RUNNING FEEDBACK ADJUSTMENT OF ENVELOPE MAKING MACHINES


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Filed: May 24, 1971

Appl. No.: 146,179

U.S. Cl. 93/61 AC, 271/52, 271/59

Int. Cl. B31f 1/00

Field of Search 93/61, 61 AC, 62, 8 R; 271/52, 271/59, 41

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ABSTRACT
The envelope making machine is provided with a multiplicity of envelope blank proximity devices which read the instantaneous position of respective blanks at important locations along the path of travel. Blank position signals are analyzed and, if a discrepancy with desired position appears, adjusting mechanisms located upstream from the sensing devices are actuated to correct succeeding blanks. Among the adjusting mechanisms disclosed are phase shifting differential transmissions connected between the machine drive train and the respective blank advancing members, and correcting drivers which include expandable and steerable driving tires for correcting blank lateral shift, skew and lead errors.

13 Claims, 17 Drawing Figures
RUNNING FEEDBACK ADJUSTMENT OF ENVELOPE MAKING MACHINES

This invention relates to rotary envelope making machines and more particularly to the adjustment thereof for optimum performance.

In adjusting high speed envelope machines for producing envelopes of different size or style from a previous run, it is necessary to make many adjustments throughout the machine. Basic coarse adjustments must be followed by a much more time-consuming fine adjustment procedure during which the machine is "tried" to perform the necessary operations accurately and repeatedly at high speed over a sustained period. Even though the machine has been finely adjusted, slight variations in envelope blank configuration, environmental temperature and/or humidity conditions, machine wear, the presence of dust, etc. may cause changes in the characteristics of machine driving portions so that the blanks do not follow in the optimum path or in the optimum timed relation intended. Unless corrected, this often results in adverse quality of the finished product, and in certain cases, a complete malfunction of the envelope machine.

In the practice of this invention, the relative positions of individual envelope blanks are monitored during machine operation with respect to both time and aspect at several chosen locations along the operational path of travel and, where excess deviations from an optimum appear, subsequent blanks entering the locations are driven correctly to an extent that proper relative positions are achieved.

The principal objects of the present invention are: to provide envelope making machinery which will produce high quality envelopes with a minimum of attention by skilled mechanics; to provide such apparatus which tends to avoid shutdowns caused by the malpositioning of blanks during machine operation; to provide a system which reduces the necessity for time consuming fine adjustments heretofore necessary in changing envelope size and style; to provide more positive quality control of blanks operated upon within an envelope machine; to provide an automatic adjusting system for envelope machines which is operable for monitoring and adjustment during normal machine runs; and to provide such apparatus adapted for the high speed production of quality envelopes consistently at reduced cost.

Other objects and advantages of this invention will become apparent from the following description taken in connection with the accompanying drawings wherein are set forth by way of illustration and example certain embodiments of this invention.

FIGS. 1a, 1b and 1c taken together show, schematically, the path of travel of envelope blanks through an envelope making machine embodying this invention.

FIG. 2 is a fragmentary plan view showing a typical envelope blank proximity sensing device or reader.

FIG. 3 is a fragmentary front elevational view of the reader with an envelope blank surface, shown in broken lines, in partially covering relation.

FIG. 4 is a fragmentary perspective and schematic representation of a power drive shaft of the envelope machine equipped with a signal pulse producing device which is connected to an analyzer and control network.

FIG. 5 is a fragmentary, schematic view showing the feed cylinder of the envelope machine in association with a phase correcting differential transmission and envelope blank proximity reader.

FIG. 6 is a fragmentary, plan view of the patch gum applying section of the envelope machine incorporating features of this invention.

FIG. 7 is a fragmentary elevational view showing a correcting driver used in pairs for dynamically modifying blank position along the operating path.

FIG. 8 is a plan view showing further details of the correcting driver.

FIG. 9 is a schematic plan view showing a pair of correcting drivers adjusted to correct a lateral shift in the envelope blanks.

FIG. 10 is a schematic plan view showing a pair of correcting drivers adjusted to correct skew in the envelope blanks.

FIG. 11 is a schematic plan view showing a pair of correcting drivers adjusted to alter the relative lead of the envelope blanks.

FIG. 12 is a fragmentary plan view showing the decollating section of the envelope machine with associated proximity reader.

FIG. 13 is a fragmentary plan view showing a scoring section of the envelope machine with proximity readers and phase shifting transmissions.

FIG. 14 is a fragmentary plan view showing the side flap gumming section of the envelope machine with proximity readers and correcting drivers.

FIG. 15 is a fragmentary plan view showing the side flap folding section of the envelope making machine with detectors and correcting drivers.

Referring to the drawings in more detail:

The reference number 1, FIGS. 1a, 1b and 1c, generally designates by way of example a typical continuously repeating cycle rotary envelope making machine, the general type manufactured by Winkler & Dunnebier, Neuwied am Rhein, West Germany, under the designation W.G. D. 127. The illustrations are schematic in nature, showing by representation features of this invention with known components defining a path of travel 2 for envelope blanks 3. The envelope blanks 3 selected for illustration are typical, having a central panel 4 with connecting top or seal flap 5, bottom flap 6, and side flaps 7 and 8 (FIG. 9). The blanks 3 are withdrawn from the bottom of a feed stack 9 by blank advancing means which includes a rotating, split feed cylinder 10; however, other blank feed devices, such as the web roll type (not shown) may also be used.

From the feed cylinder 10 (FIG. 1a), the blanks 3 travel in spaced, consecutive order through an inside and outside printing section 11, through a window cutting station 12 and then to a window gum applying section 13, a window patch or patches being applied at 14. At many positions throughout the machine the blanks are urged along the path of travel 2 by means of driven rollers, such as those designated 15, forming a bight with idler rollers such as those designated 16. Driven belts 17 carry the blanks from the seal flap gumming section 18, now in overlapping relation, through a drying tunnel 19 to a decollating section 20 (FIG. 1c) where they are again separated from each other by means of a decollating roller 21 (FIGS. 12 and 13). A drive chain 22 (FIGS. 1a and 13) has spaced pins 23 which individually engage the separated blanks, urging them into a scoring roller 24 where top and bot-
3 tom scores 25 and 26 (FIG. 14) are applied. From the scoring roller 24, the blanks are driven against plows 27 (FIG. 14) where the side flaps 7 and 8 are folded inwardly over the central panel 4 and gum is applied to the folded side flaps by a gummer 28. The bottom flap 6 is then folded over the gummed side panels at 29 (FIGS. 14 and 15) and the seal flap is folded at 30 immediately prior to the blanks entering the teeth of a delivery wheel 31 (FIG. 15) from which they are delivered as finished envelopes 32 (FIG. 16).

The above noted operating mechanisms, rollers and belts are driven in synchronized relationship by means of a drive motor 33 (FIG. 1b) which rotates a complex series of interconnected drive members including shafts 34–39, transmissions 40–42, chain and sprocket sets 43–45, and other conventional power train members both shown and deleted for clarity of illustration.

The description to this point is for background information. In the practice of this invention, a suitable signal pulse producing device 46 is associated, for example, with a selected drive shaft 35 of the envelope machine. The device 46 may consist of one or a plurality of discs 47–49 within which are embedded magnetic plugs 50 in a predetermined angularly spaced relation. As the shaft 35 rotates, the respective plugs 50 travel past a suitable detector 51 whereby pulses are created which are respectively associated with certain angular positions of the drive shaft 35 and, due to the positive drive train, known positions of the respective interconnected operating mechanisms of the envelope machine.

The pulses created in the detector 51 are transmitted to a suitable analyzer and control network 52 which may take the form of a typical computer system in which a memory contains coded information regarding the optimum position of a blank at various points along the path of travel with respect to angular positions of the shaft 35.

Proximity sensing devices or readers 53–65 are spaced along the path of travel 2 in association with respective operating mechanisms as described further below. The readers 53–65, a typical example of which is shown in FIGS. 2 and 3, respectively include a pair of closely spaced light sensing elements 66 and 66' located generally longitudinally of the path of travel 2 illustrated by the arrow 67 and responsive to reflected light by producing a signal indicating the presence or close proximity of a blank surface 68. The readers 53–65 include an extremely short duration (e.g., 1 micro-second) light pulse source 70 of the type known as a "stroboscope lamp," one supplier being General Radio Company, West Concord, Massachusetts. The source 70, upon actuation, produces a light pulse which is directed through a tube 71 and lens 72 toward an apparent position 73 which, if occupied by a blank surface 68, will produce a reflection for detection by the sensing elements 66 and 66'.

Referring to FIG. 3, an edge 74 of the blank surface 68 is shown in a location between the sensing elements 66 and 66' with the surface covering or adjacent to the sensing element 66 only. Thus, a light pulse emitted by the source 70 will be reflected from the blank surface 68 onto the sensing element 66, but not the element 66', thereby producing a response pattern which definitely locates the blank edge 74 at the instant following the generation of the light pulse by the source 70.

Referring to FIG. 5, the reader 53 is shown located near the envelope machine feed cylinder 10 in a position for detecting the leading edge 75 of a blank 76. The feed cylinder 10 is synchronously driven with the machine drive train, beginning with the drive motor 33 and normally ending with a gear 77 which engages a gear 78 normally secured to the shaft 79 which carries the feed cylinder 10.

In the practice of this invention, however, the gear 78 may not be directly connected to the gear 79 but, rather, in this example, drives a hollow shaft 80 which forms the input to a phase shifting differential transmission 81, for example, of the type manufactured by Stratos Division of Fairchild-Hiller, Winston-Salem, North Carolina, under the trade designation SPECON. A remotely controlled phase shifting motor 81, when actuated, slightly varies the usual 1:1 rotational ratio between the shafts 79 and 80, thereby slightly changing the relative position of the vacuum ports 83 on the feed cylinder 10 with respect to the drive train of the envelope machine. Thus, the presence or absence of reflected light onto the sensing elements 66 and 66' provides information regarding the instantaneous position of the blank 76 which may be used to actuate the motor 82, thereby resulting in the relative advancing or retarding of subsequent blanks. Specifically, a reflection onto both of the sensing elements 66 and 66' will be taken as a signal to retard the relative position of the feed cylinder 10 and the non-reflection to both the sensing elements constitutes a signal that the relative position of the feed cylinder 10 should be advanced.

After leaving the feed cylinder 10, the blanks pass through the printing section 11 and window cutting station 12 where, if desired, a window 84 is cut thereinto. Prior to entering beneath the window gum applying cylinder 85, a blank 86 passes beneath readers 54, 55 and 56, which are positioned to monitor the locations of the blank leading edge and selected edges of the respective side flaps 7 and 8. The reader 56 signals the lead position of the blank along the path of travel 2 (FIG. 6) and the readers 54 and 55 function to determine skew and/or lateral displacement.

The signal pattern produced by the readers 54, 55 and 56 is used to control correcting drivers 87 and 88 which are typical of similar devices used along the blank path of travel 2 and comprise an upper housing 89 having a hollow shaft 90 journaled therewith and projecting into the path of travel 2 (FIG. 7). A timing pulley 91 is engaged with the shaft 90 and carries a timing belt 92 which is directed axially downwardly through an opening in a housing base 93. Below the base 93, the belt 92 engages a drive pulley 94 which is typically operably connected to the drive train of the envelope machine. The upper housing 89 is suitably mounted on the base 93 to permit a degree of rotation about a vertical axis as illustrated in FIG. 7.

A suitable remotely controlled motion transmitting device, such as an hydraulic cylinder 96 (FIG. 8), operated by a suitable pump system (not shown) under the direction of the control network 52, is operably connected between the base 93 and upper housing 89 to produce a steering of the hollow shaft 90 in a horizontal plane as indicated in an exaggerated manner by the broken lines 97 (FIG. 8). The rear portion of the hollow shaft 90 terminates in a suitable rotating shaft seal 98 operable to permit free rotation of the shaft 90.
while hydraulic fluid or the like may be introduced thereinto without external leakage.

The forward or projecting portion of the shaft 90 terminates in a resilient hollow roller or tire 98 which is restricted against bulging axially of the shaft 90 by rigid plates 99, but is free to expand and contract radially in external diameter normally of the shaft 90 under variations in internal pressure. Thus, the introduction of hydraulic fluid 100 or the like within the tire 98 through the hollow shaft 90 may be used to control the peripheral velocity of the tire 98 relative to the input speed of the drive train pulley 94 during machine operation.

The correcting driver tires 98 are urged against respective idler rollers 101 producing a bight at 102 for grasping and driving the envelope blanks along the path 2. By placing correcting drivers 87 and 88 in opposed, facing positions along the path 2 (FIG. 6) and coordinating the rotation of the respective housings 89 about vertical axes with the diameter of the tires 98 controlled by the hydraulic pressure therein, several types of correction may be simultaneously accomplished.

Referring to FIG. 9, assuming that the envelope blank 103 is laterally displaced from the desired path 2 along a path 104, correction is accomplished by moving both correcting drivers 104 and 105 slightly clockwise. While the blank is under the driving influence of the respective tires 106 and 107, it is shifted along an angular path 108 while the centerline thereof remains parallel to the path of travel. When the conventional driving members take over from the tires 106 and 107, the blank is advancing in a proper relative position, no longer laterally displaced.

Referring to FIG. 10, the correcting drivers 109 and 110 are cooperatively operated to correct a blank which is properly centered in the path of travel 2 but skewed at an angle 112. In this instance, the respective tires 113 and 114 are maintained in axial alignment across the path 2 but the tire 113 is expanded to a size somewhat greater than tire 114, whereby the portion of the blank 111 which is driven by the tire 113 is accelerated over the opposite portion of the blank, thereby correcting the skew angle as the blank travels past the drivers 109 and 110.

FIG. 11 illustrates the correction of an error in lead of the blank 115. In this instance, the tires 116 and 117 are aligned on a common axis extending transversely to the path of travel 2 and are simultaneously equally increased or decreased in diameter depending upon whether an increase or decrease in lead along the path is desired.

It is noted that the shaft 90 of the respective correcting drivers is somewhat flexible, thus permitting the slight bending necessary to accommodate variations in tire diameter against an unyielding idler roller 101, as noted by the broken lines 118. It is further noted that multiple corrections in lateral displacement, skew and lead may occur simultaneously through the proper manipulation of the various correcting driver parameters.

Following the sensing and correction occurring between the window cutting station 12 and window gum applying station 13 (FIG. 6), the blanks, in this example, are not again monitored until they approach the decollating roller 21 (FIGS. 1c and 12). Here, the reader 57 senses only lead of the blanks and the correction for error is accomplished through a phase shifting differential transmission 119 (FIG. 1c), which is adapted to vary the phase angle between the drive shafts 38 and 39. The shaft 39 drives, through a worm 120, a pulley drum 121 about which driven belts 17 are wrapped to deliver the blanks in overlapping condition from the drying tunnel 19 to the decollating roller 21, as shown as 122 (FIG. 12). A variation in phase angle between the drive shafts 38 and 39 will vary the position where the decollating roller 121 seizes the leading envelope blank 123, thus adjusting the position to which the blank is forwarded for proper engagement by the drive chain pins 23 (FIG. 13).

Due to uneven wear of the drive chains 22 and minor progressive variations between blanks, the pins 23 sometimes do not present the leading blank 124 (FIG. 13) correctly to the scoring roller 24. To avoid this, readers 58 and 59 are utilized to sense improper lead and skew of the blanks, lateral shift correction not being particularly important at this point since top and bottom score lines have considerable transverse latitude. Correction for lead and skew is accomplished by using phase shifting differential transmissions 125 and 126 in tandem, that is, transmission 125 is utilized in the manner described in connection with the feed cylinder 10 (FIG. 5) and the transmission 126 is used to correct the phase as between the driven chain sprockets 127 and 128.

After passing beneath the scoring roller 24, the envelope side flaps 7 and 8 are folded inwardly by the plows 27 (FIG. 14) and pass beneath correcting drivers 129 and 130 under the control of readers 60, 61 and 62, which monitor for lateral shift, skew and lead. The reader 60, 61 and 62 function immediately following the application of gum 131 to the side flaps 7 and 8 by the gummer 28 and immediately prior to the blank bottom flap 6 being folded thereover at 29 (FIGS. 14 and 15). By this arrangement, succeeding envelopes are corrected in position just prior to side flap gum application and bottom flap folding.

After bottom flap folding, the blanks pass beneath correcting drivers 132 and 133 (FIG. 15), which are controlled through readers 63, 64 and 65 positioned immediately upstream from the top or seal flap folding mechanisms at 30. Here lead and skew are sensed and corrected since slight lateral shift is relatively unimportant. Following seal flap folding, the blanks are directed into the delivery wheel 31 from which they exit as finished envelopes 32 (FIG. 1b).

In the practice of this invention the downstream sensing and repeated use of feedback for upstream correcting permits a continuous monitoring of blanks and entering of effective correcting adjustments during actual production operation. Suitable signal pulses which are synchronized with the overall operation of the envelope machine are produced by the device 46 (FIG. 4) to control the reading timing as needed at the various sensing stations along the path of travel 2. It is not necessary that each blank be sensed at each station, experience dictating which stations require a frequent check and which, for example, require a check only every 1,000 blanks.
It is to be understood that the particular stations for sensing and correcting chosen herein are by way of example only and a greater or fewer number and different positions may be utilized without departing from the scope of this invention. It is to be further understood that while certain specific examples have been illustrated and described herein, this invention is not to be limited except insofar as such limitations are included in the following claims.

What I claim and desire to secure by Letters Patent is:

1. A repeating cycle envelope making machine for continuously producing envelopes from blanks, said machine having blank advancing members defining a path of travel for said blanks and operating mechanisms spaced along said path for successively operating on said blanks and driving means for driving said advancing members and operating mechanisms in synchronized relation, means for adjusting said machine comprising:
   a. signal pulse producing means associated with a portion of said driving means and creating signal pulses related to rotary positions of said driving means,
   b. a plurality of position sensing readers spaced along said path and operably connected to said pulse producing means, said readers being operable upon actuation in response to said signal pulses to produce signals indicating the presence and absence of a blank surface adjacent thereto, and
   c. adjusting means operably associated with said readers and spaced along said path upstream from respective readers and adapted to modify the position thereon of respective blanks in response to predetermined signals from said readers.

2. The envelope making machine as set forth in claim 1 wherein:
   a. said adjusting means includes a remotely controlled phase shifting differential transmission operably connected between said driving means and an operating mechanism.

3. The envelope making machine as set forth in claim 1 wherein:
   a. said adjusting means includes a remotely controlled phase shifting differential transmission operably connected between said driving means and an advancing member.

4. The envelope making machine as set forth in claim 1 wherein:
   a. said adjusting means includes a pair of opposed remotely operable steering devices respectively having a rotating driving member urged against said blanks.

5. The envelope making machine as set forth in claim 4 wherein:
   a. said rotary driving members include tires adapted to expand and contract in peripheral diameter under remote control.

6. The envelope making machine as set forth in claim 1 wherein:
   a. said position sensing readers comprise a pair of spaced apart sensing elements located generally longitudinally of said path.

7. The envelope making machine as set forth in claim 1 wherein:
   a. said position sensing readers comprise a short duration light source directed toward the apparent instantaneous position of a blank surface in said path.

8. The envelope making machine as set forth in claim 1 wherein:
   a. one of said blank advancing members is a rotary feed cylinder, and
   b. at least one of said position sensing readers is located in association with said feed cylinder.

9. The envelope making machine as set forth in claim 1 wherein:
   a. one of said operating mechanisms is a window gum applying member, and
   b. at least one of said position sensing readers is located closely upstream in said path of travel to said window gum applying member.

10. The envelope making machine as set forth in claim 1 wherein:
    a. one of said operating mechanisms is a blank decollating member, and
    b. at least one of said position sensing readers is located closely upstream in said path of travel to said blank decollating member.

11. The envelope making machine as set forth in claim 1 wherein:
    a. one of said operating mechanisms is a flap scoring member, and
    b. at least one of said position sensing readers is located closely upstream in said path of travel to said flap scoring member.

12. The envelope making machine as set forth in claim 1 wherein:
    a. one of said operating mechanisms is a bottom flap folding member, and
    b. at least one of said position sensing readers is located closely upstream in said path of travel to said bottom flap folding member.

13. The envelope making machine as set forth in claim 1 wherein:
    a. one of said operating mechanisms is a top flap folding member, and
    b. at least one of said position sensing readers is located closely upstream in said path of travel to said top flap folding member.

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