor section 43 and the third conveyor section 47 include a plurality of substantially taut parallel belts 49 and 51, respectively. The plurality of conveyor belts 49 of the first conveyor section 43 are supported by a rotatable shaft 53 at one end and a rotatable shaft 55 at the opposite end. The plurality of conveyor belts 51 of the third conveyor section 47 are driven by a rotatable shaft 57 at one end and by a rotatable shaft 59 at the other end. A convenient motor drive, not shown, gives motion to the conveyor belt sections by driving the rotatable shafts 55 and 57 at the same uniform speed.

The second conveyor belt section 45 includes a plurality of loosely held belts 61 extending between and driven by the rotating shaft 55, common with the belts 49 of the first conveyor section 43, and the rotating shaft 57, common with the belts 51 of the third conveyor belt section 47. The two different sets of conveyor belts on each of the rotating shafts 55 and 57 are alternately disposed along the length of the drive shaft. The belts 61 of the second section 45 are looped beneath an elongated idler roller 63 that is rotatably held by the frame 41. The top loop portion of each conveyor belt 61 remains slack by the weight of sheets thereon so that the trailing edges of the sheets dip below the level of the first and second conveyor sections 43 and 47. The driven rotatable shafts 55 and 57 are of the same diameter, resulting in all the belts being driven at the same linear speed. Alternatively, it may be desirable to drive the belts 61 of the second conveyor section 45 at a speed independent of the other belt sections. If this is desired, the belts 61 can be supported by idler rolls on the rollers 55 and 57.

An elongated support roll 65 is held to the main frame 41 by a pair of vertically extending posts 67 and 69. Except for rotation of the roller 65 with respect to the posts 67 and 69, the roller 65 is held stationary with respect to the rest of the machine. The roller 65 is held substantially perpendicular to the direction of travel of the conveyor belt and thus the corrugated sheets carried thereby. The roller 65 is held horizontal.

A pair of rolls **71** and **73** are hinged to a rod **75** (that is itself fixed to the printer **13**) by means of support arms **77** and **79**, respectively. The rolls **71** and **73** are disposed above the belts **49** of the first conveyor belt section **43** for holding a stream of corrugated sheets down on the belts. The roller support shafts **77** and **79** are independently hinged on the rod **75** in order to accommodate an uneven height of a stack of corrugated sheets passing beneath the rolls **71** and **73**.

FIG. **1** shows by dotted lines the edges of corrugated sheets that are being moved by the conveyor belt sections from the printer **13** to the die press **15**. Movement of sheets through the three conveyor belt sections is illustrated in an isometric view in FIG. **2**. The conveyor belts **49** of the first conveyor section **43** are operated at a speed relative to the speed that the corrugated sheets are being discharged from the printer **13** so as to shingle these sheets in a stack **81**. Each of the sheets in the stack **81** is supported by the sheet immediately in front thereof. A sheet such as sheet **83** is supported at its leading edge by the support roll **65** while its trailing edge is being moved by the slack belts **61** of the second conveyor section **45**. The sheet **83** becomes inverted by the second conveyor section **45** and pushed by the third conveyor section **47** into a reverse shingle **85**.

Each of the sheets of the stream emerging from the printer **13** follows substantially the same path. Each sheet, except for the first of a stream of sheets, is guided by the sheet or sheets ahead of it until its leading edge is in contact with the support roll **65**. Further motion of the conveyor belts inverts the sheet and adds it to the bottom of the stack **85**. Each sheet must be rigid enough to support the weight of other sheets behind it during the inverting operation, as can best be seen by FIG. **2**.

Since the reverse shingled stack **85** is fed from the bottom, the top sheets thereof may be removed one at a time and placed into the die press **15**. A roller **87** (FIGS. **1** and **3**) is held to the frame **41** by vertically extending posts **89** and **91**. The roller **87** is rotated (by a motor source not shown) to hold down the trailing edge of the top sheet of the reverse shingle stack **85** and to advance the sheets firmly against stops **101**. Bristles are provided on the roller **87** for frictional coupling with the sheets. The support posts **89** and **91** are preferably adjustable along the length of the machine so that th roller **87** may be positioned at the trailing edge of the top sheet.

When the machine is first started in operation, a stream of shingled sheets is first allowed to form on the first conveyor section **43** from the printer **13** until the stream is long enough so that the leading sheet may be lifted and placed on the support roll **65**. This is accomplished manually. So long as the stream of sheets remains continuous, no further human intervention is required to invert and reverse shingle the sheets.

A curved plate **62** is rigidly held between the posts **67** and **69** directly under the roller **65**. The plate **62** provides vertical support for the conveyor belts **61**. Alternative to a plate, rollers could be employed as well. Support of the belts **61** is desirable during start-up when the corrugated sheet load on the belts **61** is concentrated.

A hydraulic cylinder **93** is provided between the frame **41** and the first conveyor section **43** in order to provide an adjustment of the first conveyor section belts **49** with respect to the printer **13**. The hydraulic cylinder **93** also allows movement of the first conveyor section **43** to a position out of the way of the printer **13** so that a worker may gain access to the printer **13** from the conveyor belt side. The rollers **71** and **73** and their respective support arms **77** and **79** may also be swung up and out of the way to allow access to the printer **13** from the conveyor belt side.

To remove the sheets one at a time from the reverse shingle stack **85** and into the die press **15**, a mechanism including a plurality of section cups **95, 97,** and **99** are provided in a single structure, as shown in FIG. **3**. A plurality of fixed stops **101** are attached to the machine frame **41** at the end of the third conveyor belt section **47** for halting forward movement of the top sheet of the reverse shingled stack **85**. The plurality of suction cups **95, 97,** and **99** are positioned in a line substantially parallel to the plurality of stops **101** so that the top surface of the top sheet may be contacted along a line near its leading edge for lifting the sheet up above the stops **101** and into the grippers **37** of the die press **15**. By applying the suction cups near the leading edge of the sheet being removed, any warpage along the leading edge is significantly straightened out to make it easier to position the sheet in the grippers **37** of the die press **15**. The possibility that warping, which is inherent in most corrugated cardboard sheets, will prevent a sheet from being inserted between the grippers **37** and the gripper bar **39** is thus substantially reduced and the productivity of the die press **15** is increased.

In order to accommodate different size corrugated cardboard sheets, certain adjustments are provided in the machine. The spacing of the suction cups **95, 97,** and **99** along a supporting bar **103** is preferably made adjustable in order to accommodate different widths of sheets. Also, the support roll **65** is attached to the vertical posts **67** and **69** so that it may be moved up and down on the posts to accommodate different length corrugated cardboard sheets.

With reference to FIGS. **4** and **5**, details of the suction system for lifting the top sheet from the stack **85** into the die press **15** is illustrated in somewhat more detail than before. The suction cups **95, 97,** and **99** are connected at one end of tubes **105, 107,** and **109,** respectively. The opposite ends of the tubes **105, 107,** and **109** are connected to a vacuum supply pipe **111** which is operably connected to some convenient vacuum source (not shown). The support rod **103** extends at one end to pivotably connect with one of a lever **113**. The lever **113** is pivotably connected at its other end to a rotating wheel **115** at a point removed from its center of rotation. The wheel **115** is rotated through a shaft **117** from a one-to-one drive from the die press **15**. A second lever **119** is pivotably connected at one of its ends to a point on the lever **113** between its ends. The other end of the second lever **119** is pivotably connected to a rotating wheel **121** at a point removed from its center of rotation. The wheel **121** is rotated through a shaft **123** from a one-to-one drive from the shaft **117**.

The points of connection of the levers **113** and **119** to their respective driving wheels **115** and **121**, the angular speed of the wheels **115** and **121**, and intermittant control of the vacuum through the supply tube **11** is synchronized with the die press **15** in a manner to deliver a top sheet **125** from the reverse shingled stack **85** onto the die press. This is shown in three views of FIG. **5**. FIG. **5A** shows a system at an instant of time wherein the suction cups **95, 97, 99** are in contact with the top

surface of the top corrugated sheet **125.** A vacuum is supplied to the suction cups as they are lifted and transversely moved upon rotating wheels **115** and **121** as transmitted to the suction cups through the levers **113** and **119.**

FIG. **5B** shows the corrugated sheet **125** at a later instant of time with its leading edge placed between the grippers **37** and the gripper bar **39** of the die press **15.** A corrugated sheet **125** is suported near its end opposite to the end held by the suction cups by the tops of the fixed stop bars **101.** When the sheet is delivered to the grippers as shown in FIG. **5B,** the vacuum to the cups **95, 97,** and **99** is released as the continued rotation of the wheels **115** and **121** causes, through the levers **113** and **119,** the suction cups **95, 97,** and **99** to subsequently return to the third conveyor section **47,** as shown in FIG. **5C.** After release of the sheet **125** from the suction cups, the gripper bar **39** and the grippers **37** of the die press **15** move away fro the conveyor belt section from pull the sheet **125** into position for cutting by the die press **15.**

During the time that the sheet **125** has been delivered to the die press, as shown in FIGS. **5A–5C,** the conveyor belts continue operating to advance additonal sheets toward the fixed stops **101.** By the time the suction cups return from the die press **15** after delivery of the corrugated sheet **125** from the area of the third conveyor section **47,** another sheet **127** has been advanced into contact with the fixed stops **101** as shown in FIG. **5C.** After the suction cups **95, 97,** and **99** have come into contact with the top surface of the sheet **127,** the vacuum is again applied to the suction cups through the supply tube **111** and the process begins anew by lifting the sheet **127** upward and over the fixed end stops **101** onto the die press **15.**

The various aspects of the present invention have been described with respect to a specific example. It is understood that the invention is not limited by the details of this example but rather the invention is defined by the scope of the appended claims.

What is claimed is:

1. A method of inverting a plurality of sheets of material, comprising the steps of:

forming a shingled stream of said sheets that includes a first sheet and a plurality of sheets following therebehind,

lifting the leading edge of only the first sheet of said stream onto a stationary support,

advancing trailing edges of the sheets in said stream under said stationary support means in a depressed arcuate path to cause each sheet to be inverted and form a reverse shingle stream, and

guiding each of the plurality of sheets up onto the stationary support by means of the sheets of the stream in front of said each sheet without the use of auxiliary elements, the steps of advancing and guiding being performed simultaneously.

2. Apparatus for inverting a plurality of sheets of material, comprising,

means for forming said plurality of sheets into a shingled moving stream,

means positioned above the path of the moving stream of sheets for stopping movement of each sheet by engaging its leading edge, said stopping means including an elongated bar extending across the moving stream of sheets and positioned substantially perpendicular to their path of movement, said stopping means having no element for guiding the leading edge of the sheets up onto the elongated bar except for the shingled sheets themselves, and

means beneath said elongated bar for advancing a trailing edge of each sheet under said elongated bar in the direction of the flow of the stream of sheets, whereby each sheet is inverted,

said advancing means including a flexible slack conveyor belt section that is caused to travel in an arcuate path by the weight of the sheets thereon.

3. Apparatus for conveying corrugated cardboard sheets from the output of a printer to the input of a die press, comprising:

means adjacent said printer for accepting printed sheets and forming a first stack of shingled sheets,

means for inverting each of the sheets of said first stack one at a time to form a second stack of corrugated sheets in a reverse shingle, said inverting means including an elongated bar extending across a path of movement of the sheets for stopping movement of each sheet by engaging its leading edge and a flexible slack conveyor belt section capable of traveling in an arcuate path by the weight of the sheets thereon beneath said bar for advancing a trailing edge of each sheet, and

means for removing the sheets one at a time from the top of said second stack.

4. Apparatus according to claim **3** wherein said means for removing sheets one at a time from the top of said reverse shingled stack includes a plurality of suction cups oriented in a line to contact said top sheet adjacent to a leading edge of said sheet and substantially parallel thereto, means also being provided to give complex upward and lateral motion to said suction cups for removal of the top sheet to said die press.

5. Apparatus for conveying and inverting sheets from an input to an output, comprising:

a first substantially flat conveyor belt section located adjacent said input for forming said sheets into a shingled stream,

a second conveyor belt section disposed immediately adjacent said first conveyor belt section, said second conveyor belt section including a slack conveyor belt which depends downward below the level of said first conveyor belt under the weight of said sheets,

a fixedly positioned elongated support roller extending across said second conveyor belt section a distance above it, whereby the leading edges of said sheets contact said support rod while trailing edges of said sheets are passed thereunder upon movement of the second conveyor belt section, thereby to invert each sheet, and

a third conveyor belt section immediately adjacent the second conveyor belt section, each of the three conveyor belt sections travelling with the same linear speed, whereby the stream of inverted sheets is reverse shingled on the third conveyor belt section for delivery at the output.

6. Apparatus for conveying and inverting sheets, comprising:

means for moving a stack of sheets in a shingled stream from a first location to a second location along a substantially horizontal path,

means for providing motion to a trailing edge of each sheet from said first location downward along an arcuate path and back up to said second location,

means fixedly extending across said arcuate path and positioned thereabove for engaging leading edges of said sheets, and

means for removing reverse shingle sheets from the second location.

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