METHOD AND APPARATUS FOR CONTINUOUSLY PROCESSING STRIP

Inventor: Curt Braun, Riverside, Calif.

Assignee: Hunter Engineering Co., Riverside, Calif.

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Attorney—Herbert E. Kidder

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ABSTRACT

In a high-speed strip line having a processing section, through which strip must continue moving without interruption, there is a first, normally-full accumulator located ahead of the processing section, and a second, normally-empty accumulator located beyond it. Each of the accumulators has a storage capacity to allow strip to creep through the processing section at a very slow speed for a limited period of time, while one or both ends of the line are shut down to perform a servicing operation. Thus, in one case, strip is paid out of the first accumulator while the entry end on the line is shut down, and creeps through the processing station to the takeup coil. In another case, strip is taken from the payoff coil and creeps through the processing station to the second accumulator, where it is stored while the delivery end of the line is shut down. In a third case, strip is paid out of the first accumulator and creeps through the processing section to the second accumulator where it is stored while both ends of the line are shut down. In each case, the line is slowed down from full speed to creep speed, at which point it changes over automatically to creep speed mode of operation through the processing station, while one or both ends of the line are shut down.

7 Claims, 7 Drawing Figures
METHOD AND APPARATUS FOR CONTINUOUSLY PROCESSING STRIP

BACKGROUND OF THE INVENTION

The present invention pertains to a method and apparatus for continuously processing strip material, particularly cold metal strip, and is more especially concerned with a line for roller-leveling, temper rolling, stretcher leveling, or any other processing step, in which any stoppage of the strip as it passes through the processing section results in marring of the strip. Such marred strip must be removed from the line and scrapped, and this results in the generation of a large quantity of scrap strip each time that the line is stopped to attach the leading end of a new supply coil to the trailing end of an exhausted coil, or to change coils at the delivery end of the line, or to perform any other operation which may require/stopping the strip, such as inspection of the processed strip. In a continuously operating strip line, the total amount of scrap thus generated in a month may amount to many thousands of dollars, but heretofore this scrap loss has been accepted as an unavoidable expense whenever the application of full speed accumulators was not feasible or economically justified.

It is old in the art to use an accumulator ahead of a processing section, that continues to feed strip into the processing section at full operating speed while one end of the other of the line is shut down. It is absolutely essential that the strip continue to be fed through the processing section at full operational speed in any process where any variation in speed is detrimental to the quality of the finished product, such as, for example, in galvanizing, annealing, painting, anodizing, etching, etc. Such strip lines are designed for various speeds, generally of the order of 500-2,000 feet per minute, and accumulators for such lines may have to store as much as 1,000-4,000 feet of strip in order to allow for a 2-minute interruption while coils are being changed at either end, or for other servicing operations. While an accumulator of this size is big and expensive, it is absolutely necessary for this type of line, and the cost is therefore justified.

On high-speed lines for roller leveling, temper rolling, stretcher leveling, etc., where the strip is traveling through the processing section at the same speeds as above, or faster, the accumulators would necessarily be especially large and even more expensive, as most leveling lines require large diameter rolls after the leveling operation to prevent bending of the flattened strip. In most cases, the economics of strip processing of this type do not justify installation of such large accumulators, mainly because the damages produced by stopping the line are not quite as severe as in the above-described lines, and because speed variations of the line has no appreciable effect on the quality of the product. Heretofore, the alternative has been to stop the line each time for coil changes or other servicing operations, and scrap the marred strip which results from the stoppage.

With many processes such as roller leveling, temper rolling, stretcher leveling, and the like, the quality of the finished strip is not degraded by variations in speed as the strip passes through the processing section, provided the speed does not drop to zero at any time. The present invention takes advantage of the heretofore overlooked fact that strip of high quality can be produced by creeping the strip through the processing section at very low speed, e.g., of the order of 20 feet per minute, while the strip is stopped at one end of the line or the other.

SUMMARY OF THE INVENTION

The primary object of the invention is to provide a method and apparatus for continuous, non-stop processing of strip in a production line while the strip is stopped at one end or the other of the line for coil changes or other servicing operations, in which large and expensive accumulators are not required. The advantage of continuous and non-stop processing of strip during coil change and the like is that up to 200 feet or more of strip is saved on each coil, depending upon the length of the strip line. The advantage resulting from the elimination of two large accumulators in a continuous strip line of the class described, is the saving of several hundred thousand dollars for each line.

Another object of the invention is to provide a production line in which the strip can be stopped at either end of the line for any purpose without marring the strip in the processing section.

The foregoing objects are achieved in the present invention by providing relatively small accumulators ahead of any beyond the processing section, the first of which is normally filled to capacity, with enough strip to supply the processing section at a greatly reduced speed (e.g. 20 feet per minute) for a specified length of time (e.g. one and one-half minutes), which is time enough to enable the operator to make a coil change, or to attach the trailing end of one coil to the leading end of a new coil, while the second, normally empty accumulator takes up the finished strip produced during the slow-speed operation. Alternatively, instead of storing the finished strip on the second accumulator, the processed strip may be taken up by the coil at the delivery end of the line. Upon completion of the servicing operation, the line is restored to full operating speed, and the two accumulators return to their initial condition, with the first accumulator refilling itself to full capacity, and the second accumulator paying out all of its stored strip until it is empty. Among other advantages of the invention, production is increased because the line is never stopped, and this eliminates one human element, namely, the loss of production caused by an operator taking 5 minutes to do a servicing operation that should require only one or one and one-half minutes. With only a limited time in which to do the job, the operator is compelled to work at a reasonable speed, as determined by time studies.

The foregoing and other objects and advantages of the invention will become apparent to those skilled in the art from the following detailed description of the preferred embodiment thereof, with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS:

FIGS. 1A and 1B, together, form a side elevational view of a schematic representation of a roller-leveling strip line embodying the invention, FIG. 1A showing the first half of the line from payoff reel to the processing section, and FIG. 1B showing the second half of the line from processing section to take-up reel;
FIG. 2 is a somewhat simplified schematic view of the entire line of FIGS. 1A and 1B, drawn to a reduced scale, showing the line in normal, full speed operation; FIG. 3 is a somewhat similar view to FIG. 2, showing the strip stopped at the left-hand end of the line, as when joining the tail end of one coil to the leading end of a new coil on the payoff;

FIG. 4 shows the strip being advanced through the line at an intermediate speed to transport a spliced joint from the joiner to the crop shear;

FIG. 5 shows the joint being cropped out of the strip and the front end of the strip being started on a new coil; and

FIG. 6 shows the line being accelerated up to full speed operation, while the second accumulator empties itself of strip finished during the cool change.

DESCRIPTION OF THE PREFERRED EMBODIMENT:

In FIGS. 1A and 1B of the drawings, the strip processing line shown herein is designated in its entirety by the reference numeral 10, and in the present example comprises a roller-levelling line for flattening metal strip of aluminum or steel. As best shown in FIGS. 2-6, the line 10 is made up of three basic sections: (1) an entry section 11; (2) a processing section 12; and (3) a delivery section 13. The division of the line into three sections, as shown, is more or less arbitrary, but the processing section would include any components of the line that might mark the strip if the strip is stopped altogether. A payoff coil 14 of strip to be processed, is suitably supported by means (not shown) which allows the coil to turn with controlled braking restraint as it pays off strip 15 to the machine. Upon leaving the coil 14, strip 15 passes between a pair of normally open pinch rolls 16, and through a strip joiner 17. Strip joiner 17 may be a stitcher, or splicer, or welder, and its purpose is to join the tail end of the strip on one coil to the leading end of the strip on a new coil.

After leaving the joiner 17, strip 15 passes between normally closed pinch rolls 18, over a hump roll 20, which is normally retracted below the position shown in FIG. 1A, and through the brake shoes of a strip clamp 22, the function of which is to stop the strip at that point to permit changing payoff coils and to join the ends of the strip. From the strip clamp 22, the strip passes under and around the first pulley 24 of a first accumulator 26. Accumulator 26 includes a second pulley 28 and third pulley 30, the second pulley 28 being journaled in a bearing block 32 mounted on the upper end of a telescoping piston rod 34, 36 which rises from a cylinder 38 in the ground. A threading pulley 40 on the underside of pulley 30 completes the accumulator 26.

The accumulator 26 need not necessarily be as shown herein, but might take various other forms. Accordingly, it will be understood that the piston and cylinder arrangement shown in the drawings is purely illustrative, and is of no practical significance. The function of the accumulator 26 is to store enough strip 15 to supply the processing section 12 (to be described later) at a greatly reduced speed while any of several servicing operations are performed on the strip. The term "servicing operations" as used herein refers to any operation performed on the strip which requires stopping the strip at one end of the line or the other. Changing the coils at either end of the line, joining the ends of the strip at the joiner 17, inspecting the strip, or cropping out overlapping joints or other defects in the strip, are all examples of servicing operations within the context of this application.

Time studies have shown that all of the usual servicing operations can easily be performed within two minutes, and therefore the accumulator 26 must hold enough strip to supply the processing section 12 at "creep speed" for up to 2 minutes. Creep speed may be any slow speed that is a small fraction of the normal operating speed, but for the purposes of illustration might be 10 to 20 feet per minute. Assuming that it is 20 feet per minute, the accumulator 26 is required to store only 40 feet of strip. To do this, it is necessary that the second pulley 28 extend to a height of 20 feet above the pulleys 24, 30. In FIG. 1A the piston 34, 36 is shown fully extended, and pulley 28 is shown, in solid lines, at its highest point, with the maximum amount of strip stored in the accumulator. At piston 28a, the pulley is shown at the bottom end of its operational travel, at which point all of the stored strip has been paid out of the accumulator. The pulley can be further lowered to position 28b for easy threading of the strip.

After leaving the accumulator 26 and passing under pulley 30, the strip 15 enters the processing section 12, the first component of which consists of an edge-trimming, cleaning, rinsing, and drying section 42. Exiting from section 42, the strip passes over the top and around to the bottom side of a first roll 44 of a tension bridle, then up over the top and around to the bottom side of a second roll 46 of the bridle. A normally open threading roll, or holddown roll, 48 is provided on the stop side of roll 44.

From the bottom side of bridle roll 46, strip 15 enters a roller leveler section 50 at the left-hand end thereof. Within the roller leveler 50, the strip travels in a serpentine path between a series of small-diameter work rolls 51, which bend the strip back and forth, working the metal and stretching the outer fibers thereof, until the strip is quite flat, or level, under the combined action of bending and stretching. The small-diameter work rolls 51 do a high quality job of roller leveling the strip as long as the strip is maintained in proper controlled tension and continues to move through the processing section, provided that the speed never drops to zero. However, even a momentary halt in the strip causes the rolls 51 to mark the strip, making it necessary to scrap that portion. The present invention allows the line 10 to operate continuously without ever stopping the strip, and to maintain at all times a constant tension diagram in the processing section between the entry strip clamp 22 and delivery strip clamp 76 (FIG. 1B).

Leaving the roller leveler 50 at the right-hand end thereof (see FIG. 1B) the strip 15 passes under and up over the top of a first roll 52 on a second tension bridle, then under and up over the top of a second bridle roll 54. A normally open threading, and/or holddown roll, 56 is provided above roll 54. The strip 15 now leaves the processing section 12, and enters the delivery section 13.
From the top side of roll 54, the strip passes under the first pulley 59 of a second accumulator 60. Accumulator 60 is of similar design to accumulator 26, but may be of greater or lesser capacity than the latter, depending upon storage requirements. Accumulator 60 includes a second pulley 62 and third pulley 64, the latter having a threading roll 66 on its underside. Pulley 62 is carried by a bearing block 68 at the top end of a telescoping piston rod 70, 72, which protrudes from a cylinder 74. Accumulator 60 is normally empty, with pulley 62 at the lower position shown in solid lines in FIG. 1B. At position 62a, the pulley is shown extended to its maximum height, at which point the accumulator 60 would be completely filled with finished strip from the processing section 12. The pulley can also be lowered to position 62b for easy threading of the strip.

After leaving accumulator 60 and passing under pulley 64, the strip 15 goes through a strip clamp 76, which acts to stop the strip at that point to permit shearing the strip, changing the takeup reels, and inspecting the strip. From the strip clamp 76, the strip passes over an inspection table 78, then between pinch rolls 80, and through a crop shear 82. Finally, after leaving the crop shear 82, the strip passes over a roll 84 and then enters the winding reel 86, which is supported on a motor-driven spindle (not shown) that exerts tension on the strip.

The operation of the invention is as follows, with reference to FIGS. 2 to 6. In FIG. 2, the line is operating at full speed, and strip is off from coil 14, passes up over the fully extended accumulator 26, thence through section 42 and roller leveler 50, through the fully retracted accumulator 60, past the cropping shear 82, and onto the takeup reel 86. The speed of the strip in all parts of the machine is the same, and may be from 200 to 5,000 feet per minute.

In FIG. 3, a new payoff coil is being placed in the machine, and the tail end of one coil of strip is being joined to the leading end of the new coil in the strip joiner 17. The clamp 22 (not shown in FIG. 3) has clamped down onto the strip, and the strip is stopped at this point, or being inched back into the joiner 17 to make an overlapped joint. Strip is being advanced through the processing section 12 at a very slow “creep speed” (e.g. 20 feet per minute) and is being withdrawn from accumulator 26, causing the pulley 28 to be lowered as this is done. Finished strip processed by section 12 passes through the accumulator 60 and is wound onto the coil 86.

In FIG. 4, the spliced joint I is being transferred through the line at an intermediate speed (e.g. 150 feet per minute) to the crop shear 82. During this phase of the operation, the accumulator 26 extends pulley 28 to its maximum height, thereby refilling the accumulator with strip to its maximum capacity. The speed of the strip between the payoff coil 14 and accumulator 26 is somewhat greater than the speed of the strip passing through the processing section. If pulley 62 of delivery accumulator 60 was raised during the process of splicing the joint or transferring the same through the line, pulley 62 is now brought back to its low position.

In FIG. 5, the strip at the right-hand end of the machine is stopped by clamp 76, while the joint I is cropped out of the strip by shear 82, and the leading end of the new coil is attached to an empty winding reel. During this operation, the strip 15 is advancing through the processing section 12 again at creep speed, with strip being withdrawn from supply coil 14 and the processed strip being stored in accumulator 60. Beyond accumulator 60, the strip is stopped. Alternatively, the strip might be stopped at the entry end by clamp 22, in which case the strip would be withdrawn from the accumulator 26 instead of from the supply coil 14.

In FIG. 6, the line is accelerating up to full speed again. Strip leaving the accumulator 60 and entering windup reel 86 is traveling faster than the strip passing through the processing section 12, owing to the fact that the takeup coil is removing the stored strip in accumulator 60, as well as taking up all of the strip passing through the processing section. As soon as the accumulator 60 is emptied, the speed of the strip entering the coil 86 is the same as that of the strip passing through the processing section. At the same time, accumulator 26 is extending pulley 28 to its maximum height so as to refill itself with strip, in readiness for the next cycle.

An alternative mode of operation (not shown) would be to stop the strip at both entry and delivery end of the line, and cause the first accumulator 26 to supply strip to the processing station at creep speed, while accumulator 60 stores the processed strip produced during the creep-speed operation. When the servicing operation has been completed, the line is accelerated back up to full speed, while accumulator 60 empties itself and accumulator 26 refills itself.

The sequence of operational steps required to obtain the isolation of two adjacent line sections and thus to achieve the desired results can be accomplished in many ways, using control mechanisms that are already available on the market. FIGS. 1A and 1B show a control console 90 having a line speed control knob 92; a push button 94 to stop the strip at the entry end and cause the strip to travel through the processing section 12 at creep speed; a push button 95 to release the entry end of the strip and accelerate the line back up to full operating speed; a push button 96 to stop the strip at the delivery end of the line and cause the strip to travel through the processing section 12 at creep speed; a push button 97 to release the delivery end of the strip and accelerate the line back up to full operating speed; and a stop button 98 to stop the entire line.

The control console 90 is connected by wires 100 to the motors (not shown) driving the several rolls which drive the strip through the line (e.g. rolls 14, 18, 20, 44, 46, 52, 54, 66 and 80, as well as the spindle of winding reel 96) and including wires to strip clamps 22 and 76, and to solenoid valves 102 and 104 on hydraulic cylinders 38 and 74, respectively.

Thus, for example, to stop the strip at the entry end of the line so as to join the tail end of one coil to the leading end of a new coil, push button 94 is pressed, which causes the entire line to slow down from its normal full speed (e.g. 1,500 fpm) to creep speed (e.g. 20 fpm), at which point solenoid valve 102 is energized, releasing fluid from the cylinder 38 at a rate to maintain full operational tension in the strip 15, while allowing pulley 28 to be lowered at a rate to ensure delivery of strip to the processing section of the line at the rate of 20 fpm. The strip line ahead of the accumulator 26 continues to slow down to a complete stop, at which point clamp 22 clamps down onto the strip to hold it.
The strip in the processing section 12 and delivery section 13 continues to advance at the creep speed of 20 fpm, while tension is automatically maintained constant throughout the processing section by suitably presetting the pressure in the hydraulic cylinder 38. The processed strip is taken up by the winding reel 86. When the servicing operation is finished, push button 95 is pressed, which starts the sequence of operations to restore the line to full operating speed. First, proper back tension is restored to the strip in the entry section by suitable electrical, mechanical or pneumatic devices, after which clamp 22 is opened, and the strip in the entry section brought up to creep speed. At this point, the entire line is brought up to full operating speed, or to some intermediate "threading speed" (e.g. 150 fpm), as the operator requires. When scheduled line speed is reached, the entry section is further accelerated to fill accumulator 26. As the accumulator reaches full capacity and pulley 28 reaches its uppermost position, the strip in the entry section deaccelerates to the same speed as the rest of the line.

10 To stop the delivery end of the line, control button 96 is pressed, which causes the entire line to slow down until creep speed is reached, at which point solenoid valve 104 is energized, causing cylinder 74 to start extending its piston rod 70, 72. The strip in the delivery section 13 continues to slow down to a complete stop, and clamp 76 engages the strip. Strip continues to be advanced from the payoff coil 14, through the processing section 12, and into the storage accumulator 60, while the servicing operation is performed on the delivery end of the strip.

15 Upon completion of the servicing operation, control button 97 is pressed, which first puts tension on the delivery end of the stop by increasing the torque on the winding reel 86, and then releases clamp 76. The line is then accelerated up to full speed, while stored strip is paid out of accumulator 60. When pulley 62 reaches its lower position, all of the strip in the line is traveling at the same speed.

20 To stop the strip at both entry and delivery ends, both control buttons 94 and 96 are pushed simultaneously or in sequence. In this case, when clamps 22 and 76 have both engaged the strip, the two ends of the line will be stopped, and strip is paid out of accumulator 26 at creep speed, and the processed strip taken up by accumulator 60. To restore the line to full speed, both buttons 95 and 97 are pressed. Button 98 stops the entire line.

25 While I have shown and described in considerable detail one form of the invention, it will be understood by those skilled in the art that the invention is not limited to such details, and might take various other forms within the scope of the claims.

I claim:

1. The method of continuously processing strip in a high-speed processing line wherein the movement of strip through the processing section of the line must be continued despite halting of the strip at one end of the line to allow for performance of a servicing operation, and wherein the tension in the strip must be maintained constant at all positions in the processing section during the servicing operation, comprising the steps of:

a. accumulating a reserve of strip ahead of the processing section sufficient to supply the processing section with strip at a greatly reduced creep speed for a period of time sufficient to perform said servicing operation;

b. slowing said line down to said creep speed;

c. continuing to advance the strip through said processing section at said creep speed, while continuing to decelerate the strip at one end or the other of said line until the strip is topped at that point for performance of said servicing operation, and at the same time maintaining constant tension in the strip at all positions throughout said processing section during said servicing operation, so as to ensure uniform quality of processed strip;

d. meeting the requirements of said processing section during the creep-speed operation of the line by supplying strip from said reserve accumulated ahead of the processing section, or by accumulating processed strip beyond the processing section, as the case may be;

e. upon completion of said servicing operation, restoring normal operational-level tension in the strip at said one end of the line;

f. accelerating said line up to full operating speed, while paying out any finished strip accumulated beyond said processing section, and restoring said reserve accumulation of strip ahead of the processing section to its initial quantity.

2. The method of claim 1, wherein steps (c), (d), (e) and (f) are as follows:

c. continuing to advance the strip through said processing section at said creep speed, while continuing to decelerate the strip in the entry section of the line ahead of the processing section, until the strip is stopped in the entry section, for performance of said servicing operation, and at the same time maintaining constant tension in the strip at all positions throughout said processing section during said servicing operation, so as to ensure uniform quality of processed strip.

d. supplying strip to said processing section from said reserve accumulated ahead of the processing section during the creep-speed operation of the line;

e. upon completion of said servicing operation, restoring normal operational-level tension in the strip in said entry section of the line;

f. accelerating said line up to full operating speed, and restoring said reserve accumulation of strip ahead of the processing section to its initial quantity.

3. The method of claim 1, wherein the steps (c), (d), (e) and (f) are as follows:

c. continuing to advance the strip through said processing section at said creep-speed, while continuing to decelerate the strip in the delivery section of the line beyond the processing section, until the strip is stopped in the delivery section, for performance of said servicing operation, and at the same time maintaining constant tension in the strip at all positions throughout said processing section during said servicing operation, so as to ensure uniform quality of processed strip;

d. accumulating the processed strip produced during creep-speed operation of the line at a point beyond said processing section;
e. upon completion of said servicing operation, restoring normal operational-level tension in the strip in said delivery section of the line; and
f. accelerating said line up to full operating speed, while simultaneously paying out the finished strip accumulated beyond said processing section.

4. The method of claim 1, wherein the steps (e), (d), (e) and (f) are as follows:

a. continuing to advance the strip through said processing section at said creep speed, while continuing to decelerate the strip in both the entry section and delivery section of the line, ahead of and beyond the processing section, respectively, until the strip is stopped in both the entry and delivery sections, for performance of said servicing operation, and at the same time maintaining constant tension in the strip at all positions throughout said processing section during said servicing operation, so as to ensure uniform quality of processed strip;
b. supplying strip to said processing section from said reserve accumulated ahead of the processing section during the creep-speed operation of the line, and simultaneously accumulating the processed strip beyond said processing section;
c. upon completion of said servicing operation, restoring normal operational-level tension in the strip in said entry and delivery sections of the line; and
f. accelerating said line up to full operating speed while restoring said reserve accumulation of strip ahead of the processing section to its initial quantity, and simultaneously paying out the finished strip accumulated beyond the processing section.

5. Apparatus for processing a strip of material at relatively high speed, wherein the movement of the strip through the processing section must be continued despite halting of the strip at one end of the apparatus to allow for performance of a servicing operation, comprising:

a. a material-handling line of machine components, including an entry section, a processing section which requires that the strip continue moving through it at all times in order to avoid marring the strip, and a delivery section;
b. a first accumulator located ahead of said processing section, and a second accumulator located beyond said processing section;
said first accumulator having the capacity to store a quantity of strip sufficient to meet the requirements of said processing section while operating at a creep speed that is a small fraction of the normal operating speed of the line for a period of time sufficient to perform a servicing operation on the strip in said entry section of the line;
means in said entry section of the line for engaging said strip to stop the movement thereof at that point; and
control means for slowing the strip down to said creep speed throughout the entire line, and then automatically continuing creep-speed-travel of the strip through said processing section while stopping the strip in said entry section for performance of said servicing operation; tension in the strip being maintained at a sub-creeply constant level at all points within said processing section for all speeds of the strip;
said control means being operable, upon completion of the servicing operation, to restore normal tension in the strip within said entry section, and then to accelerate the strip up to normal operating speed of the line, while said first accumulator is restored to its full capacity of stored strip.

6. Apparatus as in claim 5, wherein said second accumulator is normally empty and has the capacity to receive and store the finished strip produced by said processing section during the creep-speed operation thereof for a period of time sufficient to perform a servicing operation on the strip in the delivery section of the line;
means in said delivery section of the line for engaging said strip to stop the movement thereof at that point;
said control means being operable to slow the strip down to said creep speed through the entire line, and then automatically continuing creep-speed-travel of the strip through said processing section while stopping the strip in said delivery section for performance of said servicing operation; and
said control means also being operable, upon completion of the servicing operation, to restore normal tension in the strip within said delivery section, and then to accelerate the strip up to normal operating speed of the line, while the stored strip in said second accumulator is taken up until the accumulator is empty.

7. Apparatus as in claim 6, wherein said control means is operable to slow the strip down to said creep speed throughout the entire line, and then automatically continue creep-speed-travel of the strip through said processing section while stopping the strip in said entry and delivery sections of the line for performance of said servicing operation;
said control means also being operable, upon completion of the servicing operation, to restore normal tension in the strip within said entry and delivery sections, and then to accelerate the strip up to normal operating speed of the line, while the stored strip in said second accumulator is taken up until said second accumulator is empty, and said first accumulator is refilled with strip until restored to full capacity.

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