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AUTOMATIC SEWING MACHINE SYSTEM

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2 Sheets-Sheet 1



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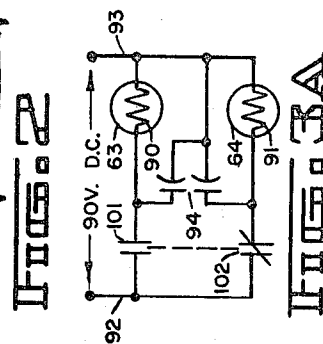
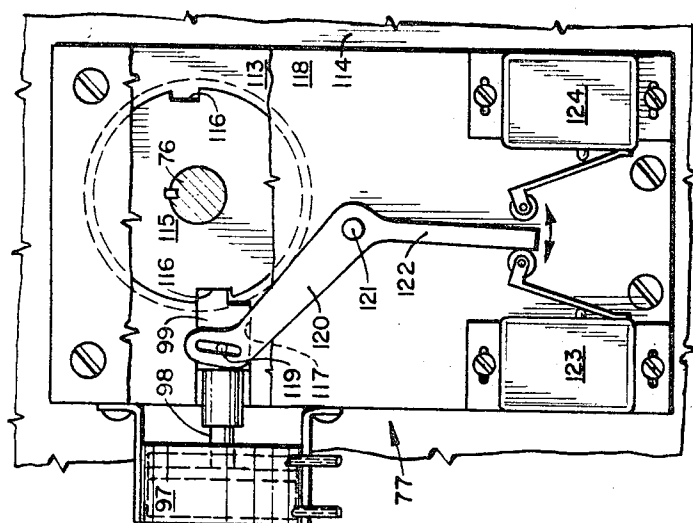
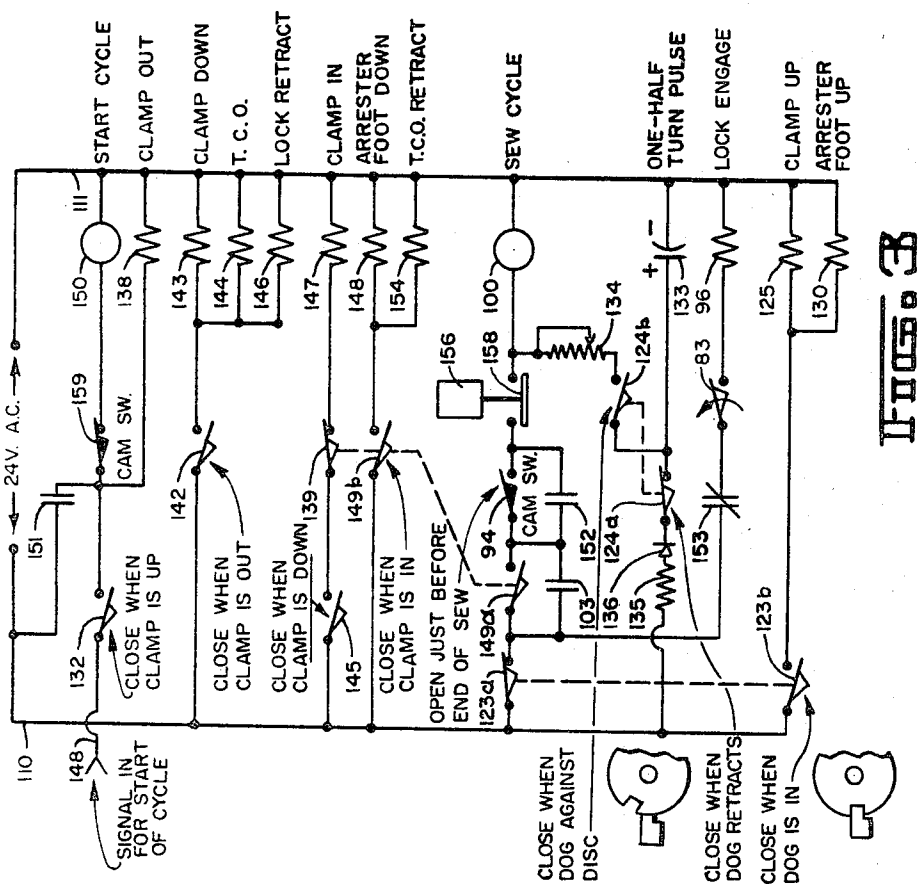
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AUTOMATIC SEWING MACHINE SYSTEM

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This invention relates to a fully automatic sewing machine for stitching fabric work material along any desired predetermined path extending in more than one dimension and having a system for stopping the needle in a raised position for releasing the completed workpiece and then for engaging the next workpiece and re-starting the stitching.

This invention is an improvement in the automatic high-speed stitching methods and apparatus disclosed and claimed in copending application Ser. No. 436,763, filed on Mar. 3, 1965.

In an automatic sewing machine system embodying the present invention the various pieces of the fabric work material are propelled with respect to the stitching station by a clamp member movable in more than one coordinate direction for producing the desired multi-dimensional stitching pattern in the material. When the stitching pattern has been completed the needle is automatically secured in an upper position to provide clearance between the tip of the needle and the clamp member. The clamp member is moved to release the completed fabric workpiece and to move over for engaging the next fabric workpiece and quickly to bring it into the stitching station and commence stitching it. Advantageously, during the movement to engage the next workpiece and to bring it into the stitching station, the clamp member is driven independently of the mechanism which propels the clamp during the stitching operation.

In this illustrative system to assure that the needle is positively secured and remains in its raised position during the unloading and reloading of the stitching station, the drive mechanism for the sewing machine is rapidly braked to a stop, and a positive lock then engages the drive mechanism. It will be appreciated that the momentum of the moving parts of the sewing machine and its drive causes some motion to take place after the fast-acting brake has been applied. This system provides that the lock does not become engaged until the motion of the parts has become slowed down below that speed at which the engagement of the lock would cause breakage. Moreover, this system provides that the needle is raised to its upper position and is locked there in the event the sewing machine initially comes to rest with the needle in a lowered position.

In this illustrative system the fabric work material is supported upon a surface, such as a smooth table top, and the clamp member engages the work material and moves it over the supporting surface by a friction grip which exceeds the friction force between the lower surface of the material and the supporting surface. During the stitching operation the clamp member is driven by cams and levers having cam followers engaging the cams. Double-acting drive means provide the resilient spring force for causing the levers to follow the motion of the cams during this stitching operation so as to produce the desired pattern. During the unloading and reloading operation the double-acting drive means takes control to disengage the levers from the cams and provides the drive for the movement of the clamp member for moving it to deliver the completed fabric workpiece and to engage the next fabric workpiece and quickly bring it into the stitching station and to reengage the levers with the cams to commence stitching the work.

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It is an object of the present invention to provide an improved automatic sewing machine system which sews the fabric work material along any desired predetermined path in more than one coordinate direction at high speed and which quickly unloads and reloads the stitching station while assuring that the needle is securely locked and held in a raised position during the unloading and reloading.

The present invention enables the stitching operation to start at the edge or at any interior point in an expanse of work material, and the stitching automatically progresses at a high rate of speed along straight lines and around bends and abrupt changes in direction to produce the desired path of stitches extending in more than one coordinate direction and which unloads and reloads the work material in a manner suitable for automatically fabricating parts and components of garments and the like in an automatic production system.

As used herein, the term "fabric work material" is intended to mean fabric, cloth, felt, canvas, leather, sheet or similar fabric-like goods upon which the stitching work is performed. This term is intended to include all such types of goods able to accommodate small amounts of distortion in the plane of the goods themselves, regardless of whether the material of the goods is in one piece or multiple pieces, one layer or multiple layers, regardless of whether the goods are woven, non-woven, felted, in sheet form, porous, perforate or imperforate, natural or synthetic or blended.

The term stitching along a path extending in more than one dimension (in multiple coordinates) is intended to mean that the path of the stitches in the work material can be defined with respect to the general plane of the work material in terms of multiple coordinates, and regardless of whether the work material itself as a whole is planar or non-planar form. In other words the stitching path may include straight-line segments, curved segments, angles, abrupt changes in directions, spirals, cusps, and the like.

In this specification and in the accompanying drawings, is described and shown an automatic sewing machine system embodying the present invention, but it is to be understood that this disclosure is not intended to be exhaustive nor limiting of the invention, but on the contrary is given for purposes of illustration in order that others skilled in the art may fully understand the invention and the manner of applying the system in practical use and will understand how to modify and adapt it in various forms, each as may be best suited to the conditions of a particular manufacturing application.

The various objects, aspects, and advantages of this invention will be more fully understood from a consideration of the following specification in conjunction with the accompanying drawings, in which:

FIGURE 1 is a perspective view of an automatic high-speed multiple coordinate sewing machine system embodying the present invention.

FIGURE 2 is an elevational view, partially broken away, of a locking mechanism, shown full size, which serves to lock the sewing machine drive with the needle in its fully raised position; and

FIGURES 3 and 3A are schematic electrical circuit diagrams of the control system.

In FIGURE 1, is shown an automatic sewing machine system 10, and the work material W which is being stitched is a plurality of layers of fabric to be used in part of a garment. This work W is held by a rapidly movable clamp member 12 which frictionally engages the top surface of the work and serves to slide the work in two coordinate directions over a work table 14. Thus, the work is moved past a reciprocating needle 16 secured in

the needle bar of a high-speed sewing machine 18, and this system is capable of producing a line of stitches S along any desired stitching path P extending in two coordinate directions.

The clamp member 12 includes a lightweight rigid frame 20 with a resilient coupling medium 22 attached to the frame and pressing down onto the work W closely adjacent to the line of stitches S. The resilient coupling medium 22 is compliant in compression so as to accommodate different thicknesses in the work material, for example where different numbers of layers are present at different regions of the work. This coupling medium 22 is also compliant in shear to accommodate the arresting of small localized areas of the work W during each instant that the needle 16 is inserted in the work while the remainder of the work is in continuous movement at high speed. In this example the coupling medium 22 is sponge rubber.

The automatic sewing machine system is capable of stitching the work material W at a high rate of speed. The clamp member 12 is connected to a long, rigid light-weight arm 24 which is driven by drive mechanism generally indicated at 25, as will be described in detail further below.

When the stitching pattern S has been completed, the needle 16 is raised up out of the way and the thread is automatically cut, for example, as explained in said copending application Ser. No. 436,763. The clamp member 12 is elevated so as to disengage the resilient coupling medium 22 from the work to release the completed work. While the clamp member 12 is elevated, it is brought into relative position above a new piece of work material at a work receiving point. The clamp member is lowered onto this new work and is quickly brought back into operative relationship with respect to the needle 16. It is noted that the completed work may be released at a different point on the work table 14 from that at which the new work is engaged, or the delivery and receiving locations may be the same, as may be desired in a particular production application.

During the stitching operation the work material W is being slid over the table 14 past the needle 16 which is reciprocated up and down by the needle bar. The needle point passes down through a throat opening in the table 14. In this example lockstitches are formed between a top thread 26 carried by an eye in the needle and a lower thread 27 supplied from a bobbin mechanism below the table in conventional manner. The localized region of the work material which is briefly penetrated by the needle 16 is arrested in its movement by an annular arrester foot 28 surrounding the needle. This arrester moves up and down into contact with work material W in timed relationship with the needle stroke as explained in said copending application. In certain production installations the arrester foot 28 may be omitted, and the needle 16 itself serves to arrest the forward movement of that region of the work material being penetrated by the needle.

The work material W as a whole is driven by the differential in friction between the coupling medium 22 and the top surface of the work W on one hand and that between the lower surface of the work and the table 14. The drive mechanism 25 includes a pair of lightweight triangular cam follower levers 34 and 35 driven by a pair of cams 36 and 37 mounted on a common vertical shaft 40. The levers 34 and 35 are disposed on generally opposite sides of the cams 36 and 37 and are arranged and connected so that the lever 34 produces mainly movement of the arm 24 in a direction parallel to its own length while the other lever 35 mainly produces angular movement of the arm 24 about a pivot 41. The lever 34 has the fixed pivot 42 and a follower roller 43, so that it produces velocity multiplication at the pivot connection 41 with the arm. Consequently, the arm 24 is moved in a direction along its length at a higher rate of speed and

with a longer relative movement than that imparted by the cam 36 to the roller 43.

The other lever 35 has a cam follower roller 44, a pivot connection 45 to a cross link 46, and an intermediate fixed pivot 47. Thus, it has approximately equal lever arms to provide a velocity and movement at the pivot connection 45 which is approximately equal to that imparted by the cam 37 to the roller 44. This velocity is transferred by the cross link 46 to a pivot connection 48 on the arm 24. With this arrangement there is a movement of the end of the arm 24 perpendicular to its length which is at a higher rate of speed and with a longer relative movement than that imparted by the cam 37 to the roller 44. Advantageously, this arrangement produces velocity and movement multiplication with respect to both coordinates of motion that are substantially equal. Consequently, the cams 36 and 37 may be of substantially the same over-all size for a wide variety of stitching patterns, thus minimizing the over-all sizes and masses of the levers, link 46 and arm 24 while enabling large pattern areas to be sewn at high speed.

The arm 24 is a truss formed of tubular members and is tapered down toward both ends and has a maximum width near the pivot connection 48 to resist bending stress where the lateral thrusts are imparted. The triangular levers 34 and 35 are hollow, and the cross link 46 is tubular to provide maximum rigidity to mass ratio.

In order to hold the follower rollers 43 and 44 against their respective cams and also to move them quickly away from their cams during unloading and re-loading of the stitching station, double-acting drive means 49 and 50 are pivoted. These drive means 49 and 50 produce spring-like forces of approximately constant magnitude exerting a force on the follower rollers 43 and 44 directed inwardly generally toward the shaft 40. In this illustrative system these double-acting drive means are lengthy double-acting pneumatic cylinders and pistons, and the gas pressure on the piston provides the resilient spring-like force. It is possible to use other double-acting drive means, for example, such as long solenoid coils and armatures which produce an approximately constant pull over a range of movement to produce the force for holding the cam follower rollers 43 and 44 against their cams. However, the pneumatic cylinders and pistons of the desired length are available commercially and operate to advantage as shown.

A piston rod 51 extends from the cylinder and piston 49 and is connected to the lever 34 by a clevis 52 to push the roller 43 against its cam. A similar piston rod 53 extends from the cylinder and piston 50 and is connected by a clevis 54 to pull on the outer end of the lever 35 so as to hold the roller 44 against its cam. The relationship as shown in FIGURE 1 is the operating position during the high-speed formation of the stitches S.

To prevent the cam movement from being influenced by the forces of the follower rollers 43 and 44 bearing against them and thus reacting against back lash in the drive gearing, suitable steady friction braking means are provided. For example, there is a disk caliper brake 56 providing a constant drag force upon a disc 57 on the shaft 40 so that any back lash present is always taken up in the same direction with respect to the rotation of the shaft 40.

To provide downward force on the clamp member 12 with a minimum of mass effect on the arm 24 there is a strip spring 58 of the type which is self-winding on a drum to generate a generally constant tension force regardless of extension, available commercially. This tension spring 58 is secured to a long, substantially vertical cable 59 which is connected to the underside of the arm 24 so as to pull downwardly on this arm with relatively constant force regardless of the horizontal position of the arm.

The driving power for the system 10 is provided by a main motor 60 having a suitable belt drive connection

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61 to a remote-controlled clutch and brake unit 62, including a magnetically actuated clutch 63 and a magnetically actuated brake 64, which are connected by a shaft 65 to a speed-reducing gear mechanism 66. A slower speed output shaft 67 is connected by a gear 68 and a change gear train 69 and 70 to a driven gear 71 on the shaft 40.

From this gear box 66 also extends a higher speed main shaft 72, and so the rotation of this main shaft 72 bears a known speed relationship with respect to the rotation of the cam shaft 40. The main shaft 72 is connected by a pulley 73, a timing belt 74, and a driven pulley 75 to the shaft 76 of a needle locking mechanism 77, which is shown in detail in FIGURE 2.

In order to drive the sewing machine 18 at a known relationship with respect to the cam shaft 40, a drive path is provided from the shaft 76 through a pulley 78 and a timing belt 79 to a driven sheave 80 on the crank shaft 81 of the sewing machine. For providing a control function as discussed below when the speed of the shaft 76 is below a predetermined level, there is a speed-sensing switch 83 which is driven by a belt 84 from the shaft 76.

The cams 36 and 37 are individually removably secured to the shaft 40 at a fixed angular orientation. To change the sewing pattern for stitching different pieces of work material, these cams are replaced by other cams. Also, the clamp member 12 is removed from the arm 24 by disconnecting bolts 82 and is replaced by a different clamp member having a shape corresponding with the desired stitching pattern. To change the movement relationship of the cams relative to the crank shaft 81 of the sewing machine 18, the change gears 69 and 70 in the gear train can be changed.

On the surface of the upper cam 36 are positioned a plurality of actuator elements 86 which operate respective switches within a control housing 87 extending closely above the top of this cam. These actuators 86 produce the desired sequence of operations for the particular pattern being sewn, and when the upper cam 36 is changed to do a different pattern, then the replacement cam has actuators on it also in the proper location to produce the sequence for the new pattern. In this system as shown, when the stitching pattern is completed, then the clutch 63 is de-energized and the brake 64 is energized to stop the shaft 65. The main drive motor 60 continues to rotate.

In FIGURE 3A is shown the operating circuit for the clutch 63 and brake 64. The clutch 63 is engaged when its magnet winding 90 is energized, and similarly the brake 64 engages when its magnet winding 91 is energized. A direct current circuit 92, 93 provides their power. Normally open relay contacts 101 are mechanically ganged with normally closed relay contacts 102, and these are in series with the respective windings 90 and 91 and are controlled by a saw-cycle relay solenoid 100 (FIG. 3). A pair of capacitors 94 are connected across the windings 90 and 91 so as to maximize their speed of response. Even though the clutch 63 and brake 64 are fast-acting, there is momentum in the sewing machine system such that a few stitches occur before the sewing machine 18 is stopped completely.

Assuming that the machine 18 is sewing and is approaching the end of the stitching path P, just before the end of the stitching pattern, to accommodate the momentum as discussed, one of the cam actuators 86 opens a normally closed cam switch 94 (FIG. 3), which interrupts an electric energizing path to the relay winding 100, thus releasing the clutch and energizing the brake winding 91. This control circuit (FIG. 3) is suitably energized by a source of power, for example 24 volts of alternating current connected to the lines 110 and 111.

As the sewing speed slows down below a predetermined level, the speed-sensing switch 83 (FIGS. 1 and 3) becomes closed. This predetermined level is set in accordance with the maximum sewing speed at which the locking mechanism 77 can be put into condition for engage-

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ment without damage to the system 10. Closure of the switch 83 energizes a winding 96 of a solenoid air valve (not shown) causing the air cylinder 97 (FIG. 2) which has a piston rod 98 connected to a locking element 99 to push this element 99 against the perimeter of a revolving locking member 115 which is in the form of a disc in the locking mechanism 77. This revolving member 115 is secured to the shaft 76 and has a pair of diametrically opposed lock-engaging means 116 in the form of recesses in the perimeter of the revolving member 115. It is noted that the pulley 78 has a diameter twice that of the pulley 80, and so the sewing machine crank shaft 81 makes two revolutions for each one of the revolving disc 115. Thus, the needle 16 makes two strokes for each revolution of the locking disc 115. The lock-engaging notches 116 are positioned so that the needle 16 is locked up in the desired elevated position when the dog 99 engages into either of them.

The locking mechanism 77 includes a block 113 fixed to the machine frame 114 and having a channel 117 in which the dog 99 can be slid and includes a front plate 118 which covers the dog and disc 115. At the instant when the dog 99 touches the perimeter of the disc 115, this disc is continuing to turn as the machine 18 is coming to a stop. Thus the disc 115 turns sufficiently for the dog 99 to drop into one of the recesses 116, locking the needle up. The dog has a laterally projecting pin 119 projecting into a slot in one end of a bell crank lever 120 which is pivoted at 121 and has a leg 122 for actuating a pair of switches 123 and 124. The switch 123 includes normally-closed contacts 123a and normally-open contacts 123b, and similarly the switch 124 includes normally-closed contacts 124a and normally-open contacts 124b. When the dog 99 moves into a notch 116, the leg 122 closes the normally-open contacts 123b, which energizes a winding 125 of a solenoid air valve (not shown) causing lift means 126 (FIG. 1) to raise the arm 24. This lift means includes an air cylinder 126, having a vertical piston rod 127 with a horizontal bar 128 extending across the top. A slippery plate 129 covers the top of this bar 128 providing easy sliding means for enabling the arm 24 to be moved rapidly while supported on the lift means. For example, this slide plate 129 is made of polytetrafluoroethylene.

Closure of the switch 123b also energizes a winding 130 of a solenoid air valve (not shown) causing the arrester foot 28 (FIG. 1) to be lifted, for example, as shown in said depending application.

In the event that the locking disc 115 happens to be in such a position that it comes to rest before the dog 99 is engaged, that is, the locking mechanism is in an intermediate condition not fully engaged, then the disc 115 is automatically turned further by means producing a brief electrical pulse so that the dog will fully engage, as will be explained. When the dog rests against the perimeter of the disc 115, the normally closed contacts 124a are opened, and the normally open contacts 124b become closed. The means for producing a brief electric pulse includes the switch 124b which discharges a relatively large pulse from the charged capacitor 133 through a time-pulse adjusting resistor 134 and through the relay winding 100, controlling the brake and clutch. Thus, for a brief instant the brake is released and the clutch is re-engaged, with the main drive motor 60 running continuously, so as to turn the sewing machine pulley 80 a sufficient distance that the dog 99 does become engaged. The capacitor 133 is energized through a charging circuit including a peak-current limiting resistor 135 and a diode 136 and through the contacts 124a which are closed only during the period of time when the locking dog 99 is out. The resistor 134 is adjusted to a value to provide a current pulse of the proper duration to provide one-half revolution of the locking disc 115. This is sufficient rotary motion to assure that the dog 99 engages, without producing an undue amount of mechanical shock or

torque. Engagement of the lock dog 99 causes the switch 123b to become closed so as to raise the clamp 12 and to raise the arrester foot 28, as discussed before.

Now that the clamp 12 is up, the present production cycle is ended, and the system is awaiting a new signal before beginning the next production cycle. When the lift means 126 raises the clamp, an arm 131 projecting from the piston rod 127 closes a normally open switch 132 (FIG. 1, and top of FIG. 3) in a start-cycle circuit.

It is noted that there are switches 139, 142, and 149 (FIG. 1) which are actuated by a sector-shaped plate 140, depending upon whether the lever 35 is in such a position that the roller 44 engages the cam 37 or the lever 35 is moved away from the cam 37. When the lever 35 is following the cam 37, the clamp 12 is "in" the sewing station, and when it is not, the clamp is "out" of the sewing station. The switch 139 is normally closed, and it is held open by the sector shaped member 140 only when the lever 35 is in position for the roller 44 to engage and follow the cam 37, that is, when the clamp is in the sewing station. The sector shaped member 140 is rigidly attached to the lever 35 by a sleeve which surrounds the pivot 47. The switch 149 includes two sets of normally open contacts 149a and 149b (FIG. 3). These contacts 149a and 149b are held closed when the clamp is "in."

As mentioned closely above, the clamp is up and the start of the next production cycle is being awaited. When it is desired to start the next production cycle, an electrical signal is fed in through a lead 148, through the clamp-up sensing switch 132, and through a cam switch 159 to a solenoid 150 of a cycle start relay. This relay winding 150 controls three sets of contacts: normally open contacts 151 and 152, and normally closed contacts 153. The energization of the start relay 150 closes the self-holding contacts 151 to maintain relay 150 energized until the cam switch 159 is actuated into its open position. This cam switch 159 becomes opened by movement of the cam 36 during the sewing operation, as explained further below. The purpose of this cam switch 159 is to prevent inadvertent recycling until the sewing operation is completed.

The energization of the start relay 150 also opens the normally-closed contacts 153. The purpose of these contacts 153 is to serve as an interlock to insure that the dog 99 does not become re-engaged after a new start signal has been given.

The closure of the contacts 151 serves to energize the winding 138 of a clamp-out solenoid valve, which controls the double-acting cylinders 49 and 50. Thus, the piston rod 53 is extended and the rod 51 is retracted to slide the arm along the elevated slide pad 129 until the clamp 12 is moved "out" of the stitching station, that is, so as to be directly positioned above the next workpiece W-2. Because the clamp was raised before it was shifted into position over the next workpiece W-2, the completed workpiece W remains in the sewing station.

When the clamp 12 is in its "out" position correctly located above the new workpiece W-2, a normally open switch 142 is closed by the sector shaped member 140. This energizes a winding 143 of a solenoid air valve (not shown) causing the lift means 126 to retract to lower the arm 24 so that the clamp 12 now firmly engages the new workpiece W-2. At the same time, a winding 144 of a solenoid valve which controls the thread cut off operation is energized so as to cut the top thread 27 and the bottom thread 28, for example, as described in said copending application.

The completed workpiece W can now be taken away manually or automatically. In this example, the clamp 12 includes laterally extending fingers 160 having friction gripping tips 161, for example of sponge rubber, which will engage down upon the completed workpiece W when the clamp is lowered. These fingers 160 will serve to move the completed workpiece W from the stitching station

over to a discharge station D while the next piece W-2 is being brought into the stitching station. When the clamp 12 is raised later on at the completion of the workpiece W-2, then the workpiece W can be removed from the discharge station D either manually or automatically.

Also, the winding 146 of a solenoid valve is energized by closure of the contacts 142, causing the cylinder 97 (FIG. 2) to retract the locking dog 99, thus opening the switch 124b and allowing the switch 123a to close and closing the switch 131 to recharge the capacitor 133.

As explained above, the clamp-out contacts 142 are closed so that the clamp-down control winding 143 has been energized, and the clamp 12 has now been lowered down upon the next workpiece W-2. This closes the switch 145, and so the winding 147 of a solenoid air valve is energized so that the piston rod 51 becomes extended and the rod 53 becomes retracted, which moves cam follower rollers 43 and 44 back into engagement with the cams. Normally open switch contacts 149a are now closed by the sector shaped member 140 which partially closes a circuit to the sew cycle relay 100. Also normally open switch contacts 149b are closed when the clamp 12 is brought into the sewing station, which energizes a control winding 148 to lower the arrester foot 28 onto the new workpiece W-2. Moreover, a control winding 154 is energized to retract the thread cutting mechanism.

The clamp 12 is now positioned in the same location as it was when the preceding stitching pattern was completed. The stitching pattern which is about to be made is made in the reverse direction from the preceding one. The reason for doing this reverse stitching is that it enables each pattern to be begun at exactly the same point where the preceding one was ended. This provides maximum production when stitching a pattern having the ends of its path P separated, because it avoids the time which would otherwise be required to re-position the cams so as to provide the same starting point each time, but this re-positioning to the same starting point can readily be accomplished if desired.

In order to accomplish the reverse stitching of each successive pattern, the cams 36 and 37 are turned only one-half of a revolution during each pattern, and they are shaped so that the second half of each cam produces the desired reverse movement of the clamp 12.

There are interlock means 156 responsive to the following conditions which control a normally open safety interlock switch 158. This interlock switch 158 is not closed until the following conditions are present:

- (1) Clamp 12 is down.
- (2) Dog 99 is retracted to unlock sewing machine 18.
- (3) Thread cut off mechanism is retracted.
- (4) Arrester foot 28 is down in operating position.

The switch 149a serves as a further interlock means to assure that:

- (5) Clamp 12 is in sewing position.

When these five conditions are met, then the switches 158 and 149a are closed. The contacts 152 became closed upon energization of the start relay 150, and so the sew cycle relay 100 becomes energized to release the brake and engage the clutch, thus initiating the high speed sewing. It is noted that the relay 100 also includes self-holding contacts 103 which are normally open but which become closed by energization of the winding 100. Thus, the next sewing operation now begins.

As soon as the cam 36 moves, the actuator 86 moves so that the cam switch 159 is momentarily opened. Thus, the relay 150 is de-energized to open the contacts 151 and 152 to prevent inadvertent re-cycling of the system unless the proper sequence has been completed.

It was explained that one of the actuators 86 is positioned to open the cam switch 94 just before the end of the sewing pattern. The particular distance, i.e. lead time,

before the end of the sewing pattern depends upon the speed of the sewing machine 18 and its momentum and operating characteristics. In typical applications this lead time is in the range from two to six stitches before the end of the stitching pattern.

It was explained that each successive workpiece can be sewn in the opposite direction; this is desirable where the stitching path commences and ends at different points in the workpiece W, i.e. an "open" pattern. However, there are "closed" patterns, that is, the stitching path P terminates near where it commenced. In such a case each workpiece is sewn in the same direction. If desired, the cams 36 and 37 can be shaped and the actuators 86 arranged such that "open" patterns are all sewn in the same direction, as indicated further above. This system is extremely flexible and can be set up so as to sew larger patterns or smaller patterns, complex patterns or relatively simple patterns in accordance with this specification.

From the foregoing description, it will be understood that the automatic sewing machine system of the present invention is well adapted to provide the many advantages and features set forth and that by means of various changes, the system described can be adapted for a wide variety of automatic production applications in accordance with the teachings of this specification, and that the scope of the present invention includes such modifications and changes as claimed.

What is claimed is:

1. An automatic sewing machine system comprising a movable needle for stitching fabric workpieces, drive means connected to the needle for moving the needle to form stitches, brake means connected to said drive means for stopping the needle, a motor, clutch means connecting said motor to said drive means for providing power thereto, locking means connected to said drive means and engageable in a predetermined position for locking said drive means to secure the needle in an inactive position, speed sensing means responsive to the speed of said drive means for conditioning said locking means toward engagement after the speed of said drive means has fallen below a predetermined safe level, and means responsive to said drive means in other than said predetermined position for momentarily releasing the brake means and re-engaging the clutch means for moving said drive means until said drive means reaches said predetermined position for engagement of said locking means.

2. An automatic sewing machine system as claimed in claim 1 and wherein said clutch means and brake means are electrically actuated and said means for momentarily releasing the brake means and for re-engaging the clutch means includes means producing a brief electrical pulse.

3. An automatic sewing machine system as claimed in claim 2 and wherein relay means are connected to said clutch means and to said brake means, and said pulse means includes a capacitor and a charging circuit for said capacitor, and a discharging circuit extending from said capacitor through said relay means momentarily releasing the brake means and re-engaging the clutch means upon discharge of said capacitor through said relay means.

4. An automatic sewing machine system as claimed in claim 3 and wherein said discharging circuit includes a variable resistor adjusting the duration of said electrical pulse.

5. An automatic sewing machine system comprising a movable needle for stitching fabric workpieces, drive means connected to the needle for moving the needle to form stitches, brake means connected to said drive means for stopping the needle, a motor, clutch means connecting said motor to said drive means for providing power thereto, locking means connected to said drive means and engageable in a predetermined position for locking said drive means to secure the needle in an inactive position, said locking means including a revoluble member

connected to said drive means and revolving when said drive means is moving, said revoluble member having lock-engaging means thereon, a locking element having a retracted position, an intermediate position touching said revoluble member and a forward position engaged with said lock-engaging means, speed sensing means responsive to the speed of said drive means for moving said locking element toward engagement after the speed of said drive means has fallen below a predetermined safe level, and means responsive to said locking element in said intermediate position for momentarily releasing the brake means and re-engaging the clutch means for moving said drive means until said drive means reaches said predetermined position for engagement of said locking means.

6. An automatic sewing machine system as claimed in claim 5 and wherein said lock-engaging means includes at least one recess in the perimeter of said revoluble member and said locking element is a dog which is movable toward engagement with said recess, said dog in its intermediate position resting against the perimeter of said disc without engagement in said recess, and said dog in its forward position engaging in said recess and positively locking said revoluble member against revolution.

7. An automatic sewing machine system as claimed in claim 1 and including a movable clamp member for holding the workpiece and operable to move the workpiece with respect to the movable needle for producing a desired pattern of stitches in the workpiece, cam means connected to said drive means and driven thereby for moving said clamp, said locking means locking said cam means simultaneously with the locking of the needle, and double-acting means connected to said clamp member and operable while said locking means is engaged for moving said clamp member independently of said cam means.

8. An automatic sewing machine for stitching a pattern in a fabric workpiece comprising a movable needle at a sewing station, drive means connected to the needle for moving the needle to form stitches, a movable clamp member for holding the workpiece and operable to move the workpiece with respect to said sewing station for producing a desired pattern, lever means connected to said clamp member, cam means connected to said drive means and engaging said lever means for operating the clamp member to move the workpiece with respect to said sewing station, locking mechanism for locking said needle and for locking said cam means in a predetermined position, double-acting means connected to said lever means and having a first condition of operation causing said lever means to follow the movement of said cam means during stitching and having a second condition of operation for moving said lever means and clamp member independently of said cam means when said cam means and needle are locked for moving the clamp member in and out of the sewing station for transferring workpieces with respect to the sewing station.

9. An automatic sewing machine system as claimed in claim 8 and wherein said double-acting means in said first condition provide a spring-like force for holding said lever means in operative engagement with the moving cam means thereby to follow the movement of said cam means.

10. An automatic sewing machine system as claimed in claim 9 and wherein said double-acting means are long stroke double-acting air cylinders providing a spring-like force for holding said lever means in operative engagement with the cam means during movement of said cam means.

11. An automatic sewing machine system as claimed in claim 8 wherein said clamp member has laterally projecting elements thereon enabling said clamp member to engage more than one workpiece simultaneously.

12. An automatic sewing machine system as claimed in claim 8 and including an arm connecting said clamp

member to said lever means, lift means engageable beneath said arm for raising said arm to lift the clamp member, said lift means including a horizontal bar having a low friction surface engaging the lower surface of said arm, and said arm when elevated on said bar being readily slidable therealong for moving the elevated clamp member.

13. An automatic sewing machine system for stitching a predetermined pattern of stitches in successive fabric workpieces and wherein said pattern of stitches commences and terminates at points which are spaced apart in the fabric workpiece comprising a movable needle at a stitching station, drive means connected to the needle for moving the needle to form stitches, a movable clamp member operable to move the workpiece at the stitching station relative to the needle to produce said pattern of stitches in the workpiece, cam means driven by said drive means for controlling the movement of said clamp member at the work station, lock mechanism for locking said cam means at the completion of one stitching pattern, control means for removing the completed workpiece from said stitching station, for introducing a second workpiece into the stitching station in an initial position which is the same as the final position of the completed workpiece, and for unlocking said cam means, and for starting the stitching of said second workpiece, and said cam means being arranged to stitch the pattern in the second workpiece in the reverse direction from the preceding workpiece.

14. An automatic sewing machine system as claimed in claim 13 and wherein said drive means is connected to both said needle and said cam means, said locking mechanism simultaneously locking said cam means and said needle means, and double-acting means controlled by said control means for moving said clamp member while said locking mechanism is locked for transferring successive workpieces with respect to the stitching station.

15. An automatic sewing machine system for stitching a pattern in a fabric workpiece comprising a movable

needle at a sewing station, drive means connected to the needle for moving the needle to form stitches, a movable clamp member holding the workpiece and operable to move the workpiece with respect to said sewing station for producing a desired pattern of stitches, lever means connected to said clamp member, cam means connected to said driving means and engaging said lever means for operating the clamp member, switch means connected to said driving means for controlling the operation thereof, said switch means being positioned adjacent to said cam means, a plurality of actuator elements mounted on said cam means in positions to engage said switch means for actuating said switch means to control the operation of said drive means, lock means for simultaneously locking said needle and said cam means, said lock means being controlled by said switch means, and double-acting means holding said lever means in cam-follower relationship with said cam means when said lock means is unlocked, and said double-acting means moving said lever means for moving said clamp member independently of said cam means during the engagement of said lock means.

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