An improved electronic control for industrial sewing machines has first and second control switches for stopping the needle at its lower dead point and for controlling cutting of the thread while positioning the needle at its top dead point. Three transparent rings are keyed, in adjustable positions, to the needle control shaft, each ring having an opaque sector, and each being arranged to rotate between a source of light and respective transistor connected to logic circuits. When the first switch is operated a first transistor excites an electromagnetic clutch for coupling the control shaft of the needle to the low-speed motor and successively excites for a short period an electromagnetic brake which arrests the shaft at its lower dead point: when the second switch is operated the other two photo-transistors cause the electromagnetic clutch to be engaged, followed for a short period by the electromagnetic brake to bring the needle to its top dead point and at the same time energize electromagnetic actuators which advance a cutter blade and slacken a thread-tensioning device of the sewing machine and, after a predetermined delay, energize an electromagnetic actuator which withdraws the cutter blade towards a counter-blade to sever the thread.

5 Claims, 5 Drawing Figures
ELECTRONIC CONTROL ARRANGEMENT FOR THE NEEDLE AND THREADCUTTER IN AN INDUSTRIAL SEWING MACHINE

BACKGROUND OF THE INVENTION

The present invention relates to an electronic control arrangement for the needle and threadcutter in a sewing machine of the industrial type.

In sewing machines of the industrial type there are normally at least two manually operated controls. One control consists of a lever which controls the sewing machine at high speeds (of the order of some thousands of revolutions per minute) for normal sewing. The worker must be able to stop the machine momentarily, and with precision, for example to rotate the material in order to resume sewing in a new direction. For this purpose it is necessary for the needle to come to rest at its lower dead point, when machine stops, in order not to lose alignment between the seam and needle, and to facilitate the movement of the material around the needle. To obtain such precision stopping and such positioning of the needle, the sewing machine may be operated momentarily at a second auxiliary speed, (of the order of a few hundred r.p.m.) considerably lower than the normal high speed of operation, immediately prior to stopping of the machine. To achieve this slowing down the drive shaft of the machine arm is disconnected from the main motor and connected to an auxiliary motor which brings the sewing machine to a stop with the needle of the machine at its lower dead point.

Driving arrangements for sewing machines capable of operating at a main speed or at a slower auxiliary speed are described, for example in Italian Patent Specification Nos. 779,473 and 881,801.

When sewing on a given job is ended the worker must be able to stop the machine and cut the thread to remove the work done by the machine. Consequently a sewing machine of the industrial type is normally provided with a stop control capable of stopping the machine with the needle at its top dead point, in which the needle is out of engagement with the material. A further control, possibly the same control, is provided for operating a threadcutter contained below the working plane of the machine.

The above-mentioned controls may be operated by suitable means of a single control toggle of the sewing machine. For this purpose a control arm may be connected to the usual toggle of the machine to effect all the said controls selectively through a treadling or back-treading movement, as described in the above-mentioned Italian Patent Specification No. 881,801.

Up to now, the controls of the machine in the various modes of operation (starting, running, stopping of the needle at its lower dead point, stopping of the needle at its top dead point, and cutting of the thread) were effected by electromechanical devices such as relays, mechanical interconnections being provided for the controls with interconnections for preventing simultaneous operations which would be incompatible, such as, for example, stopping of the needle at its lower dead point and cutting of the thread which, if effected simultaneously would damage the needle and/or the machine.

Electromechanical control arrangements were adequate, even with the need to effect continuous regulation and maintenance, for sewing machines having the relatively low working speeds customary up to a few years ago. The higher working speeds (6000-7000 r.p.m. and more) possible with the mechanical structure of modern machines have not, however, been met by a corresponding improvement in the precision of control of such electromechanical control means. In fact, the relays employed hitherto have a relatively slow response and are rather imprecise in operation, due to wear and tear of the relay contacts and consequent fluctuation of the instants of closing and/or opening of the contacts of the relay with respect to the instants of energization and de-energization of the relay.

Even at relatively moderate working speeds, however, it has long been a problem to provide control devices for sewing machines of the industrial type, particularly as regards the operation of the threadcutter. In fact, errors in positioning the needle at its top dead point (which in earlier known devices could be of the order of some tens of degrees) could cause the threadcutter to interfere with the needle itself, breaking or deforming the needle, or could cause severing of the thread in such manner that the latter is not taken up automatically by the needle upon starting to sew a new seam, forcing the operator to intervene and manually thread the needle or to unwind a length of thread from the bobbin to obtain a sufficient length of free end. This naturally increases the working time, defeating the object of higher machine working speeds.

To prevent incorrect use of the threadcutter under conditions of excessive slaming of the needle from its desired position, with the abovementioned harmful consequences for needle and/or thread, a previously known sewing machine makes use of mechanical means for checking the positioning of the needle. The worker has to test these mechanical means before the needle is stopped, the threadcutter being operated only when the test shows that the needle is in the correct position; should the test indicate that the needle is in an incorrect position the worker must operate the machine again at low speed for another rotation, perform the test again, and so on, until the test gives a satisfactory result indicating that the threadcutter can be operated. The disadvantages of such working methods are self-evident. Positioning of the needle at its top dead point with certainty and within tolerances, without the need of checking, would avoid lost time in testing, and on the other hand would make it possible to effect simultaneously stopping of the needle at its top dead point and operation of the threadcutter by means of a single control switch.

A main object of this invention is to provide a control arrangement for sewing machines of the industrial type, capable of synchronizing the various operations of transition from high speed to auxiliary low speed operation of the needle of the machine, stopping of the needle at its lower dead point, stopping of the needle at its top dead point and cutting of the thread, without the necessity of frequent regulation or maintenance of the control arrangement itself, and without appreciable wear of the parts.

SUMMARY OF THE INVENTION

According to the invention there is provided an electronic control arrangement for sewing machines of the industrial type having a high-speed motor, a low-speed motor and a threadcutter device, characterized in that the control arrangement comprises, in combination: a control switch operable to stop the needle at its lower
dead point, a first transparent ring keyed to the needle control shaft and having an opaque sector, the said first ring being arranged to rotate between a source of light and a first photo-transistor and logic circuits controlled by said switch and said photo-transistor to excite an electromagnetic clutch for coupling the control shaft of the needle to the low-speed motor and successively to excite for a short period an electromagnetic brake acting on the said control shaft to arrest the latter as its lower dead point; a control switch for controlling cutting of the thread and for positioning the needle at its top dead point, second and third transparent rings with respective opaque sectors adapted to rotate with the control shaft between respective sources of light and respective second and third photo-transistors and logic circuits controlled by the said switch and by the said second and third photo-transistors to engage the said electromagnetic clutch and successively for a short period the said electromagnetic brake to bring the needle to its top dead point, to energize electromagnetic actuator means for advancing a cutter blade of the thread cutter device and for slackening a thread-tensioning device of the sewing machine, and finally, after a predetermined delay, to energize electromagnetic actuator means for withdrawing the cutter blade towards a counter-blade to sever the thread; the said first, second and third rings being adjustable in angular position relative to the control shaft to regulate the instants of operation of the clutch, the brake and of the electromagnetic actuator means of the threadcutter and thread-tensioning devices.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the invention will now be described, merely by way of non-limiting example, with reference to the accompanying drawings, in which:

FIG. 1 is a view in axial section of a synchronizer and photo-transistor assembly for the control of an industrial sewing machine, forming part of a control arrangement according to the invention;

FIG. 2 is a diagrammatic representation of three rings with obscured sectors forming part of the synchronizer assembly of FIG. 1;

FIG. 3 is a block schematic circuit diagram of the control arrangement according to the invention, and

FIGS. 4a and 4b are two contiguous halves of a detailed circuit diagram of the control arrangement of FIG. 3.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Referring to the drawings, a support 10 is attached to a fixed part of the arm (not shown) of a sewing machine and carries a bearing 12, retained by a resilient ring 14, which rotatably supports a shaft 16 connected to a shaft 18 mounted in the arm of the sewing machine. The shaft 18 is arranged to be driven selectively by a high speed motor or a low-speed motor (not shown), as hereinafter described. A neoprene casing 20 is secured to the support 10 by a screw 22. recesses are formed in the casing 20 to receive three lamps L1, L2, L3, further described with reference to FIGS. 3-5. The lamps L1, L2, L3 are permanently illuminated when the machine is running, and are supplied with current by feed conductors (not shown in FIG. 1).

To the neoprene casing 20 and to the support 10 is secured a cover 24, fixed by screws 26. The cover 24 supports a bracket 30, attached to the cover by a screw 28. The bracket 30 extends within the casing 20 and supports three sheaths 32, 34, 36 housing three photo-transistors P1, P2, P3, further described with reference to FIGS. 3-5. Each photo-transistor is associated with a respective one of the lamps L1, L2, L3. The bracket 30 also acts as support for an electrical printed circuit described hereinafter with reference to FIGS. 3-5.

Between the photo-transistors P1, P2, P3 and the lamps L1, L2, L3 there is interposed a tube 38 of transparent material, such as methylmethacrylate resin, attached by means of a collar 40 to the end of the shaft 16, to rotate with the latter. Three transparent rings 42, 44, 46 are fixed to the outside of the tube 38, these rings also being made, for example, of methyl methacrylate resin. Each of the rings 42, 44, 46, as shown in FIG. 2, has an opaque sector of suitable circumferential extent, so as periodically to interrupt the illumination of the respective photo-transistor P1, P2, P3 upon rotation of the shaft 16. The relative phases of interruption of the illumination of the three photo-transistors may be varied as desired by varying the angular position of each ring 42, 44, 46 on the transparent tube 38, and securing each ring in the desired angular position by means of fixing devices such as that indicated diagrammatically at 48.

The control arrangement according to the invention will now be described with reference to FIG. 3.

In FIG. 3 a supply of stabilized voltage at +16 volts (not shown) supplies the control voltages for the various parts of the circuit. The circuit includes a switch P1 for controlling stopping the motor of the sewing machine with the needle of the machine arrested in its lower dead point. The switch P1 when closed supplies a reset signal to the reset input 110 of a flip-flop 112. A direct output A1 of the flip-flop 112 is connected to an input of an OR gate 114, the output of which, retarded by a delay circuit 116, is passed to the set (S) input 118 of the flip-flop 112, to set the latter after a predetermined interval of time determined by the delay circuit 116. The OR gate 114 has a second input to which is applied a signal from the photo-transistor P1, illustrated in FIG. 1, whenever the latter is illuminated while the output A1 of the flip-flop 112 is low.

The other output A1 of the flip-flop 112 is connected through a NOT circuit 119 to a first input of an AND gate 120. The second input of the AND gate 120 receives the control voltage (+16v) through the series arrangement of the photo-transistor P2 and a cut-off switch P2 arranged to be closed when the needle is in its top dead point, with simultaneous cutting of the thread. The output B1 of the AND gate 120 passes to a first input of an OR gate 122, the output C1 of which controls a switch 124 in series with a winding 126 which, upon energization, operates a friction clutch to disengage the shaft of the needle from the high speed motor and engage said shaft with the low-speed motor. The second input of the OR gate 122 is connected to the output A1 of the flip-flop 112. A negative output C1 of the OR gate 122 passes to a monostable circuit 128 which upon excitation operates, for a limited period of time, a switch 130 in series with a brake winding 132. The winding 132 upon energization operates a brake for stopping the control shaft of the needle.
A negative output B1 of the AND gate 120 passes to an input of an AND-NOT gate 134, the output of which controls a switch 136 in series with a relay winding 138 which, upon energization, advances a blade forming part of a threadcutting device (not shown) incorporated in the sewing machine. A threadcutting device suitable for use with the present invention is, for example, described in an Italian Patent application, Ser. No. 71072-A/70, filed on Dec. 7, 1970 and entitled: "Threadcutting device for sewing machines."

The control voltage for the second input of the AND-NOT gate 134 is supplied by the photo transistor P3 which forms part of the synchronizer assembly of FIG. 1.

The output of the AND-NOT gate 134 also controls, by means of a manual switch 140, a first input of an OR gate 142, the output of which controls closure of a switch 144 in series with a winding 146 which when energized opens the discs of a thread-tensioning device on the arm of the sewing machine. An explanation of the operation and construction of such discs in a thread-tensioning device is also given in the said Italian Patent application number 71072-A/70.

The output of the AND-NOT gate 134 is also passed through a delay circuit 148, the output of which controls closure of a switch 150 in series with a winding 152 which when energized causes retraction of the threadcutting blade so that the thread is severed by this blade cooperating with a counter-blade. The output of the delay circuit 148 passes to the second input of the OR gate 42.

The winding 152 is maintained in partial excitation by a holding circuit 154, which is controlled from the output of a NOT circuit 158 which in turn is piloted from the output of the AND-NOT gate 134.

The operation of the circuit shown diagrammatically in FIG. 3 is as follows:

Under conditions of normal running at high speed, the switches P1 and P2 are open. Consequently the flip-flop 112 is in the "set" position due to the periodic excitation of the delay circuit 116 by the phototransistor P1. The output A1 is therefore low and consequently the windings 126 and 132 are de-energized. Also, with the switch P2 open the output B1 of the AND gate 20 is low and consequently the output B1 is high and maintains the AND NOT gate 134 closed. Consequently the windings 138, 146 are both de-energized. The winding 152, on the other hand, is maintained partially energized by the NOT circuit 158 which thus ensures that the blade is gently retained in its withdrawn position, to avoid accidental interference of the blade with the thread or the needle during sewing.

It will be supposed that the operator of the machine closes the switch P1, thus resetting the flip-flop 112. The output A1 of the flip-flop 112 becomes high and, through the OR gate 122, causes closure of the switch 124, thereby energizing the winding 126 of the friction clutch, which disconnects the needle control shaft from the high speed motor and connects said shaft to the low-speed motor. The control shaft, after a short transition period, therefore starts to rotate at low speed in preparation for its subsequent stopping.

In the meantime the periodic illumination of the photo-transistor P1 causes signals to be transmitted periodically to the delay circuit 116 through the OR gate 114, so that the flip-flop 112 reverts to its "set" condition after a predetermined period of time, and the output of the flip-flop 112 returns to its low value A1. Consequently the output C1 of the OR gate 122 becomes high and excites the monostable 128, causing closure of the switch 130 for a limited period of time, sufficient to bring about arrest of the control shaft for the needle by energization of the brake winding 132. The transparent ring 42, with its opaque sector, is so orientated that the switch 130 is closed, energizing the brake winding 132, to apply the brake to the needle control shaft when the needle is at its lower dead point.

If during this period the operator closes the switch P2 to arrest of the needle at its top dead point and cut the thread, the output A1 of the NOT circuit 119, being low, prevents the AND gate 120 from opening and precludes any action in response to the operation of the switch P2.

When it is desired to cut the thread the operator closes the switch P2, which is a push-button switch. Thereafter, as soon as the phototransistor P2 is illuminated, one of the two inputs is provided to the AND gate 120. The second input to the AND gate 120 is provided by the signal A1, which appears at the output of the NOT gate 119 as soon as the flip-flop 112 is set, that is, when the needle regains its lower dead point and there stops. The output signal B1 of the AND gate 120 passes through the OR gate 122, to close the switch 124 and re-engage the friction clutch controlled by the winding 126 to cause further slow rotation of the needle control shaft by means of the low-speed motor. This rotation ceases as soon as the phototransistor P2 is obscured by the opaque sector of the ring 44. The ring 44 is so orientated as to cause obscuration of the phototransistor P2 when the top dead point has been reached by the needle. At this point, therefore, the winding 126 is de-energized, while the converted output signal C1 of the OR gate 122 causes, through the monostable circuit 128, temporary energization of the relay winding 132 and temporary actuation of the control shaft brake, analogously to the arrest of the needle at its lower dead point.

At the same time the output B1 of the AND gate 120 becomes high, priming the AND-NOT gate 134, so that the signal supplied by the phototransistor P3 upon illumination of the latter through the transparent section of the ring 46 is transmitted through the gate 134 to cause the following sequence of operations: the switch 136 is closed to energize the winding 138, causing the thread cutter blade to advance. Simultaneously, through the normally closed switch 140 and through the OR gate 142, the switch 144 is closed to energize a winding 146 controlling opening of the discs of the thread tensioning device, thereby slackening the thread in preparation for the successive dragging of the thread against the counter-blade by the cutter blade itself. The output signal of the gate 144 also passes to the delay circuit 148 which closes the switch 150 after a time delay calculated so as to enable complete advance of the blade and complete slackening of the thread tensioning device, energizing the winding 152 to cause retraction of the cutter blade and thereby to bring the thread against the counter-blade and thus sever the thread. The holding circuit 154 has already been energized at this point by the output of the AND-NOT gate 134 applied through the NOT circuit 158, upon the appearance of the control signal for advancing the cutter blade and slackening the thread tensioning device.
In practice, as described in another prior Patent application by the applicants, No. 53972-A/69, the switches P1 and P2 may be combined for operation by a single control handle, the lowering of which causes closure of the switch P1 and the raising of which, by means of back-treading, causes closure of the switch P2.

In particular cases known to those skilled in the art it is advantageous for the slackening of the thread to occur only at the moment of withdrawal of the blade of the thread cutter. This applies particularly when sewing very heavy work, for example when sewing hides and skins. In such cases the switch 140 is opened before the start of the thread-cutting operation, and control of the switch 144 is then effected through the OR gate 142 by the output signal of the delay circuit 148.

With reference to FIGS. 4a and 4b, considered together, the circuit of the arrangement shown diagrammatically in FIG. 3 will now be described in further detail.

As shown in FIGS. 4a and 4b, a direct voltage supply at +24 volts supplies a stabilizer circuit 200 which provides on a line 202 a direct voltage stabilized at +16 volts.

The OR gate 114 comprises a transistor 204 connected, with grounded emitter, to the base of which is connected a base polarization resistor 206 a resistor 208 for connection to the output A1 of the flip-flop 112 and a resistor 210 connected to the photo transistor P1.

The delay circuit 116 comprises a unijunction transistor 212, polarized by resistors 214, 216 and controlled by the collector of the transistor 204 through a delay network comprising a capacitor 218 and variable resistor 220. The variable resistor 220 permits adjustment of the delay time of the delay circuit 116. The output signal generated by the unijunction transistor 212 is differentiated by a capacitor 222 and a resistor 224, having in parallel a protection diode 226. The differentiated pulse is applied to the input of the flip-flop 112 through a diode 228.

The output A1 of the flip-flop 112 passes to the base of a transistor 230, through a resistor 232. The transistor 230 is normally cut off by a base resistor 234 and is switched on by the appearance of the flip-flop output A1. The transistor 230 thus functions as the NOT circuit 119.

The bistable AND gate 120 comprises two transistors 236, 238 polarized by respective resistors 240, 242, 244, 246, 248, 250, 252, performing the AND function. One of the inputs to the AND gate 120 is provided, through the resistor 240, from the switch P2 in series with the photo transistor P2.

The OR gate 132 comprises a transistor 254 having a base resistor 256 which keeps the transistor 254 normally cut off. To the base of the transistor 254 there is connected a resistor 258 connected to the output A1 of the flip-flop 112 and a resistor 260 connected to the output B1 of the AND gate 120. The collector load of the transistor 254 is constituted by two resistors 262, 264 in series.

Two transistors 266, 268 in cascade, and interconnected by a potential divider comprising resistors 270, 272 constitute the switch 124. The output signal C1 of the OR gate 122 for control of the switch 124 is taken off from the junction between the resistors 262 and 264 and is applied to the base of the transistor 266. The collector load of the transistor 268 is constituted by the relay winding 126.

The monostable circuit 128 comprises a transistor 270 having a resistor 272 as its collector load, the base of the transistor 270 being controlled by a signal C1 tapped off at the collector of the transistor 266 and applied to the transistor 270 through a potential divider comprising resistors 274, 276. The transistor 270, under normal conditions, that is, in absence of the voltage C1, is cut off. Therefore a capacitor 278 connected between the collector of transistor 270 and earth, through a diode 280 and two resistors 282, 284, charges up from the stabilized supply voltage of 16 volts. The appearance of a priming signal on the base of the transistor 270 causes conduction of the transistor 270 and the discharge of the capacitor 278. Thus there appears, for a limited period, a priming signal at the base of the transistor 286 which, through the resistive potential divider 288, 290, primes a further transistor 292, and which in its turn primes, through a further resistive potential divider 294, 296, a transistor switch 298, having as its collector load the relay winding 132.

The transistors 268 and 298 are weakly polarized, through two decoupling diodes 300 and 302, by the 24-volt supply voltage, reduced by a series arrangement of two Zener diodes 304, 306.

The AND-NOT gate 134 comprises a transistor 308 to the base of which is applied the signal B1 through a potential divider comprising resistors 310, 312. The collector of the transistor 308 is connected to the base of a transistor 314 provided with a base resistor 316. The collector of the transistor 308 is also connected to the photo-transistor P3 through an arrangement in series of a resistor 318 and a Zener diode 320. The transistor 314 is connected to the stabilized supply through two resistors 322, 324 in series. Therefore the transistor 314 is normally cut off, inasmuch as its base is maintained at earth potential by the conduction of the transistor 308, in the presence of the signal B1. When the signal B1 is cancelled, however, the transistor 308 is cut off and the photo transistor P3, when illuminated through the respective transparent ring 46, applies to the transistor 314 an unblocking voltage which renders the transistor 314 conducting.

The junction between the resistors 322, 324 is connected to the base of a transistor 326 the collector load of which is constituted by two resistors 328, 330 in series. The collector of the transistor 326, normally at zero voltage, assumes positive potential when this transistor is switched on by the conduction of the transistor 314.

The junction between the resistors 328, 330 is connected to the base of a transistor-switch 136 polarized by a decoupling diode 332, which is normally cut off and which is switched on by the output signal of the AND-NOT gate 134 to energize the winding 138 for advancing the cutter blade.

The delay circuit 148 comprises a transistor 334 having a resistor 336 as its collector load, and having its base piloted by the output signal of the AND-NOT gate 134 through a potential divider comprising resistors 338, 340. The collector of the transistor 334 is connected to a delay network comprising a capacitor 342, resistors 344, 346, and a diode 348. The transistor 334 is normally cut off, and thus the capacitor 342 is charged from the stabilized supply. Conduction of the transistor 334, caused by the signal supplied via the
AND-NOT gate 134, earths left-hand (as viewed) electrode (anode) of the capacitor 342, causing the latter discharge through resistors 344, 346, and switching on the transistor 350 for a limited period of time. The collector of the transistor 350 is connected to the supply voltage through two resistors 352, 354 in series. Conduction of the transistor 350 causes conduction of a further transistor 356, which, through a resistor 358, the base of a transistor switch 150. The transistor 150 is polarized through a decoupling diode 360, and the conduction of the transistor 150 causes excitation of the relay winding 152 for effecting withdrawal of the cutter blade for a limited time, corresponding to the time constant of the delay network including the capacitor 342.

The output of the delay circuit 148 is connected through a resistor 362 to the base of a transistor switch 144 which is polarized through a decoupling diode 364 and through a base resistor 366. The transistor 144, when switched on by the delay circuit output, causes energization of the relay winding 146 which effects opening of the discs of the thread tensioning device. The output signal of the AND-NOT gate 134 reaches the base of the transistor 144 through the normally closed manual switch 140 and through a resistor 368, 25

The junction between the resistors 368, 362 and the base of the transistor 144 thus acts effectively as the OR gate 142 of FIG. 3.

It now remains to describe the holding circuit 154 which provides for partial excitation of the blade withdrawal winding 152 in normal conditions. A transistor 370 having resistor 372 as collector load is held normally conducting by a potential divider comprising resistors 374, 376. The collector of the transistor 370 is connected to a delay network comprising a diode 378 and a capacitor 380 connected in parallel with the transistor 370 and two resistors 382, 384 in series connected across the capacitor 380. The junction between the resistors 382, 384 is connected to the base of a transistor 386 having as its collector load two resistors 388, 390 connected in series.

The collector voltage of the transistor 370 follows the course of its base voltage, which in turn follows any variations in the unfiltered and unstabilized supply at 24 volts. The diode 378 transmits any variations in the said supply voltage to the capacitor 380, which filters the applied voltage and applies to the base of the transistor 386 a direct voltage capable of maintaining the transistor 386 lightly conducting. Consequently the transistor 392 is maintained in conduction, having as its load two resistors 394, 396 in series, the junction of the said resistors 394, 396 being connected to the base of the transistor switch 150 to maintain the latter in weak conduction and thus to maintain the withdrawal winding 152 partially or weakly excited.

When the transistor 326 of the AND-NOT gate 134 is conducting, its high collector voltage is transferred to the base of the transistor 370 through a resistor 398, stabilizing the collector voltage of the latter and saturating it. The voltage across the capacitor 380 is therefore annulled, cutting off the transistor 386 and consequently the transistor 392. The transistor switch 150 is then cut-off.

What is claimed is:

1. In a sewing machine of the industrial type having a high-speed motor, a low-speed motor, a needle control shaft adapted to be driven selectively by said motors, a reciprocating needle operable by said control shaft, a threadcutter device having a movable cutter blade and a fixed counter blade, and a thread tensioning device, the improvement which consists in an electronic control arrangement comprising, in combination:

a. a first control switch operable to stop the needle at its lower dead point;

b. a first transparent ring keyed to the needle control shaft and having an opaque sector;

c. a source of light;

d. a first photo-transistor;

e. means supporting said first photo-transistor to be illuminated by said source through said first ring;

f. first logic circuits controlled by said first switch and said first photo-transistor;

g. an electromagnetic clutch controlled by said first logic circuits and upon energization coupling the needle control shaft to the low-speed motor;

h. an electromagnetic brake controlled by said first logic circuits and adapted to be energized thereby for a short period to arrest said control shaft at its lower dead point;

i. a second control switch controlling cutting of the thread and for positioning the needle at its top dead point;

j. second and third transparent rings having respective opaque sectors adapted to rotate with the control shaft;

k. second and third respective sources of light,

l. second and third respective photo-transistors supported for illumination by said respective sources through said second and third rings respectively;

m. second logic circuits controlled by said second switch and by the said second and third photo-transistors to engage said electromagnetic clutch and successively for a short period said electromagnetic brake to bring the needle to its top dead point;

n. first and second electromagnetic actuator means controlled by said second logic circuits for advancing the cutter blade of the threadcutter device and slackening the thread-tensioning device respectively, and

o. third electromagnetic actuator means operable after a predetermined delay by said second logic circuits for withdrawing the cutter blade towards the counter-blade to sever the thread; and

p. said first, second and third rings being adjustable in angular position relative to said control shaft to regulate the instants of operation of said clutch, said brake and said first, second and third electromagnetic actuator means.

2. Electronic control arrangement as defined in claim 1, and further including a holding circuit adapted to maintain weak excitation of said third electromagnetic actuator means for effecting withdrawal of the cutter blade during the periods in which the first actuator means is not excited.

3. Electronic control arrangement as defined in claim 1 including delay means actuating said electromagnetic brake after a predetermined delay following engagement of said electromagnetic clutch.

4. Electronic control arrangement as defined in claim 1, wherein said delay means include a variable resistor for regulating said predetermined delay.

5. Electronic control arrangement as defined in claim 1, including means for delaying excitation of said second electromagnetic actuator means for slackening the thread tensioning device following the excitation of said first electromagnetic actuator means for advancing the cutter blade.

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