NEEDLE POSITIONER FOR A SEWING MACHINE

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ABSTRACT

A needle positioner for a sewing machine having an electric motor, including electrical circuitry for driving the electric motor at a uniform low speed and at variable speeds greater than the low speed, a dynamic braking circuit connected to the motor and adapted to be energized when the motor is de-energized to reduce the speed of the motor, automatic electric controls for de-energizing the dynamic braking circuit and re-energizing the motor when the speed of the motor has decreased to the low speed, a switch element responsive to the up or down position of the needle and adapted to energize controls for simultaneously de-energizing the motor and actuating braking means to stop the motor when the needle is in the desired up or down position.

4 Claims, 9 Drawing Figures
Fig. 1

Fig. 2

Fig. 4
REED SWITCH TELLS MOTOR TO STOP

A B C D
BRAKE OFF BRAKE OFF BRAKE OFF BRAKE OFF
MOTOR ON (DYNAMIC) (DYNAMIC) BRAKE OFF
MOTOR ON BRAKE ON MOTOR OFF BRAKE ON
MOTOR ON MOTOR OFF

0 RPM 250 RPM 5000 RPM

TIME (PERIODS)

Fig. 7

Fig. 5

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BACKGROUND OF THE INVENTION

This invention relates to electrical sewing machine controls, and more particularly to a needle positioner for a sewing machine.

Heretofore, most needle positioners for sewing machines include an auxiliary motor adapted to be energized after the main motor has been de-energized to simultaneously release the clutch and energize a mechanical brake. The auxiliary motor drives the needle at low speed until a switch element responsive to the position of the needle de-energizes the auxiliary motor to stop the machine with the needle in the desired up or down position.

More recently, some needle positioners for sewing machines have been designed which include solid-state circuitry. However, most of these still retain the auxiliary motor, or the clenching arrangement, or an electromechanical brake for carrying out all the braking functions.

SUMMARY OF THE INVENTION

The needle positioner for a sewing machine in accordance with this invention includes only a single electric drive motor without clenching, and solid-state circuitry. Moreover, the braking of the motor from a normal high operating speed down to the low, needle positioning speed is carried out by a dynamic braking circuit. The braking of the motor from the needle positioning speed down to zero is carried out by an electromechanical brake, or by the dynamic braking circuit.

Furthermore, the solid-state circuitries for this needle positioner are completely different from any known prior art circuit, not only in the structure of the circuits but also in their functions.

The needle positioner made in accordance with this invention includes the single electric drive motor connected in a speed control circuit and also connected to a dynamic braking circuit. These circuits in turn are connected to a logic circuit through a motor clamping circuit including switching transistors. The logic circuit is energized by releasing the foot pedal which closes the logic circuit switch. Initial energization of the logic circuit simultaneously closes the clamping circuit which bypasses the speed control circuit to de-energize the motor, and also energizes the dynamic braking circuit.

By sensing the negative back EMF in the dynamic braking circuit, the logic circuit automatically de-energizes the dynamic braking circuit and re-energizes the motor at a predetermined low, needle positioning speed. The logic circuit includes an SCR which is responsive at the low speed to turn on, when the switch element, in this case a magnetic reed switch, responsive to the position of the needle in an up or down position, is closed. The closing of the reed switch turns on the SCR to energize either the electromechanical brake or the dynamic braking circuit, and also closes the clamping circuit to de-energize the motor. The needle then comes to rest in the pre-selected up or down position.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevation of a sewing machine incor-
A.C. source is impressed upon the diode bridge of the electromechanical braking circuit 42, which also includes the energizing coil of the brake 20.

The motor speed control circuit 39 includes a low speed trim potentiometer 45 adapted to be adjusted to determine the low speed setting of the motor 12. In a similar manner, the motor speed control circuit 39 is provided with a high speed trim potentiometer 46, also adjustable to determine the high speed, or normal operating speed, of the motor 12.

Contained within the tarell 22 is a foot speed potentiometer, or rheostat, 47 in which the wiper is moved proportionally to the movement of the tarell 22, in order to vary the speed of the motor 12 between its set low speed and high speed. The foot speed potentiometer 47 is so set or adjusted that when the foot pressure is removed from the pedal or tarell 22, the motor 12 will automatically operate at its low speed setting.

Also contained within the tarell 22 is the foot switch 48 which connects the logic circuit 41 to its B+ supply. The foot switch 48 is so positioned that when the tarell 22 is depressed, the switch 48 is opened, to de-energize the logic circuit 41. When foot pressure is removed from the tarell 22, foot switch 48 closes to energize the logic circuit 41.

The logic circuit 41 includes a main supply line 49 connected to the switch 48, and a grounded line 50 separated from the main line 49 by the capacitor 51.

In the left-hand part of the logic circuit 41, lines 49 and 50 are bridged by knee switch circuit 52, in which the knee switch 28 and the knee switch relay coil 53 are connected in series. The knee switch relay coil 53 controls the selector relay switch 54. When the relay coil 53 is de-energized, the selector switch 54 is in its solid-line position, disclosed in FIG. 3, to energize the down position circuit 55. When the relay coil 53 is energized, the selector switch 54 shifts to its dashed-line position to energize the up position circuit 56. The down and up position circuits 55 and 56, although connected in parallel, are both connected through capacitor 57 and resistor 58 in signal line 59 to the junction 60.

A clamping circuit 62 connects the motor speed control circuit 39 through the contacts A to the logic circuit 41. One end of the clamping circuit 62 connects, through diodes 63 and 64, in parallel, the base circuits of the transistor 65 and the unijunction transistor 66.

The other end of the clamping circuit 62 is connected to the collector circuit of clamping transistor 68 and also through diode 69 to the junction 60, the diode 69 being in parallel with the transistor 68. Also connected in parallel with the diode 69 and transistor 68 is a motor relay bypass switch 70.

The collector circuit of switch transistor 72 is connected to the base circuit of clamping transistor 68, and is also connected to the main supply line 49 through the capacitor 73 and resistor 74, in parallel. The base circuit of transistor 72 is connected through resistor 75 and potentiometer 76 to the main supply line 49. Thus, when foot switch 48 is in its solid-line, closed position, as disclosed in FIG. 3, transistor 72 is turned off while transistor 68 is turned on, or vice-versa.

The dynamic braking circuit 40 is connected across the motor 12, and includes in series, braking resistor 78, SCR 79 and transistor 80. Connecting the base and collector circuits of the transistor 80 is a Zener diode 81. A resistor 82 connects the base circuit and emitter circuit of the transistor 80. The gating lead 84 of the SCR 79 is connected to one pole of the SCR 79 through resistor 85, and to the other pole through resistor 86 and relay switch 87. The relay switch 87 is controlled by relay coil 88, connected in series with capacitor 89 across the logic circuit lines 49 and 50.

Accordingly, it will be seen that when the foot switch 48 is in its solid-line, closed position, that is when the foot tarell 22 is relaxed, the relay coil 88 will be momentarily energized through the capacitor 89 to close the relay switch 87 in the dynamic braking circuit 40 long enough to fire the SCR 79. Current then flows through the braking resistor 78, SCR 79 and transistor 80 from the motor 12. The voltage across transistor 80 is fixed by the Zener diode 81. Accordingly, when the back EMF of the motor 12, as determined by the braking resistor 78, is reduced to a value which is equal and opposite to the voltage across the transistor 80, current ceases to flow through the dynamic braking circuit 40, and the SCR 79 will turn off.

The dynamic braking circuit 40 is coupled to the logic circuit 41 through connecting lead 90, one end of which is connected between the braking resistor 78 and the resistive shunt circuit 85–86. The other end of the lead 90 is connected through the resistor 91 to the base circuit of the switch transistor 72. Thus, when the current in the dynamic braking circuit 40 is reduced to zero, the transistor 72 is turned on, to automatically turn off the transistor 68 and open the clamping circuit 62, thereby re-energizing the motor speed control circuit 39 to re-start the motor 12. As long as the tarell 22 is relaxed, the corresponding position of the foot speed potentiometer 47 permits the motor 12 to run steadily at its low speed.

A brake actuating circuit 93 is connected to junction 60 through lead 94. The B+ supply voltage is impressed upon the brake actuating circuit 93 through the capacitor 95 and resistor 96, connected in series with a Zener diode 97. The Zener diode 97 couples the connecting lead 94 to the gating lead 98 of the SCR 99. When SCR 99 is fired by the appropriate signal on the gating lead 98, brake relay coil 100 is energized to close brake relay switch 101 in the brake circuit 42 and close motor relay by-pass switch 70. When brake relay switch 101 is closed, the electromechanical brake 20 is energized to stop needle 18.

The other side of the brake relay coil 100 from SCR 99 is connected through lead 103 to parallel diodes 104 and 105, each of which is connected to the selective switch 54 in one of its alternate positions. The diode 104 is connected in parallel with the down reed switch 34, while the diode 105 is connected in parallel with the up reed switch 33.

Also connected in the down position circuit 55 is heel switch 107, which is located beneath the heel portion of the tarell 22. The heel switch 107 is opened by depression of the operator's heel upon the lower end of the tarell 22. Opening of the heel switch 107 will automatically de-energize the electromechanical brake 20 and simultaneously open the clamping circuit 62 by opening relay by-pass switch 70, so that the motor 12 will re-start at its low speed.

The operation of the invention is as follows:

Referring to FIGS. 3 and 4, initially assuming the motor 12 is de-energized, the needle is at rest and the tarell 22 is relaxed, all of the switches are in their solid-line positions as indicated in FIG. 3, with the exception that the up reed switch 34 will be closed, since the
needle 18 will normally be in an up position, after completion of the cut cycle in the previous sewing operation.

When the power switch 25 is turned on, power supply circuit 38 and speed control circuit 39 are energized. Current is then supplied to the logic circuit 41 through the closed foot switch 48 to saturate clamping transistor 68 through capacitor 73. With clamping transistor 68 turned on, current is bled off through the clamping circuit 62 to de-energize motor 12. The initial current in the logic circuit 49 will also momentarily energize the dynamic brake relay coil 88 to briefly close the relay switch 87. However, since the motor 12 has not been running, no current will flow through the dynamic braking circuit 40, or connecting lead 90.

The initial surge of current through logic circuit 41, created by turning on the power supply, flows from the B+ supply into the brake actuating circuit 93, through capacitor 95, resistor 96, diode 97, and gating lead 98, to fire SCR 99, and energize brake 20.

When the operator is ready to sew, she depresses the treadle 22, which opens the foot switch 48, thereby de-energizing the logic circuit 41. De-energization of the logic circuit 41 turns off both transistors 72 and 68, so that the clamping circuit 62 is open and the motor speed control circuit 39 is energized to start the motor 12.

Continued depression of the treadle 22 proportionally varies the resistance in the foot speed potentiometer 47 to gradually increase the speed of the motor 12 to its operating high speed, e.g., 5,000 RPM, as indicated in the initial portion of phase A of FIG. 4.

With the treadle 22 fully depressed, motor 12 continues at its operating high speed until it is desired to stop the sewing operation. At the end of phase A of FIG. 4, the operator removes her foot from the treadle 22, permitting it to be restored to its relaxed position. The resistance in the foot speed potentiometer 47 returns to its original value to set the speed control circuit 39 at the low needle-positioning speed, for example 250 RPM, as indicated in FIG. 4, and foot switch 48 returns to its closed position to re-energize the logic circuit 41.

As soon as the logic circuit 41 is re-energized, the dynamic brake relay coil 88 is again momentarily energized to close the relay switch 87 and fire the SCR 79, so that current created by the back EMF of the motor 12 through the braking resistor 78 flows through the SCR 79 and transistor 80. Also, as logic circuit 41 is re-energized, transistor 72 is switched from on to off, and transistor 68 is switched from off to on, thereby closing the clamping circuit 62 to de-energize the motor speed control circuit 39. As indicated in FIG. 4, the operation is now in phase B, with the motor turned off and the dynamic braking circuit energized to rapidly reduce the speed of the motor to its low, needle-positioning speed, e.g., 250 RPM.

Phase C of FIG. 4 is initiated as soon as the back EMF decreases to a value equal to an opposite from the constant voltage applied across the transistor 80 by the Zener diode 91, to turn off the SCR 79 and de-energize the dynamic braking circuit 40. When the dynamic braking circuit 40 is de-energized, transistor 72 is turned off to turn off clamping transistor 68 and open clamping circuit 62. The motor 12 is then re-energized to operate at the needle-positioning speed.

Phase C continues until the next closing of the down reed switch 34. Since the clamping circuit 62 is now open and the transistor 68 will not conduct, the current coming through the junction 60 from the signal line 59 closed by down reed switch 34, will energize the brake actuating circuit 93. The value of the Zener diode 97 is such that the signal pulse from the closed down reed switch 34 will exceed the threshold voltage to fire the brake SCR 99 and thereby energize the electromechanical brake 20. Immediately, the sewing machine 10 stops with the needle 18 in its up position. As previously mentioned, when the electromechanical brake is energized, the by-pass relay switch 70 is closed to bypass the non-conducting transistor 68, close the clamping circuit 62, and de-energize motor control circuit 39. This operation is illustrated in phase D of FIG. 4.

Although the down reed switch 34 is continuously closing on each revolution of the arm shaft 17, nevertheless, the down switch 34 receives no power during phase A because foot switch 48 remains open. During phase B, clamping transistor 68 is conducting. Accordingly, any pulses transmitted through signal line 59 from the closing of either reed switch 34 or 33 is switched through transistor 68, and are not strong enough to exceed the threshold voltage of Zener diode 97. Accordingly, the mechanical electrical brake 20 is never energized until motor 12 is operating at its low speed in phase C, FIG. 4.

If the operator desires that the needle 18 stop in its up position, she merely actuates the lever 30 to close the knee switch 28 (FIG. 1). Thus, the knee relay coil 53 is energized to move the selective switch 54 to its dashed-line position in FIG. 3, which automatically and simultaneously opens the down position circuit 55 and closes the up position circuit 56. Thus, when the motor is operating at its needle-positioning speed, the next time the up reed switch 33 closes, the brake 20 will be actuated and the motor relay switch 70 will be closed to stop the needle 18 in its up position.

After the needle 18 is stopped in its down position, the operator may open the heel switch 107 by depressing the heel portion of the treadle 22. Opening of the heel switch 107 de-energizes the brake relay coil 100 to de-energize the mechanical-electrical brake 20 and to open the by-pass switch 70 and clamping circuit 62, to permit the motor 12 to resume running at low speed. With the heel switch 107 open, the motor continues running at low speed until a conventional cam mechanism, not shown, automatically engages mechanism within the machine 10, not shown, which initiates the cut cycle. After the cut cycle is completed, the machine automatically stops with the needle 18 in its up position.

MODIFICATION

A modified form of the needle positioner made in accordance with this invention is disclosed in FIGS. 5, 6 and 7. In FIG. 5, the same sewing machine 10 is mounted upon a table 11, to support, for vertical reciprocals movement, the needle 18. However, a different type electrical motor 112 is mounted on top of the table 11. The motor drive shaft 113 is connected through axial coupling 114 to the arm shaft 17, for a direct drive. The upper and lower reed switches 133 and 134 are fixed upon the housing of the motor 112, in positions corresponding to the respective up and down
positions of the needle 18, and are adapted to be actuated by a magnet 136 fixed to the magnet collar 135 mounted on motor shaft 113 for rotation therewith.

FIG. 5 also discloses the conventional foot pedal or treadle 22, and knee lever 30. The switches within the treadle 22 are connected through cable 123 to control box 124 upon which is mounted the power switch 125. The control box 124 is connected to the motor 112 through electrical cable 126, and through cable 129 to the knee switch 128, mechanically actuated by the knee lever 30.

Referring now to FIG. 6, the electrical circuitry for the modified needle positioner includes a power supply circuit 137, including a B+ power supply circuit 138, and a logic circuit 141.

The power supply circuit 137 includes a transformer with several secondary circuits transmitting stepped-down voltages to the SCR bridge circuit 143 in the motor speed control circuit 139; to the diode bridge circuit 144 in the dynamic braking circuit 140; to the motor speed control circuit 139; and to the B+ power supply circuit 138.

The motor speed control circuit 139 includes a low speed trim potentiometer 145, a high speed trim potentiometer 146, and a foot speed potentiometer or rheostat 147, which function in the same manner as their counter-parts 45, 46 and 47 in the circuit of FIG. 3.

Foot switch 148 connects the B+ power supply to the logic circuit 141, in operative position, in the same manner as its counterpart, foot switch 48. The logic circuit 141 also includes a main supply line 149 and a ground line 150 separated from the main line 149 by the capacitor 151. The logic circuit 141 also includes knee switch circuit 152, in which the knee switch 128 and knee switch relay coil 153 are connected in series to control the selector relay switch 154, in the same manner as their counterparts 53 and 54 of FIG. 2, in order to selectively energize the down and up position circuits 155 and 156, respectively. Both the down and up position circuits 155 and 156 include, respectively, reed switches 134 and 133 and are connected through capacitor 157, and resistor 158 to the Zener diode 160.

The Zener diode 160 is in turn connected to the gate circuit 161 of SCR 162. When SCR 162 is turned on, it will energize transistor 163 through its base circuit.

The collector circuit 164 of transistor 163 is connected to junction 165. Connected in parallel to the junction 165 are the base circuits of clamping transistor 166 and switch transistor 167. The clamping transistor 166 is connected in the clamping circuit 168 through contacts C to three parallel diodes 169, 170 and 171 in the motor speed control circuit 139. Diode 169 is connected to the parallel collector circuit of transistor 172 and base circuit of unijunction transistor 173 in the motor speed control circuit 139. Diode 170 is connected through the foot speed potentiometer 146 to the base circuit of transistor 174; while diode 171 is connected directly to the base circuit of the transistor 174.

Unijunction transistor 173 supplies its output, when biased into conduction, to the parallel gate circuits of the SCRs in SCR bridge circuit 143.

The dynamic braking circuit 140 includes the diode bridge circuit 144, previously mentioned, which is energized from power supply circuit 125. When the dynamic braking circuit 140 receives a signal through the contact D, the input signal is amplified through the amplifying transistors 177 and 178, and the resulting output signal turns on the switch transistors 179 and 180 to produce a constant current through the dynamic braking circuit 140 in a direction opposite to the current which is supplied to the motor 112 by the motor speed control circuit 139.

The main line 149 of the logic circuit 141 is connected through resistor 181 to braking contact D and switch transistor 182 in parallel, so that when the switch transistor 182 is off, or non-conducting, and the logic circuit 141 is energized, then the dynamic braking circuit 140 will receive an input signal through the contact D. On the other hand, when the switch transistor 182 is turned on, or is conducting, the dynamic braking circuit 140 will receive no input signal, and will be de-energized.

In the logic circuit 141, a resistive back EMF sensing lead 184 is connected through contacts A between the motor 112 and the dynamic braking circuit 140, as illustrated in FIG. 6. The sensitivity of the lead 184 is controlled through the trim potentiometer 185. This sensing lead 184 is adapted to sense the back EMF of the motor 112. The back EMF signals are transmitted to the base circuit of sensing transistor 186, the emitter of which is connected to the gate of SCR 187. When the SCR 187 is turned on, current from main line 149 is grounded through SCR 187, to short-circuit and turn off the clamping transistor 166 and switch transistor 167.

Connected to the collector lead 164 between the transistor 163 and junction 165 is lead 189, which is connected to relay coil 190 and filter circuit 191 in parallel. The relay coil 190, when energized, closes relay switch 192 in the base circuit 193 of switch transistor 182. The opposite end of the base circuit 193 is connected through a series of diodes 194 to contact A. The base circuit 193 is also connected through lead 195 to the filter circuit 191.

In the operation of the modified needle positioner, reference is made to the graph of FIG. 7, as well as to the circuit in FIG. 6.

With the power switch 125 turned on, power is supplied to motor SCR bridge circuit 143, the motor speed control circuit 139, the dynamic braking circuit 140, the B+ power supply supply 138 and the logic circuit 141, while the foot switch 148 is closed.

When the operator depresses the treadle 22, the foot switch 148 is opened to de-energize the logic circuit 141. When the logic circuit 141 is de-energized, no power is supplied through either of the reed switches 133 or 134, even when closed, nor through contacts D to the dynamic braking circuit 140, nor to any of the transistors 163, 186, 166, 167 or 182. Since no power is supplied to the transistor 166, it will be turned off to open the clamping circuit C, and permit the motor speed control circuit 139 to operate the electric motor 112 at the speed dictated by the foot feed potentiometer 146.

When the sewing operation is completed and the operator removes her foot from the treadle 22, the foot switch 148 closes to re-energize the logic circuit 141. Phase A of FIG. 7 is now complete.

With the logic circuit 141 now turned on, Phase B of FIG. 7 commences, and the sensing lead 184 transmits the negative voltage signal from the back EMF of the decelerating electrical motor 112 to sensing transistor...
186. However, SCR 187 remains turned off, until the decreasing negative value of the back EMF reaches a value corresponding to the low, needle-positioning speed. Current from main line 149 is then transmitted through junction 165 to turn on both of the transistors 166 and 167. When transistor 166 is turned on, clamping circuit 168 is closed to de-energize the motor speed control circuit 139, and consequently the motor 112.

When transistor 167 is turned on, simultaneously switch transistor 182 is turned off to divert the current from the main line 149 through resistor 181 to contacts D to energize the dynamic braking circuit 140. Thus, as indicated in phase B of FIG. 7, the motor 112 is turned off, while the dynamic braking circuit 140 is energized to force a constant reverse current through the motor 112.

As the back EMF becomes less negative, and the motor 112 decelerates to the needle-positioning speed, indicated in the graph of FIG. 7 as approximately 250 RPM, the trim potentiometer 185 is pre-set to cause sensing transistor 186 to turn on SCR 187. Consequently transistors 166 and 167 turn off to open clamping circuit 168 and re-energize speed control circuit 139 to re-start electric motor 112 at the low positioning speed. When switch transistor 167 simultaneously turns off, switch transistor 182 is turned on to divert current from the contact D, and thereby de-energize the dynamic braking circuit 140. Accordingly, the motor 112 continues to run at the constant low needle-positioning speed until the next time the down reed switch 134 is closed by magnet 136.

When down reed switch 134 is closed, at the end of phase C to commence phase D of FIG. 7, it remains closed for a comparatively long time, because of the low speed of the motor 112 and the motor drive shaft 113. The length of time the down speed switch 134 is closed in positioning speed is sufficient to generate a large enough pulse through the capacitor 157 and resistor 158 to exceed the threshold value of the Zener diode 160, and thereby turn on the SCR 162. When the SCR 162 is turned on, a signal is transmitted through transistor 163 and lead 164 to the junction 165, to again turn on the transistors 166 and 167. Again, the conducting transistor 166 will close the clamping circuit 168 to turn off the motor speed control circuit 139 and thereby de-energize the motor 112. Again, when switch transistor 167 is turned on, switch transistor 182 is turned off to re-energize dynamic braking circuit 140, which brings the motor 112 to a halt with the needle 18 stopped in its down position.

The signal transmitted by the transistor 163 through lead 164 is also transmitted through lead 189 to the filter circuit 191 and relay coil 190. Relay coil 190, when energized, closes relay switch 192 to couple the back EMF of the motor 112 through contacts A, and circuit 193 to the transistor 182. The filter circuit 191 also functions to produce a slight time-delay, so that for a predetermined time after the motor 112 reaches a complete halt, the dynamic braking circuit 140 remains energized. However, when the delayed signal is transmitted through lead 193 to the switch transistor 182, switch transistor 182 is again turned on to divert current from the contacts D and thereby turn off dynamic braking circuit 140 after the sewing machine motor 112 is completely stopped.

The lead 197 by-passes current from the down position circuit 155 to the collector lead of switch transistor 167, so that whenever the switch transistor 167 is turned on, it bleeds any current from the down position circuit 155, when the down reed switch 134 is closed, to ground. Accordingly, the down reed switch 134 will not accidentally trip the logic circuit 141 during phase B. Thus, the reed switch 134 is on only for actuation during phase C, that is, when the dynamic braking circuit is off and the motor is running at positioning speed.

The knee switch 128 and heel switch 207 operate identically to their counter-parts 28 and 107 in FIG. 3, as has been previously described. It will be noted that circuit 203 and diodes 204 and 205 function in the same manner as their counter-parts 103, 104 and 105 to turn off the transistor 163, thereby de-energizing the dynamic braking circuit 140 when the heel switch 207 is opened.

As best disclosed in phase B of FIG. 4, the deceleration of the motor 112 decreases exponentially because the back EMF is decreasing to decrease the current through fixed resistor 78. On the other hand, as disclosed in phase B of FIG. 7, the deceleration is substantially linear, because a constant current is being fed by the dynamic braking circuit 140 through motor 112.

What is claimed is:

1. An electric drive system for a sewing machine having a needle and an electric motor operatively connected to the needle for axially reciprocating said needle, comprising:
   a. a speed control circuit connected to said motor and having control means for operating said motor at a predetermined constant low speed,
   b. operator-controlled switch means in said speed control circuit for varying the speed of said motor above said low speed,
   c. a dynamic braking circuit connected across said electric motor,
   d. a logic circuit connected to said speed control circuit,
   e. a lead connecting said dynamic braking circuit to said logic circuit for transmitting a signal corresponding to the back EMF of said motor to said logic circuit,
   f. automatic switch means in said logic circuit for de-energizing said speed control circuit and for energizing said dynamic braking circuit to reduce the speed of said motor when said operator-controlled switch means is de-actuated,
   g. said automatic switch means being responsive to said signal to de-energize said dynamic braking circuit and to re-energize said speed control circuit when the value of said back EMF corresponds to said low speed,
   h. a position switch in said logic circuit adapted to close for a corresponding axial position of said needle,
   i. brake switch means in said logic circuit connected to said dynamic braking circuit,
   j. means responsive to the closing of said needle-position switch for actuating said brake switch means to energize said dynamic braking circuit to stop said motor only when said motor is operating substantially at said low speed.

2. The invention according to claim 1 in which said dynamic braking circuit includes means for maintain-
ing a constant voltage of a predetermined value substantially corresponding with said low speed to oppose the back EMF produced by said motor in said dynamic braking circuit, when said dynamic braking circuit is energized.

3. The invention according to claim 2 in which the means for maintaining a constant voltage in said dynamic braking circuit comprises means for driving a constant current in said dynamic braking circuit in opposition to the current produced by the back EMF of said motor, while said dynamic braking circuit is energized.

4. The invention according to claim 1 in which said automatic switch means comprises a clamping circuit connected to said speed control circuit, and an electronic switch in said clamping circuit, said brake switch means being operatively connected to said electronic switch, said operator-controlled switch means comprising a foot switch for energizing said logic circuit when said dynamic braking circuit is de-actuated, said electronic switch closing said clamping circuit to de-energize said speed control circuit and simultaneously actuating said brake switch means to energize said dynamic braking circuit, when said foot switch energizes said logic circuit; said electronic switch being responsive to said back EMF signal to open said clamping circuit to energize said motor speed control circuit and to actuate said brake switch means to de-energize said dynamic braking circuit, when said back EMF signal decreases to a value corresponding to said low speed.

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