United States Patent

Henkel

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[45] **Nov. 21, 1972**

[54] **PLANETARY SHEET SLOWDOWN AND LAYDOWN MECHANISM**

[72] Inventor: **Allmen P. Henkel,** Lake Forest, Ill.

[73] Assignee: **Western Printing Machinery Co.,** Schiller Park, Ill.

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[52] **U.S. Cl.**.....**271/79**

[51] **Int. Cl.**.....**B65h 29/28,** B65h 29/06

[58] **Field of Search**.....271/79, 80, 68, 82, 64

[56] **References Cited**

UNITED STATES PATENTS

3,284,081	11/1966	Huck	271/64
2,093,228	9/1937	Barber	271/68
2,620,033	12/1952	Wood	271/68

FOREIGN PATENTS OR APPLICATIONS

446,462	4/1936	Great Britain	271/79

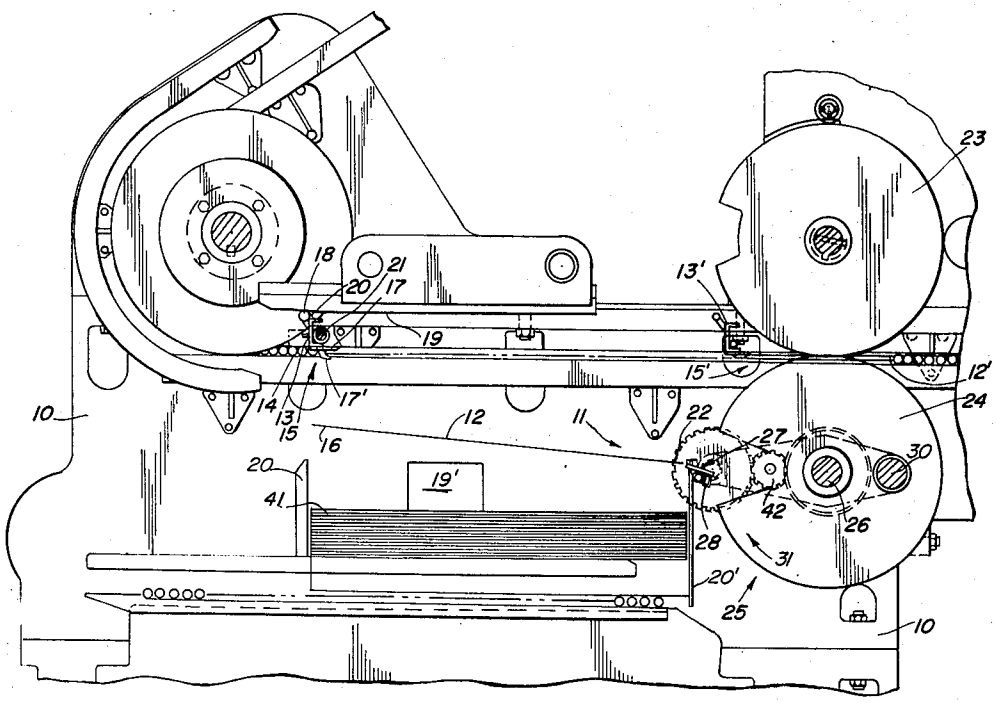
Primary Examiner—Richard E. Aegerter

Attorney—Charles W. Rummler and William A. Snow

[57] **ABSTRACT**

A sheet slowdown and stacking mechanism having horizontal grippers for engaging the tail edge of a sheet moving at high speed over a sheet stack followed by release of the leading edge of the sheet from a conveying transport gripper bar, the tail edge of said sheet being carried forward and downward on a curvilinear path engaged by the horizontal grippers which are gyrating about the axis of a rotating reel, said grippers decelerating the forward motion of the sheet substantially to zero at the point of release over the sheet stack for laying down the sheet on the stack pile.

5 Claims, 5 Drawing Figures



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SHEET 1 OF 4

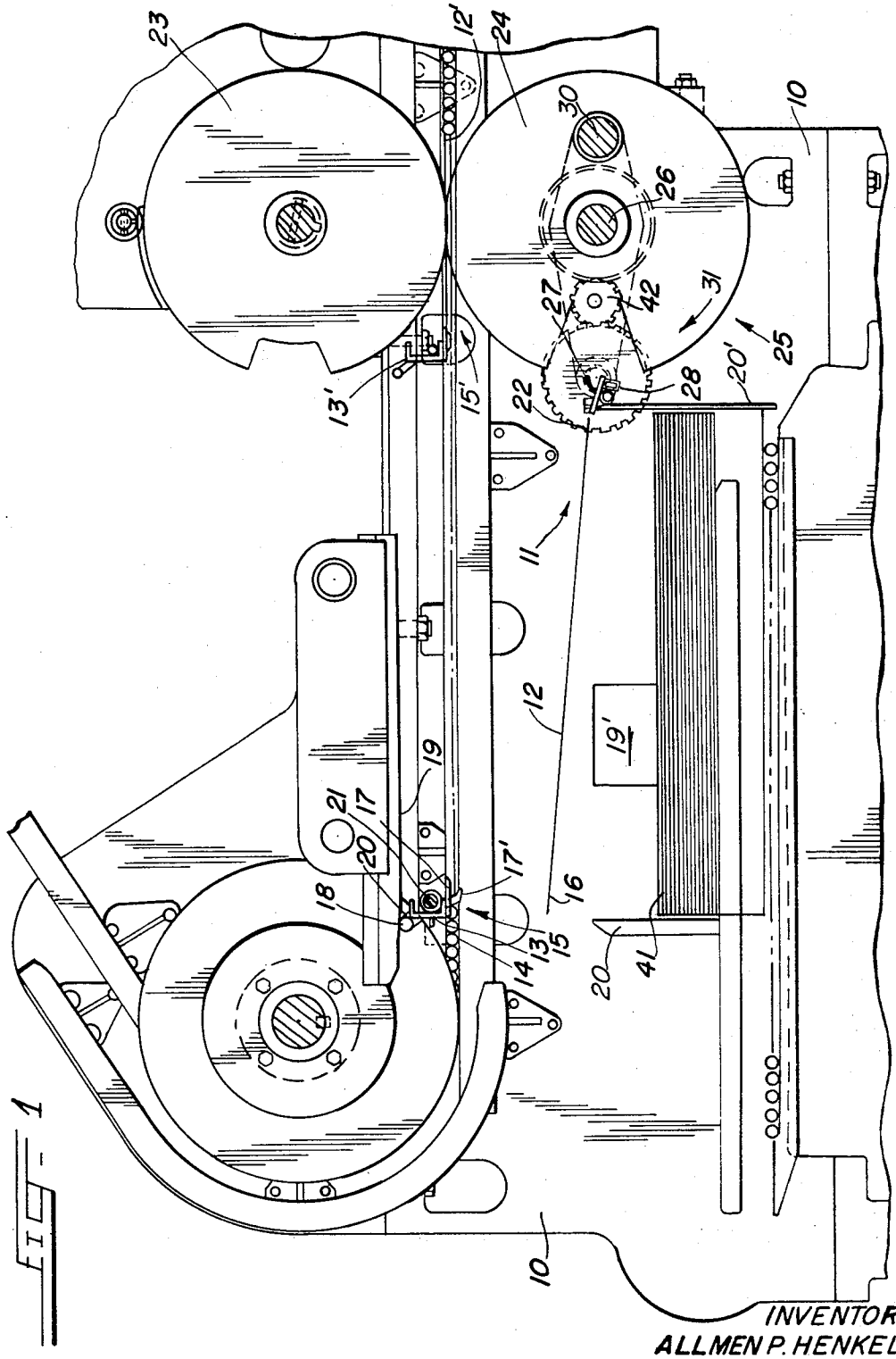


FIG. 1

INVENTOR.
ALLMEN P. HENKEL

BY Rummler & Snow.
ATTYS.

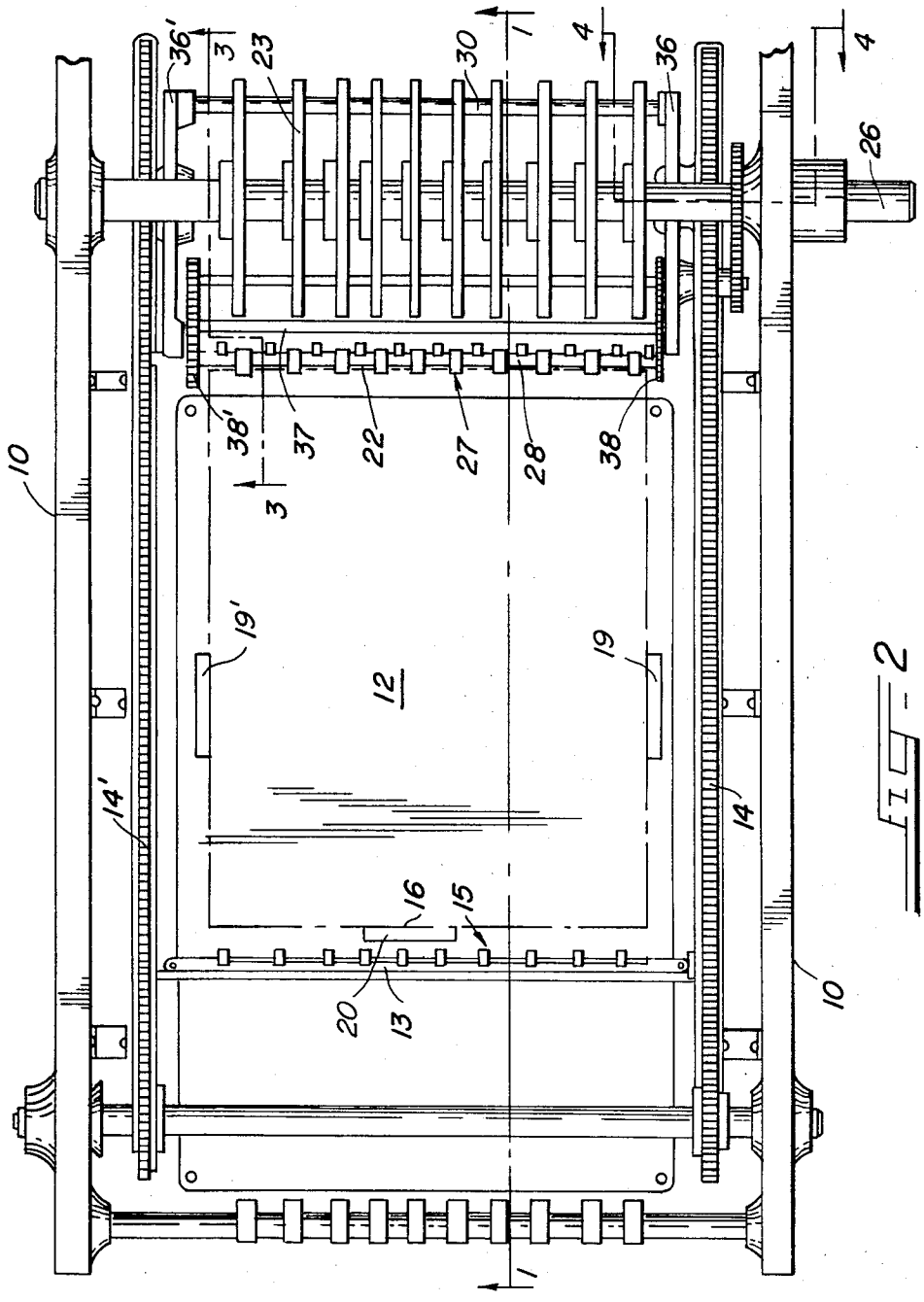


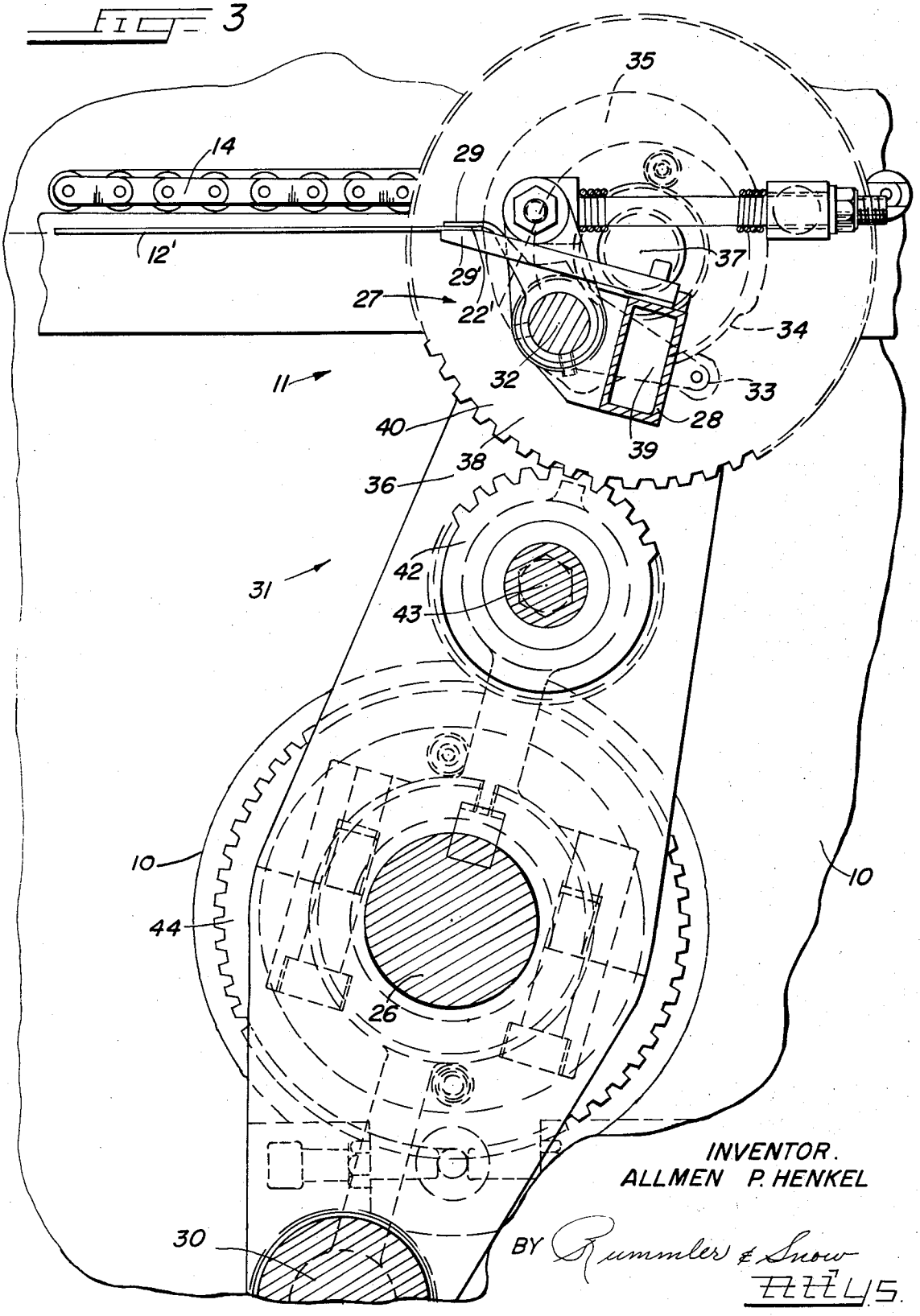
FIG-2

INVENTOR.
ALLMEN P. HENKEL

BY Rummler & Snow

ATTYS.

FIG. 3



INVENTOR.
ALLMEN P. HENKEL

BY Rummler & Snow
ATTYS.

FIG - 4

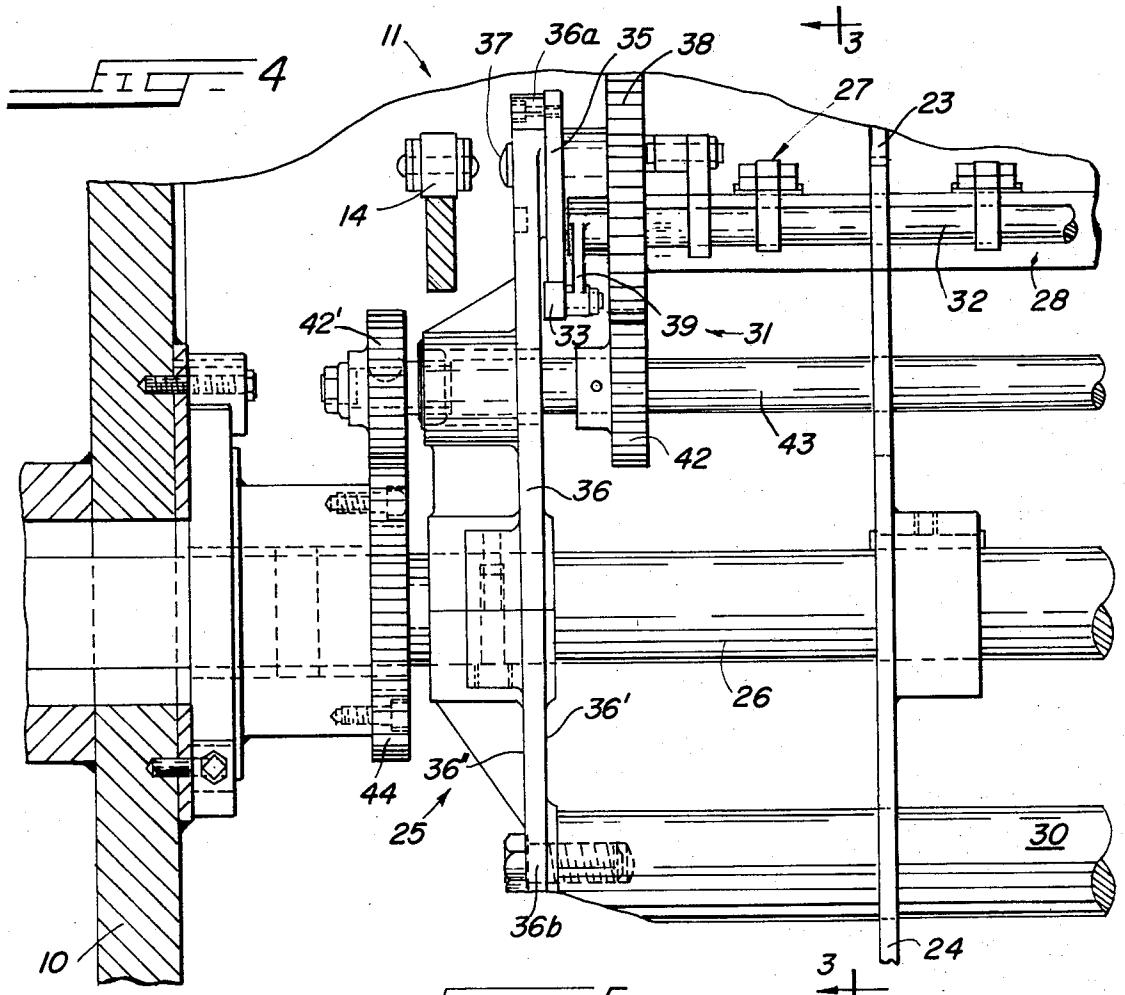
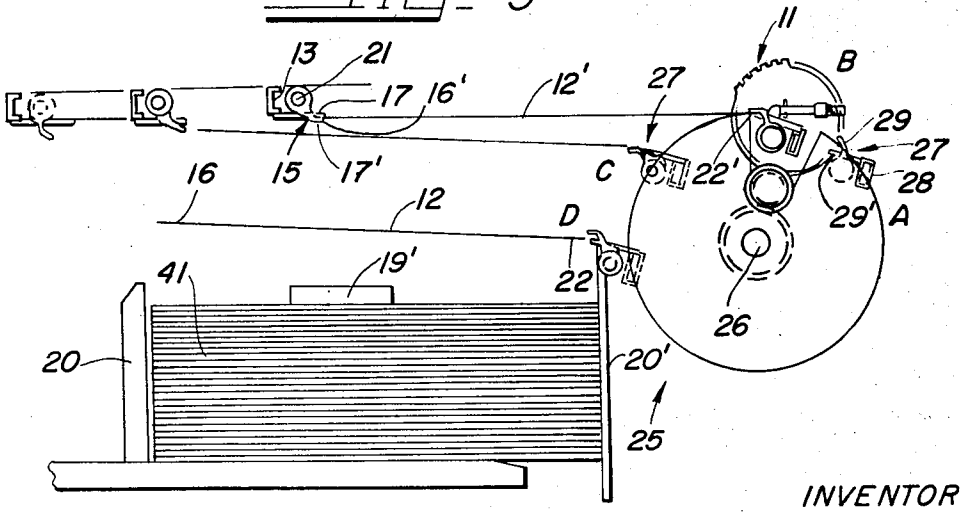


FIG - 5



INVENTOR.
ALLMEN P. HENKEL

BY Kummler & Snow
Attys.

PLANETARY SHEET SLOWDOWN AND LAYDOWN MECHANISM

BACKGROUND OF THE INVENTION

The present invention relates to non-stop, high speed pile delivery of sheets by positive control of the stacking process permitting more effective sheet stacking at a higher productivity rate than has been achieved in the past.

Machines for automatic sheet deceleration and laydown can be functionally classified as mechanical or vacuum operated. One type of vacuum operated machine employs a power driven slowdown roller in a vacuum box having a slot in its top over which the trailing edge of the sheet is pulled by the transport gripper bar. The peripheral speed of the roller against which the sheet is pulled by the vacuum is less than the speed of the sheet so that the traveling sheet is slowed down by the contact. Air blast from above the sheet can assist vacuum pull to make the contact more positive. Although not positive in control, this slowdown means is widely used on printing presses although it cannot be used to deliver sheets with die cut or perforate holes or cutouts.

One purpose of automatic sheet slowdown devices is to obviate the buckling of the forward moving sheet material as the front edge is brought to rest against the stop plate in its deposition on the stack pile and to achieve orderly piling of sheets at as high a speed as is practical.

Another purpose is to move the sheets as quickly as possible downward with a minimum of dependence on gravity to settle the sheet to rest in the desired position on top of the pile before the arrival of the next sheet. This factor is of increasing importance as higher sheet speeds are sought.

Completely controlled slowdown of sheets from the tail where the tail edge of the sheet is engaged by gripper pads which are in a deceleration portion of a path of simple harmonic motion is a most effective method of sheet slowdown. Inertia of the sheet is used to advantage to maintain the sheet planar in its bodily motion along a curvilinear path from pick-up to deposition on the pile. Only the inertia slowdown avoids the buckling problems of high speed sheet skidding to a stop on top of the pile.

It has been said that the speed of a rotary press is determined primarily by the sheet delivery system. Thus, with effective tail edge control of the sheet, the speed of the press can be increased and the reliability of the press operation benefited.

The U.S. Pat. to Ellis et al., No. 3,378,256, relates to a sheet slowdown mechanism which includes a vacuum cup gripper which is moved in a substantially horizontal position along an elongated endless path, which vacuum cup grips a sheet while moving at sheet speed and then decelerates to slow the speed of the sheet, where movement of the sucker member through its endless path is effected by an actuating means including a pair of rotatable drive elements connected with the vacuum cup by a parallel four-bar linkage arrangement wherein the actuating means also includes a separate actuating mechanism, for imparting superimposed horizontal and vertical movement to the vacuum cup, comprised of a link member pivotally connected with the vacuum cup member and driven by a rotatable drive element. This slowdown mechanism suffers from the disadvantage that the vacuum cup member, after it takes the sheets, tilts relative to the horizontal to clear the pile in its endless path causing some problems in sheet bending which prohibits its application to the slowdown of die-cut sheets.

The U.S. Pat. to Huck, No. 3,284,081, is closest to the concept of a gyrating gripper for sheet piling. FIGS. **8, 9** and **10** of that patent show an arrangement whereby the leading edge of a sheet delivered from the press is engaged by a gripper mounted on the periphery of a rotary transfer member. In that case, however, the sheet is not released until the rotary member has traveled substantially through 180° of revolution. Thus the sheet deposited on the pile is inverted, printed side down, and the sheet is moving at maximum speed at the time of release. This patent cannot be considered to suggest the idea of sheet slowdown by a constant level gyrating gripper releasing at the point of zero forward movement along a path of harmonic motion.

Spooner et al. U.S. Pat. No. 3,081,082 discloses another arrangement of vacuum means for engaging a printed sheet subsequent to its release from the delivery chain. The disclosure of this patent includes an air blast arrangement for slowing the forward progress of the sheet as it is delivered to the pile. The patent does not suggest the invention of the constant level gyrating gripper.

Yingling et al. U.S. Pat. No. **2,942,878** provides a sheet slowdown mechanism having vacuum cups engagable with the tail of the sheets to deposit them on the pile, said slowdown mechanism being operated by an over-center rotary link drive for moving the vacuum cups in a continuous decelerating forward and downward path from sheet pick-up to release. This slowdown mechanism, which operates to accelerate the vacuum cup member to initially engage and take the sheet while moving at sheet speed, suffers from the disadvantages that it is complex and the vacuum cup member, after it takes the sheet, tilts relative to the horizontal causing some problems in sheet ending and sheet peeling off the vacuum cup member.

U.S. Pat. No. 2,093,228 is an invention directed to improvements in flat sheet deliveries for web printing presses and more particularly to means for operating sheet tail end engaging devices whereby they are moved in an endless path and operated to successively grasp the tail end of a sheet, stop its travel and depress it below the path of its endless delivery carrier and then to release the tail end of the sheet after its supporting surface on the delivery carrier has moved out from under it, thereby permitting the sheet to drop on the pile. This patent differs from the present invention in that the forward descending movement of the constant level gripper is achieved by complex cam action rather than simple planetary gear means.

Positive deceleration from the tail edge of a sheet moving at high speed is the optimum means of control for rapid piling of successive sheets. There is a need, therefore, for a simple sheet laydown device which delivers the sheet without damage against the stop plate of the pile and with decreased time interval between successive sheets by engaging the tail edge of the rapidly moving sheet so as to keep constantly horizontal and to decelerate it under positive control, without

bending the sheet, along a curvilinear downward path to a point of release close to the top of the pile.

SUMMARY OF THE INVENTION

The gist of this invention lies in the adaption of a gripper reel having one or more sheet tail edge grippers which are maintained in a generally horizontal position while gyrating about the reel axis by means of suitable planetary gearing so that the grippers at the top of their gyration will engage the tail edge of a sheet carried by a transport gripper bar while traveling at the speed of the transport bar. As the grippers continue through the next 90° of their gyration about the reel axis carrying the sheet, the leading edge of the sheet having been released from the transport gripper bar shortly after engagement of the tail edge of the sheet by the reel carried gripper, the forward speed of the grippers and the sheet decreases, harmonically, to almost zero, where the grippers automatically release the tail edge of the sheet for laydown of the sheet between the guides of the stack pile. This arrangement achieves the purpose of stopping of forward travel of the sheet in such a manner that the sheet tail is carried downwardly and released close to the top of the pile without bending and the front edge is subsequently brought to rest without damage against the pile stop plate.

Accordingly, the principal object of this invention is to provide a sheet slowdown mechanism comprising a gyrating gripper having timed cam actuated engagement of the tail edge of a forward moving sheet while at the top of its gyration and providing positively controlled forward deceleration of the sheet while in a forward and downward curvilinear path, followed by a cam actuated release at the position when the forward movement of the gripper and sheet is approximately zero and the sheet can be dropped directly onto the stack pile, the gyrating gripper being maintained in a substantially horizontal position at all times.

DESCRIPTION OF THE DRAWINGS

A specific embodiment of this invention is shown in the accompanying drawings, in which;

FIG. 1 is a fragmentary side view of the sheet deceleration and laydown mechanism of this invention along section line 1—1 of FIG. 2 showing the moving sheet released by the tail edge gripper for laydown on the stack;

FIG. 2 is a fragmentary top plan view of the sheet deceleration and laydown mechanism of this invention;

FIG. 3 is a fragmentary side view of the sheet deceleration and laydown mechanism of this invention, as taken along section lines 3—3 of FIGS. 2 and 4, in the sheet pickup position showing the gyrating horizontal sheet-tail-edge grippers and the mechanism for operating them;

FIG. 4 is a fragmentary end view of the sheet deceleration and laydown mechanism of this invention along section line 4—4 of FIG. 2 in the sheet pickup position showing the gyrating tail edge grippers mounted on the tail edge gripper bar, the horizontal position of which is controlled by a planet gear system; and

FIG. 5 is a schematic showing a time-picture sequence of operation of the sheet deceleration and laydown mechanism, showing the approach phase A of the tail edge grippers relative to the tail edge of the sheet, the pickup phase B with closure of the grippers on the tail edge of the sheet, the disengagement of the sheet delivery transport grippers from the leading edge of the sheet at sheet phase C, and the release of the tail edge grippers from the tail edge of the sheet at stack phase D.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring particularly to FIGS. 1 and 2, which show fragmentary sections of the frame **10** of a rotary, sheet fed printing, die cutting and creasing press or other high speed converting machine comprising in part the controlled laydown and stacking of sheets of paper, solid paperboard, corrugated paperboard, metal or other sheet materials by the deceleration and laydown mechanism **11** of this invention, it will be seen that a sheet **12'** is drawn at high speed from the converting equipment by a more-or-less conventional sheet delivery means transport gripper bar **13'** which is mounted on chain conveyor **14** and which has a plurality of transport grippers **15'** engaging the leading edge **16'** of the sheet **12'**. The transport grippers **15** have upper gripper pads **17**, which engage the leading edge **16** of sheet **12** as it is delivered from the rotary sheet converting mechanism, and are mounted on the preceding transport gripper bar **13**. The transport gripper bar **13** carries a rotatable gripper shaft **21** journaled on the bar **13** and having a lever arm **20**, extending radially therefrom, for carrying a cam follower **18** which engages and runs along a linear cam track **19**. The gripper shaft **21** carries a plurality of lower gripper pads **17'**, one opposite each upper gripper pad **17** for coaction therewith, and these lower gripper pads are actuated to close on the leading edge of sheet **12** by rotation of the gripper shaft **21** as the cam follower **18** moves onto and off from the cam track **19**. The cam track **19** is mounted on the frame **10** and extends along the path of the cam follower **18**, as it travels with the transport gripper bar **13**, and its position along the said path determines the point of engagement and the point of disengagement of a sheet **12** delivered from the rotary press or the like mechanism.

Referring again to FIG. **1**, sheet **12'** is engaged between a plurality of upper tension reels **23** and a plurality of lower sheet delivery control reels **24**, the control reels **24** being part of a lower sheet delivery control reel assembly **25** which is rotatably mounted on a driven shaft **26** journaled on the frame **10**. As shown in FIGS. **1** and **2**, each reel **24** is provided with a plurality of sheet tail edge grippers **27** mounted on a gripper bar **28**.

Referring to FIG. **3**, sheet tail edge gripper bar **28** carries a rotatable gripper pad support shaft **32** journaled on the bar **28** and having a cam lever **39** extending radially therefrom, for carrying a cam follower **33** which engages the running surface **34** of a circumferential cam **35**. The gripper shaft **32** carries a plurality of upper gripper pads **29**, one opposite each of the lower gripper pads **29'** for coaction therewith, and these upper gripper pads are actuated to close on the tail edge of sheet **12'** by rotation of gripper shaft **32** as the cam follower **33** engages the running surface **34** of circumferen-tial cam **35**. Referring to FIG. **4**, it will be

seen that the cam **35** is fixedly mounted on and constrained to rotate with the reel end support arm **36** so that the cam follower **33** and its position along said running surface **34** of the cam **35** determines the point of pickup and release of a sheet **12'** by the horizontal grippers **27** of sheet deceleration and laydown mechanism **11**.

Sheet tail edge gripper bar **28** and grippers **27** are maintained horizontal by the action of deceleration and laydown mechanism **11** in their gyration about an endless circular path. As shown, the deceleration and laydown mechanism **11** is comprised of the planetary gear assembly **31** shown in FIG. **4**, in addition to the sheet tail edge grippers **27** discussed above. The gear assembly **31** is rotatably mounted on a reel end support arm **36** which is rotatably mounted on drive shaft **26** journaled in frame **10**. The reel end support arm **36** has an outer end **36*a***, an inner side **36'** and an outer side **36''**, with support bar **30** mounted to the opposite outer end **36*b*** of the reel support arm **36** for supporting the plurality of reels **24** intermedially spaced therebetween. The reel end support arm **36** carries a spindle **37** fixedly mounted to its outer end **36*a*** and to its inner side **36'**, respectively, and a gripper planet gear **38**, shown in FIG. **3**, is rotatably mounted on the spindle **37** which fixedly carries the end of the gripper bar **28** rigidly mounted thereto. The gripper **27** mounted on the gripper bar **28** then rotates about the spindle **37** as the spindle **37** gyrates about the drive shaft **26**.

The reel end support arm **36** pivotally carries the primary idler planet gear **42**, shown in FIG. **4**, fixedly mounted on an idler shaft **43**, disposed adjacent the inner side **36'** of the support arm **36**, and which is enmeshed with a gripper planet gear **38**. The idler shaft **43** lies between the spindle **31** and drive shaft **26**. Again, as shown in FIG. **4**, the idler shaft **43** is rotatably supported by and extends through the end support arm **36** and fixedly mounts a secondary idler planet gear **42'** adjacent the outer side **36''** of arm **36**. The idler planet gears **42** and **42'** have the same pitch diameter, and the sun gear **44**, which is fixedly mounted to frame **10** coaxial with drive shaft **26**, has the same pitch diameter as said gripper planet gear **38** and meshes with the secondary idler planet gear **42'**, as shown in FIGS. **3** and **4**, so that in the gyration of the primary and secondary planet gears **42** and **42'** and the gripper planet gear **38** about sun gear **44**, the gripper planet gear **38** rotates the same number of turns in the revere direction as the reel end support arm **36**, on the drive shaft **26**, rotates in the forward direction with the net result that the gripper planet gear **38** does not rotate but maintains a fixed or set angular position in space regardless of the angular position of reel end support arm **36**. Once the sheet tail edge gripper **27** is set horizontal for sheet deceleration and laydown control, the sheet tail edge gripper bar **28**, affixed to planet gear **38**, maintains the sheet tail edge grippers **27** horizontal, regardless of the angle of reel end support arm **36**. Tail edge **22'** of sheet **12'**, which is held in the grip of gripper **27**, is then also maintained horizontal and sheet **12'**, which has previously been disengaged from transport grippers **15**, as shown in FIG. **5**, is under the control of tail edge gripper **27**, and thus remains essentially horizontal throughout its forward and downward curvilinear path in the course of its deceleration and laydown. Once sheet **12** is released for laydown on stack **41**, it is a free body with essentially downward and very little forward movement. Stop plate **20** and side guides **19** and **19'** mounted adjacent the end and sides of the stack **41**, respectively, ensure that the sheet **12** falls onto the stack **41** without slipping or buckling. Back stop **20'** prevents back fall of the sheet **12** as it drops down onto the stack **41**.

In the description of this sheet slowdown invention, only those elements shown in the drawings are designated by numerical reference numbers in the specification and drawings. Elements on the side opposite in exact contra distinction thereto will be named by implication.

In the operation of the sheet deceleration and laydown mechanism of this invention, the time-picture sequence as shown in FIG. **5** has been broken into sheet tail edge approach phase A, sheet pickup operation B, sheet deceleration phase C and sheet release and stacking phase D.

FIG. **5** shows approach phase A wherein the decelerating mechanism **11** is moving to pickup of sheet **12''** during the course of which the tail edge gripper **27**, mounted on tail edge gripper bar **28**, approaches the tail edge **22** of sheet **12'** from below and behind along a path of gyration about the axis of the driven shaft **26**. The movable upper gripper pad **29** of tail edge gripper **27** is opened from the fixed level lower gripper pad **29'** during this approach. The approach of the tail edge grippers **27** is coordinated with the transport of the tail end **22'** of sheet **12'** so that the horizontal lower gripper pad **29'** moves up under tail end **22'** of sheet **12'** in its approach to the top or 12 o'clock position of the delivery control reel **24** for sheet pickup operation B.

The sheet pickup operation "B", shown in FIGS. **3** and **5**, occurs at the top of the gyrating path of the grippers **27**, during their rotation about the driven shaft **26**, when the movable upper gripper pad **29** closes down on the tail end **22** of the sheet **12** as it lies on the horizontal fixed lower gripper pad **29'** underneath. For proper pickup, the circumferential speed of the gripper **27** about driven shaft **26** must be substantially the speed of the sheet delivery conveyor chain **14**. At the instant of pickup, the leading edge **16'** of sheet **12'** is still engaged by transport grippers **15** and remains thus for a relatively short time thereafter. After pickup and subsequent disengagement by transport grippers **15**, the sheet **12'** is under the control of the deceleration and laydown mechanism **11** which acts to maintain the sheet **12** substantially horizontal.

In sheet pickup operation B, the closing of movable upper tail edge gripper pad **29** on the end **22'** of sheet **12'**, the gripper bar **28** and lower gripper pad **29'** are maintained at a constant level in a substantially horizontal position by the gyration of the grippers **27** about drive shaft **26** under the action of the planetary gear assembly **31**. The upper gripper pads **29** are mounted on an upper gripper pad support shaft **32** which is cammed to open and close the upper gripper pads **29** on the end of sheet **12'** in the proper time sequence for pickup and release of the sheet.

Reference again to FIG. **5** also shows that the grippers **27**, in their horizontal position gyration

throughout their endless circular path, increase the radius of their circular path after the pickup operation and throughout the downward curvilinear path of phase C. This articulating motion of the grippers **27** allows the transport grippers **15** to hold to leading edge **16** of sheet **12** a little longer than do conventional pile deliveries employing vacuum drums or other vacuum means and thus helps to maintain the horizontal stability of the sheet **12** during laydown on the stack. This is especially important in the case of jogging or slow run compared to fast run as the tail end grippers **27** positively convey the end of the sheet **12** down and away from the path of the next oncoming transport gripper bar **13'** and engaged sheet **12'**.

At the instant in its forward and downward curvilinear path at which forward movement has substantially decelerated to zero, the sheet **12** is released by horizontal gripper **27**. This corresponds to release operation D after which sheet **12** is delivered downwardly as a free body onto the pile **41**.

Although but one specific embodiment of this invention has been herein shown and described, it will be understood that the details of construction shown may be altered or omitted without departing from the spirit of the invention as defined in the appended claims.

I claim:

1. A mechanism for the horizontal slowdown and laydown deceleratingly along a forwardly and downwardly curvilinear path of a sheet delivered from a rotary printing, die cutting or other high speed converting means, having a frame, a sheet delivery transport gripper means mounted for movement on said frame, and a drive shaft horizontally journaled therein, comprising:

a. a pair of laterally spaced end support arms mounted on said drive shaft for rotation about its axis,

b. a planetary gear means mounted on each of said support arms,

c. a sheet tail end gripper means mounted on and extending between said planetary gear means for opera-tion thereby to pick up the tail edge of said sheet, maintain it horizontal in its forward and downward movement along said curvilinear path, and release it at the extent of its forward travel, and

d. a cam means for closing and opening said tail end gripper means, in the pickup and release of said trailing edge of said sheet, in the proper time sequence with the delivery of the sheet from said converting means.

2. A horizontal slowdown and laydown mechanism according to claim **1** wherein the planetary gear means for maintaining the sheet horizontal comprises:

a. a sun gear fixed to the frame at each support arm coaxially with the drive shaft,

b. a gripper gear rotatably mounted on a spindle carried by each support arm at its outer end, and

c. an idler gear means rotatably mounted on each support arm and enmeshed with said sun gear and said gripper gear.

3. A sheet horizontal slowdown and laydown mechanism according to claim **2** wherein the sheet tail edge gripper means comprises:

a. a gripper bar mounted on said gripper gears and fixedly mounting a plurality of horizontal laterally spaced lower gripper pads, and

b. a gripper shaft rotatably mounted on said gripper gears and carrying a plurality of laterally spaced movable upper gripper pads, one opposite each fixed lower gripper pad, for coaction therewith in the pickup and release of the tail edge of said sheet therebetween.

4. A sheet horizontal slowdown and laydown mechanism according to claim **3** wherein the cam means for actuating the sheet tail edge gripper means in pickup and release of said trailing edge of said sheet comprises:

a. a circumferential cam fixedly mounted on the end support arm centered on the spindle mounted to each support arm, and

b. a cam follower in running engagement with said cam mounted on a lever arm radially extending from said gripper shaft to open and close the movable upper gripper pad on the tail edge of the sheet lying on the fixed horizontal gripper pad for pickup and release of the sheet in the proper time sequence with delivery of the sheet from the converting means.

5. A sheet horizontal slowdown and laydown mechanism as set forth in claim **2** wherein the idler gear means comprises two gear sets each set having a common shaft journaled in each end support arm and each set having a gear on each side of each end support arm.

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