United States Patent

Helmig et al.

[15] **3,667,352**

[45] **June 6, 1972**

[54] LOOP STABILIZE WEB FED VARIABLE REPEAT CUTTER-CREASER SYSTEM

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[22] Filed: **Apr. 16, 1970**

[21] Appl. No.: **29,103**

[52] **U.S. Cl.** ....**93/58.2 R,** 53/51, 93/1 G, 226/123, 226/160

[51] **Int. Cl.** **B31b 1/20,** B65b 57/02, B31b 1/10

[58] **Field of Search** ....93/58, 58.2, 58.3, 80, 93 DP, 93/1 G, 33; 226/113, 114, 123, 141, 142, 156, 160; 101/226, 227, 228; 53/51

[56] **References Cited**

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[57] **ABSTRACT**

A web fed rotary variable repeat cutter-creaser system is provided for the packaging industry which is fed from a web stock of material either printed or unprinted or both. This system consists basically of a pair of large diameter, very heavy walled drums on which is mounted a pair of cutting and creasing dies. These dies are in the form of a sheet metal blanket into which the shape to be cut and creased has been chemically milled. The dies are mounted on these two drums so that as they rotate together, with the dies being matched one to another in a registered position.

A feeder is provided for the die cylinders which has the qualities of feeding a selected length of material, yet is continuously supplied from roll web stock of material. A crank working directly from the die cylinders forms storage loops in the web and advances it periodically. Swing rolls are oscillated by the crank arm and these are geared to a mechanism for advancing or retarding the fed portion of the web of material in accord with registration marks on the web stock. Apparatus is provided for stabilizing the storage loops at high speeds to prevent the loops from distorting and doubling back on itself. Also, an arrangement is provided to create a definite bend in the web so that the break or start of the storage loop occurs at a predetermined point in the system during operation thereof.

24 Claims, 18 Drawing Figures

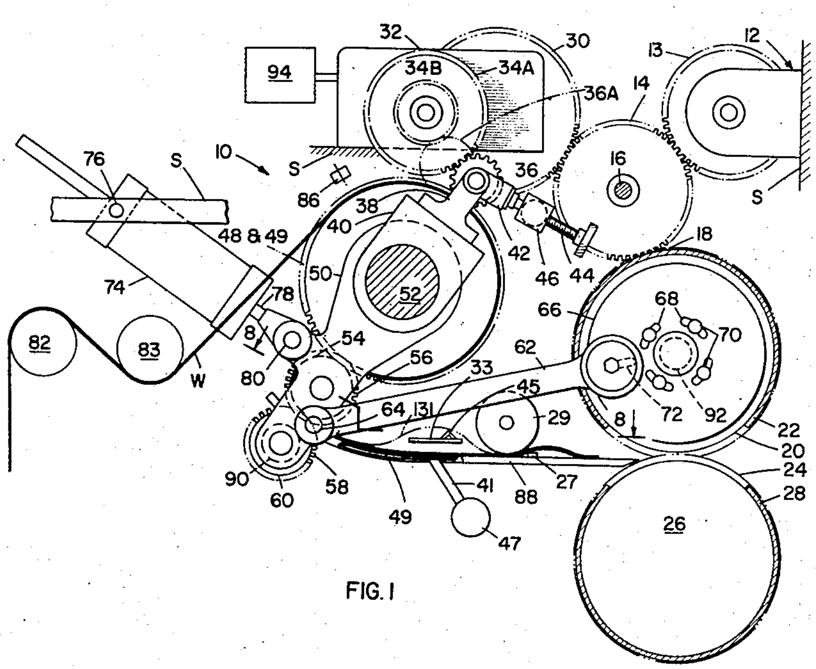

FIG. 1

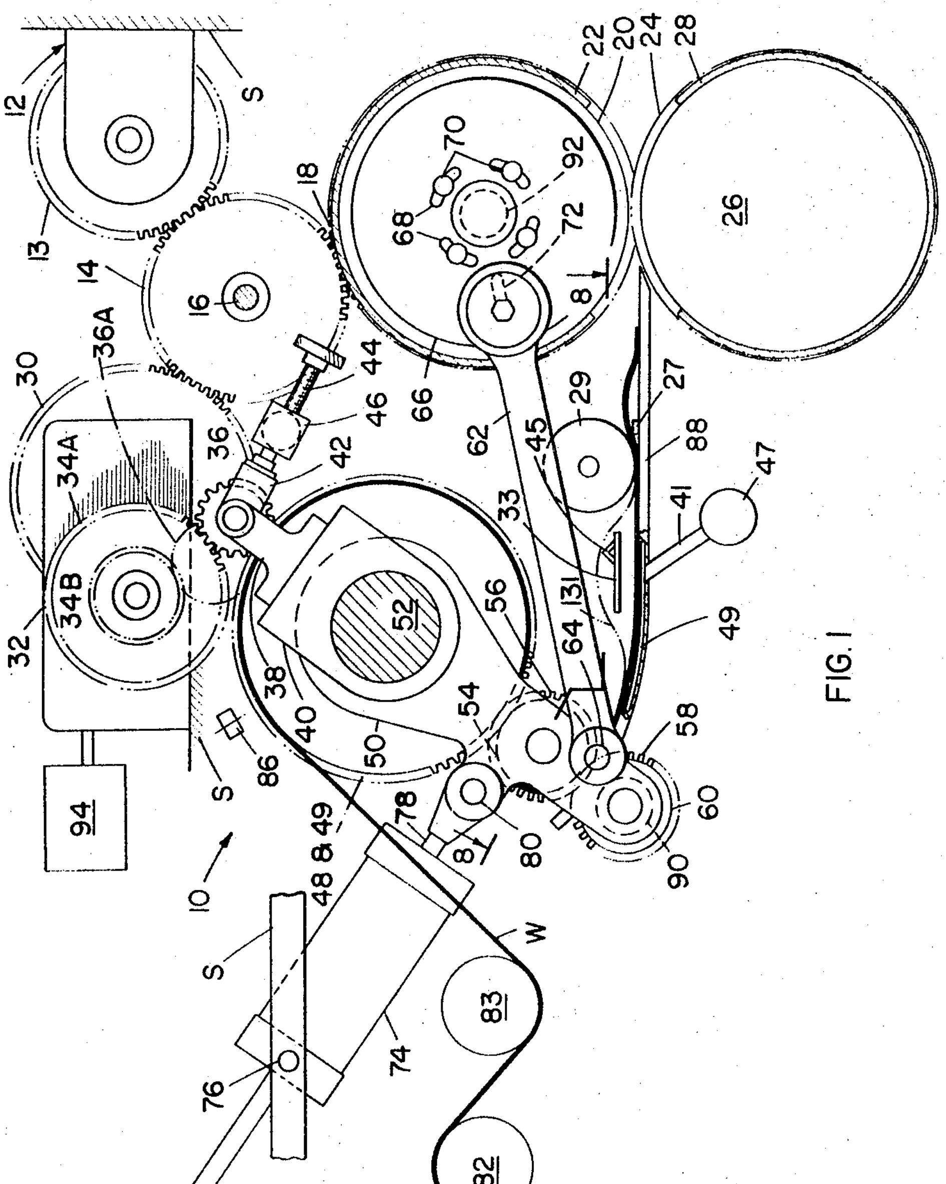

FIG. 1

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ATTORNEY

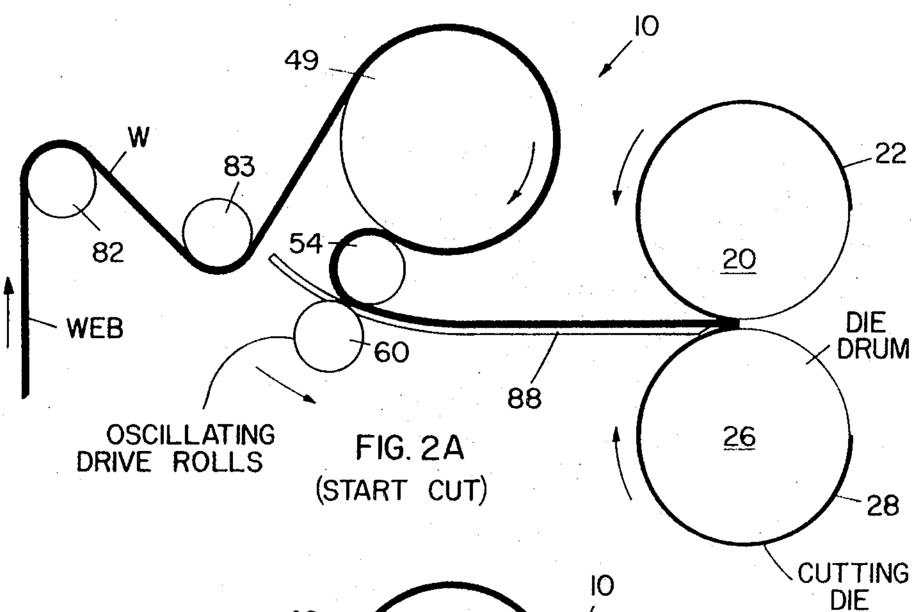

FIG. 2A
(START CUT)

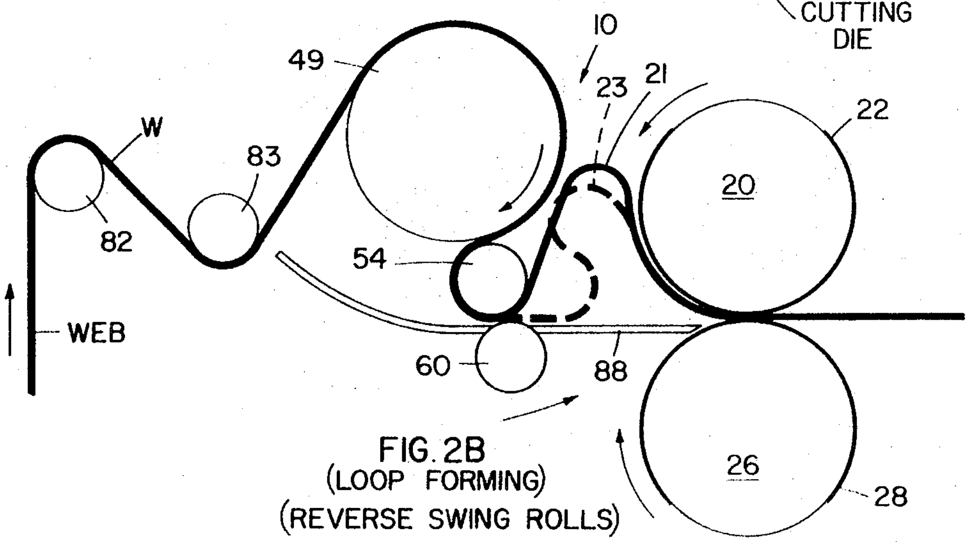

FIG. 2B
(LOOP FORMING)
(REVERSE SWING ROLLS)

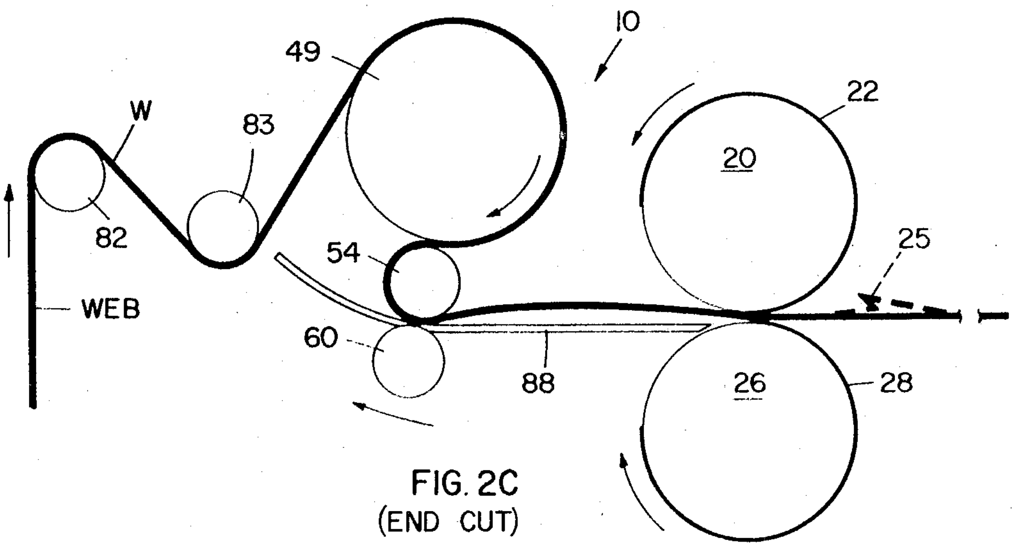

FIG. 2C
(END CUT)

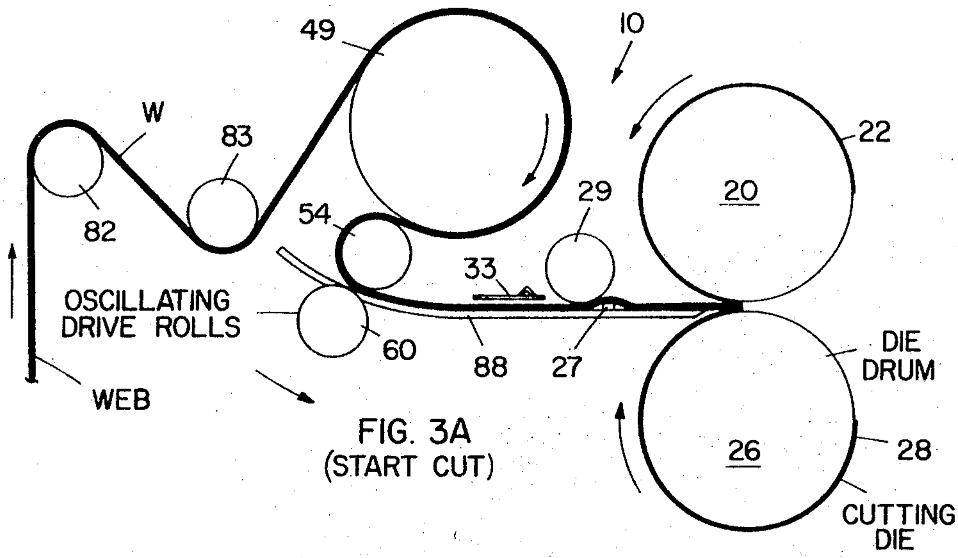

FIG. 3A
(START CUT)

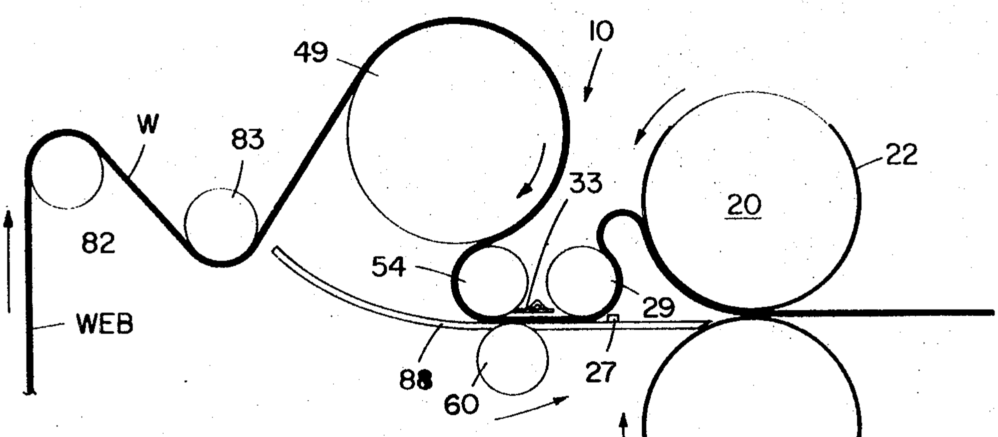

FIG. 3B
(LOOP FORMING)
(REVERSE SWING ROLLS)

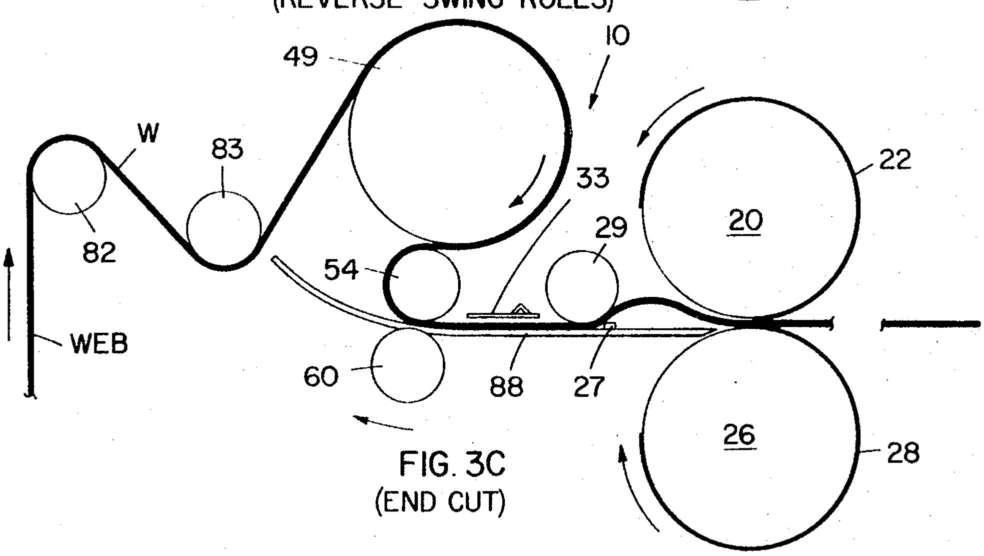

FIG. 3C
(END CUT)

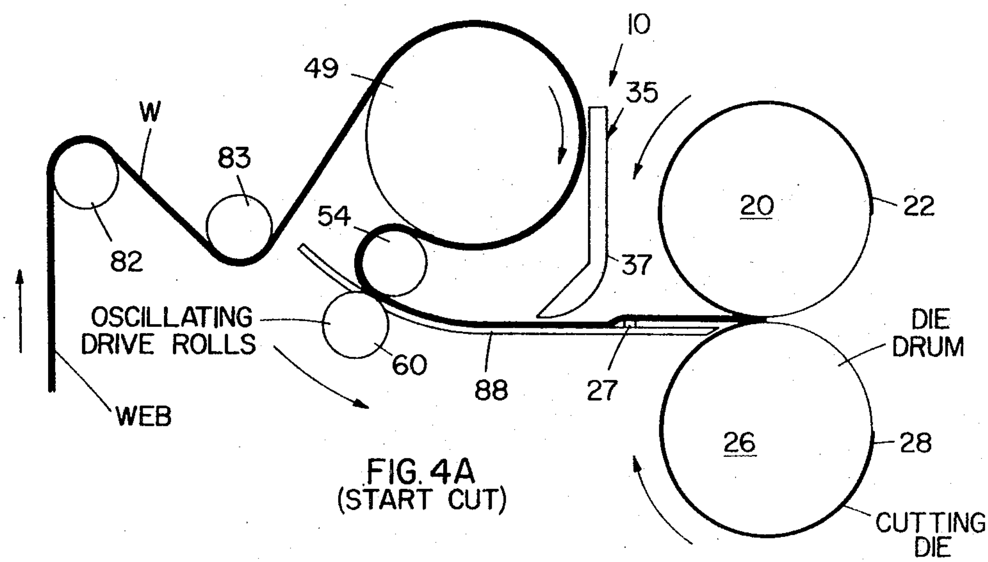

FIG. 4A
(START CUT)

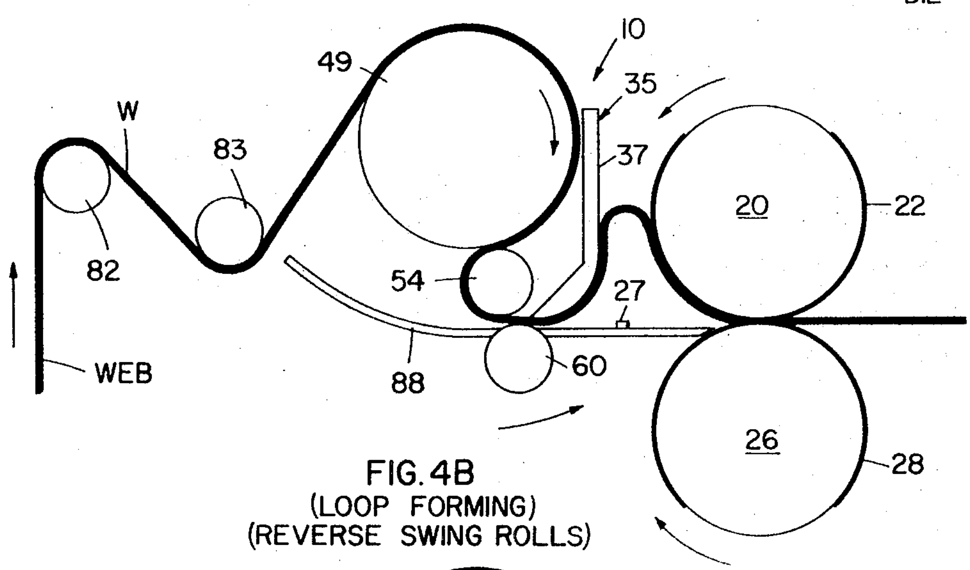

FIG. 4B
(LOOP FORMING)
(REVERSE SWING ROLLS)

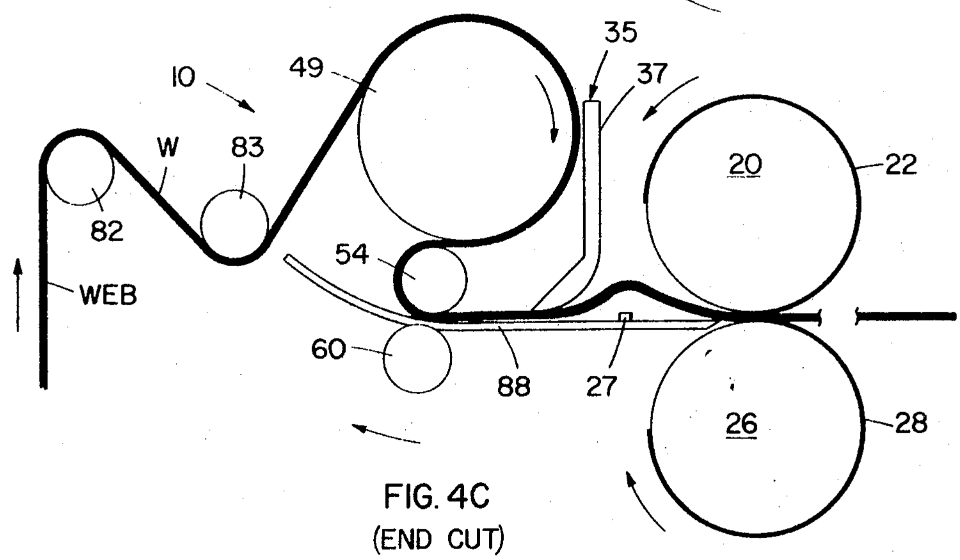

FIG. 4C
(END CUT)

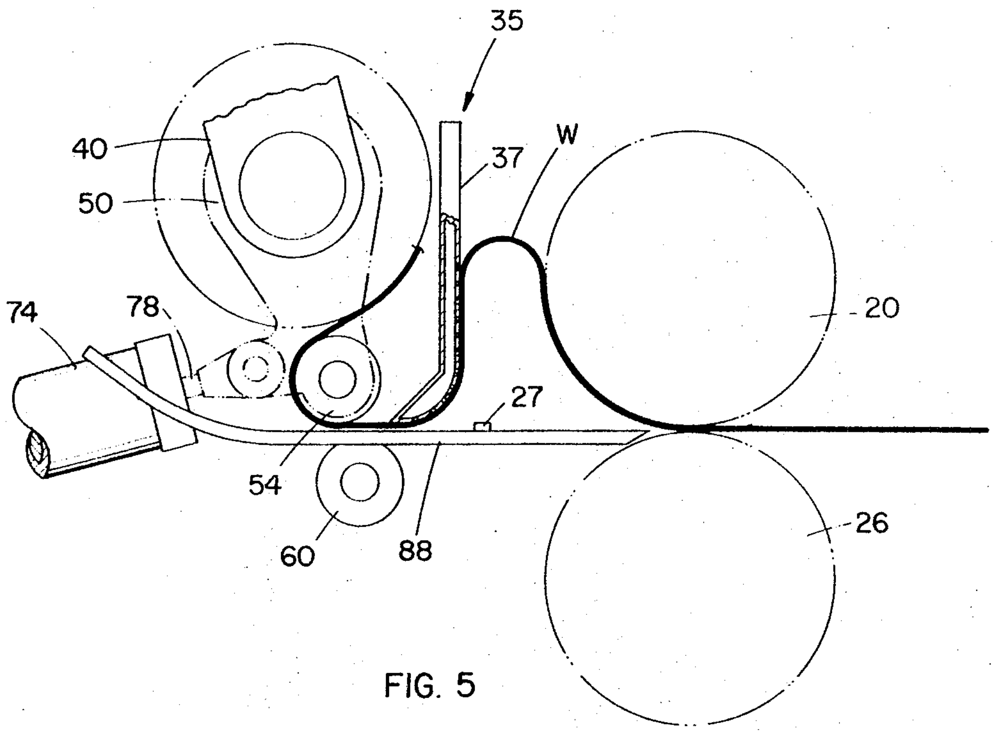

FIG. 5

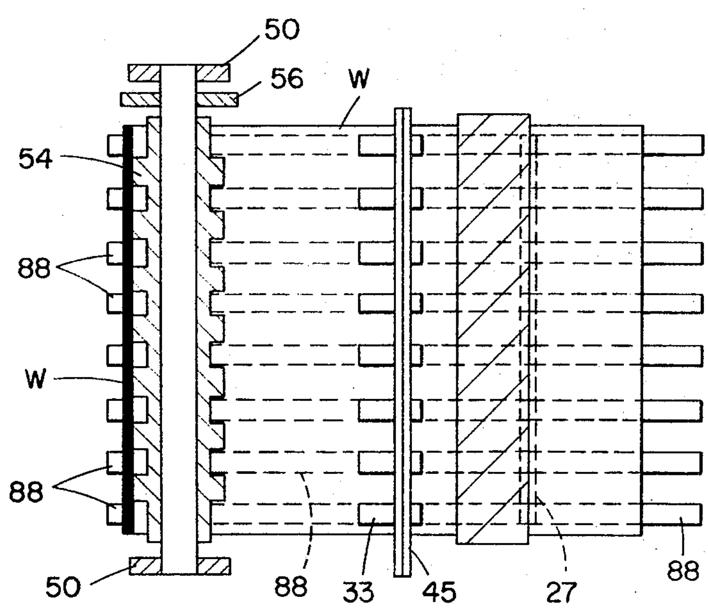

FIG. 8

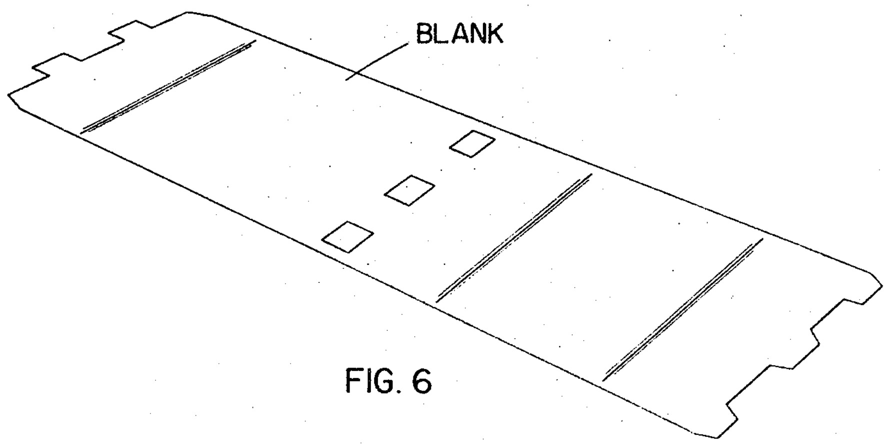

FIG. 6

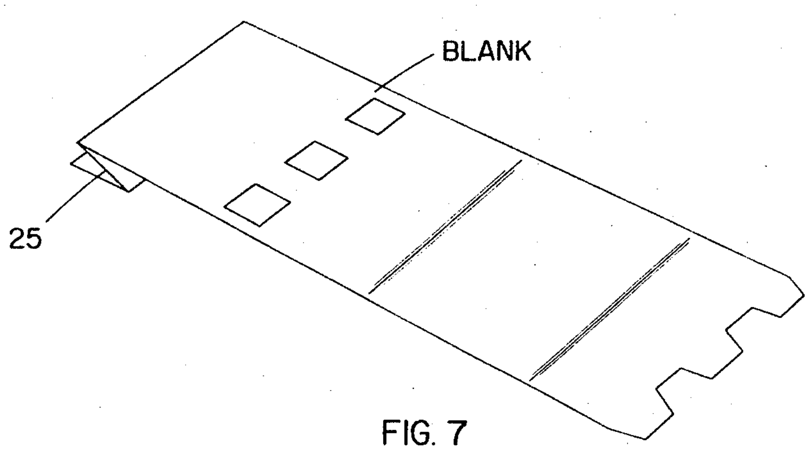

FIG. 7

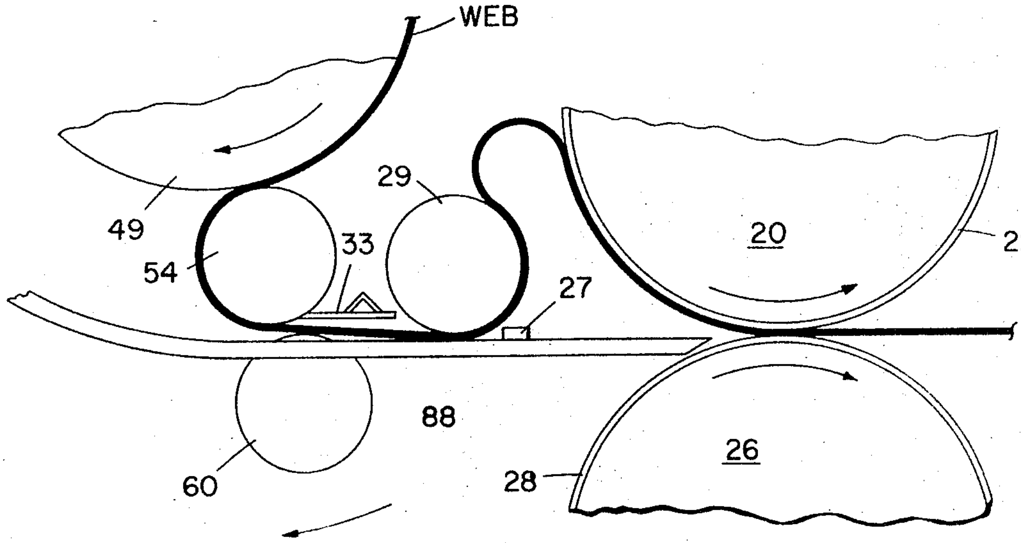
WEB
49
54
33
29
20
22
27
88
60
26
28

FIG. 9

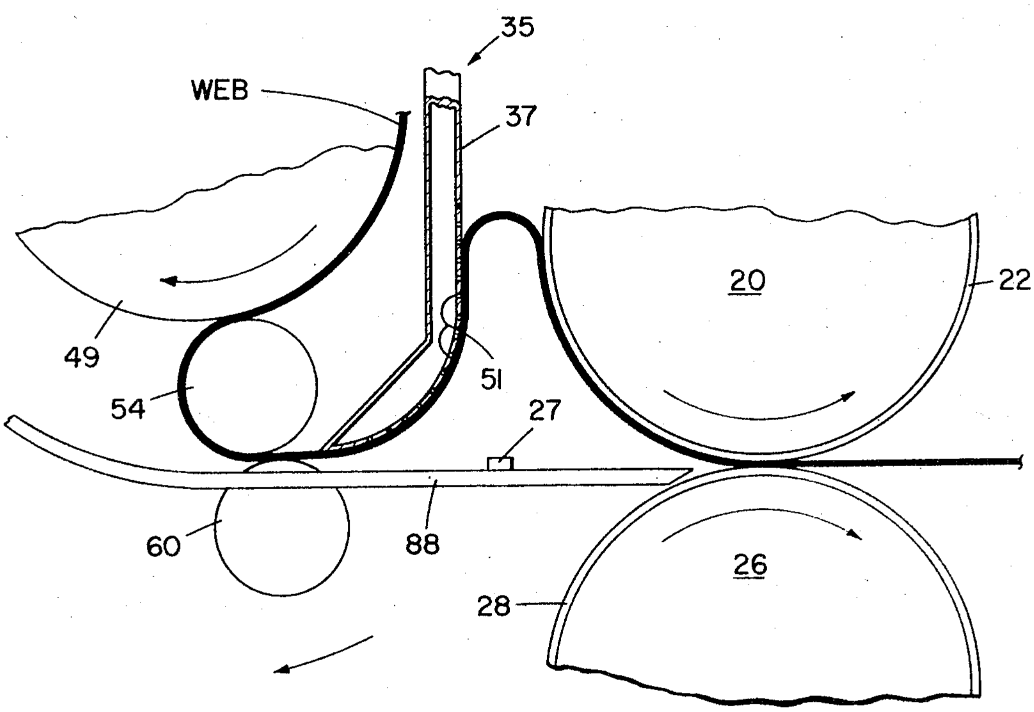
35
WEB
37
20
22
49
51
54
27
60
88
26
28

FIG. 10

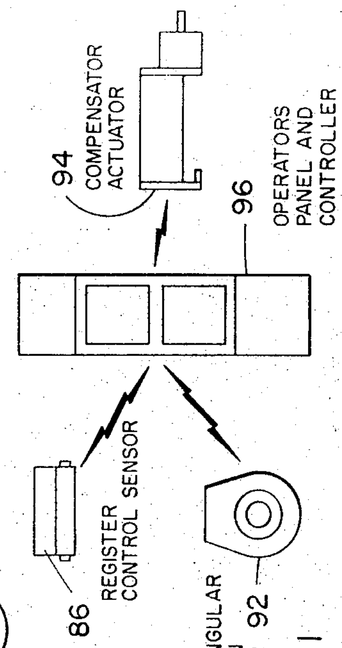
94
COMPENSATOR ACTUATOR
96
OPERATOR'S PANEL AND CONTROLLER
REGISTER CONTROL SENSOR
86
ROLL ANGULAR POSITION MONITOR
92

FIG. 11

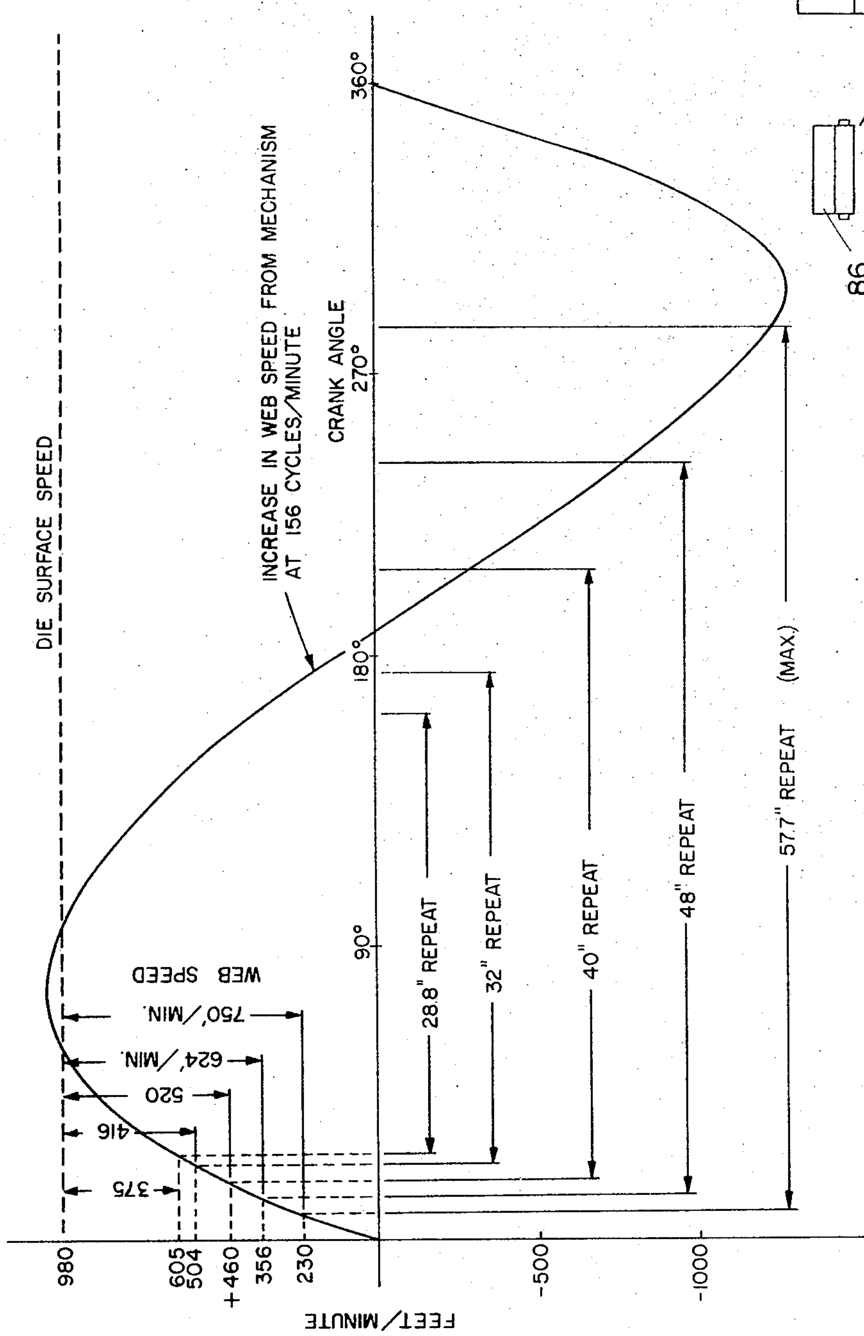
DIE SURFACE SPEED
INCREASE IN WEB SPEED FROM MECHANISM AT 156 CYCLES/MINUTE
CRANK ANGLE
360°
270°
180°
90°
WEB SPEED
750'/MIN.
624'/MIN.
520
416
375
28.8" REPEAT
32" REPEAT
40" REPEAT
48" REPEAT
57.7" REPEAT (MAX.)
980
605
504
+460
356
230
-500
-1000
FEET/MINUTE

FIG. 12

LOOP STABILIZE WEB FED VARIABLE REPEAT CUTTER-CREASER SYSTEM

This invention relates generally to cutting and creasing machines, and more particularly it pertains to a web fed rotary variable repeat cutter-creaser system for use in the packaging industry. This invention is an improvement over the inventions shown and described in U. S. Pat. application Ser. No. 795,326 filed Jan. 30, 1969 invented by Floyd Steinmetz for "Web Fed Rotary Variable Repeat Cutter-Creaser System," and U. S. Pat. application Ser. No. 743,748 filed July 10, 1968 invented by Floyd Steinmetz and Henry D. Ward, Jr. for "Web Fed Rotary Variable Repeat Cutter-Creaser System."

One of the major unsolved problems facing industry today relates to die cutting, creasing, embossing, or printing webs of material with an infinite variety of repeat lengths.

In the past, the method for producing a variable cut or print length on a web stock of material has been to either change the diameter of the printing or cutting cylinder of the machine to suit the repeat length that is being produced on the web, or secondly to feed a variable length of web material between two heavy tables or platens which can then cut the particular length of web fed between them. At that point, the platens open again, and again a length of web of material is fed into them.

Another method to accomplish the above has been to first cut the web of material into sheets of the length required and then to feed the sheets through a platen or between rotary drums. In this last method, of course, there is no problem with feeding a variable sheet length. Whatever sheet is fed into the machine, can simply pass straight on through the machine and it is only necessary to feed one sheet per revolution of the machine to produce a variable cut or print length.

To clarify matters, it is well to define "variable repeat length" here. By this, it is meant that adjustments can be made to a cutter-creaser type system to cut any length of stock required within the specific limits. Out of the material that is being fed through the system, the length of cut must be variable in the direction of sheet travel and if a web stock of material is being fed through a cutter-creaser, this stock may be printed with a repeat pattern, with one printed pattern appearing, for example, every 25 inches on the sheet.

If the sheet is to be cut into paperboard containers, such as for ice cream containers, the cut length must be positioned directly and exactly on the printed matter and the cut length must be exactly the length of the repeat of the printing without cumulative error. The next order, for instance, could be bacon board made from a different and unprinted roll of paper stock, and the repeat might be 38 inches long, for example.

Basically, the problem is to produce this variable repeat length of cut accurately. To produce the highest running speeds, it is desirable to use a pure rotary motion for the cutting action. This is because the cutting and creasing loads are of a fairly high magnitude and this means that the structural members, such as the platen tables, which are used in platen presses, have to be extremely massive to be rigid enough to resist deflection under the cut and crease loads and, therefore, a reciprocating motion of the cutting mass and limits the physical speed of the machine. For this reason, it was found that a pure rotary motion of a pair of drums lends itself to much higher running speeds.

Secondly, it was deemed essential that there be a smooth feed of the web stock of material into the system. On a platen press, for example, the stock must be fed into the machine while the platen tables are open. The web stock of material has to be stopped and held in a stationary position while the platens are brought together for the cutting operation. This, of course, means that the running motion of the machine has momentarily stopped and therefore, production has, in effect, been lost. Thirdly, it was necessary to use drums of a fixed diameter on which there are mounted cutting dies or perhaps printing plates or dies of different lengths to eliminate the requirement to physically change drums in order to produce a different drum circumference which, in turn, would produce a different sheet length or repeat length.

It is common, for instance, on milk container rotary cutter-creasers to manufacture the entire machine for a specific sheet length, with a specific diameter of drum being used.

On various web printing presses in order to change repeat lengths, it is necessary to change the entire drum which carries the printing dies or plates to obtain the exact repeat length desired. In a regular jobbing shop for producing a variety of different types and kinds of boxes, this conversion or interchange of drums is a time consuming operation and is undesirable because of high cost.

It is also highly desirable to have a web fed machine rather than a sheet fed machine in order to allow the most economical use of paper stock. Quite often the shape which is to be cut from the paper stock is irregular and it is often designed so that the cut patterns will interlock with one another, thereby reducing the amount of waste paper around the edge of the cut.

Obviously, if the stock must be cut into sheets and then printed and die cut, these sheets will be rectangular and all of the material around the edges of these irregular blanks will be lost. On the other hand, if a regular web fed machine is used, the irregular cuts can be planned to interlock with one another and reduce the waste stock to a minimum.

In boxes of this type, the cost of the material itself is a large portion of the cost of the box and any savings that can be introduced into the operation through a reduction in the amount of material used has a very real and very direct effect on the cost of the boxes themselves.

It is an object of the present invention, therefore, to provide a web fed variable repeat cutter-creaser system which positively feeds predetermined isolated increments of continuous web stock into dies, at both low and high speeds of operation.

Another object of this invention is to provide a web fed variable repeat cutter-creaser system which feeds a predetermined length of patterned material in register into dies.

Still another object of this invention is to provide a feeder system for die cylinders which has the qualities of individual blank feeding, yet is continuously supplied from web stock.

Other objects of this invention are to provide a web fed rotary variable repeat cutter-creaser system in which variable repeat lengths of cut are made at the highest running speeds of the system.

To provide a web fed rotary variable repeat cutter-creaser system which is continuously fed with web stock of material, is still another object of this invention.

Also, even another object of this invention is to provide a web fed variable repeat cutter-creaser type system having drums of a fixed diameter on which there are mounted cutting dies of different lengths to eliminate the requirement to physically change drums in order to produce the drum circumference which, in turn, would produce a different sheet length or repeat length.

And another object of this invention is to provide a cutter-creaser system which is web fed in order to allow the most economical use of web stock of material.

Still even another object of this invention is to provide a web fed, variable repeat cutter-creaser system which is effectively and efficiently operated at both low and high speeds.

Another object of this invention is to provide a web fed variable repeat cutter-creaser system having means for stabilizing storage loops at high speeds to prevent the loops from distorting and doubling back on themselves.

And another object of this invention is to provide a web fed variable repeat cutter-creaser system having an arrangement to create a definite bend in the web so that the break or start of the storage loop occurs at a predetermined point in the system during operation thereof.

Other objects and attendant advantages of this invention will become more readily apparent and understood from the following detailed specification and accompanying drawings in which:

FIG. 1 is a side elevation in diagrammatic form embodying the components of a web fed variable repeat cutter-creaser system;

FIGS. 2A, 2B, and 2C are diagrammatic views showing in sequence, the stages of one cycle of operation of the members of the system of FIG. 1 forming an undesirable storage loop at high speeds;

FIGS. 3A, 3B, and 3C are diagrammatic views showing sequence, the stages of one cycle of operation of the members of the system of FIG. 1 modified by features of one embodiment of this invention to form a desirable storage loop at high speeds;

FIGS. 4A, 4B, and 4C are diagrammatic views showing in sequence, the stages of one cycle of operation of the members of the system of FIG. 1 modified by the features of a second embodiment of this invention to form a desirable storage loop at high speeds;

FIG. 5 is an enlarged schematic of the second embodiment of the invention as shown in FIGS. 4A, 4B, and 4C;

FIG. 6 is a perspective of a desirable blank formed by the web fed variable repeat cutter-creaser system shown in FIG. 1 at both low and high speeds of operation of the system;

FIG. 7 is a perspective of an undesirable blank formed by the web fed variable repeat cutter-creaser shown in FIGS. 2A, 2B, and 2C, at high speeds of operation of the system;

FIG. 8 is a cross-section taken along line 8—8 of FIG. 1;

FIG. 9 is a schematic of the first embodiment of the invention as illustrated in FIGS. 1, 3A, 3B, and 3C;

FIG. 10 is a schematic of second embodiment of the invention as illustrated in FIGS. 4A, 4B, 4C, and 5;

FIG. 11 is a schematic of a control arrangement for the web fed variable repeat cutter-creaser system of the invention; and

FIG. 12 is a graphical representation of a curve showing increase in web speed versus crank angle from the cutter-creaser system of the present invention.

Referring now to the details of the invention as shown in FIG. 1, reference numeral 10 indicates generally a preferred embodiment of the novel web fed rotary variable repeat cutter-creaser system of this invention. This system 10 will first be described generally and then followed by a detailed description of the main parts thereof.

A main drive 12 attached to the structure S of the system is the prime power source at variable speed for the cutter-creaser system 10. A main drive gear 13 on the drive 12 meshes with an idler gear 14 on a shaft 16. This idler gear 14 meshes with a gear 18, which is secured to an upper die drum 20 carrying dies 22 for creasing or cutter operations. Another gear 24 meshes in 1 to 1 ratio with gear 18 and it is secured to a lower die drum 26 carrying the lower dies 28.

It should be understood the lower drum 26 is adjustable vertically, longitudinally and circumferentially by means not shown, to accommodate respectively different web thicknesses of material and to register the dies 22 and 28.

The idler gear 14 also meshes with an input gear 30 of a positive infinitely variable drive 32. Because this drive 32 has a limited speed range, a set of change gears 34A, 34B . . . etc. (only one of which is used at any given time) is supplied for taking off the output of the drive 32.

To mesh with the different diameters of these change gears, an idler gear 36 is provided, which is journaled on a trunnion 38. The trunnion 38 is fastened to a saddle 40 which pivots about a shaft 52. A yoke 42 which is journaled with the idler gear 36 has an adjusting screw 44 extended through a threaded post 46. Post 46 is pivotally secured to the structure S of the system 10. In this manner, by advancing the adjusting screw 44, the idler gear 36 can be advanced from the position shown in solid lines to the position 36A shown in phantom lines to accommodate the largest diameter gear 34A or the smallest gear 34B of the change gear set previously mentioned.

The idler gear 36 further meshes with a gear 48 which rotates on the shaft 52. Oscillating arms 50 also pivot on the shaft 52 and they carry a pair of swing feed rolls 54 and 60. The upper swing feed roll 54 has a gear 56 which is meshed with the gear 48 and also meshes with a gear 58 on the lower swing feed roll 60, the latter in 1 to 1 ratio.

A connecting rod or crank 62 from a pivot 64 on the oscillating arms 50 extends to a crank disc 66 and is coupled thereto by a crank pin. This crank disc 66 is attached by bolts 70 to the end of the die drum 20. This attachment is circumferentially adjustable through the medium of arcuate slots 68 for the bolts 70 and thus varies the relative phase angle between the sweep of the crank 62 and the rotation of the dies 22.

The stroke length of the connecting rod or crank 62 is adjustable by means of a slot 72 which receives the crank pin and allows the pivotal radius to be selected.

A buffer or air cushion is provided at reference 74, the cylinder of which is pivoted at 76 from the machine structure S. The piston rod 78 of this air cushion 74 is attached to the oscillating arms 50 with a connecting pin 80.

Reference numerals 82 and 83 designate idler rolls over which in named sequence the roll stock material web W passes in the direction of the arrows. It then passes as shown, first over the drum 49 and then upper swing feed roll 54. The web W is carried halfway around the latter to pass through the nip comprising rolls 54 and 60 in conjunction. A guide 88 defines a path for the web stock W to the engagement line of the drums 20 and 26. Clearance grooves 90 in the swing feed roll 60 are provided for the guide 88 with the latter having a suitable radius of curvature to accommodate the sweep as arms 50 oscillate. A negative air pressure is maintained within the extended length of guide 88. This air pressure is communicated to the web stock W through perforations as will be explained.

A register control sensor 86 which through well-known means such as printed marks on the web stock W viewed by light sensitive cells, signals the positive infinitely variable drive transmission 32 to cause a readjustment of the speed of output to correct misregister of printed matter on the web stock W with the dies 22 and 28. It was discovered in the construction of the machine that the free loop 131 formed in guide 88 behaved in different fashions at different speeds of operation of the system. The free loop 131 is that portion of the web between the swing rolls 54 and 60 and the die drums 20 and 26. This portion of the web is flat when the cut starts, but after the cut starts, it forms a loop 131 and there is no roll or apparatus under the loop to maintain its shape; that is, there is no dancer roll.

At low and medium speeds, the free loop 131 was properly formed as will be discussed subsequently. However, at increased speeds of the system, the inertia of the particles of the web and also aerodynamic effects caused the loop 131 to distort as shown by the dotted portion in FIG. 1. This phenomenon is shown in FIGS. 2A, 2B, and 2C. In FIG. 2A, it is seen that the web W between the swing rolls 54 and 60 and the die drums 20 and 26 is, in fact, flat on guide 88. Then, in FIG. 2B, where the web W has been overfed into the area, a loop 21 has formed and the loop 21 is just about what you get from the system during operation.

The low and medium speeds would be up to, perhaps, 100 rpm of the system. Top speed of the machine is 208 rpm so that loop problems occur at about 50 percent speed of the machine. The dotted loop 23 shown in FIG. 2B, is exactly the configuration that is encountered at high speeds of operation of the machine. It can be seen that the loop 23 would double back on itself and when it collapses, which occurs at extremely high rates of speed of the machine, the loop 23 would actually create a fold 25 and go through the dies 22 and 28 on the die drums 20 and 26 in a folded fashion. This is shown very well in FIGS. 6 and 7 which illustrate a blank cut-out.

Another problem encountered in the system as shown in FIG. 2A is that the web W is a straight line between the swing rolls 54 and 56 and the die drums 20 and 26 and it is lying against the guide 88. The portion of the web W that is not a straight line is guided in a curved form so that as the swing rolls 54 and 60 move forward, the web W tends to press into the table or guide 88 and is restrained in that direction.

The problem that is encountered here is that the web W is fairly strong and stiff and there would be a column effect, whereas it was not known at which point the column would break or begin to bend. In the curved portion of the guide **88**, the vacuum system previously mentioned was added to prevent the breaking point from occuring back there.

This helped a great deal and did allow the speed of operation of the machine to be increased somewhat. However, by adding a bar **27** across the guide **88**, as shown in FIGS. **1**, 3A, 3B, and 3C, this problem was alleviated. This bar **27** prevents the web W from lying completely flat on the guide **88** and when used in conjunction with the vacuum near the swing rolls **54** and **60**, it creates a definite bend in the web W so that the break or start of the loop would occur exactly at that point.

In FIGS. **1**, 3A, 3B, 3C,**8** and **9**, there is shown a series of guide bars **33** which lie above the web W just beyond the vacuum point. These guide bars **33** prevent any inadvertent forming of a secondary loop in that area.

In FIGS. 3A, 3B, 3C, and **9**, a curved bar **29** is shown, which is stationary. This curved bar **29**, in the form of a cylinder or roll, does not turn and is rigid. This curved bar or cylinder **29** is positioned so that it forms a bend in the lower portion of the loop. It can readily be seen that the bend in the web W resembles the natural troublesome loop **23** that was shown in FIG. 2B by the dashed lines.

In other words, the web W is allowed to form its natural loop, but a cylinder is positioned in the lower portion of it to prevent the top from collapsing down onto itself and doubling over, as previously discussed.

Another arrangement for solving this problem is shown in FIGS. 4A, 4B, and 4C and **10** wherein a curved baffle device **35** is positioned between the swing rolls **54** and **60** and the die drums **20** and **26**. This baffle device **35** is formed of a double-walled sheetmetal piece having vacuum apertures or perforations in the forward curved wall **37**. Vacuum is applied to the baffle device **35** so that the web is sucked against the forward curve to prevent formation of the troublesome loop **23** that was shown in FIG. 2B by the dashed lines. It is to be noted that the cylinder **29** that is shown in FIGS. 3A, 3B, 3C, and **9** does not rotate at all and is stationary. It is made as a cylinder merely from an economic standpoint and could be a partial cylinder with the section from about 1 o'clock to 7 o'clock being the working surface. The remainder could be discarded.

With these improvements mentioned to the looped area, the machine described can be operated at top speed thereof of 208 rpm. The advantages of the loop control systems described are mainly that with average thicknesses of web—average thickness would be maybe from 15 thousandths to 25 thousandths thickness of web—the machine can be operated at very high speeds, namely the top speeds of the machine. Another advantage is that the loop control systems will allow the machine to work with thinner web materials which would be more flimsy and tend to have loop instability.

To give some idea of what is meant by high speed, if the machine were operated at its top speed of 208 rpm, with about 42 inch repeat, it would be operating with web speeds something over 700 feet per minute. If it operated at 208 rpm with a 57 ½ inch repeat length, it would be operating at 1,000 feet per minute web speed.

The type of dies **22** and **28** envisioned for use on this cutter-creaser system **10** are of the chemically etched or milled type as described in U.S. Pat. No. 3,244,335 issued Apr. 5, 1966, entitled "Method for Forming Severance Lines," issued to R. H. Downie. Of course, it is not essential that the cutter-creaser system **10** be limited to these specific dies **22** and **28**. Conventional rotary dies such as are used for the manufacture of milk containers would be perfectly satisfactory for mounting on the die drums **20** and **26**.

Fixed ahead of these rotary drums **20** and **26** as previously indicated by reference to FIG. **1** are the pair of swing feed rolls **54** and **60**, which are mounted on the pair of oscillating arms **50** which, in turn, are linked together with the heavy torque shaft **52** to make sure that the swing feed rolls **54** and **60** rock back and forth and remain parallel to the two die drums **20** and **26**.

The swing feed rolls **54** and **60** are geared together and are driven by the large gear **48** which is mounted on the center line of the torque shaft **52** previously mentioned. As the two swing feed rolls **54** and **60** rock back and forth on their arms **50** about the center of the torque shaft **52**, their gears also rock back and forth around the large drive gear **48**.

This means that a web stock W of material which is gripped between these two swing feed rolls **54** and **60** is driven by a speed which is the sum of the rotational speed of the large gear **48** plus the additional speed imparted by the rotation of the roll drive gears **56** and **58** about the large gear **48** plus the linear forward displacement of the swing feed rolls **54** and **60** themselves so that what is produced is a curve of motion which is the sum of a continuous speed which is the average speed of the web stock W and which is then modified by a speed which varies somewhat like a sine wave, upwards and downwards once each revolution of the main drums **20** and **26**, as best illustrated in FIG. **12**. It is assured that this wave is produced once each revolution of the die drums **20** and **26** because the arms **50** on which the swing feed rolls **54** and **60** are mounted are linked back to the crank pin on the drum **20**.

It should be pointed out that the large gear **48**, which is sometimes called a bull gear and which is mounted on the torque or rocker shaft is also geared back through the gear train and the variable speed transmission **32** to the gears **30**, **14**, and **13** which drive the two main cutting drums **20** and **26**. This allows a variation of the speed of the bull gear **48** and, therefore, the average feeding speed of the two swing feed rolls **54** and **60** by varying the gear ratios in the gear train and also by varying the drive ratio through the variable speed transmission **32**.

Turning now to the speed curve of FIG. **12**, there is shown, for example, a condition in which the main drums **20** and **26** are running at such a speed as to produce a surface speed on the dies **22** and **28** of 980 surface feet per minute at a predetermined speed. If, for example, a repeat length on the web stock W of 57.7 inches is to be cut, the gear ratio would be adjusted by the variable speed transmission **32** to produce an average feed into the system **10** of 750 feet per minute surface speed on the feed rolls **54** and **60**. This produces a differential in feeding speed of the web stock W relative to the cutting dies **22** and **28** of 230 feet per minute.

This speed of 230 feet per minute is then added to the feeding speed of the web stock W by the forward rocking motion of the swing feed rolls **54** and **60** about the torque shaft **52**. This means that at the instant of the beginning of the cut, the web stock W of material will be entering the cutting point directly between the two die drums **20** and **26** at substantially the surface speed of the cutting dies **22** and **28**.

If then, it is desired to change the system **10** to produce a cut repeat length of 28.8 inches, this would, of course, necessitate changing the length of the cutting dies **22** and **28** on the drums **20** and **26** to new dies which are 28.8 inches long. The varying cut length is produced by simply varying the length of the cut pattern on that die **22** and **28**.

Let it now be assumed that a die **22** and **28** have been mounted on cutting drums **20** and **26**,which cutting length is 28.8 inches. The gears can be changed, together with the setting of the variable speed transmission **32** to produce a a web speed of 375 feet per minute. This produces a speed differential if the drums **20** and **26** are run with the surface speed of 980 feet per minute as previously mentioned. This produces a differential of 605 feet per minute between the die speed and the web speed. The motion of the arms **50** can be adjusted to cause the addition of 605 feet per minute by moving the swing feed rolls **54** and **60** forward at a corresponding speed, so that once again the web stock W is inserted into the leading edge of the cutting dies **22** and **28** between the two drums **20** and **26** at a net 980 feet per minute.

The correcting action of the swing feed rolls **54** and **60** and their effect on the web stock W can be adjusted by selecting a different point on the speed curve of FIG. **12**. This is done by moving the crank pin which is mounted on the end of cutting drum 20. The angular relationship of that crank pin to the leading edge of the cutting dies 22 and 28 can be moved. This in effect means that the web stock W is inserted between the cutting dies 22 and 28 at a higher point on the speed curve of the roll motion to produce a greater speed correcting action, such as is required for short cut lengths. Or, the crank pin can be adjusted to a different position to cause the web stock W to be inserted between the cutting dies 22 and 28 at a lower point on the speed curve such as a point near the end of the roll stroke where the forward motion of swing feed rolls 54 and 60 is relatively much smaller. This would be the case for instance, when a longer cut length is being fed.

In the particular design of system 10, the crank pin which produces the rocking motion of the swing feed rolls 54 and 60 is mounted on the end of the rotary cutting drum 20. Of course, it is not necessary that this crank pin be located there. It could be mounted on any gear in the drive train which makes one revolution per revolution of the cutting drum 20. A simple crank motion has been used for the connecting rod or crank 62 such as shown in FIG. 1, materially for simplicity. It would also be possible to drive the oscillating arms 50 with a cam mechanism or any similar device.

It is also to be pointed out that a straight line motion back and forth could be used for the swing feed rolls 54 and 60 rather than having them rock back and forth around a torque shaft 52. In that particular mechanism, the gears which drive the feed rolls engage a rack which would be fixed in the system and a speed change is produced by shifting the rolls back and forth along this rack. However, such an arrangement using a rack, does not produce an easier motion as does the motion described for the swing feed rolls 54 and 60. In system 10, a combination of changed gears together with a variable speed transmission 32 produces the varying driving speed between the die cut drums 20 and 26 and the bull gear 48.

This was done specifically this way because the change gears give an absolute speed ratio. Unfortunately, one set of change gears must vary from the next by a fixed increment of whole numbers of teeth and here it was desirable to have an infinitely variable ratio without steps from one cut length to another. Therefore, the variable speed transmission 32 was introduced into the creaser-cutter system 10. Its speed adjustment range is quite narrow and its purpose is simply to allow for a slight modification to the particular gear ratio which has been selected so as to give a smooth and infinite transition of speed ratios from that which is produced from one change gear set to the next.

It is to be noted that one problem foreseen in inserting the web stock W into the cutting dies 22 and 28 is the fact that a relatively long free end of web stock W is being pushed from the drum 49 and swing feed rolls 54 and 60 into the die cut drums 20 and 26. For this reason, a series of vacuum bars 88 were added along the track of the web stock W from the swing feed rolls 54 and 60 into the die cut drums 20 and 26 and these bars 88 are equipped with a perforated surface through which a slight suction is applied. This suction effort will be just enough to be sure that the web stock W of material is held firmly along the surface of the guides and yet will still be free to slide. This will have the effect of definitely controlling the position of the web stock W and will impart a certain amount of support to the web stock W to prevent buckling as the protruding end of the web stock W is accelerated forward into the nip of the cutting dies 22 and 28. In addition, the curve of the guides will impart a slight curve to the web stock W to increase its stability.

As previously indicated, a secondary pair of idler rolls 82 and 83 are provided to obtain maximum angle of wrap of the web on the drum 49. The drum 49 operating at a constant predetermined speed will pull the web stock W of material from the primary roll or other source. The material would be led through an edgeguiding and tension controlling set of equipment which is conventional in the industry.

System 10 was developed as a pure rotary machine, with no high accelerations and decelerations to throw off the accuracy of the machine with the sole exception of the rocking motion of the swing feed rolls 54 and 60.

In order to smooth out the affect of the acceleration of the rocking mechanism, a link from the rocking or oscillating arms 50 was added which carry the swing feed rolls 54 and 60 back to the frame of the system 10. This link is in effect the air cushion cylinder 74 which operates more or less like a shock absorber. The compression of air in the air cushion cylinder 74 on the return stroke of the rolls 54 and 60, for instance, will contribute to decelerating the rocking or oscillating arms 50 and the swing feed rolls 54 and 60. On the feed stroke, of course, the pressure which has been built up into the swing feed rolls 54 and 60 will assist in accelerating the rolls 54 and 60 in the forward direction.

Generally, a printed repeat pattern is provided on the web stock W of material being fed into the system 10. A set of change gears has been provided, together with a speed ratio in the variable speed transmission 32 so as to produce the same cut length in the system 10 that occurs in the web stock W on the printed matter. Of course, this can only be done to a certain degree of accuracy. This error would occur for instance, in the setting of the variable speed transmission 32.

It may also occur in the length of the printed repeat on the web stock W. For example, if the material of the web stock W stretches or shrinks slightly through its length due to changes in moisture content, the repeat length will change slightly and it is necessary for the system 10 to automatically correct itself as it runs so that each cut will be located directly on each printed pattern.

For example, if only one thousandths of an inch error is being made in cut length, after 1,000 cuts, 1 whole inch of material would be out of register unless a continuous correction were made.

Thus, to remedy this error, the scanning eye or register control sensor 86 has been added. This register control sensor 86 is a photocell which is located directly over the web stock W as it enters the swing feed rolls 54 and 60. This eye would pick up a register mark which is part of the printed matter. It picks up the position of the printing on the web stock W. An additional sensor or roll angular position monitor 92 is provided as shown in FIG. 1 on the end of one of the cutting drums, for example, drum 20 which continuously senses the position of the cutting drum 20 in the system 10, that is, its rotary or angular position. A signal from each of sensor 86 and monitor 92 is then fed back into an electrical control system 96, as shown in FIG. 11, which is more or less a computer which then, taking these two sensing signals, can detect any error in the desired position of the cutting drum 20 and 26 relative to the printed web stock W.

At this point, an error signal can be sent to a small motor or compensator actuator 94 which, in turn, controls the speed ratio setting in the variable speed transmission 32 causing the transmission to introduce a correction into the gear train which is driving the swing feed rolls 54 and 60. This, in turn, will advance or retard the material of the web stock W slightly so that the cut will then be continuously re-registered to the printed matter on the sheet at each cut. This will insure that although some error does occur, or can occur, in each cut length, this error can be limited to within a very small margin.

Of course, it is to be noted that this system 10 has been developed to detect a printed register mark on the web stock W of material. Of course, this mark need not be a printed mark or even a mark at all. It can, for example, be a magnetic impulse which is imparted to the web stock W of material at the required intervals or it could be a hole punched through the web stock W of material.

In the cutter-creaser system 10 described so far, there are two drums 20 and 26 involved, each of which carries a sheet metal type cutting and creasing die 22 and 28, respectively. Of course, the general principles of this system 10 can be applied, for example, to a variable repeat web fed printing press in which one drum would simply be a smooth cylinder to back up the web stock W of material. The other drum, for example, would carry the printing dies or plates which would be inked by a conventional inking mechanism. Or, if, for example, the system were to be used as a somewhat cruder form of cutting and creasing system, a single set of dies could be made by inserting a cutting rule in the curved plywood for example. This type of die is currently being used on sheet fed rotary die cutters for corrugated board and the like.

In that particular instance, the system would be designed so that one drum would accept the curved plywood die. The opposed drum would then be covered with a continuous blanket of a resilient material such as a polyurethane and this would allow the cutting blades in the die to drive through the web stock being cut into the polyurethane.

Another possible variation of the cutter-creaser system **10** would be as a sheeter. A sheeter is a machine which takes a web stock of material and simply cuts it into sheets. In this case, for example, there need only be one drum which would carry a blade running along its length. It is common in sheeters for the matching blade to simply be a beam with a cutting edge on it mounted under the drum. As the cutting edge of the blade passes over the corner of the beam, a shearing cut is produced. In this type of design of the system, for example, there would only be one drum involved and a fixed beam would supply the other cutting member. In the case of the sheeter with only one drum, the rest of the mechanism that has been described here would still be used to produce the variable length of sheet feed per cut.

There is another possible version of system **10**, for example, where the two drums **20** and **26** would be the main blanket-covered drums of an offset press. In this example, the top and bottom of the sheet could be printed on and the printed matter could be applied to both drums at the same time by a regular offset printing press mechanism.

Of course, with that kind of an application the change gears and variable speed transmission **32** and the rest of the feeding mechanism would still be the same. The only thing that would change would be the particular surface configuration of the drums themselves.

Another possible variation to this design includes the variable speed ratio equipment between the cutting drums **20** and **26** and the bull gear **48**, with a combination of change gears and a variable speed transmission **32** being used. It is known that infinitely variable speed transmissions have a small percentage of error of the speed ratio through the transmission **32**. In this instance of the present system **10**, transmission **32** has been used to give a speed variation in very small increments which can be obtained by making a small change in the change gear ratio. Using the system this way, any error which matures through the variable speed transmission **32** is only a very small portion of the total speed ratio and, therefore, can be tolerated even on an extremely accurate machine.

It is quite possible that a variable speed transmission **32** can be designed which will have an extremely accurate control of the ratio within the transmission itself. In this case, if this error is very small it then means that it would no longer be necessary to use change gears at all. The total control of sheet length range could be obtained by taking the entire drive ratio change in the transmission **32** itself and any slight errors which this extremely accurate transmission might produce, would then be controllable by the automatic scanning and correcting devices, previously mentioned.

There is one other modification which is desirable to be made to the cutter-creaser system **10** under certain circumstances, which is the ability to adjust the radius of the crank pin at the end of the connecting rod **62**; that is, the radius from the center of the crank pin to the center of the drum **20**. This crank pin, through the connecting rod **62**, drives the rocking motion of the swing feed rolls **54** and **60**. It may be desirable to change this radius of the crank pin for different sheet length conditions, in order to produce the very minimum necessary acceleration in the rocking mechanism for each particular sheet length. This adjustment will only be necessary in case it is desired to run the system **10** at very high web speeds such as in the neighborhood of 1,000 feet per minute or better.

As previously mentioned, the oscillating arms **50** which carry the swing feed rolls **54** and **60** are connected to the shock absorbing type cushion cylinder **74** to help absorb or level out the accelerating and decelerating forces which are produced by the linear back and forth motion of the swing feed rolls **54** and **60** themselves. Of course, these swing feed rolls **54** and **60** are also accelerating and decelerating in a rotary direction about their own centers because their driving gears are rocking back and forth around the bull gear **52** which drives them.

This introduces also a rotary accelerating and decelerating force back and through the gear train and for extreme accuracy it is desirable to absorb and level out back load.

To do this, an extra gear (not shown) has been connected to the bull gear **48**. This extra gear drives a hydraulic pumping system. The valving in this system is such that once each revolution the connections through the hydraulic system are reversed so that the pump which is connected to this extra gear alternately becomes first a pump and then a hydraulic motor; so, during that period of the cycle in which the bull gear **48** is attempting to accelerate the swing feed rolls **54** and **60**, the hydraulic system is valved to produce an auxiliary assist to the driving motion, and it helps to smooth out the loads back through the gear train. During that portion of the cycle when the bull gear **48** is attempting to decelerate the rotary motion of the swing feed rolls **54** and **60**, the valving is then reversed so that this gear becomes the drive gear for a pump and it then absorbs the energy which is produced by the deceleration of the swing feed rolls **54** and **60**.

Obviously many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A web fed variable repeat length system for performing at least one operation on a web, comprising, structure including a work member positioned thereon for working on a continuously supplied web fed thereto during each working cycle of said work member, means arranged to form free storage loops in said web and advance said web periodically to said work member, means for stabilizing said free storage loops formed in said web, and means coupled to said means for forming said free storage loops and controlled by said structure having said work member to cause said storage loop means to feed a predetermined length of web to said work member for operation thereon by said work member.

2. A web fed variable repeat length system for performing at least one operation on a web, comprising, structure including a work member positioned thereon for working on a continuously supplied web fed thereto during each working cycle of said work member, means arranged to form free storage loops in portions of said web and advance said web including said loop portions periodically to said work member, means for stabilizing said free storage loops formed in said portions of said web, and means coupled to said means for forming said free storage loops and to said structure having said work member to cause said storage loop means to feed a predetermined and adjustable length of web to said work member for operation thereon by said work member.

3. A web fed variable repeat length system for performing at least one operation on a web, comprising, means including a work member positioned thereon for working on a continuously supplied web fed thereto during each working cycle of said work member, means arranged to form free storage loops in portions of said web and advance said web including said loop portions periodically to said work member, means for stabilizing said free storage loops formed in said portions of said web during a period when said loops are being formed and advanced to said work member, and means coupled to said means for forming said free storage loops and to said means having said work member to cause said storage loop means to feed an adjustable length of web to said work member for operation thereon by said work member.

4. A web fed rotary variable repeat length system for performing at least one operation on a web, comprising, means including at least one rotary drum having a work member positioned thereon for working on a web fed to said drum, feeding means arranged to feed said web to said rotary drum, means for causing said feeding means to travel through one complete control cycle for each revolution of said rotary drum, means coupled to said feeding means and to said rotary drum to cause said feeding means to feed an adjustable length of web to said rotary drum at substantially the surface speed thereof for operation thereon by said work member on said rotary drum, and means for stabilizing said adjustable length of web fed to said rotary drum.

5. A web fed rotary variable repeat length system for performing at least one operation on a web, comprising, means including at least one rotary drum having a work member positioned thereon for working on a web having spaced indicia thereon fed to said drum, feeding means arranged to form and feed free storage loops of said web to said rotary drum, means for causing said feeding means to travel through one complete control cycle for each revolution of said rotary drum, means coupled to said feeding means and to said rotary drum to cause a change in the feeding action of said feeding means to correct for misregister between said spaced indicia on said web and the work member on said rotary drum, and means for stabilizing said free storage loops of said web as said loops are being formed and fed to said rotary drum.

6. A web fed rotary variable repeat length system for performing at least one operation on a web, comprising, means including a pair of spaced rotary drums having work members positioned in register with one another thereon for working on a web fed between said rotary drums, feeding means arranged to form and feed free storage loops of said web between said rotary drums, means for causing said feeding means to travel through one complete control cycle for each revolution of said rotary drums, means coupled to said feeding means and to one of said rotary drums to cause said feeding means to feed adjustable lengths of said free storage loops of said web to said rotary drums at substantially the surface speed thereof for operation thereon by said work members, and means for stabilizing said adjustable lengths of said free storage loops of said web as said loops are being formed and fed to said rotary drums.

7. In a web fed rotary variable repeat length system as recited in claim 6, wherein said feeding means includes a pair of spaced members mounted thereon for receiving and feeding said web to said rotary drums.

8. In a web fed rotary variable repeat length system as recited in claim 7, wherein said means coupled to said feeding means and to one of said rotary drums includes a variable ratio drive mechanism.

9. A web fed rotary variable repeat length system for performing at least one operation on a web, comprising, means including a pair of spaced rotary drums having work members positioned in register with one another thereon for cutting and creasing sections from a web having spaced indicia thereon and fed between said rotary drums, feeding means arranged to form and feed free storage loops of said web to said rotary drums, means for stabilizing said free storage loops of said web as said loops are being formed and fed to said rotary drums, means for causing said feeding means to travel through one complete control cycle for each revolution of said rotary drums, drive means coupled to said feeding means and to one of said rotary drums, and means for sensing said spaced indicia on said web and the angular position of said rotary drums and for signaling said drive means to cause a change in the feeding action of said feeding means in order to correct for misregister of said spaced indicia on said web and said work members on said rotary drums.

10. A web fed rotary variable repeat length system as recited in claim 9, wherein said feed means is pivotally mounted and includes a pair of feed rolls for receiving and feeding said web to said rotary drums at substantially the surface speed thereof.

11. A web fed rotary variable repeat length system as recited in claim 9, wherein said drive means is of the variable ratio type.

12. A web fed rotary variable repeat length system as recited in claim 9, and additionally means for cushioning the movements of said feeding means.

13. A web fed rotary variable repeat length system as recited in claim 9, wherein said work members are work dies for cutting, creasing, embossing and/or printing of said web.

14. A web fed rotary variable repeat length system as recited in claim 9, and additionally feed rolls for continuously feeding said web to said feeding means for further operation thereon.

15. A web fed rotary variable repeat length system as recited in claim 14, and means for sensing and controlling the rate of feed of said web to said feeding means.

16. A web fed rotary infinite variable repeat cutter-creaser system, comprising, means including a pair of spaced rotary members having work elements positioned in register thereon for cutting-creasing sections from a web having spaced indicia thereon fed between said rotary members, feeding means having spaced rolls mounted thereon arranged to receive said web between said rolls and to form free storage loops of said web forward of said rolls and feeding said free storage loops of said web into said rotary members at substantially the surface speed thereof, means for stabilizing said free storage loops of said web as said loops are being formed and fed to said rotary members, means coupling said feeding means with one of said rotary members, a variable ratio drive means coupled to said feeding means and to said one rotary members, and means for sensing said spaced indicia on said web as well as the angular position of said rotary members and for signaling said variable ratio drive means to cause a readjustment of the speed of output of said variable ratio drive means to correct for misregister of said indicia on said web with said work elements on said rotary members.

17. A variable repeat length system for performing at least one operation on a web, comprising, means having a work member positioned thereon for working on a continuously supplied web having spaced indicia thereon fed to said work member during the working cycle thereof, feeding means arranged to form free storage loops in said web and advance said free storage loops in said web periodically to said work member, means for stabilizing said free storage loops as said loops are being formed and fed to said work member, means for causing said feeding means to travel through one complete control cycle for each cycle of operation of said work member, and means coupled to said feeding means and to said means having said work member to cause a change in the feeding action of said feeding means to correct for misregister between said spaced indicia on said web and the work member.

18. A web fed rotary variable repeat length system for performing at least one operation on a web, comprising, means including a pair of spaced rotary members having work elements positioned in register with one another thereon for working on a continuously supplied web fed between said rotary members during the working cycle thereof, feeding means arranged to form free storage loops in said web and advance said loops in said web periodically to said work elements, means for stabilizing said free storage loops in said web as said loops are being formed and advanced to said work elements, means for causing said feeding means to travel through one complete control cycle for each cycle of operation of said rotary members, and means coupled to said feeding means and to one of said rotary members to cause said feeding means to feed an adjustable length of web to said rotary members at substantially the surface speed thereof for operation thereon by said work elements.

19. A web fed rotary infinitely variable repeat cutter-creaser system, comprising, means including a pair of spaced rotary members having work elements positioned in register thereon for cutting-creasing printed carton sections from a continuously supplied web having spaced indicia thereon fed

between said rotary members, feeding means arranged for forming and feeding free storage loops of said web to said rotary members at substantially the surface speed thereof, means for stabilizing said free storage loops of said web as said loops are being formed and fed to said rotary members, means coupling said feeding means with one of said rotary members, drive means coupled to feeding means and to said one rotary member, and means for sensing said spaced indicia on said web as well as the angular position of said rotary members and for signaling said drive means to cause a readjustment of the speed of output of said drive means to correct the misregister of said indicia on said web with said work elements on said rotary members.

20. In a web fed rotary variable repeat length system as recited in claim **1**, wherein said stabilizing means includes means disposed between said storage loop forming means and said work member for permitting the formation of a natural loop in said web with a bend being formed in the loop about said permitting means to prevent the top of the loop from collapsing down onto itself and doubling over.

21. In a web fed rotary variable repeat length system as recited in claim **20**, wherein said permitting means includes a stationary bar which extends across the path of movement of the web and is formed with a curved portion over an exterior portion thereof whereat the bend in the natural loop of said web is formed.

22. In a web fed rotary variable repeat length system as recited in claim **1**, wherein said stabilizing means includes a plurality of guide means located above the path of movement of said web between said storage loop forming means and said work member to prevent the undesirable formation of a secondary loop during the formation of said free storage loops in said web.

23. In a web fed rotary variable repeat length system as recited in claim **1**, wherein said stabilizing means includes means located between said storage loop forming means and said work member and having a loop engaging surface for permitting a trailing portion of the free storage loops to be formed thereagainst and means for holding said trailing portion thereagainst until said loop is advanced to said work member to prevent the formation of an undesirable loop form when said free storage loops are formed.

24. In a web fed rotary variable repeat length system as recited in claim **23**, wherein permitting means includes a baffle device having a curved wall and a linear wall extending from said curved wall and said holding means includes apertures formed in said curved and linear walls and a vacuum being applied to said baffle device to draw and hold the trailing portion of said free storage loops thereagainst.

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