A web feeding and splicing device for a cigarette or other continuous rod making machine includes a reservoir in which a length of web is accumulated prior to splicing, the accumulation of sufficient web being sensed by an integrator responsive to the difference between the speeds with which the web is fed into and out of the reservoir.
A WEB FEEDING AND SPLICING DEVICE

This invention is concerned with web feeding devices, particularly for cigarette making machines and other similar continuous rod making machines including, for example, cigarette filter making machines. It is especially concerned with web feeding devices as described generally in British Pat. No. 1,086,065. As described in that patent, a moving web is drawn from a bobbin and is fed via a reservoir into which an excess amount of web can be fed in preparation for splicing, so that the web can be pulled continuously from the reservoir during splicing.

A system according to the present invention includes an integrator circuit which recieves voltage or other electrical signals proportional to the speeds at which the web is fed into and out of the reservoir during preparation for splicing, and which initiates the splicing operation when there is sufficient web in the reservoir.

Apparatus in accordance with the invention will now be described by way of example with reference to the accompanying drawings in which:

FIG. 1 is an elevation of web feeding and splicing mechanism in a continuous rod cigarette-making machine;

FIG. 2 is a part of FIG. 1 with the mechanism in a different operation position;

FIG. 3 is a circuit diagram associated with the mechanism of FIG. 1;

FIG. 4 is a diagrammatic switching circuit; and

FIG. 5 is a block diagram of the improvement in the web feeding and splicing mechanism of FIGS. 1 to 4.

FIGS. 1 to 4 and the following description of the mechanism shown in these figures are concerned with a prior art web feeding and splicing mechanism disclosed in British patent No. 1,086,065.

Referring first to FIG. 1, reference numeral 1 indicates a reservoir in which a reserve of running web material 2 supplied from a cigarette-paper bobbin 3 is to be accumulated so that when the bobbin 3 is nearly exhausted, its web 2 can be spliced to a stationary but waiting web 4. Both the bobbin 3 and the bobbin from which the waiting web 4 is taken are carried on rails 5, this latter bobbin being to the left of the former as seen when looking at FIG. 1. The waiting web 4 is led under a control spring 6 and a counterknife 7 and is anchored over pins 8 of a paper clamp roller 9, which together with the counterknife 7 is fixed to a bracket 10.

The running web 2 is drawn from the bobbin 3 by paper draw rolls 11 and 12 of which 11 is driven by a paper drive servo-motor 13 (see FIG. 3), while the draw roll 12 is free to rotate about a shaft 14. The shaft 14 is carried on a bracket 15 which is pivotable about a pin 16. The draw roll 12 is held against the driven draw roll 11 by tension in a spring 17 fixed to the bracket 15.

Between the bobbin 3 and the draw rolls 11 and 12, the running web 2 passes over a lead roll 18 attached to a cramped arm 19, under a fixed knife 20 and the counterknife 7 and through a paper guide 21. A further lead roll 22 ensures that the angle of approach to the fixed knife 20 must always exceed a minimum figure. Between the knife 20 and the counterknife 7 the running web 2 passes over a stationary surface 23 made of a resilient material known by the trademark "Perspex" which belongs to the class of acrylic resins beneath which is placed a 1/32 inch rubber sheet. A movable knife 24 is fixed by a set screw 25 to a bracket 26 which is pivotable about a pin 27, and which is provided with a diamond impregnated surface 28. The bracket 26 is fixed to the cramped arm 19. A cam roller 29 fixed to the arm 19 is held by the action of a spring 30, which is anchored by a set screw 31 to the frame of the machine against the face of a cam 32 rotatable about a shaft 33.

The shaft 33 is coupled to the drive shaft of a cam motor 34 which is shown diagrammatically in FIG. 4. Two further cams 35 and 36 are keyed to the shaft 33, the former operating a roller 37 of a microswitch 38 while the latter operates a roller 39 of a second microswitch 40 behind the microswitch 38.

Positioned below the bobbin 3, when it is in its position as shown in FIG. 1, is a bobbin arm 41 which is pivotable about a pin 42 fixed to a bracket 43. An adjustable ferrous surface 44 is attached to the arm 41 and is located so as to be held to a permanent magnet 45 when the arm 41 is depressed. When, however, the arm 41 is lifted so that the surface 44 is removed from the field of the magnet 45, it is held firmly against the circumference of the bobbin 3 by the action of a spring 46, one end of which is fixed rigidly connected to the bobbin arm 41, with the other end anchored to the machine frame 48. A further arm 49 which is also caused to pivot about the pin 42 by the rotation of the bobbin arm 41 carries a roller 50 and an operating projection 51. The roller 50 and the projection 51 are arranged to operate respectively a first diameter microswitch 52 (which cannot be seen in FIG. 1 but which is shown schematically in FIG. 3) and a roller 53 of a second diameter microswitch 54.

The approximate position of the bobbin arm 41 at which the microswitch 52 operates is indicated by chain line 55 while chain line 56 shows the position of the arm for the operation of the microswitch 54. The microswitch 52 also completes a circuit to an indicator light 57 (see FIG. 4 in which the microswitches are shown schematically) which informs the machine operator that the splicing operation is impending.

The web material 2 enters the reservoir 1 from the draw rolls 11 and 12, passes under a flexible fabric strip 58 having a weight 59 at its end, around an arm pin 60 and passes out over a strip 61 and a lip 62 of a wall 63 of the reservoir 1. The arm pin 60 extends into the reservoir 1 through an arcuate slot 64 and is attached to the remote end of web sensing arm 65 which is pivotable at the other end about a stub shaft 66. Keyed to the shaft 66 is a gear 67 which engages with a further gear 68 fixed to an A.C. pick-off 69 (see also FIG. 3). A light spring 70 applies a turning moment to the gear 68 so that when no external forces are applied, the arm 65 comes to rest in its lowest position with the arm pin 66 at the bottom of the slot 64. The action of the spring 70 also helps eliminate backlash from the gears.

Referring now to FIG. 3, the paper drive motor 13 is a two-phase induction type servo-motor, operated from a 50/60 cycle, 110 volt supply 71 via a silicon controlled rectifier 72, full wave operation being obtained through a bridge with rectifiers 73, 74, 75, and 76. The gate of the rectifier 72 is triggered from a complementary pair of transistors 77 and 78 which are supplied with pulses from the bridge by clipping its output (to a peak voltage of 12 volts) by means of diodes 79 and 80. The input signal to the complementary pair consists of
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A sawtooth waveform coupled through a resistance 81 and a variable D.C. level appearing through a resistance 82. The sawtooth waveform is generated by charging condenser 83 from the positive supply through a resistance 84 and discharging it rapidly through a transistor 85 at the end of each half cycle of the supply. This is achieved by connecting the base of the transistor 85 to the clipped bridge waveform through a diode 86, positive voltage being applied to its base block for the duration of the half cycle of the supply, thus permitting the condenser 83 to charge to about 2 volts peak amplitude. The resulting waveform is applied to the base of an emitter follower 87. The variable D.C. level is provided by error amplifiers 88 and 89, which form a differential D.C. amplifier coupled to the transistors 77 and 78 via a biasing zener diode 90 and the resistance 82. The balance of the amplifier can be set by varying a bias control 91.

A synchronizing tacho-generator 92, which is connected mechanically to the main shaft of the cigarette-making machine, feeds to a three-phase bridge rectifier 93, the resulting D.C. output from which is filtered by a resistance 94 and a condenser 95 and attenuated by voltage dividers 96 and 97. The output is connected to the error amplifiers 88 and 89 through summing resistors 98 and 99, the former being shorted out by the microswitch 52 when the reservoir build-up is required. The motor 13 is stopped for splicing by connecting the amplifier input to the negative supply through a resistance 100 by closing the microswitch 54. To prevent the motor 13 from switching the web 2 after splicing, a slow start capacitor 101 charges up through the resistor 100. A further resistor 102 protects the microswitch 54 when the capacitor 101 discharges through it.

In order to obtain maximum acceleration of the servo-motor 13 when the cigarette-making machine is started up, the output from the tacho-generator 92 is coupled directly to the base of the amplifier 88 through a capacitor 103. This coupling only functions when the speed is changing rapidly, i.e. when the capacitor 103 is charging or discharging. To prevent the capacitor 103 from stopping the servo-motor 13 too rapidly and causing the bobbin 3 to over run, diodes 104 and 105 are used to make a phase advance active only in a positive direction. Velocity feedback for the servo-motor 13 is derived from a second tacho-generator 106 mechanically coupled to it. The A.C. output from the tacho-generator 106 is rectified by a three-phase bridge 107 and is filtered by a capacitor 108 to a resistor 109. Velocity feedback is controlled by adjusting a resistor 110.

The pick-off 69, which is a variable reluctance bridge type angular displacement pick-off, is energized by a 6 volt 50/60 cycle supply 111. Its output is amplified by amplifiers 112 and 113 which are coupled through a phase shifting network comprising two capacitors 114 and 115 and a resistor 116, correcting an inherent phase shift of 90° produced by the pick-off 69. The output from the amplifiers is rectified in a phase sensitive rectifier comprising diodes 117 and 118, capacitors 119 and 120, and resistors 121 and 122, which is supplied with a reference voltage 8—0—8 volts at mains frequency. The D.C. signal from the phase sensitive rectifier is then coupled to the error amplifiers 88 and 89 through a summing resistor 123.

The D.C. supply is 12 volts positive and negative, stabilized by zener diodes 124, 125, 126 and 127. Any switching transients likely to be produced by rectifiers 128, 129, 130 and 131 are suppressed by a network 132 and 133.

The operation of the mechanism will now be described. The web 2 taken from the bobbin 3 (which may be in the position shown in FIG. 1 or may be in a position to the left of that) passes under the raised surface 28, through the paper guide 21 and between the draw rolls 11 and 12 into the reservoir 1, in which it passes around the arm pin 60 and out over the lip 62 into a tensioning device (not shown). The weighted fabric strip 58 is kept in contact with the web and serves to control loops in the web during the initial build-up period. The strip 61 helps to prevent a complete loop of the web from passing out of the reservoir 1 over the lip 62.

To enable the cigarette-making machine to operate, the web 2 must be fed from the reservoir 1 at the exact rate at which the machine requires it. This is achieved by driving the draw roll 11 by the servo-motor 13 which is synchronized to the cigarette-making machine through the tacho-generator 92 driven from the hopper drive at the rear of the machine. A D.C. potential derived from the tacho-generator 92 and proportional to the machine speed is compared with the D.C. output of the tacho-generator 106 which is mechanically coupled to the servo-motor 13. The voltage difference proportional to the difference between the machine and servo-motor speeds is fed to the amplifiers 88 and 89. The output from the amplifier 89 changes the firing angle of the silicon controlled rectifier 72 which in turn alters the average value of the two-phase A.C. current supplied to the servo-motor 13.

As this method of synchronization is only approximate and would result in the web 2 accumulating due to excessive feed or breaking due to insufficient feed, an additional fine control is provided. This is done by measuring the displacement of the arm pin 60 by means of the pick-off 69, this measurement being proportional to differences in the rate of supply and demand of the web 2. The D.C. output from the pick-off 69 is fed to the error amplifiers 88 and 89 together with the error signal from the two tacho-generators 92 and 106. This results in exact synchronization over all periods of practical duration.

When the running bobbin 3 is reduced in diameter to a predetermined level, the machine operator's attention is drawn to this fact by an indicator light (not shown in any of the Figures). The operator then moves the bobbin 3 along the rails 5 to its right-hand position, as shown in FIG. 1, and releases the bobbin arm 41 from its inoperative position in which it was locked by the action of the permanent magnet 45. The spring 46 now controls the arm 41 so that it rides against the rotating circumference of the bobbin 3. A new bobbin is then placed in the left-hand position on the rails 5 and its web 4 is threaded under the surface 28, over the counterknife 7 and is anchored over the pin 8 to the paper clamp roller 9. The web 4 is then ready for splicing to the running web 2.

The operator's task is now completed. The remainder of the splicing operation is automatic. When the diameter of the bobbin is reduced to the predetermined level, as indicated by the chain line 55, the roller 50 closes the microswitch 52 and short-circuits the resistor 98. This increases the signal to the amplifiers 88 and 89 and thus causes the servo-motor 13 to increase in
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speed. The increase in speed is sufficient to ensure that the web supply exceeds the cigarette machine demand. The arm pin 60 drops to the bottom of the slot 64 thus reducing the signal from the pick-off 69 to a minimum value. The web 2 forms into loops in the reservoir 1 and thus builds up the required accumulation.

At a still further reduction in the diameter of the bobbin to a second predetermined level as indicated by the chain line 56 the projection 51 causes the microswitch 54 to close, thereby, connecting up the input of the amplifier 88 to the negative supply of −12 volts through the resistor 100. This causes the servo-motor 13 to stop and leaves the mechanism in condition to form the splice with the web supply stopped but with the demand continuing and using the accumulation in the reservoir 1.

The closing of the microswitch 54 also switches on the cam motor 34 driving the shaft 33 (see FIG. 4), thus causing the cams 32, 35 and 36 to rotate in a clockwise direction as seen when looking at FIG. 1. The spring 38, which has a high rate, causes the bracket 26 to move downwards as soon as the cam roller 29 reaches the fall in the face of the cam 32. As the bracket 26 moves downward the web 4 is cut between the blade 24 and the counterknife 7 while impact of the diamond impregnated surface 28 against the stationary perspex surface 23 causes the cut end of the web 4 to adhere to the uncut web 2, the spring 6 serving to prevent the former web from whipping to the left when its tension is released on being cut. The bracket 26 then starts to rise under the gradual action of the cam 32 and while it is rising the spring 6 assists in stripping the web 4 from the surface 28.

As the shaft 33 continues to rotate, the microswitch 38 operates and starts up the servo-motor 13. Due to the time taken for the capacitor 101 to charge, the servo-motor starts slowly and thus avoids snatching at the new running web. Until the accumulation of web in the reservoir 1 is used up the arm pin 60 remains in its lowest position, thus ensuring that the web supply into the reservoir is less than the cigarette machine demand. When the reservoir 1 is empty the arm pin 60 starts to rise and, as described heretofore, supply again matches demand.

When the servo-motor starts up, the previous running web is cut against the fixed knife 20 due to the fact that the lead roll 18 is lowered away from the web 2 since it is attached to the bracket 26. The positions of the various components just prior to cutting is shown in FIG. 2.

Still further rotation of the shaft 33 results in the cam 36 causing the microswitch 40 to operate, thereby switching off the cam motor 34. When the new bobbin is ready to be moved across the rails 5 to the right-hand position, the arm 41 is pushed down so as to be retained by the magnet 45. The remains of the bobbin 3 can then be removed. When the arm 41 is depressed the cam motor 34 is caused to rotate a further 20° so as to bring the cams 32, 35 and 36 into their starting position. The arm 41 should not be moved until at least 20 seconds after splicing so as to allow plenty of time for the cams to complete their cycle.

In a preferred arrangement of the present invention, the splicing mechanism described in U.S. Pat. No. 3,514,363 to Stone and Raymond is substituted for the splicing mechanism described above and is used in conjunction with the web feeding mechanism. Thus, while the means for feeding the new web 4 and old web 2 into the splicing mechanism and the means for drawing the web 2 away from the splicing mechanism and into the reservoir 1 is the same as described above, the preferred cam operated splicing mechanism described in U.S. Pat. No. 3,514,363 is substituted for the cam operated splicing mechanism described in the present application and in British Patent No. 1,086,065.

Referring now to FIG. 5 which illustrates the improvement over the prior art arrangement, a pneumatic or other fluid-powered jack is substituted for the timing cam 83 which serves to control the movement of arm 9 (shown in FIG. 3 of U.S. Pat. No. 3,514,363) to initiate a splicing operation. More specifically, the pneumatic jack, consisting of a cylinder 210 and a piston 212, extends between the pivoted arm 309 (to the left of the cam follower 10 on pivoted arm 9 in U.S. Pat. No. 3,514,363) and backplate 312 (backplate 12 in U.S. Pat. No. 3,514,363). The cam follower 10 and the spring 11 shown in U.S. Pat. No. 3,514,363 are omitted.

The paper web 4 is pulled from the bobbin 3 by means of the variable-speed motor 13 which has its speed controlled normally so as to match the speed at which the web is pulled from the reservoir 1 by the main drive motor 209 of the cigarette-making machine. The main drive motor 209 is connected to the tachogenerator 92 while the variable-speed motor 13 drives the tachogenerator 106. During normal running, the outputs of these two tacho-generators are compared by the circuit shown in FIG. 3. This arrangement controls the actual speed of the web drive motor 13 so that the web is delivered to and from the reservoir 1 at substantially the same speed.

The arm 41 which bears against the bobbin 3 operates the microswitch 52 when the bobbin 3 is nearly empty. The closing of the microswitch initiates the sequence of operations which leads to splicing, that is to say, the joining of the web on the old bobbin (near its trailing end) to the leading end of the web on a new bobbin.

Referring to FIG. 5, when the switch 52 is closed, it operates a relay R1 which alters the control circuit of the web drive motor 13 as described earlier, so as to introduce an excess speed of 8 to 10 percent. At the same time, the relay R1 introduces into the circuit an integrator consisting of a D.C. high-gain amplifier 220 with a capacitance 221 connected between the input and output of the amplifier 220.

This integrator receives a voltage signal related to the difference between the outputs of the two tacho-generators. For this purpose the tacho-generators are connected to the integrator in the manner shown, via resistances 215 and 217 (each for example of 4.7K ohms), a potentiometer 219 and a resistance 219A (for example 10K ohms). The output from the integrator (220 and 221) is connected to a voltage sensing device 222 in the form of a unijunction transistor which operates for example when the input to it reaches 7 volts. The amplifier and capacitance combination acts as an integrator because the output voltage of the amplifier 220 builds up progressively (i.e. not instantaneously) to its full value on account of the capacitance 221. The larger the value of the capacitance, the slower is the rate of voltage increase. However, for a given capacitance, the rate at which the voltage increases at any moment depends upon the voltage input to the integrator.
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tor, which depends upon the difference between the voltage outputs of the two tacho-generators. Thus the integrator integrates in terms of the speed difference between the two motors, and arrives at an output of 7 volts when a predetermined length of web is accumulated in the reservoir.

The capacitance 221 may for example be about 25 microfarads and the resulting manner of operation may be such that the output from the integrator reaches a level of 7 volts at between ¼ minute and 2 minutes after the motor 13 is speeded up to feed excess web into the reservoir. The potentiometer enables the strength of the input to the integrator to be adjusted and this allows for adjustment of the length of web accumulated in the reservoir prior to splicing.

When a sufficient length of web has accumulated in the reservoir, as reflected in terms of the predetermined voltage (e.g. 7 volts) being applied to the voltage-sensing device 222, the device 222 operates a relay R2 which switches off the power supply to the web drive motor 13. As the web drive motor slows down, a voltage-sensing device 224 connected to the tacho-generator 106 receives a steadily decreasing voltage input from the tacho-generator. When the voltage received by the circuit 224 indicates that the motor has stopped, the circuit 224 operates a relay R3 which changes the position of a valve 226 controlling the pneumatic jack 210, 212. During normal running the valve 226 admits compressed air from an air pipe 228 to the lower end of the cylinder 210 of the jack so as to hold the jack in its extended position. When the position of the valve 226 is reversed, compressed air is admitted instead to the upper end of the cylinder 210 so as to retract the jack and pull down the splicing arm 309.

As soon as the jack reaches its fully retracted position, it operates a microswitch (not shown) which again reverses the valve 226 so as to extend the jack and drive the splicing arm upwards. On reaching its upper position the piston 212 or the attached splicing arm operates another microswitch (not shown) which operates a further relay which starts the web drive motor 13 running again at the normal speed and performs the other operations necessary to reset the circuit in preparation for the next splicing operation.

Solid-state devices may be used in place of the relays. The second microswitch 54, operated by arm 41 when the bobbin is almost exhausted, is omitted with the improvement illustrated in FIG. 5. The operation by the arm 41 of the first microswitch 52 initiates the complete sequence of events needed for splicing; this is arranged to happen early enough to ensure that there is sufficient web left in the bobbin to enable the necessary reserve to be accumulated in the reservoir so that web can be drawn continuously out of the reservoir by the motor 209 during splicing.

What we claim as our invention and desire to secure by Letters Patent is:

1. A web feeding device for a continuous rod making machine, including a variable-speed motor for pulling the web from a bobbin and for feeding it towards a reservoir, a second motor for feeding the web from the reservoir at a predetermined speed, and a splicing mechanism comprising means for sensing when the bobbin is nearly empty and for starting a splicing operation, means for increasing the speed of the variable-speed motor to accumulate web in the reservoir, first means associated with said variable-speed motor for providing a first electrical output signal dependent on the speed of said variable-speed motor, second means associated with said second motor for providing a second electrical output signal dependent on the speed of said second motor, an integrator circuit for sensing the progressive accumulation of web in the reservoir, said integrator circuit being responsive to the difference between said first and second output signals and comprising a direct current amplifier with a capacitance connected between the input and output of the amplifier, means for stopping the variable-speed motor when the integrator circuit senses that there is a sufficient length of web in the reservoir, and a web splicer for then automatically joining the trailing end of the web on the old bobbin to the leading end of the web on a new bobbin before again starting the variable-speed motor.

2. A web feeding device according to claim 1 in which each of the motors is operatively connected to a tacho-generator to provide an output signal dependent on the speed of the motor, the integrator circuit being responsive to the difference between the outputs from the two motors.

3. A web feeding device according to claim 1 in which the output of the integrator is connected to a voltage-sensing device which operates the means for stopping the variable-speed motor in preparation for the joining of one web to the other.

4. A web feeding device according to claim 1 in which the device for joining one web to the other is operated by a pneumatic jack.

5. In a web feeding device for a continuous rod making machine, including a variable-speed motor for pulling the web from a bobbin and for feeding it towards a reservoir, a second motor for feeding the web from the reservoir at a predetermined speed, and a splicing mechanism comprising means for sensing when the bobbin is nearly empty and for starting a splicing operation, means for increasing the speed of the variable-speed motor to accumulate web in the reservoir, means for stopping the variable-speed motor when there is a sufficient length of web in the reservoir, and automatic means for then joining the trailing end of the web on the said bobbin to the leading end of the web on a new bobbin and for then restarting the variable-speed motor, the improvement comprising first means associated with said variable-speed motor for providing a first electrical output signal dependent on the speed of said variable-speed motor, second means associated with said second motor for providing a second electrical output signal dependent on the speed of said second motor, and an integrator circuit for sensing the progressive accumulation of web in the reservoir and for operating said automatic means when there is sufficient length of web in the reservoir, said integrator circuit being responsive to the difference between said first and second output signals and comprising a direct current amplifier with a capacitance connected between the input and output of the amplifier.

6. The web feeding device of claim 5 wherein said first and second means associated with the variable speed motor and the second motor, respectively, comprise a pair of tacho-generators, one driven by said variable-speed motor and the other driven by said second motor, for providing said electrical output signals dependent on the speed of said motors respectively.
7. The web feeding device of claim 5 further comprising a voltage-sensing device connected to the output of said amplifier and adapted to operate said means for stopping said variable-speed motor.

8. The web feeding device of claim 5 further comprising an adjustable potentiometer for receiving and combining said output signals and feeding the combined signal to said amplifier, whereby the strength of the combined signal may be adjusted to adjust the length of the web accumulated in said reservoir prior to splicing.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,785,902 Dated January 15, 1974
Inventor(s) Edward George Preston and Jerzy Wladyslaw Czoch

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Cover page, first column, between "Appl. No. 112,669" and "U. S. Cl. ...156/351" insert:

Foreign Application Priority Data
February 9, 1970 Great Britain ........... 6032/70

Signed and sealed this 7th day of May 1974.

(SEAL)
Attest:
EDWARD M. FLETCHER, JR. G. MARSHALL DANN
Attesting Officer Commissioner of Patents