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CONTROL SYSTEMS FOR SEWING MACHINES

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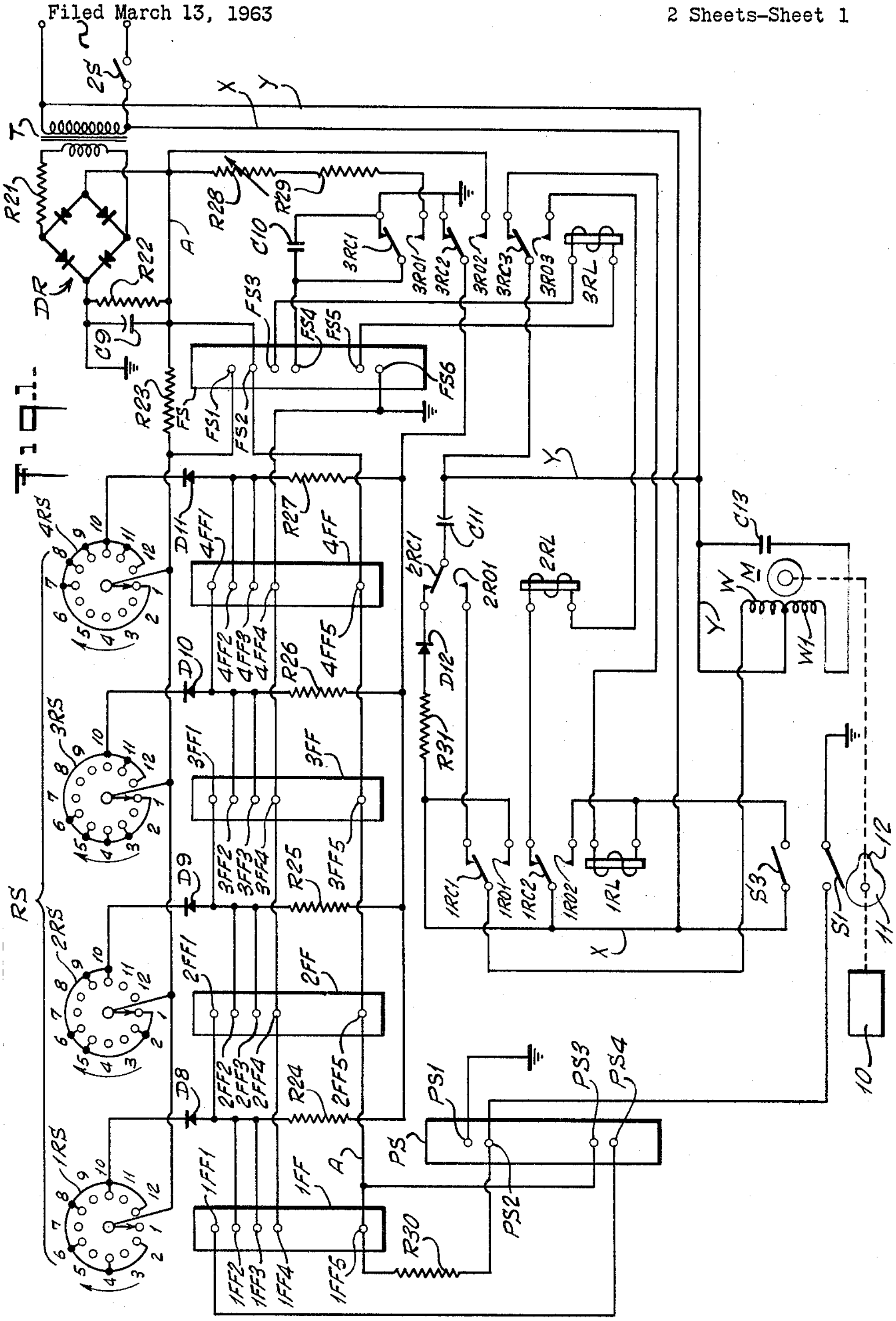

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Fig. 2.

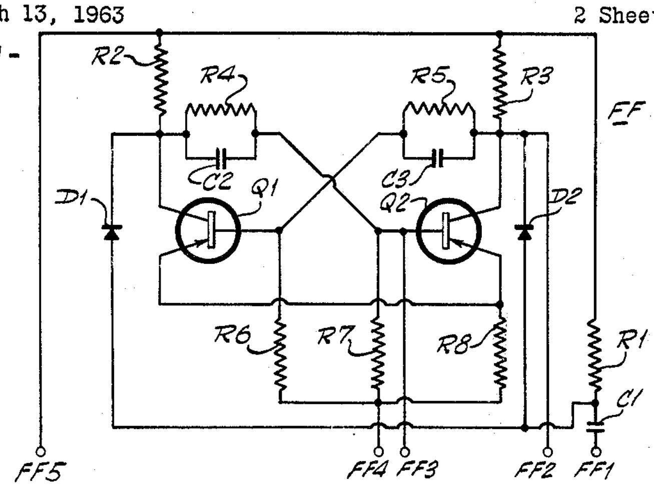
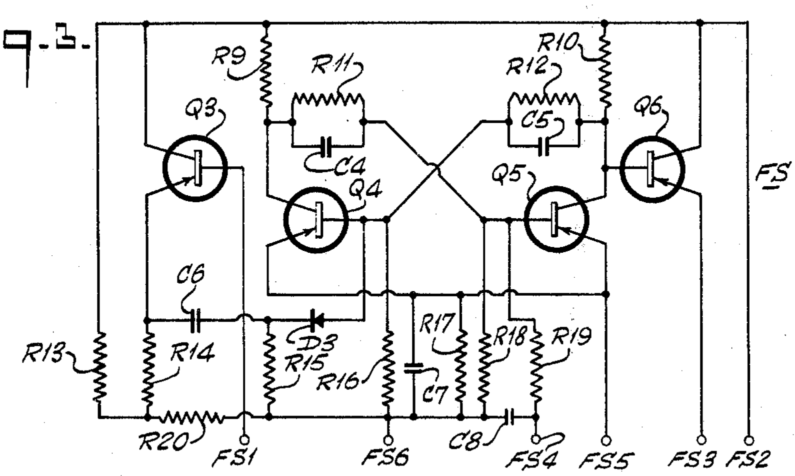


Fig. 3.



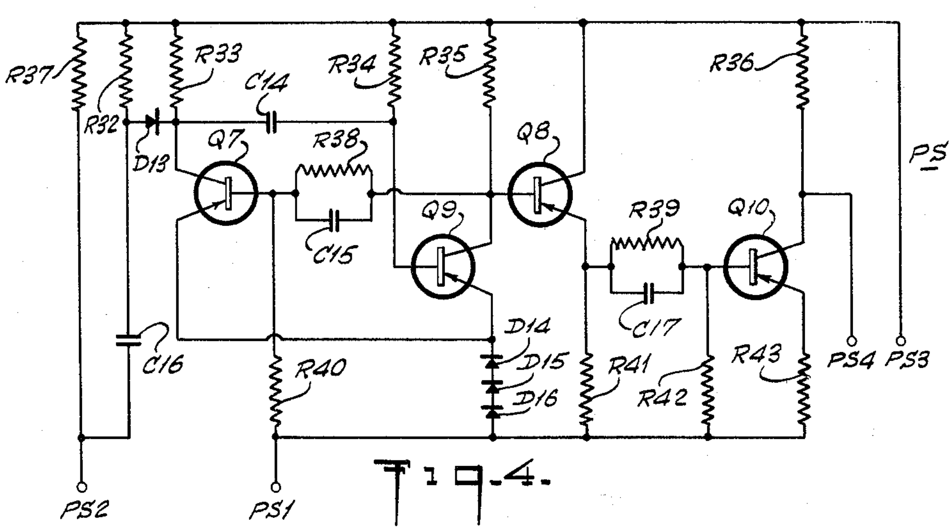


Fig. 4.

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CONTROL SYSTEMS FOR SEWING MACHINES

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9 Claims. (Cl. 112—219)

The present invention relates generally to improvements in control systems for sewing machines, and in particular it relates to an improved apparatus for automatically effecting a sewing sequence of a predetermined number of stitches.

There are many sewing operations, particularly in the commercial production of various articles of wearing apparel, where it is necessary repeatedly to apply a sequence of a predetermined number of stitches. In order to attain maximum operational quality and efficiency, not only should the number of stitches successively applied be uniform, but also a minimum of the operator's time should be consumed in repetitively effecting the desired sequence. The control of the application of a sequence of a predetermined number of stitches is generally left to the skill and judgment of the machine operator. As a consequence, due to variations between individual operators, as well as in the individual operator's inability to precisely repetitively control the formation of a precise number of stitches at high speed, there is not only a lack of uniformity, which may detract from the quality of the end product, but the efficiency of the operation is lowered. In order to achieve the desired precise number of stitches, it is generally necessary to slow the sewing considerably as the end of the sequence is approached and frequently to adjust the position of the needle at the termination of the sequence. Mechanisms have heretofore been employed and proposed automatically to effect a sequence of a predetermined number of stitches but these have been characterized by their inflexibility and unreliability. They are generally lacking in accuracy, cannot be closely controlled, are subject to frequent malfunctioning and rapid wear, are of limited application, and otherwise leave much to be desired.

It is, therefore, a principal object of the present invention to provide an improved sewing machine control system.

Another object of the present invention is to provide an improved sewing apparatus for effecting automatically the application or formation of a predetermined number of stitches.

Still another object of the present invention is to provide an improved sewing apparatus for automatically forming or applying a simply pre-adjusted or predetermined number of stitches.

A further object of the present invention is to provide a sewing apparatus for automatically forming or applying a predetermined number of stitches and stopping the sewing machine with the needle in a predetermined position.

Still a further object of the present invention is to provide a sewing machine of the above nature characterized by its accuracy and reliability in operation, its versatility and easy adjustability, and its structural ruggedness.

The above and other objects of the present invention will become apparent from a reading of the following description taken in conjunction with the accompanying drawing, wherein:

FIGURE 1 is a schematic view and a block diagram of a sewing apparatus embodying the present invention;

FIGURE 2 is a circuit diagram of a counter module;

FIGURE 3 is a circuit diagram of a switch module; and

FIGURE 4 is a circuit diagram of a pulse forming module employed in the present apparatus.

In a sense, the present invention contemplates the pro-

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vision of a sewing apparatus comprising means for applying stitches, means for producing electric pulses in accordance with the number of said stitches, and means responsive to a predetermined number of said electric pulses for deactivating said stitch-applying means.

According to a preferred form of the present apparatus, there is provided a pulse-forming network, the input to which is a pulse produced by the closing of a sensing or keying switch by the sewing machine with the production of each stitch. The pulse counter includes a plurality of series connected flip-flop circuits; the input to the leading flip-flop circuit is the output of the pulse-forming network. A rotary switch is associated with each of the flip-flop circuits, the rotary switches being ganged and having their arms interconnected electrically. Selected contacts of each of the rotary switches are connected to the outputs of respective flip-flop circuits so that different combinations of these outputs are connected in parallel with different positions of the ganged switch. The parallel-connected arms of the ganged switches are connected to the set terminal of a control bi-stable flip-flop circuit provided with means for automatically resetting after an adjustable predetermined period. The sewing machine drive is an alternating current motor connected through a selectively actuatable relay switch to a source of alternating current. The set output of the control flip-flop circuit effects resetting of the counter flip-flop circuits, the opening of the motor relay switch and the closing of a switch connecting the drive motor to a source of direct current for braking the motor, the resetting of the control flip-flop circuit effecting the opening of the latter switch.

Referring now to the drawings which illustrate a preferred embodiment of the present invention, reference numeral **10** generally designates a sewing machine of any desired type which is suitably coupled to the rotor of an alternating current drive motor M including a running winding W and a starter winding W1 shunted by a starting capacitor C13. A cam **11** is mounted on and rotates with the drive shaft of sewing machine **10**, making one revolution for each stitching cycle, and includes a rise portion **12**. A normally open high-speed sensing or keying switch S1, which may be of any well known type such as the breaker point assembly of an automobile engine ignition system, is engaged by cam **11** and momentarily closed by the rise portion **12** during each stitching cycle. Other than mechanical types of sensing switches may be employed, as, for example, optical sensing and the like, and each sensing unit may be completed with the needle in up or in work-disengage position or in the down, work-engage position.

The closing of switch S1 effects the production of an electrical pulse and the network for counting these pulses and controlling the drive of sewing machine **10** includes a pair of electrical lines X and Y connected through a main switch 2S to a suitable source of alternating current, such as the commercial power lines. A step-down transformer T has its input connected across lines X, Y and its output connected to the opposite input terminals of a solid state bridge rectifier DR through a resistor R21, the positive output terminal of rectifier DR being grounded and the opposite negative terminal being connected to a negative line A. Connected across the output terminals of rectifier DR is a filter capacitor C9 shunted by a resistor R22.

In order to count the number of stitching cycles as indicated by the closings of switch S1 there are provided a pulse shaping network and filter PS and a binary counter including a plurality, for example four as shown, of bistable flip-flop circuits 1FF, 2FF, 3FF and 4FF. The mechanism for selecting the number of stitches in a sewing sequence includes a gang RS of rotary switches 1RS, 2RS, 3RS and 4RS associated with the corresponding flip-flop circuits FF and a control circuit defining flip-flop circuit FS and relay solenoids 1RL, 2RL and 3RL. Actuated by relay solenoid 1RL are a double-throw switch including the normally closed switch 1RC1 and the normally open switch 1RO1 and a double-throw switch including the normally closed switch 1RC2 and the normally open switch 1RO2. Actuated by relay solenoid 2RL is a double-throw switch including the normally closed switch 2RC1 and the normally open switch 2RO1. Relay solenoid 3RL actuates three double-throw switches including the normally closed and open switch pairs 3RC1 and 3RO1, 3RC2 and 3RO2, and 3RC3 and 3RO3.

The power voltage terminals PS3, PS4 of the pulse shaper PS, 1FF5, 2FF5, 3FF5 and 4FF5 of the flip-flop circuits FF, and FS2 of the control network are connected to negative line A and the corresponding ground terminals PS1, 1FF4, 2FF4, 3FF4, 4FF4 and FS6 are connected to positive ground. The pulse-shaper circuit PS has a signal input terminal PS2 connected through the sensing switch S1 to ground and through a resistor R30 to negative line A, and it has a pulse output terminal PS4 connected to signal input terminal 1FF1 of the leading flip-flop circuit 1FF. The signal output terminals 1FF2, 2FF2 and 3FF2 of flip-flop circuits 1FF, 2FF and 3FF are connected respectively to the signal input terminals 2FF1, 3FF1 and 4FF1 of the next successive flip-flop circuits 2FF, 3FF and 4FF.

The rotary switches 1RS, 2RS, 3RS and 4RS are ganged so that the switch arms thereof engage similarly located contacts of corresponding switches. Alternate contacts number **2, 4, 6, 8, 10** and **12** of switch 1RS are connected through a diode D8 to flip-flop output terminal 1FF2; alternate pairs of contacts number **1, 2, 5, 6, 9** and **10** of rotary switch 2RS are connected through a diode D9 to the flip-flop output terminal 2FF2; contacts number **1, 3, 4, 5, 6, 10, 11** and **12** of rotary switch 3RS are connected through a diode D10 to flip-flop output terminal 3FF2; and contacts number **1, 7, 8, 9, 10, 11** and **12** of switch 4RS are connected through a diode D11 to signal output terminal 4FF2 of the last flip-flop circuit 4FF. It should be noted that if a disconnected rotary switch contact is considered as zero and a connected rotary switch contact is considered as 1, the decimal numbers corresponding to the binary numbers defined by the successive positioning of the rotary switch arms from the number **2** contact position upwardly through contact number **12** are 3 to 13 successively, and at contact position number **12** the corresponding decimal number is 14. It should also be noted that the number of successive contacts in each group and the spacing between successive groups in the successive rotary switches are equal to 2N1 where N is the position of the respective rotary switch in the group of switches. The arms of the rotary switches RS are connected to the signal input or set terminal FS1 of control circuit FS and are connected through a resistor R23 to negative line A.

The output terminals FS3 and FS5 of control circuit FS are connected to the terminals of relay solenoid 3RL. The control circuit FS has a reset terminal FS4 which is connected through the normally closed relay switch 3RC1 which is shunted by a capacitor C10 to ground and through the normally open relay switch 3RO1 in series with a resistor R29 and a rheostat R28 to the negative line A. Reset terminals 1FF3, 2FF3, 3FF3 and 4FF3 of flip-flop circuits FF are connected through resistors R24, R25, R26 and R27 respectively to a common line, which is, in turn, connected through the normally closed relay switch 3RC2 to ground and through the normally open relay switch 3RO2 to negative line A.

The series-connected normally closed relay switch 1RC2, relay solenoid 2RL and normally open relay switch 3RO3 are connected between the lines X and Y. Relay solenoid 1RL is connected in series with a normally open, manually or otherwise selectively operated switch S3, and the normally closed relay switch 3RC3 across the lines X, Y, switch S3 being shunted by the normally open relay-hold switch 1RO2. Switch S3 may be operated manually in any suitable manner, by the knee, a foot lever or the like. A storage capacitor C11, employed for braking motor M and the sewing machine **10** is connected in series with the normally closed relay switch 2RC1, a diode D12 and a resistor R31 across the lines X, Y. Motor winding W is connected through the normally open relay relay switch 1RO1 across the lines X, Y and through the series-connected normally closed relay switches 1RC1 and normally open relay switch 2RO1 across capacitor C11.

In FIGURE 2 of the drawing there is illustrated in detail one of the counter flip-flop circuits FF which includes a pair of transistors Q1 and Q2, the collector of transistor Q1 being connected to the emitter of transistor Q2 through a resistor R4 shunted by a capacitor C2 and the collector of transistor Q2 being connected through a resistor R5 shunted by a capacitor C3 to the emitter of the transistor Q1. Input terminal FF1 is connected through an input capacitor C1 to the collectors of transistors Q1 and Q2 through diodes D1 and D2 respectively and to the power input terminal FF5 through a resistor R1. The collectors of transistors Q1 and Q2 are connected through resistors R2 and R3 respectively to terminal FF5 and the bases thereof are connected to the terminal FF4 through resistors R6 and R7 respectively, as are the emitters thereof through a common resistor R8. The base of the transistor Q2 is connected to the reset terminal FF3.

Flip-flop circuit FF operates in conventional manner switching from one state to another upon the application of a positive pulse to the terminal FF1. The output as taken from the terminal FF2 is either in a zero or off state which is positive, or a one or on state which is negative. The application of a negative pulse to terminal FF3 resets the circuit to its zero or off state.

The control flip-flop circuit FS is shown in detail in FIGURE 3, and comprises an emitter follower stage including a transistor Q3, a bi-stable flip-flop stage including transistors Q4 and Q5 and an output coupling stage including transistor Q6. The collector of transistor Q3 is connected directly to negative power terminal FS2 and through series-connected resistors R13 and R20 to ground terminal FS6, and the base thereof is connected to the input terminal FS1. The emitter of transistor Q3 is connected through resistor R14 to the junction of resistors R13 and R20 and to the base of transistor Q4 through a series-connected capacitor C6 and diode D3, the junction of which is connected through a resistor R15 to terminal FS6.

The collector of transistor Q4 is connected through a resistor R9 to terminal FS2 and through a resistor R11 shunted by a capacitor C4 to the base of the transistor Q5, the collector of transistor Q5 being connected through the resistor R10 to terminal FS2 and through the resistor R12 shunted by the capacitor C5 to the base of transistor Q4. The bases of transistors Q4 and Q5 are connected through resistors R16 and R18 respectively to terminal FS6 and the emitters thereof are also connected to the terminal FS6 through a common resistor R17 of low resistance shunted by a capacitor C7. The reset terminal FS4 is connected through a resistor R19 to the base of transistor Q5 and through a capacitor C8 to terminal FS6. The emitter of transistor Q6 is connected directly to terminal FS3, the collector to terminal FS2 and the base to the collector of transistor Q5.

In operation of circuit FS, a negative pulse to the terminal FS1 drives the flip-flop circuit to a state where the transistor Q4 conducts and the transistor Q5 is substantially at cut-off to impress a negative signal on transistor Q6 base rendering the transistor Q6 highly conducting and providing a low impedance voltage between the terminals FS3 and FS5. A negative pulse to the reset terminal FS4 switches the flip-flop circuit to drive the transistor Q6 substantially to cut-off and opening the voltage circuit to output terminal FS3.

The pulse shaping of forming circuit PS, as seen in detail in FIGURE 4, serves to provide uniform pulses to the counter leading flip-flop circuit FF1 and to filter out noise from the switch S1 so that there are no spurious or random counts. The pulse shaping circuit PS is a mono-stable flip-flop circuit including four transistors Q7, Q8, Q9 and Q10. The emitters of the transistors Q7 and Q9 are joined and connected through a series of Zener or regulating diodes D14, D15 and D16 to terminal PS1. The collector of transistor Q7 is connected through a resistor R33 to terminal PS3, through a capacitor C14 to the base of transistor Q9 and through a diode D13 to the junction of a series-connected resistor R32 and capacitor C16 connected between terminals PS2 and PS3, the resistor end being connected to terminal PS3. The terminals PS2 and PS3 are also connected by a resistor R37. The base of transistor Q7 is connected through resistor R40 to terminal PS1 and through a resistor R38 shunted by a capacitor C15 to the base of transistor Q8 and the collector of transistor Q9. The bases of transistors Q8 and Q9 are connected through resistors R35 and R34 respectively to terminal PS3, the collector of transistor Q8 being connected directly to terminal PS3, and the emitter thereof being connected through resistor R41 to terminal PS1 and through resistor R39 shunted by capacitor C17 to the base of transistor Q10. The base of transistor Q10 is connected through resistor R42 to terminal PS1, the emitter thereof is connected through resistor R43 to terminal PS1, and the collector is connected directly to output terminal PS4 and through a resistor R36 to terminal PS3.

In the operation of circuit PS, the application of a positive pulse to the input terminal PS3 as by the grounding of the terminal through the closing of switch S1 results in a positive pulse at the output terminal PS4 which is of predetermined amplitude and duration substantially independent of the input pulse. Moreover, the pulse shaper is disabled the predetermined period of its flip-flop cycle which is a short time less than the open period of the switch S1 during the fastest single stitch cycle whereby to eliminate spurious counts and assure an accurate count.

Considering now the operation of the improved sewing apparatus described above, in its dormant state the circuit network is in the condition illustrated in FIGURE 1 with the various switches being in the positions shown. The circuit is energized by closing main switch 2S, the braking capacitor C11 being charged through the resistor R31 and diode D12 by reason of the circuit thereto from the lines X, Y being completed by the closed relay switch 2RC1. The rotary switch gang RS is illustrated in its **14** stitch position. The counter flip-flop circuits FF are in their off state so that the input to circuit FS is positive and the control flip-flop circuit FS is off. It should be noted that the control flip-flop FS is switched to its on position only when all of those of the counter flip-flop circuits FF which are inserted by the respective rotary switches RS are in their on state.. Thus, in the fourteen stitch position illustrated, it is only when flip-flop circuits FF2, FF3 and FF4 are in their on states that the control flip-flop circuit FS is switched to its on state.

In order to initiate the sewing sequence the switch S3 is momentarily closed to complete the circuit to and energize the relay solenoid 1RL, opening relay switch 1RC1 and 1RC2 and closing relay switches 1RO1 and 1RO2. The closing of relay switch IRO1 completes the alternating current circuit to and energizes the drive motor M and the closing relay switch IRO2 shunts switch S3 and holds the relay solenoid 1RL energized. The sewing machine **10** is driven by the motor M and with each stitching cycle the concurrently rotating cam **11** momentarily closes the keying switch S1 to ground the input terminal PS2 of the pulse shaper circuit PS and apply a positive pulse thereto. The resulting positive pulse output from the circuit PS is applied to the input of the leading counter flip-flop circuit FF1 switching it to its on state which is negative at its output terminal 1FF2. The next stitching cycle results in a second pulse being applied to the input terminal 1FF1 to switch it back to its off state which results in a positive signal output applied to the input of the next flip-flop circuit FF2 to switch it to its on state. The successive counter flip-flop circuits FF3 and FF4 operate in a similar manner, as well known in the art. Thus, the counter flip-flop circuits FF1, FF2 and FF3 switch on and off at alternate pulses, alternate pairs of pulses and alternate groups of four pulses applied to the input of the leading flip-flop circuit FF1, and the flip-flop circuit FF4 is switched on upon the application of eight input pulses, as in the conventional binary counters. Thus, upon the application of fourteen pulses to the counter input consequent to fourteen stitching cycles, the flip-flop circuits FF2, FF3 and FF4 assume their on states resulting in the application of a negative signal to the control flip-flop circuit FS, switching the circuit and closing the current supply circuit to the output terminals FS3 and FS5 to energize the relay solenoid 3RL.

The energized relay solenoid 3RL opens relay switches 3RC1, 3RC2 and 3RC3 and closes relay switches 3RO1, 3RO2 and 3RO3. The opening of relay switch 3RC3 opens the circuit to relay solenoid 1RL, de-energizing the solenoid and thereby returning the relay switches 1RC1 and 1RC2 to their closed condition and 1RO1 and 1RO2 to their open condition. The opening of switch 1RO1 breaks the energizing current circuit to the drive motor M. The closing of relay switch 3RO3 completes the circuit to relay solenoid 2RL through relay switch 1RC2 following its release to its closed position to energize the relay solenoid 2RL. The energized solenoid 2RL closes relay switch 2RO1 connecting the capacitor C11 through the relay switch 1RC1 across the motor M. The capacitor C11, which is of a high capacitance and charged to the full line voltage, discharges through the motor winding sharply to break motor M and sewing machine **10**. It is important to note that the cam **11** is phased to close the keying switch at a point where the sewing machine will stop with the needle in a desired predetermined position, usually raised, or depressed under certain conditions. The time difference between the closing of switch SL corresponding to the termination of a stitching sequence and the stopping of the motor M depends primarily on the relay switching time and the motor braking time and to some extent on the circuit switching times, and the lead of the cam **11** in closing the switch S1 should compensate for these in effecting the termination of a stitching sequence with the needle in a predetermined position.

The closing of relay switch 3RO2 applies a negative pulse to terminals FF3 and counter flip-flop circuits FF to reset flip-flop circuits FF to their off or zero states. The opening of relay switch 3RC1 and the closing of relay switch 3RO1 connects reset terminal FS4 of control flip-flop circuit FS through resistor R29 and rheostat R28 to the negative line A, and through capacitor C10 to ground. Upon capacitor C10 being charged to a sufficient negative potential to trigger circuit ES, the circuit FS is switched to its off state, thereby opening the energization terminals FS3 and FS5 and de-energizing relay solenoid 3RL. The reset time of circuit FS may be adjusted by means of rheostat R28 which controls the charging rate of capacitor C10. Upon de-energization of relay solenoid 3RL, the relay solenoids and switches return to their initial state, capacitor C10 being discharged through closed relay switch 3RC1 and capacitor C11 being recharged through closed relay switch 2RC1. The stitching sequence may be now repeated or a sequence of a different number of stitches effected by adjustment of the rotary switch gang RS.

While there has been described and illustrated a preferred embodiment of the present invention it is apparent that numerous alterations, omissions and additions may be made without departing from the spirit thereof.

Having described the invention, what is claimed and desired to be secured by Letters Patent is:

1. A sewing apparatus comprising means for applying stitches, means for producing electric pulses in accordance with the number of said stitches, and a binary counter responsive to a predetermined number of said electric pulses for deactivating said stitch applying means.

2. A sewing apparatus comprising means for applying stitches, means for producing electric pulses in accordance with the number of said stitches, a solid state binary counter responsive to a predetermined number of said electric pulses for deactivating said stitch applying means, and means for adjusting said predetermined number of pulses.

3. A sewing apparatus comprising a sewing machine, means for driving said sewing machine successive stitching cycles, means for producing electric pulses corresponding to the number of said stitching cycles, and a solid state binary counter responsive to a predetermined number of said electric pulses for deactivating said driving means.

4. A sewing apparatus comprising a sewing machine, an alternating current drive motor connected to said sewing machine, a source of alternating current, a storage capacitor, means for connecting said storage capacitor to said source of direct current, a source of direct current, switching means for alternatively connecting said drive motor to said alternating current and across said storage capacitor, means for selectively actuating said switching means to connect said drive motor to said alternating current, means actuated with said sewing machine for producing electric pulses related to the number of stitching cycles of said sewing machine, and means responsive to a predetermined number of said electric pulses for actuating said switching means to connect said drive motor across said storage capacitor.

5. A sewing apparatus comprising a sewing machine, means driving said sewing machine successive stitching cycles, means for selectively actuating said driving means, a sensing switch actuated by said sewing machine each of said stitching cycles, means responsive to the actuation of said sensing switch for producing an electric pulse, a binary counter actuated by said pulses, and means responsive to a predetermined count on said binary counter for deactuating said driving means.

6. The sewing apparatus of claim 5, including means for resetting said binary counter following said network reaching said predetermined count.

7. The sewing apparatus of claim 5, wherein said binary counter comprises a plurality of bi-stable flip-flop circuits connected in series and including a leading flip-flop circuit having an input connected to the output of said pulse-producing means.

8. The sewing apparatus of claim 7, wherein said count responsive means includes means for connecting the outputs of preselected of said flip-flop circuits in parallel, and a circuit network responsive to said preselected flip-flop circuit being in a predetermined state.

9. The sewing apparatus of claim 7, wherein said count responsive means comprises a rotary switch associated with each of said flip-flop circuits, said rotary switches being ganged and having their arms interconnected and being provided with a corresponding plurality of contacts, means connecting selected of said contacts of each of said rotary switches to the output of a corresponding flip-flop circuit whereby different combinations of said outputs are connected in parallel in accordance with the position of said switch, and a circuit network responsive to said flip-flop circuits whose outputs are connected in parallel being in a predetermined state.

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