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De Ligt

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[54] **ACCORDION, FOLDING AND CUTTING APPARATUS**

[75] Inventor: **John De Ligt,** Covington, Va.

[73] Assignee: **Westvaco Corporation,** New York, N.Y.

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[21] Appl. No.: **176,487**

[52] **U.S. Cl.** **270/79,** 270/83

[51] **Int. Cl.** **B65h 45/20**

[58] **Field of Search** 270/21, 39–40, 270/79, 73

[56] **References Cited**

UNITED STATES PATENTS

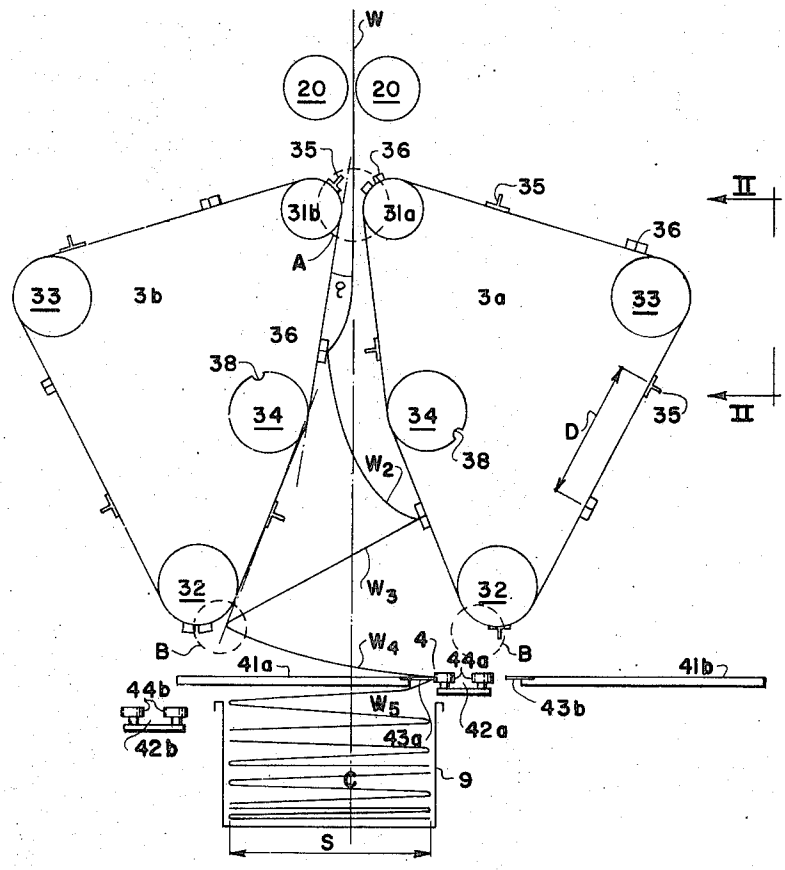
2,675,747	4/1954	Greiner et al.	270/73
1,832,556	11/1931	Jensen et al.	270/79
3,032,337	5/1962	Holman	270/79
1,242,262	10/1917	Straubel	270/39
1,109,296	9/1914	Lewis	270/73
2,246,336	6/1941	Wyrick	270/39

Primary Examiner—Robert W. Michell
Assistant Examiner—A. J. Heinz
Attorney—W. Allen Marcontell & Richard L. Schmalz

[57] **ABSTRACT**

Apparatus for forming accordion folds in a longitudinally traveling web of substantially uniform width and indefinite length including web cutting means disposed upstream or downstream of said folding apparatus.

6 Claims, 13 Drawing Figures



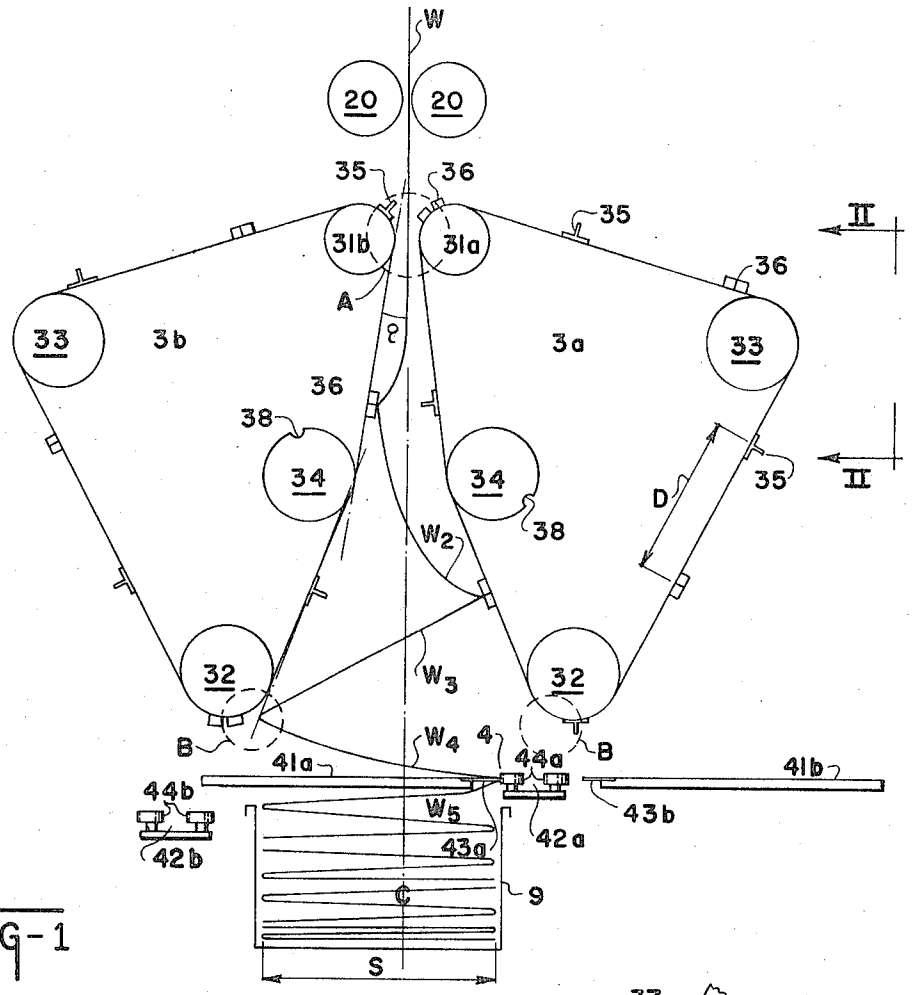


FIG-1

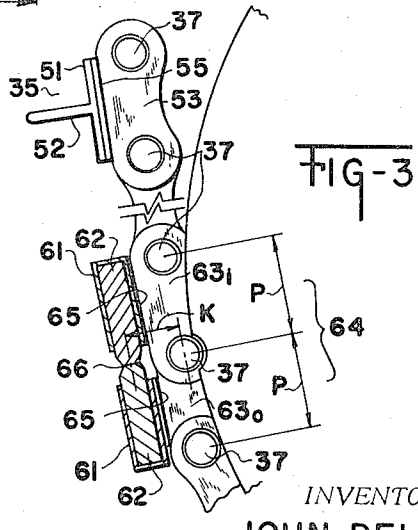


FIG-3

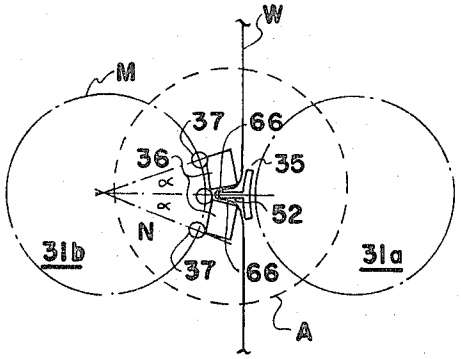


FIG-4

INVENTOR.
JOHN DELIGT

BY

W. L. Marcontell

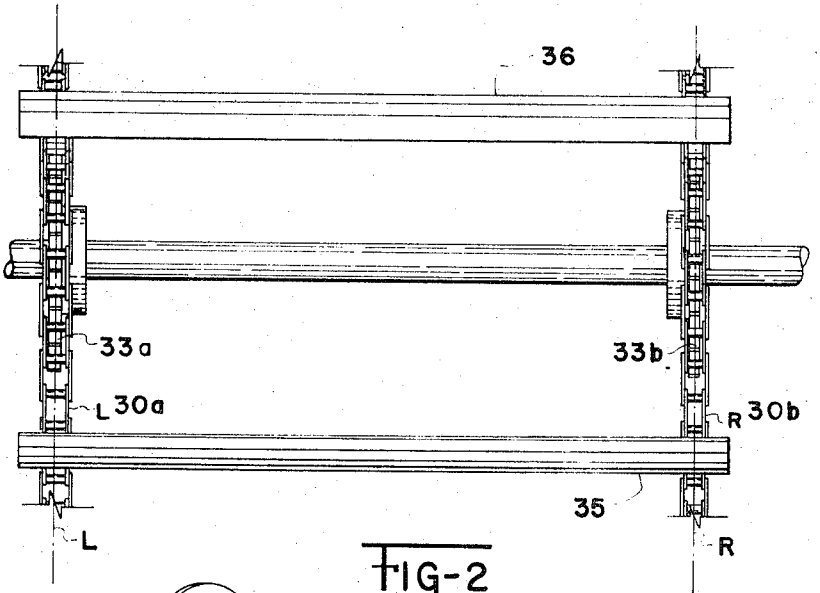


FIG-2

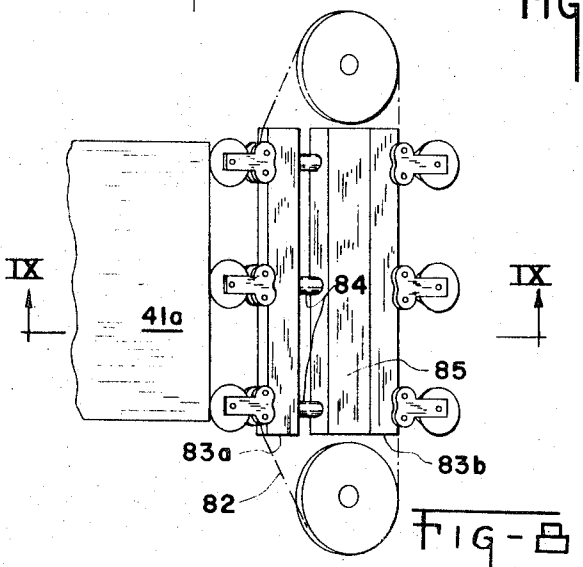


FIG-8

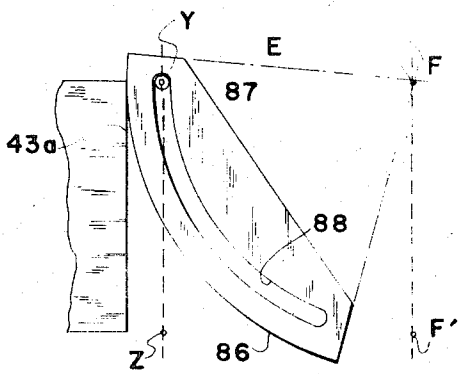


FIG-10

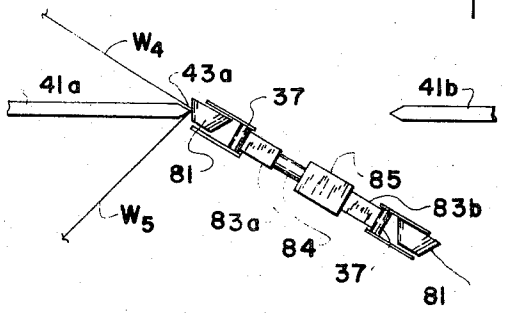


FIG-9

INVENTOR.
JOHN DELIGT

BY

W. Marcontell

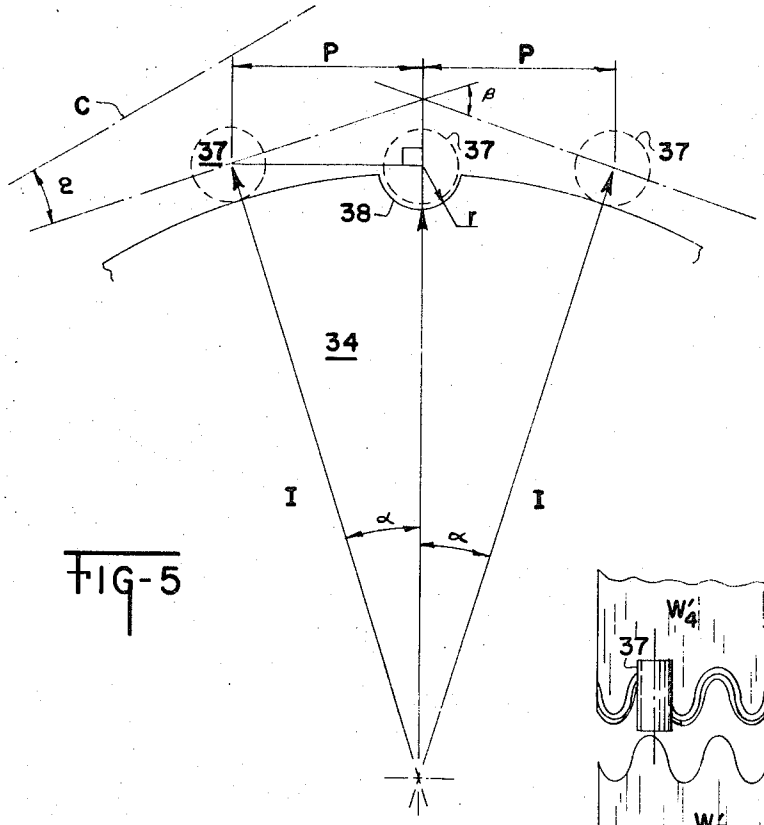


FIG-5

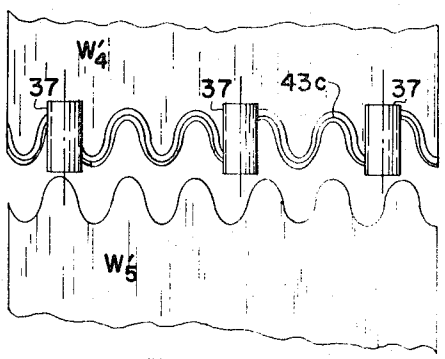


FIG-13

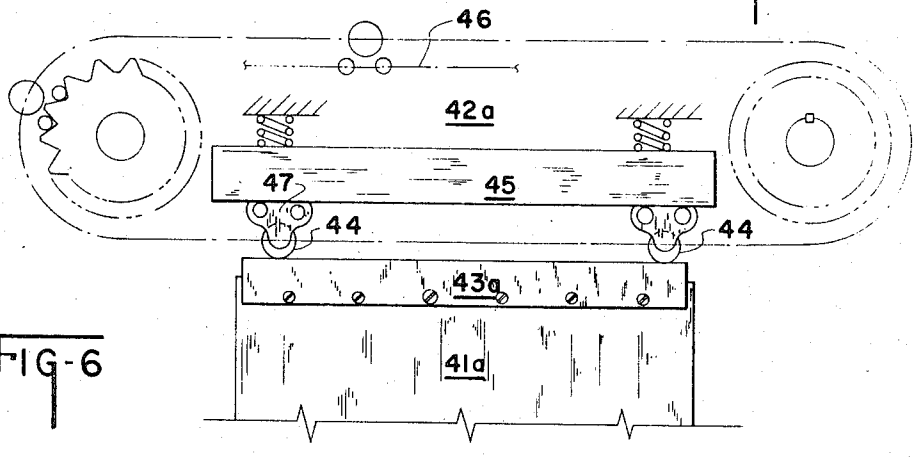


FIG-6

INVENTOR.
JOHN DELIGT

BY

W. E. Maronteld

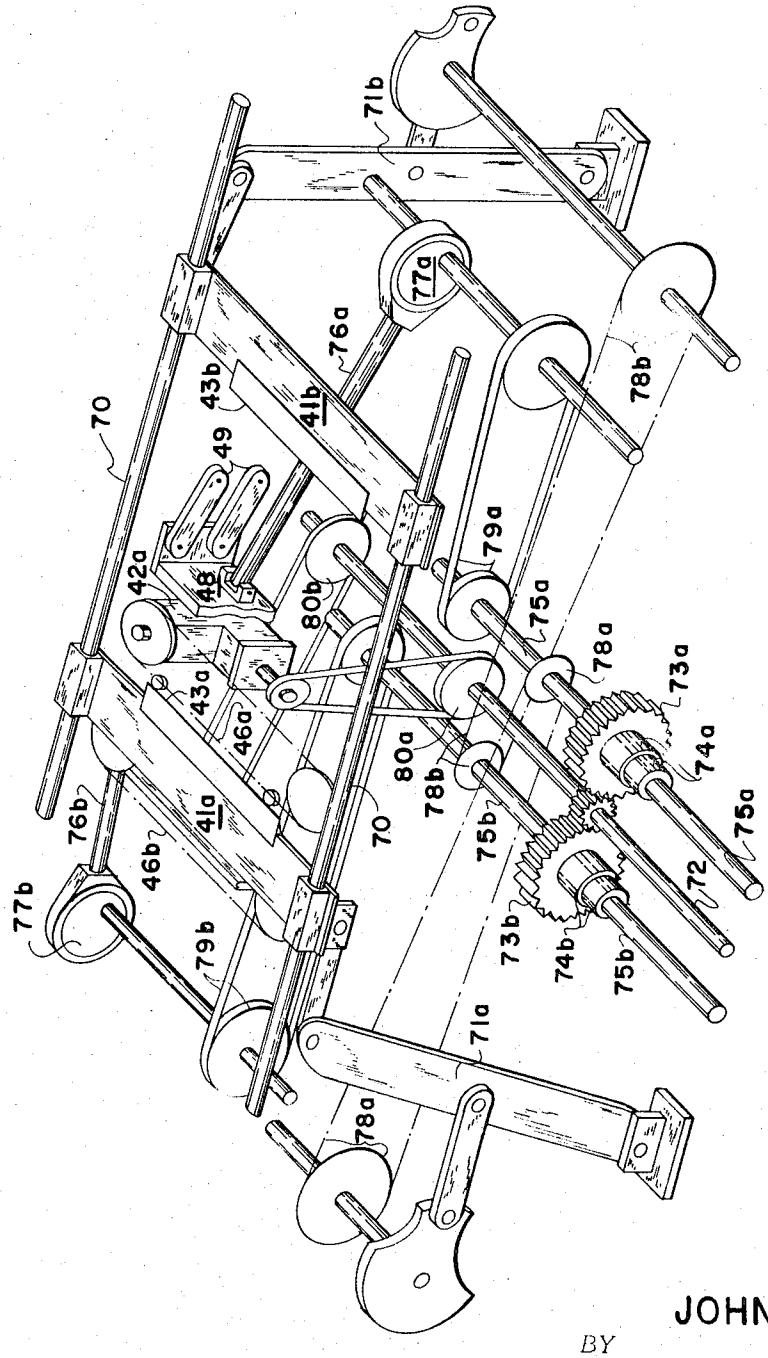


FIG-7

INVENTOR.
JOHN DELIGT

BY

W. G. Macomber

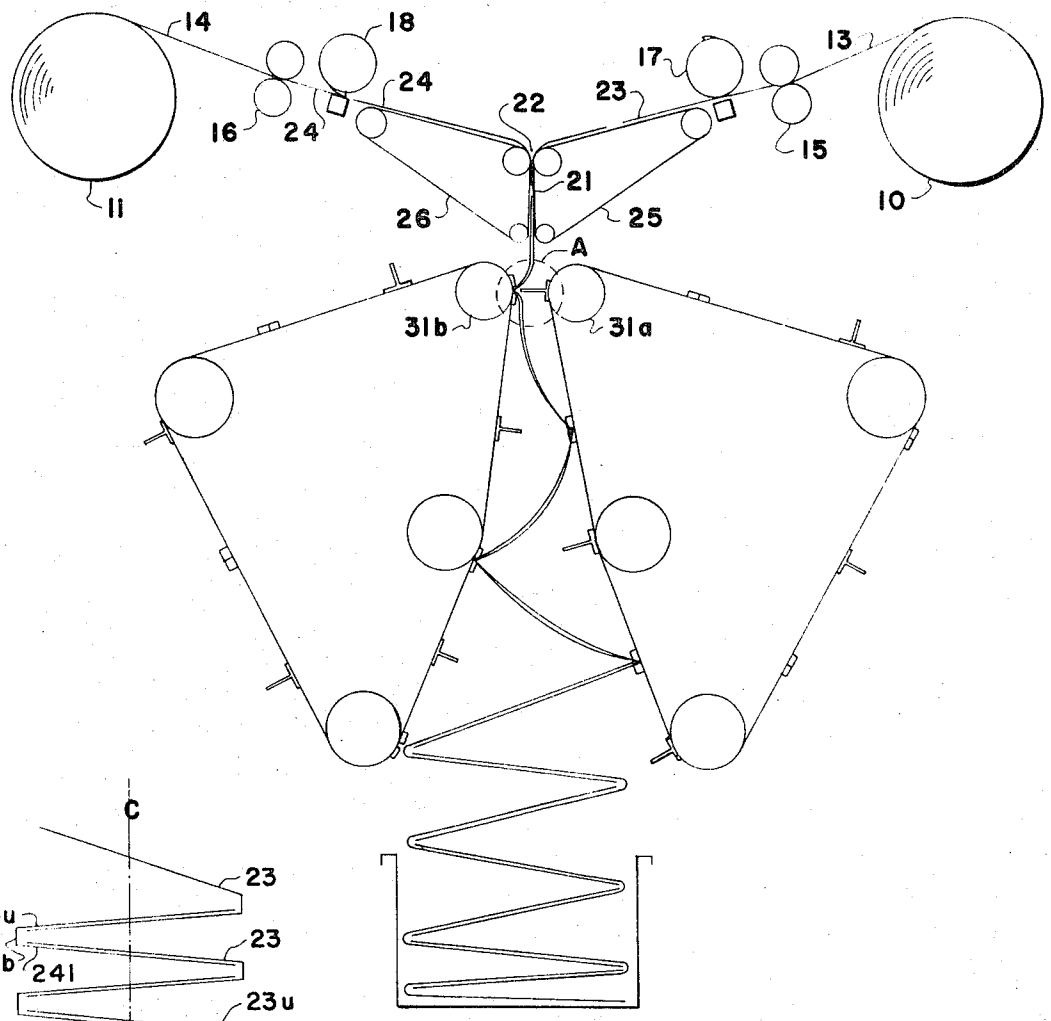


FIG-12

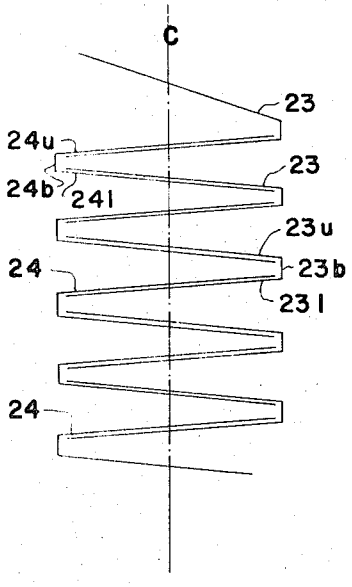


FIG-11

INVENTOR.
JOHN DELIGT

BY

W. E. Marcontell

ACCORDION, FOLDING AND CUTTING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the field of paper converting and comprises apparatus for accordion folding and cutting of a continuous paper web supply.

2. Description of the Prior Art

The continuous, mechanized, accordion folding of a paper web of indefinite length has long been a valuable technique in the process of coverting large, roll quantities of paper into smaller, more convenient units suitable for individual consumer handling. Through the years, many devices to perform this function have evolved as the demand for greater web speed has increased.

Among such prior art devices have been inventions of Meisel, U.S. Pat. No. 568,307, and Teall, U.S. Pat. No. 1,290,800. Both of these inventions, like that of the present, utilize identical link chain carriers on opposite sides of an oncoming web having a multiplicity of projections secured with uniform spacing around the periphery of each chain set which operatively cooperate to displace the web first to one side of a center plane and then to the other, forming a small radius crease at the position of direction reversal. However, both of said earlier inventions require substantial dynamic mass as related to the fold length: an intolerable characteristic for high speed machinery.

Moreover, due to the large turning radius of such prior art machines, similarly large clearances from the point of crease formation to other cooperating machinery such as web cutters are required. An undesirable incident of such large clearances is the long, uncontrolled paper "tail" following a prefold web cut which must be caught and drawn into the accordion fold machinery to a point of positive control.

The present invention discloses a continuous web, accordion folding apparatus suitable for construction with small, light weight elements commensurate with high speed operation.

Another object of the present invention is to provide accordion folding apparatus requiring small operational clearance to decrease the proximity between a pre-creasing web cutter and the first point of positive control within the folding apparatus.

Other objects of the present invention include the disclosure of a post-creasing web cutting apparatus for severing a continuous web in the bight of a crease after the formation of same.

SUMMARY OF THE INVENTION

The folding apparatus of the present invention comprises two identical pairs of link-chain circuits, each pair being disposed on opposite face sides of an oncoming web of paper or other thin sheet material of indefinite length. Chain circuits respective to each pair are disposed for running in parallel planes around respective sprocket sets. Each chain in a pair has secured thereto the respectively opposite ends of several tucker and gripper bars extending between and across the two chains of a pair. Said tucker and gripper bars are positioned perpendicularly to the chain running plane and distributed alternately at uniform intervals around the circuit periphery.

Each gripper bar comprises two, channel shaped structural members, each having one leg thereof secured to one of two longitudinally contiguous chain links. The bight openings of said channels are disposed in facing opposition and filled with a soft, compliant substance such as elastomer.

Each tucker bar comprises a structural "T" element having the crossmember thereof secured to respective chain links and the "T" leg projecting perpendicularly therefrom.

Operationally, the two chain pairs are synchronized whereby the tucker bar on one chain pair coincides with the gripper bar nip opening of the other chain pair. As the two, longitudinally contiguous links retaining the gripper bar are turned over a small diameter sprocket, the consequent angular divergence between the gripper faces causes a nip to open therebetween. Said nip opening receives the tucker bar leg as it rolls a projection of the web into meshing contact with the nip opening. Separation from the sprocket returns the two contiguous gripper bar carrier links to a straight line geometry thereby closing the gripper faces on the web held therebetween.

Since the straight-run sections of chain circuit departing from the meshing sprockets are aligned for slight relative divergence, the tucker leg is withdrawn from the gripper nip at very slight planar misalignment. As soon, however, as the tucker leg is withdrawn from the gripper, the chain angle of divergence is increased greatly by turning around an idler sprocket having a chain engagement profile such as to retain a straight line geometry between the two contiguous gripper bar carrier links. This geometry prevents the gripper from opening and prematurely releasing the crease.

This increased divergence angle rapidly advances the web crease to the desired release position where at the chain circuit is directed around another, small diameter, conventional profile, sprocket for the purpose of opening the gripper to release the web.

If the web is to be cut following folding, a reciprocating blade engages the web along the crease bight. Simultaneously, a set of chain driven, cylindrical rollers are positioned against the web on the side opposite from the blade edge for loaded rolling contact there along to cut the web.

As an alternative embodiment of the invention, an interleaved series of short sheets may be accordion folded into a rectangular dispensing stack by prefold cutting the webs of two, independent supply streams into sheet length increments, merging the two supply streams into one, double layer stream with the transverse edges of one stream indexed to coincide with the midpoint between sheet edges of the other stream and orienting the double layer stream with the present folding apparatus to grasp, within the nip of a single gripper, two, serially adjacent, transverse sheet edges within the linking bight of a laterally adjacent sheet crease.

BRIEF DESCRIPTION OF THE DRAWINGS

Relative to the drawings wherein like reference characters designate like or corresponding parts throughout the several views;

FIG. 1 is a line schematic of the accordion folding apparatus of the present invention integrated with a post-fold cutting apparatus;

FIG. 2 is a partial elevational view of the folding apparatus of FIG. 1 as seen at cut II—II;

FIG. 3 is a detail of the chain carried tucker and gripper elements of the folding apparatus;

FIG. 4 is a schematic illustrating the mechanics operative in placing a transversely creased portion of web within the open nip of a gripper element;

FIG. 5 is a geometric detail of the cam element for turning the folding apparatus chain direction without prematurely opening the grippers;

FIG. 6 is a plan detail of the rolling cutter apparatus for cutting a web after the accordion fold is formed;

FIG. 7 is an isometric schematic showing the power transmission train to the rolling - cutter apparatus;

FIG. 8 is a plan view of an alternative scheme for selectively retracting the rolling cutters from the reciprocating blade table plane;

FIG. 9 is a sectional elevation of FIG. 8 as seen across cut IX—IX;

FIG. 10 is a second alternate to the rolling-cutter apparatus of the invention;

FIG. 11 is an exaggerated schematic of folded product from the apparatus illustrated in FIG. 12;

FIG. 12 is a folding apparatus of the present invention integrated with a prefold-cutting apparatus for producing the interleaved sheet product of FIG. 11.

FIG. 13 is a schematic of an alternative blade shape and associate web cutting pattern available from the roller-cutter apparatus of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

1. OPERATION FLOW SEQUENCE

Starting with the FIG. 1 schematic, a paper web W of indefinite length is shown as delivered to the accordion folding apparatus at a controlled rate by pulling rolls **20.** Right and left roller chain circuits **3***a* and **3***b* functionally cooperate in the proximal region A to alternately engage the web W at regularly spaced distances along the web length. The engagement forms a straight crease or pinch line extending perpendicularly transverse to the web length axis with the bight openings of successive creases facing in alternately opposite directions, i.e. away from the chain supporting that particular crease.

Each crease is carried by its respective supportive chain to the lower, release proximity B where the web panel W_4 is substantially horizontal and will gravity drop to a flat position without wrinkling.

Although this disclosure of the preferred embodiment describes the endless carrier elements **3***a* and **3***b* as roller chains, it should be appreciated that numerous alternatives, generically characterized as endless traction means, may be equally suitable for particular applications. Among such alternative may be included other types of chain drives, belts, ropes or cables. Relative rotational timing between the two circuits **3***a* and **3***b* is critical since rigid elements structurally secured to each circuit must physically cooperate by meshing. However, it is entirely possible to design a belt carrier system in which the inherent slippage between the traction carriers and the associate sheaves (sprockets) is not so great as to be within meshing tolerance from one meshing half cycle to the next. Coincident therewith, each incident of meshing would physically correct any misalignment of relative index occurring within the preceding half cycle of operation.

To cut the infinite length web W into uniform lengths terminating precisely along a crease bight centerline, a post-fold cutting mechanism **4** is disposed between the folding apparatus and product receiving hopper **9.** If provision for cutting web creases falling on either side of web flow centerline C is desired, cutting mechanism **4** may comprise two blade tables **41***a* and **41***b* and two roller-cutting units **42***a* and **42***b*. Blade table **41***a* and roller unit **42***a* functionally cooperate as a set to sever crease lines on the right side of centerline C whereas table **41***b* and roller unit **42***b* cooperate for left side cuts, exclusively.

An alternative embodiment is illustrated by FIG. **12** where prefold cutting is performed on two web sources **10** and **11** for the purpose of interleaving one panel section of a folded sheet between integral panels of a second, folded sheet.

2. FOLDING MECHANISM

Each chain circuit **3***a* and **3***b* in FIG. **1** comprises a pair of roller chains **30** encompassing sprockets **31, 32, 33** and cam **34.** There being two, parallel, chain running planes, R and L (FIG. **2**), having rigid transverse structural ties (tucker **35** and gripper **36**), in each chain circuit **3***a* and **3***b*, a total four chain closures, L**30***a*, R**30***a*, L**30***b* and R**30***b*, are described herein. It should be understood, however, that the number of running planes, e.g. R and L, may be increased for the purpose of folding wider paper. To do so, would increase the number of chain closures by two for each running plane added.

Both chain circuits **3***a* and **3***b* being of identical construction, further description will be focused on circuit **3***a*.

Relative to FIGS. **2** and **3,** it may be seen that each gripper bar **36** comprises two, longitudinal structural channel elements **61** filled with elastomer **62.** The interface between the two elastomer portions **62** is separable to form respective gripper jaws **66.** The two elements **61** of each gripper bar **36** are respectively carried by the two, relatively articulatable, contiguous, link pairs **63***o* and **63***i* forming link set **64.** Tabs **65,** integral with the links **63,** may be used as attachment platforms for the channels **61** to the links **63.**

Tucker bar **35** is shown to be a unitary, extruded "T" or "L" element comprising cross-bar **51** and leg projection **52.** Like the gripper **36,** tucker bar **35** may be secured to link pair **53** by means of an attachment platform **55.**

The number of tuckers **35** and grippers **36** allowed on each chain circuit is arbitrary above the permissible minimum of **2** tuckers and **2** grippers. For purposes of timing, coordination, etc., there should be a whole number ratio between the sum of grippers and tuckers and the length of the circuit in pitches.

The distance D between a gripper **36** and adjacent tuckers **35** on the same chain is related to, but not the same as, a panel length S. Therefore, the linear quantity of web W pushed by the rolls **20** between chain circuits **3***a* and **3***b* in the interim between points of tucker-gripper engagement is greater than the distance D as represented by the sag in FIG. **1** web sections W_1 and W_2.

The opening and closing operations of grippers **36** are functions of relative geometry as the chains are drawn over the periphery of sprockets **31** and **32.** The distance P(FIGS. **3** and **5**) between chain rollers **37** is

held constant by the interconnecting rigid links **63.** Accordingly, the sprocket pitch P may be defined as a chord subtending an α degree arc on the pitch circle M of radius of N (FIG. 4). Gripper faces **66** are placed at a distance K (FIG. 3) above the plane including the axes of two adjacent rollers **37** and disposed to abut, or nearly so, between sprockets when the roller center beneath the gripper face **66** falls into a plane common to the centers of those rollers adjacent both sides. Since the geometry of a link pair **63** between adjacent rollers **37** is rigid, when a gripper bar unit **36,** having cooperative jaw elements on two adjacent link pairs **63***i* and **63***o* of a link set **64,** is drawn over the periphery of a sprocket, the jaws **66** are separated by a mean distance substantially equal to 2(K) (Sin α). As the chain departs from contact with a sprocket, the roller centers return to the straight line relationship thereby closing the jaws **66.**

Rotational timing of the chain circuits **3***a* and **3***b* is as shown by FIGS. **1** and **4** whereby the tucker leg **52** of one chain circuit rolls between the opened jaws **66** of gripper **36** on the opposite chain circuit. Since the meshing of cooperative tuckers and grippers is from opposite sides of the web W, a portion thereof is pressed between the open gripper jaws **66** as shown in FIG. **4.** As the chain rolls off the sprocket **31***b*, jaws **66** are pulled together to close on tucker leg **52,** clamping the web W therebetween.

In order to withdraw the tucker leg **52** from the nip of jaws **66** without disrupting or damaging the web therebetween, the chains course half angle of departure ρ from sprockets **31***a* and **31***b* must be held to shallow maximums. The exact angle may be analytically derived by those of ordinary skill in the art but for purposes of example, half angle ρ may be in the order of 5°.

At this point in the operation, gripper **36** has established a crease in the web and leg **52** of tucker **35** has been withdrawn therefrom. Moreover, the crease held by chain circuit **3***b* is slightly to the left (FIG. **1**) of center plane C. The next succeeding crease will be held by chain circuit **3***a* and will be drawn to the right of center plane C thereby establishing an accordion geometry bias. However, no reliably repetitive fall pattern may be acquired or positive control exercised if the web is released. Wrinkles and irregular stacking patterns will result if the web is released from the positions W_2 or W_1. Therefore, the generally vertical disposition of the accordion must be reoriented to a generally horizontal disposition as represented by web sections W_3 and W_4. To accomplish this result, the creased end of web section W_3 held by chain circuit **3***b* must be advanced laterally (to the left) from the center plane C at a greater rate than the circuit **3***a* held crease of the same section W_3. Simultaneously, the vertical displacement between the two ends of section W_3 must be reduced.

An obvious technique of such reorientation is to increase the rate of circuit divergence by the half angle quantity of β, 25° for example, as by bending around an intermediate cam **34.** But if the idler includes a conventional profile, gripper jaws **66** will open and release the web prematurely as the gripper bar **36** passes thereover.

To avoid this result, cam **34** of the present invention are provided with notches **38** which are rotationally timed to receive the center roller of the three roller groups supporting a gripper bar link set **64.** As represented by FIG. **5** the centers of the three link set **64** supportive rollers **37** are allowed to sustain a straight line reltionship at the point of chain tangency to the idler **34.** The depth and profile of the notch **38** may be determined analytically by those of ordinary skill in the art from chain pitch P, chain roller radius *r*, the initial departure angle α and the final departure angle β. Since link pairs **63***i* and **63***o* are precluded from relative angular displacement as the set **64** turns about idler **34,** jaws **66** are held tightly closed on the crease of web W.

The next critical design point of the present invention is the vertical placement of release sprocket **32** below idler **34.** The controlling criterion is the length of a moderately tensioned web secton W_3 so that gripper bar **36** on chain circuit **3***b* will open as the gripper **36** on chain circuit **3***a* moves into position to pull the **3***b* circuit crease from between jaws **66.**

If only continuous and rapid accordion folding of web W is desired, the aforedescribed apparatus will flawlessly deliver a rectangular column continuum of accordion folded web to a receiving station such as chute or hopper **9.**

However, if finite lengths of folded web, in whole number increments of web sections between creases, are desired, the aforedescribed folding apparatus may have integrated therewith the post-fold cutting mechanism **4.**

3. POST-FOLD CUTTING MECHANISM

The preferred embodiment of the post-fold cutter comprises two blade tables **41***a* and **41***b* disposed in the same plane below release sprockets **32.**

The two tables **41***a* and **41***b* function alternately with one, **41***a* of FIG. **1,** penetrating the material flow column between web sections W_4 and W_5 from the left of center plane C and the other, **41***b*, penetrating between web sections W_3 and W_4 from the right of center plane C.

Both tables **41***a* and **41***b* are provided with knife edges **43***a* and **43***b* for positionment within the bight of a crease.

Rotating into position against the knife edges **43***a* and **43***b* but from opposite sides of the web W_1 are respective roller mechanisms **42***a* and **42***b*. As best illustrated by FIG. **6** relatively wide, flat tread wheels **44** cut the web W by pressing same against the knife edge **32***a* with rolling contact. Resiliently loaded backing bar **45** maintains a relatively constant contact pressure between wheels **44** and the web W to assure complete cutting across the full web width as the edge and tread surfaces wear. The treads of wheels **44** should be "flat," i.e. relatively long surface elements of a regular cylinder, to provide broad accommodation for the degree of functional misalignment as eventually, if not initially, occurs in high speed, cyclically reversing machinery.

Rollers **44** are mounted on carrier links **47** of a sprocket driven roller chain **46.** Spacing between rollers **44** along the chain **46** may be as desired, one factor of consideration being the length of allowable cutting interim within an operational cycle: a smaller separation distance between rollers yields a shorter cutting time for a given chain speed.

It should be appreciated that a cutting operation performed by the aforedescribed apparatus of this invention is not only rapid due to simultaneous cutting of several small increments across the web width but is

also neat, there being no opportunity for shredding due to blade misalignment. The present invention allows only one cut line, that allowed by the continuous line of knife edge **43***a* or **43***b*, regardless of the variance the edge line may follow from true (within the limits of the wheel **44** tread width). Therefore, a single, continuous cut line may be achieved with the rapidity of multiple cutters.

Although any number of mechanisms may be devised for selectively engaging the knife edges **43** with rollers **44**, the schematic shown in isometric by FIG. **7** is of a particularly successful example. Knife tables **41***a* and **41***b* are mounted on guide bars **70** and reciprocably driven by four-bar crank mechanisms **71***a* and **71***b*. Since the web cutting operation is cyclical over an interrupted period, greatest flexibility for programing the cycle period is afforded by linking the input power line shaft **72** with the lateral, power transfer shafts **75***a* and **75***b* carrying lateral spur gears **73***a* and **73***b* through electrically latched, single revolution clutches **74***a* and **74***b* such as a type **6** as specified by the Hilliard Corporation of Elmira, N.Y.

Condition sensory means such as a limit switch or photo sensory switch, not shown, for actuating either of clutches **73***a* or **73***b* by the emission of a suitable electrical signal, may be responsive to select portions of the folding mechanism or drive therfor such as the notched cam **34**.

With each operational cycle of the blade tables **41***a* and **41***b*, so too, are positioned roller-cutter units **42***a* and **42***b* by means of carriage **48**, parallel swing arms **49** and eccentric **77** driven connecting rod **76**.

With clutch **74***a* engaged, for example, power is transferred from shaft **72** to shaft **75***a* via spur gear **73***a*. Shaft **75***a* transfers power to the four-bar linkage **71***a* via chain transmission **78***a* (thereby sliding blade table **41***a* between web panels W_4 and W_5 (FIG. **1**)). Simultaneously, chain transmission **79***a* draws power from shaft **75***a* to rotate eccentric **77***a* for raising the roller-cutter unit **42***a* into operative engagement with knife edge **43***a* mounted on blade table **41***a*.

Roller chain **46** carrying cutting wheels **44** is driven continuously by direct power take-off **80***a* from main input power shaft **72** thereby further minimizing the cutter delay time.

As of the aforedescribed point of operation, the cutting cycle for the crease joined web panels W_4 and W_5 is only half complete although the web is completely severed. However, since the ratio between the power shaft **72** gear is **2**:**1** for a complete cycle, the one revolution clutch **74***a* must be actuated a second time to withdraw blade table **41***a* from the web flow column. This second actuation may be keyed to such an event as the completion of a dump cycle for hopper **9** to remove the material collected therein and severed from the web W by the rolling-cutter apparatus.

After the cutting plane between guide bars **70** has been cleared by the retraction of roller-cutter **42***a* and blade table **41***a* therefrom, the circuit for actuating cutting apparatus **41***b* and **42***b* is prepared for completion by a second panel counting circuit. In this manner, web creases on sequentially opposite sides of the material flow axis C are cut with a predetermined number of integrally connected panels therebetween.

It should be understood that the scale and disposition of elements in FIG. **7** is distorted to further the ends of clarity and disclosure. Although the gear and sprocket ratios of the FIG. **7** mechanism are critical, they are so for a very limited product range. These are matters within the competence of ordinarily skilled practitioners of the art and need no further elaboration.

It should be noted, however, that depending on associated machine geometry and the nature of power available, the rolling-cutter mechanisms disclosed by FIGS. **8, 9** and **10** may be more suitable.

The FIG. **8** and **9** embodiment, for example provides an alternative to physically displacing a driven sprocket under load as required the FIG. **7** mechanism. In FIGS. **8** and **9** the rolling contact surfaces are frustums of regular cones **81** carried on an expansible chain circuit **82** loaded tensionally by reciprocable load shoes **83***a* and **83***b*. Linking piston rods **84** fitted through cylinder block **85** rigidly unitize shoes **83***a* and **83***b* whereby fluid pressure resiliently biased against an annular collar piston surface (not shown) within the cylinder block **85** engages the rolling contact surface **81** with the knife edge **43***a*. When the cut is complete, fluid pressure bias on the piston collar is reversed to retract all chains and roller elements from the blade table reciprocation plane.

The rolling cutter mechansim of FIG. **10** is highly simplified and represents the basic elements of an application where the most convenient power application is a single or double stroke linear displacement of a machine element from point Y to point Z. The elements of FIG. **10** include the arcuate segment of a cylinder having a radius E. The cyclindrical surface **86** is rolled into contact with the knife edge **43***a* by driving a rod or roller element **87** along arcuate slot **88** from point Y to point Z. As surface **86** rolls about the axis F, the axis position translates to point F'.

FIG. **13** further illustrates the design flexibility available to the present invention by allowing complex cutting patterns such as the undulating or scalloped edge of panel W_5' without sacrifice of cutting speed or precision. Since the thread width of rollers **37** exceeds the amplitude of knife edge **43***c* undulations, the cut line for web W_5' will follow exactly that of the knife edge notwithstanding the fact that several rollers **37**, rapidly traversing short increments of the web width, serve as separate anvils over respective increments.

Many variations of the scalloped edge scheme of FIG. **13** may be comprehended within the teaching of the invention, such as Greek scroll or sawtooth, the primary criterion being that the web W is pressed against all transverse elements of the edge **43***c* by loaded, rolling, contact pressure.

4. PREFOLD CUTTING MECHANISM

Due to the relatively short radial clearance required by the sweep of tucker **35** and gripper **36** devices of the present invention, it is also possible to integrate the present accordion folding apparatus with prefold cutting apparatus to deliver a continuum of interleaved, single folded sheets as schematically represented by FIG. **11**. Distinctive characteristics of the FIG. **11** product include sheets **23**, folded so as to open to the left of the center line, and sheets **24**, folded so as to open to the right of the center line. The upper panels **23***u* of sheets **23** are disposed to overlie the lower panels **24**L of sheets **24**. Conversely, panels **24***u* overlie panels **23**L. An integral pair of panels, **23***a* and **23**L for example, are joined by he bight of a crease **23***b*.

Relating now to the FIG. 12 apparatus for producing the product of FIG. 11, there are shown two web supply streams 13 and 14 pulled from reels 10 and 11 by pulling rolls 15 and 16. Rotary knives 17 and 18 cut the respective webs into a continuum of sheets 23 and 24, respectively.

Subsequent to cutting, the two supply streams are merged into a single plane of supply 21 by the converging nip 22 between belt conveyors 25 and 26. Rotation of the knife 17 is timed for 180° angular phase displacement from the rotation of knife 18 so that upon emergence from the nip 22, the transversely cut edges of serially adjacent sheets 23 from supply stream 13 align with the approximate midpoint between transverse edges of laterally adjacent sheets 24. From the nip 22, the single supply stream 21 is delivered to the pickup area A between sprockets 31*a* and 31*b* where the junction between serially adjacent edges of sheets 23 and the midpoint of sheets 24 is pressed into the nip of grippers 36.

As the foregoing cycle is reversed and repeated, panels from respective webs are interleaved in the manner represented by FIG. 11.

Having disclosed a specific, preferred embodiment, I claim as my invention:

1. Thin sheet material folding and cutting apparatus comprising:

means for reverse folding an indefinite length web of thin sheet material into a continuum of transverse crease connected panels of uniform length, the bight of a first crease open to a first direction and the bight of a second, successive crease open to a second direction;

planar support means reciprocable in a plane substantially parallel with said creases, said planar support means having a cutting edge for engaging a longitudinal element of a first transverse crease bight along the full length thereof;

a rolling pressure surface having a line of rolling contact for pressing said web against said cutting edge;

support structure for said rolling pressure surface, said support structure including guide means for confining said line of rolling contact to a plane parallel with said cutting edge;

pressure surface drive means secured to said support structure for driving said rolling pressure surface along said line of rolling contact; and,

transmission means to coordinate the engagement of said cutting edge with the bight of said first transverse crease from said first direction, to move said rolling pressure surface ans support structure therefor into rolling pressure surface engagement with a face of said web opposite from said cutting edge and to energize said drive means for transverse severance of said web.

2. Thin sheet material folding and cutting apparatus as described by claim 1 wherein said transmission means further comprises means to sequentially withdraw a first planar support means cutting edge and a first rolling pressure surface from said web engagement position and to engage said web along the bight of a second transverse crease between a second planar support means cutting edge and a second rolling pressure surface having support structure therefor.

3. Thin sheet material folding and cutting apparatus as described by claim 1 wherein said pressure surface drive means comprises an endless tensile element driven about a planar periphery, a portion of said planar periphery being parallel with said planar support means cutting edge, said rolling pressure surface comprising a plurality of wheel elements secured to said tensile element for rotation about an axis disposed substantially perpendicular to said cutting edge.

4. Apparatus for cutting, folding and interleaving sheets of thin material comprising:

two web supply streams of thin sheet material having substantially uniform width and indefinite length;

web cutting means in each supply stream for cutting said stream into panels of uniform length, said two supply streams subsequently merging into a single stream comprising two parallel planar rows of said panels, said two cutting means being relatively synchronized whereby severed transverse edges of panels in one of said parallel planar rows align substantially midway between severed transverse edges of panels in said other row;

said single stream continuously entering the proximity between a pair of first sprocket means, each carrying one of a pair of endless chain assemblies operatively disposed around respective closed circuits, each of said chain assemblies comprising a plurality of chain links, each of said chain links having one of two distally opposite ends thereof pivotally joined at a pivot axis to one such end of respectively adjacent links;

tucker means and gripper means alternately secured around the periphery of each said chain assembly, each gripper means comprising gripping elements respectively secured to two adjacent chin links whereby two gripping elements cooperatively converge when traversing linear portions of said closed chain circuit to grasp the sheet material and open when traversing arcuate portions of said closed chain circuit, tucker means on one of said chain assemblies meshing with an open nip of gripper means on the other chain assembly and vice versa in the proximity between said first sprocket means to press a portion of said single stream into said open nip whereby a longitudinal half panel of one row is disposed between crease connected half panels of the other row and vice versa;

each of said chain assemblies following first mutually divergent paths from first sprocket means to withdraw said tucker means from closed nips of gripper means; and,

turning guide means respective to each chain assembly for directing same about a turning axis from said first divergent path to a second, different divergent path terminated by second sprocket means, said turning guide means including grip retaining means for supporting in a substantially common plane, the pivot axes of at least three pivot joints of two adjacent chain links respectively supporting two cooperating gripping elements while in arcuate traversal about said turning axis whereby said gripping elements remain closed throughout said traversal.

5. Apparatus as described by claim 4 wherein said gripping elements comprise a bar element secured to each of said two adjacent chain links.

6. Apparatus as described by claim 5 wherein each said turning guide means further comprising a rotatable element having a peripheral support surface for said re-

spective chain assembly, said support surface having a depression therein synchronized to cooperate with that chain link pivot joint common to said two adjacent gripping element supporting links to accommodate a more proximate radial position of said common joint relative to said turning axis than the distally opposite joints of said adjacent gripping element supporting links.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,784,188 Dated January 8, 1974

Inventor(s) John DeLigt

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 18, following "been" insert --the--. Column 7, line 45, "cutter" should be --cutting--. Column 8, line 68, following "joined by" correct the spelling of --the--. Column 9, line 52, following "surface" correct the spelling of -- and --.

Signed and sealed this 25th day of June 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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