TENSIONLESS VARIABLE FEED SYSTEM FOR A TRAVELING STRIP

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ABSTRACT

An improved system is disclosed for feeding a strip of material at variable speeds under substantially tensionless conditions. The strip is fed into a loop forming area where a light source is disposed along one side thereof and extends therealong. A single photosensitive device is disposed along an opposite side of the loop forming area and is provided with a lens system, such as a wide angle lens, to enable the photosensitive device to receive light from substantially the entire length of the light source. The photosensitive device is operatively associated with a control circuit which generates an electrical signal proportional to the size of the input to the circuit from the photosensitive device. The proportional electrical signal is then used to regulate the speed of the traveling strip so as to maintain the substantially tensionless conditions.

9 Claims, 2 Drawing Figures
TENSIONLESS VARIABLE FEED SYSTEM FOR A TRAVELING STRIP

BACKGROUND OF THE INVENTION

Numerous processes in divergent industries and for diverse reasons, feed a strip of material along a path with a loop being formed in the strip intermediate the length of the path. Obviously, it is quite desirable to control the length of the loop of strip material so as to maintain continuity in the process and to maintain control over the process. Various and sundry arrangements have heretofore been devised for maintaining such a loop at a constant length and, upon detecting a change in loop length, varying the speed of the strip so as to return the loop to its proper length. Likewise, loops in a traveling strip have been provided to maintain the strip tensionless for certain reasons. Such prior attempts have involved a series of photocells, each cell being spaced at a different position along the length of the loop whereupon excitation of the photocell by a light source when the strip moves from between the cell and the light calls for an adjustment in strip speed. Likewise, banks of individual photocells have been utilized to accomplish a similar purpose where a larger number of photocells are employed along one side of the loop while a like number of light sources are applied along an opposite side of the loop. Further, pressure systems have been introduced for the control of a loop where a pressure differential within the chamber in which the loop is formed changes the speed of the strip traveling therethrough.

The present invention is a further improvement over the systems heretofore devised. The present invention is advantageous over the prior systems from several standpoints. A plurality of photocells which are used according to much of the prior art are actuated on an intermittent basis, depending upon the particular position of the bottom of the loop. The present invention, however, receives more or less light from the light source with every incremental move of the bottom of the loop and is thus not an intermittent system. Instead, the system of the present invention is continuous and directly proportional to changes in the loop. As such, changes in the speed of the traveling web are less abrupt which is highly preferred to avoid the introduction of tension on the strip. For example, the feeding of knit fabric from an unwinder to an inspection frame requires substantially tensionless conditions on the knit fabric to avoid changes in the physical dimensions of the fabric. Likewise, tension in a traveling magnetic tap is detrimental to the accurate reproduction of information recorded thereon.

The prior art is deficient in either teaching or suggesting the subject matter of the present invention. Insofar as the prior art is concerned, the following U. S. Pat. are felt to be exemplary thereof and include: No. 2,800,327 to Bandy; No. 3,047,198 to Long; No. 3,152,794 to Alexeff et al.; No. 3,156,109 to Fieldgate; No. 3,177,749 to Best et al.; No. 3,236,429 to Klein; No. 3,240,411 to Zarlen; and No. 3,277,305 to Anderson, Jr.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an improved feeding system for a traveling strip.

Another object of the present invention is to provide an improved loop control system that is capable of continuously monitoring a loop at each incremental change.

Still further, another object of the present invention is to provide a loop control system wherein a single photosensitive device receives light from a light source extending along the opposite side of a loop forming area.

Another object of the present invention is to provide a strip feeding system that is capable of coupling two independent pieces of equipment while permitting the speed of one of said pieces of equipment to automatically change a proportional amount to a speed change in the other said piece of equipment.

Generally speaking, the strip feeding system of the present invention comprises a light source disposed on one side of a loop forming area and extending substantially therealong; a photosensitive device disposed along an opposite side of said loop forming area, said photosensitive device having a lens system associated therewith capable of receiving light from at least substantially all of the length of said light source; and a control circuit associated with said photosensitive device, said control circuit generating an electrical signal proportional to the amount of light received by said photosensitive device, said electrical signal providing input to strip drive means to control the speed thereof.

More specifically, a photosensitive device is applied along one side of a loop and equipped with a suitable lens system for receiving light from a source on the opposite side of the loop and extending at least substantially along the length thereof. Depending upon the intensity of light received by the photosensitive device, the photosensitive device provides a voltage input to a control circuit which generates an electrical signal proportional thereto that is used to regulate the speed of the strip. Hence a change in speed of the strip out of the loop forming area will automatically bring about a change in strip speed into the loop forming area to retain the tensionless conditions on the strip.

The control circuit of the present invention is variable so as to add further flexibility to the system. For example, a variable offset, variable gain amplifier is used to amplify the voltage input from the photosensitive device to produce a proper electrical signal for controlling the speed of the strip material. Hence, the variable offset capability produces an input balance to the amplifier whereby so long as the input from the photosensitive device is within a certain range of the offset setting of the amplifier, the strip feed continues to operate at a certain level. Utilization of a variable gain for the amplifier permits variation of the degree of change of strip feed depending upon the size of the input to the amplifier. For example, a motor operating at 1,000 rpm depending upon the desired change, may be varied from 800 to 1,200 in response to input from the photosensitive device. Likewise, other parameters of change may be instituted by variation of the amplifier gain so as to enable the system to be versatile in the sense of numerous operations.

Insofar as the strip speed control is concerned, only one of the drives for the strip is controlled according to the teachings of the present invention. If, however, the
speed of the uncontrolled drive means is changed, then the loop size will change and the speed of the controlled drive means will also change to maintain a tensionless condition in the traveling strip. As mentioned above, the present invention is quite useful for coupling two machines where the speed of both machines may be controlled by changes instituted for one of the machines. For example, the present invention may be employed between an unwinder for a knit fabric and an inspection frame. The loop between the two machines is very desirable to avoid tensioning the fabric which would change the width of the fabric. An operator may be visually inspecting the fabric as the fabric is being fed by, at a speed of 20 yards per minute, and wish to slow down the speed due to a large number of defects in the fabric or the like. A manual reduction in the drive speed of the inspection frame would thus cause the loop to lengthen. Upon sensing the lengthened loop the present system will slow down the unwinding speed to maintain tensionless condition on the fabric.

**BRIEF DESCRIPTION OF THE DRAWINGS**

FIG. 1 is a line sketch showing a preferred embodiment of the present invention.

FIG. 2 is a circuit diagram showing a control system according to the teachings of the present invention.

**DESCRIPTION OF THE PREFERRED EMBODIMENTS**

Referring to the Figures, preferred embodiments of the present invention will now be described in detail. In FIG. 1, a strip S in a particular process is being fed into a loop forming area generally indicated as 10. Strip feed means are generally indicated in FIG. 1 as a roll 12 and strip removal means as a roll 16. Certainly, strip feed and removal means are both driven though the actual rollers at the entrance and exit of loop forming area 10 may be idler rolls. In other words, rolls 12 and 16 are to be broadly construed as representative of the feed and removal means respectively and not purely as driven rolls. Either the strip feed means 12 or the strip removal means 16 may be controlled by the system of the present invention. In either case, the controlled means becomes the slave of the independent means. In other words, where strip feed means 12 are controlled as shown in FIG. 1, feed means 12 becomes a slave to strip removal means 16, whereby a change in the speed of strip removal means 16 automatically brings about a proportionate change in the speed of strip feed means 12.

The driving power for the strip feed means 12 and the strip removal means 16 may be derived from a mechanical, electrical, hydraulic, air or other power source that may be adapted to a variable power output proportionately responsive to an electrical signal received thereby. Such systems are well within the purview of one skilled in the art and will not be elaborated on here. Instead, drive control means for strip feed means 12 are generally indicated as 14. Though not shown, a like drive control means would be provided for strip removal means 16 if it were to be controlled instead of strip feed means 12. Hence drive control means 14 is operatively associated with photosensitive device 20 through the control circuit generally indicated as 15. The control circuit 15 as shown in FIG. 2 could be physically located at either photosensitive device 20 or drive control means 14.

The strip S as shown in FIG. 1 thus passes strip feed means 12 and extends downwardly into loop forming area 10 to produce a loop of a particular length. At the bottom of the loop, strip S turns upwardly and passes around strip removal means 16. A photosensitive device 20 is positioned along one side of loop forming area 10 being supported by a stand 21. Photosensitive device 20 has associated therewith a lens system 22 which permits photosensitive device 20 to receive light from an elongated source 24 on the opposite side of loop forming area 10. Though numerous suitable commercial photosensitive devices are available, a photosensitive type is preferred. Likewise, a wide angle lens such as a plano convex lens is preferred for the lens system.

Light source 24 is illustrated in FIG. 1 as a fluorescent tube extending completely along the length of the loop and beyond. While a fluorescent tube is shown, the particular type of light source is not critical so long as light is disposed along the length of area in which the control is required. Hence depending upon the particular position of the loop, photosensitive device 20 receives a certain amount of light from light source 24 and provides a voltage input to control circuit 15 to properly control the speed of strip feed means 12.

A preferred control circuit is shown in FIG. 2 wherein a light source 24 is shown exciting a photosensitive device 20. Photosensitive device 20 creates a signal proportional to the intensity of light received thereby. The signal then passes along a connector 23 to an amplifier 30. Amplifier 30 according to the preferred teachings of the present invention and as indicated in FIG. 2 is variable offset, variable gain amplifier. In this sense, a potentiometer 32 is provided for the variable offset capability of the amplifier while a variable resistor 34 is provided for the variable gain feature of the amplifier. Hence a signal emitted from photosensitive device 20 and traveling along line 23 enters amplifier 30 where it is balanced with potentiometer 32 so as to determine whether an output is to be generated by amplifier 30 to change the speed of the desired strip drive means. The signal from amplifier 30 then passes along connector 31 to drive control means 14 where the drive means speed is varied proportional to the signal. Likewise, variable resistor 34 is provided so as to permit varying the magnitude of speed change for a drive means at the same input to amplifier 30.

One arrangement of the present invention involves the use of a CLAIREFX CL604 photocell, manufactured by Clairex Corporation equipped with a 23.9 mm diameter plano convex wide angle lens as the photosensitive device 20. On the opposite side of the loop forming area 10 is a 4 foot fluorescent tube vertically disposed along the length of the loop forming area. The photosensitive device 20 is then connected to the control circuit 15 as shown in FIG. 2 where an operational amplifier is employed. Control circuit 15 is connected to a proportional flow hydraulic valve which controls a hydraulic motor on a PEMCO unwind, manufactured by Piedmont Engineering and Machine Company, Inc., Spartanburg, S.C. to feed knit fabric to the loop forming area 10. A PEMCO open width inspection frame,

In operation, according to the arrangement illustrated in FIG. 1, a strip S is fed into loop forming area 10 by strip feed means 12 and withdrawn by removal means 16. A loop is thus formed between photosensitive device 20 and light source 24, the length of which is determined by the relative speeds of the feed and removal means 12 and 16. Where, for example, an unwinder feeds knit fabric into the loop forming area 10 and an inspection frame draws the fabric out of the loop forming area 10, the operator of that inspection frame may wish to visually observe the fabric at a faster rate. The operator thus would speed up the inspection frame drive means (16 in FIG. 1) whereby fabric would move out of loop forming area 10 at a faster rate. The loop would then move away from its normal length to a shorter length as shown in broken lines labeled (B). A greater amount of light would then be received by photosensitive device 20 which produces a voltage at amplifier 30 proportional to the amount of light received. Amplifier 30 then generates an electrical signal proportional to the voltage from device 20 to increase the speed of fabric being unwound whereby the length of the loop leaves (B) and stabilizes somewhere between (B) and the original loop as shown in solid lines. Change in the speed of the unwinder is continued until a new equilibrium is reached for the loop at the faster fabric removal speed. Conversely, should the operator of the inspection frame wish to reduce the speed of removal of fabric from loop forming area 10 to permit closer visual inspection thereof, then the loop lengthens towards the broken line indicated as (C) and less light is received by photosensitive device 20. A resulting slow down in speed of the unwinder is realized and the speed change continues until the new equilibrium is reached.

In the event that the strip removal means 16 is the desirable speed to control, then the reverse would be true to that mentioned above for feed drive means 12. In other words, for a shortened loop, the removal drive means would slow down whereby more strip would be fed into the loop forming area 10 prior to its removal. Likewise, should the loop become too long, then the removal drive means 16 wound speed up to remove strip S removal loop forming area 10 at a faster rate.

The present invention may likewise be employed for processes where it is desirable to maintain a certain loop length in the control of a process. Hence where the process is subject to changes due to different strip characteristics, machine conditions and the like, the present invention may be used to maintain the loop at a constant length by controlling the speed of one of the drive means.

Strip according to the present invention may be any length of material being fed through a loop forming area. For example, as mentioned above, the strip could be a textile material, a magnetic recording tape, a film or virtually any material that requires feeding at substantially tensionless conditions or where the process requires control in loop length, dwell time, or the like.

The present invention as described above is thus quite an improvement over the commonly known systems for tensionless feeding, in that, it is not necessary for the loop to pass a single or series of separate photocells prior to instituting a strip speed change. Instead, the one photocell being utilized to scan the entire length of the light source and the control circuit can be adjusted to the point where a very minute change in the position of the loop will institute corrective action. As such, corrective action may be continuous upon the detection of a needed change as opposed to intermittent or step-wise corrections for the conventional loop control systems.

Having described the present invention in detail, it is obvious that one skilled in the art will be able to make modifications and variations thereto without departing from the scope of the invention. Accordingly, the present invention should be determined only by the claims appended hereto.

What is claimed is:

1. A tensionless feeding system for a variable speed traveling strip comprising:
   a. a loop forming area for receiving a loop of strip;
   b. a light source disposed on one side of said loop and extending at least substantially along the length of said loop;
   c. a single photosensitive device disposed along an opposite side of said loop, said photosensitive device having a lens system associated therewith capable of receiving light from at least substantially all of the length of said light source;
   d. a controlled circuit associated with said photosensitive device, said circuit comprising a variable gain, variable offset amplifier, said control circuit generating an electrical signal proportional to the amount of light received by said photosensitive device; and
   e. a strip drive means operatively associated with said control circuit, said drive means receiving input from said control circuit to control the speed thereof.

2. A tensionless strip feeding system as defined in claim 1 wherein said light source is a single elongated light.

3. A tensionless strip feeding system as defined in claim 1 wherein said light source is a bank of separate lights.

4. A tensionless strip feeding system as defined in claim 1 wherein the strip is a textile material.

5. A tensionless strip feeding system as defined in claim 1 wherein the strip is a magnetic recording tape.

6. A loop control system for maintaining a constant loop in a traveling strip comprising:
   a. strip feed means;
   b. a loop forming area adjacent said strip feed means;
   c. a light source disposed along one side of said loop forming area and extending therealong;
   d. a single photosensitive device disposed on an opposite side of said loop forming area, said photosensitive device having a lens system associated therewith to enable said photosensitive device to receive light from the length of said light source; and
   e. a control circuit operatively associated with said photosensitive device, said circuit comprising a variable gain, variable offset amplifier, said circuit receiving input from said photosensitive device and generating an electrical signal proportional...
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7. A loop control system as defined in claim 6 wherein said strip feed means is received on a first unit of equipment and a strip removal means is received on a second unit of equipment, one of said feed and removal means being operatively associated with said circuit.

8. A tensionless strip feeding system as defined in claim 1 wherein strip feed means comprises a fabric unwinding machine and further comprising strip removal means.

9. A tensionless strip feeding system as defined in claim 8 wherein said strip removal means comprise an inspection frame.

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