AUTOMATIC PROGRAM-CONTROLLED SEWING MACHINES

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This invention relates in general to automatic program-controlled sewing machines.

In the garment-making industry, it is frequently necessary to stitch two or more pieces of material together in some form of linear or curved seam or line of stitches. For example, in applying pockets to shirt fronts, the pocket which has been cut out of a suitable piece of material and marginally turned under is laid upon the material constituting the shirt front and stitched in place by a U-shaped line of stitches which extends down one side, across the bottom, and up the other side. Similarly, in attaching to an appliqué of either symmetrical or non-symmetrical stockpile, the figure constituting the appliqué may be cut out of a separate piece of fabric and placed in the proper location upon the underlying piece of fabric. It is then necessary for the operator to stitch the appliqué in place by a continuous and circular line of stitches which follows the outline or edge of the appliqué. Such stitching operations require a high degree of skill on the part of the operator for a number of reasons. In the first place, the line of stitches must accurately follow the margins of the piece of material which is being stitched in place, and must be spaced inwardly from such margins by some prescribed distance which must be uniform. In the second place, the work cannot be fed beneath the needle in a continuous straight line but must be rotated with respect to the needle and presser foot as the line of stitches changes its course of direction. In shifting the work around, the operator must be careful to avoid wrinkling or soiling the work, and should maintain a reasonable degree of speed without sacrificing accuracy. Even the most experienced operators cannot maintain particularly high production yields in performing such operation and, furthermore, even the most careful operators will make certain numbers of errors in the course of a day's work, resulting in pieces which do not pass inspection.

It is, therefore, the primary object of the present invention to provide an automated program-controlled sewing machine which is capable of performing either linear or curved stitching operations in any and all directions within a relatively large area of the work automatically and without requiring guidance on the part of the operator.

It is another object of the present invention to provide a sewing machine of the type stated which can be operated at a relatively high rate of speed with precision and accuracy and with a minimum amount of personal attention, so that a single worker can supervise several such automated sewing machines.

It is an additional object of the present invention to provide a sewing machine of the type stated which can be quickly set up, perform a wide variety of sewing operations, or can be quickly changed from one sewing operation to another without requiring any appreciable period of downtime for set-ups and adjustments.

It is a further object of the present invention to provide a sewing machine of the type stated which is relatively simple in construction and, therefore, can be manufactured economically at comparably low cost.

It is an additional object of the present invention to provide a sewing machine of the type stated which is rugged, durable, and requires minimum maintenance.

With the above and other objects in view, our invention resides in the novel features of form, construction, arrangement and combination of parts presently described and pointed out in the claims.

In the accompanying drawings—

FIG. 1 is a perspective view of an automatic program-controlled sewing machine constructed in accordance with and embodying the present invention;

FIG. 2 is a fragmentary top plan view of the automatic program-controlled sewing machine shown in FIG. 1;

FIG. 3 is a fragmentary side elevational view of the sewing machine as viewed from the right side of FIG. 1;

FIG. 4 is a front elevational view of the sewing machine partially broken away to show interior construction;

FIG. 5 is a fragmentary side elevational view of the sewing machine as viewed from the left side of FIG. 1;

FIG. 6 is a rear elevational view of the sewing machine partially broken away to show interior construction;

FIG. 7 is a horizontal sectional view taken along line 7—7 of FIG. 4;

FIGS. 8 and 9 are fragmentary sectional views taken along lines 8—8 and 9—9, respectively, of FIG. 2;

FIG. 10 is a fragmentary sectional view taken along line 10—10 of FIG. 3;

FIG. 11 is a fragmentary sectional view taken along line 11—11 of FIG. 10;

FIG. 12 is a fragmentary sectional view taken along line 12—12 of FIG. 11;

FIG. 13 is a fragmentary top plan view of the work-holding fixture and related mechanism forming a part of the present invention, said work-holding mechanism being shown in work-holding position;

FIGS. 14, 15, and 16 are fragmentary sectional views taken along lines 14—14, 15—15 and 16—16, respectively, of FIG. 13;

FIG. 17 is a fragmentary sectional view taken along line 17—17 of FIG. 2;

FIGS. 18 and 19 are fragmentary sectional views taken along lines 18—18 and 19—19, respectively, of FIG. 17;

FIGS. 20, 21, 22, 23, and 24 are schematic wiring diagrams illustrating the various electrical connections constituting the circuitry of the present invention; and

FIG. 25 is a schematic fragmentary plan view of the program tape or film utilized in connection with the present invention.

Referring now in more detail and by reference characters to the drawings, which illustrate a preferred embodiment of the present invention, A designates an automatic program-controlled sewing machine comprising a base frame 1, integrally including vertical front legs 2, 3, and vertical rear legs 4, 5, which are integrally connected at their upper ends by four rectangularly arranged horizontal cross-members 6. Rigidly mounted upon the cross-members 6 is a horizontal top 7 consisting of a front rail 8, rear rail 9, two side rails 10, and an intermediate cross-beam 11. Mounted between the front rail 8 and cross-beam 11 is a horizontal front board 12 which extends transversely across the front of the machine and provides a surface upon which the operator can initially arrange the work for placement in the machine. The rear rail 9 and cross-beam 11 are provided with a series of tapped apertures or bolt-holes 13, 13', arranged symmetrically on opposite sides of the longitudinal centerline of the machine A, each aperture 13 being aligned with a corresponding aperture 13'. Between the cross-beam 11 and rear rail 9, the top 7 is substantially open and is centrally subdivided by two spaced parallel medial bars 14, 15, into a work area 16.
The bars 14, 15 are held in any one of several selected positions by bolts 17, 17, which can be threaded into any of the apertures 13, 13', so that the transverse width of the work area 16 can be varied as may be desired.

Rigidly secured at their ends to, and extending horizontally between, the legs 2, 3, 4, 5, respectively, are horizontal cross-beams 18, 19, which are located at the same vertical height. These cross-beams are held in pairs by bolts 20, 20', 21, 21' and are transverse extending horizontal parallel slide rails 22 of identical construction and each integrally comprising a flat bottom flange 23, a vertical web 24, and a horizontal head section 25 of circular cross-sectional shape. Mounted for transverse sliding movement on the head sections 25 are two identical slide frames 26, each including a horizontal channel 27 integrally provided at its opposite ends with upwardly extending legs 28, 29. The channels 27 are each provided along their under faces with downwardly opening slots or grooves 30 and rigidly mounted therein are elongated rectilinearly downwardly presented slide bearings 31, which are operatively engaged upon the head sections 25 of the slide rails 22. The forward slide rail 22 (reference being made to the bottom of FIG. 2) is rigidly provided across its right end (reference being made to the right side of FIG. 2) which projects laterally outwardly on opposite sides of the vertical web 24, and is interposed in the path of movement of the forward slide frame 26 for operatively contacting the plunger 33 of a limit switch 34 mounted adjacent to the right end of the channel 27 forming a part of such slide frame 26. Similarly, the rear slide rail 22 is provided, on its left end, with a stop plate 35 which projects laterally outwardly on opposite sides of the vertical web 24 of such rear slide rail 22 and is thus interposed in the path of the rear slide frame 26 for abutting engagement against the plunger 36 of a limit switch 37 mounted on the left hand end of such rear slide frame 26.

Rigidly mounted upon, and extending longitudinally between, the upper ends of the legs 28, 29 of each slide frame 26 are horizontal slide rails 38 of identical construction, and each integrally comprising flat bottom flanges 39, vertical webs 40, and head sections 41 of circular cross-sectional shape. Mounted for longitudinal shifting movement upon the head sections 41 are two identical slide frames 42, each including a horizontal channel 43 integrally provided at its opposite ends with upwardly extending slide rails 38. The left slide rail 38 is rigidly provided across its forward end with a stop plate 49 which projects laterally outwardly on opposite sides of the vertical web 40, and is interposed in the path of movement of the right hand slide frame 43 for operatively contacting the plunger 50 of a limit switch 51 mounted adjacent to the forward portion of the channel 44 forming a part of such slide frame 43. Similarly, the right slide rail 38 is provided, on its rear end, with a stop plate 52, which projects laterally outwardly on opposite sides of the vertical web 40 of such right slide rail 38 and is thus interposed in the path of the left slide frame 43 for abutting engagement against the plunger 53 of a limit switch 54 mounted adjacent to the rear end of such left slide frame 43.

Rigidly mounted upon the upper ends of the legs 45, 46, is the flat horizontal platen or bed plate 55 of a sewing machine 56 which is substantially conventional and is, therefore, not illustrated or described herein in specific detail. It is sufficient for present purposes to indicate that the sewing machine head 56 consists of a tubular vertical standard or leg 57 merging auctiously at its upper end into a horizontal top-housing 58 which extends, in the clear, upwardly spaced relation above the plane of the front board 12, and is provided at its forward end with the usual downwardly extending housing-arm 59, the latter being operatively provided with an oscillatory needle shaft 60 which is conventionally provided at its lower end with needle mounting means 61. It will, of course, be evident that the length of the housing 58 will establish limits in the longitudinal size of the work area 15, and such limits can be varied as desired length for the top housing 58. Preferably mounted upon the upper end of the needle shaft 60 and disposed, in the manner of a guard, externally around the needle mounting means 61, is a downwardly and outwardly flaring conical spring-helix 62, the convolution of which is widely spaced so that the needle shaft 60 approaches the lower limit of its travel, the lowestmost convolutions of the spring-helix 62 will engage the work and theremainder of the spring-helix 62 will be more or less compressed. Similarly, as the needle shaft leaves its lower limit of travel, the spring-helix 62 will still engage the work for a brief instant, thereby momentarily continuing its hold-down action until the needle is fully clear of the work.

Jouarded in, and extending rearwardly from the standard 63 is a main shaft 64 which is operatively connected interiorly of the standard 63 to a conventional sewing machine mechanism (not shown) by which the needle shaft 60 is oscillated up and down responsive to the rotative movement of the shaft 63. Rigidly secured upon the shaft 63 directly to the rear of the standard 63 is a set collar 64 which bears operatively upon its rearwardly presented face against a conventional sleeve bearing 65, which is also mounted upon the shaft 63, and supports a shallow-grooved idler pulley-wheel 66 which is thereby freely rotatable with respect to the shaft 63. Trained around the idler pulley-wheel 66 is a belt 67 which is also trained around a drive pulley 70 mounted upon the shaft 69 of a conventional electric motor 70 suspended upon the underside of, and carried by, the platen 55.

Pinned upon the shaft 63 in close, but nevertheless rearwardly spaced, relation to the idler pulley-wheel 66, is a pulley-wheel 71 of the same diameter as the pulley-wheel 66 and is adapted to receive and be driven engaged by the belt 67 whenever the latter is shifted from the idler pulley-wheel 66 to the pulley-wheel 71. On its rearwardly presented face, the pulley-wheel 71 is rigidly provided with a cam-shaped stop-member 72 having a radial detent notch 73, a radial stop-face or abutment 74 and a lower edge 75 which is radially contoured.

The shifting of the belt 67 is accomplished by a belt-shifter 76 which is swingingly mounted at its lower end upon the upper face of the platen 55 by means of a suitably supported pintle 77 which extends at right angles to the longitudinal axis of the shaft 63 so that the upper end of the belt-shifter 76 can rock toward and away from the pulley-wheel 71 and its associated stop-member 72.

The belt-shifter 76 is integrally provided with a forwardly extending arm 78 having a belt-encircling loop 79 by which the belt 67 is shifted between the pulley-wheels 66, 71, responsive to rocking movement of the belt-shifter 76. Along its right lateral face, the belt-shifter 76 is provided with a vertical slot 80 which is open at its upper end and, in effect, bifurcates the upper portion of the belt-shifter 76 to form front and rear side walls 81, 82, connected by a back wall or bight 83. For purposes of illustration herein, the motor 70 is assumed to rotate in a counterclockwise direction to turn the shaft 63 in the direction of the arrow, as shown in FIG. 8, and thus the slot 80 will open laterally away from the direction of rotation of the stop-member 72. Extending horizontally between the side walls 81, 82, is a pivot pin 84 which rockingly supports a stop-arm 85 integrally provided on its lower end with a tail-plate 86. Interposed between the tail-plate 86 and the inner face of the back wall 83 is a spring compression spring 87 which biases the stop-arm 85 in a counterclockwise direction against the back wall 83.
In its upper end, the stop-arm 85 is axially drilled, counterbored and tapped in the provision of an elongated cylindrical recess 88 which is internally threaded at its upper end to receive a tubular stop-nut 89. Sildably disposed in the recess 88 and extending through the stop-nut 89 is a pin-like stop-finger 90 which is urged resiliently upwardly by means of a spring 91 seated within the recess 88. At its upper or projecting end, the stop-finger 90 is adapted to ride against the rear face of the cam-shaped stop-member 72ices and rock forwardly to ride endwise against the periphery of the stop-member 72 when the low-point 75 thereof rotates into downward position. Upon continued rotation, the periphery of the stop-member 722 will push the stop-finger 90 downwardly a short distance, compressing the spring 91 and causing the stop-finger 90 to drop into the detent notch 73. On its forward face, the side wall 82 of the belt-shifter 76 is integrally provided with an apertured boss 92 for retentionly engaging the rear end of a strong tension spring 93 which is, in turn, hooked at its forward end in a similar apertured boss formed on the sewing machine standard or leg 57. The spring 93 normally urges the belt-shifter 76 forwardly toward the cam-shaped stop-member 72.

Welded or otherwise rigidly mounted upon the upper face of the plate 55 along the rear margin thereof and on opposite sides of the standard 57 are two heavy arms 94, 95, formed preferably of angle-iron of sufficient size and strength so as to be capable of supporting a substantial outboard load without significant deflection. At their rear ends, the arms 94, 95 are mitered and bent upwardly to form two vertical legs 96, 97, the mitered joints being preferably welded so that the arm 94 and leg 96 form a unitary L-shaped bracket-like structure and, similarly, the arm 95 and the leg 97 form a matching unitary L-shaped bracket-like structure. Welded upon the upturned or upwardly presented flat faces of the arms 94, 95, is a horizontal mounting plate 97, and similarly welded or otherwise secured upon the rearwardly presented faces of the legs 96, 97, is a vertical mounting plate 98.

Rigidly bolted or otherwise secured upon the upper face of the horizontal mounting plate 97 is a heavy duty solenoid 99 which is provided with a horizontally reciprocal plunger 100 which is, in turn, hingedly connected at its forward end by means of a short link 101 to an apertured boss 102 formed integrally upon the rear face of the side wall 81 of the belt-shifter 76. Where the solenoid 99 is energized, the plunger 100 will be pulled rearwardly, thereby rocking the belt-shifter 76 to the position shown in FIG. 11 and causing the belt 67 to move over onto the pulley-wheel 71, thereby driving the shaft 63. As the belt-shifter 76 moves to this position, the stop-finger 90 will, of course, be entirely disengaged from the stop-member 72.

Similarly bolted or otherwise rigidly secured upon the upper face of the horizontal mounting plate 97, directly beneath the drive shaft 63, is another heavy duty solenoid 103 having a horizontally reciprocally outwardly spring biased plunger 104 which is hingedly connected at its outer end by means of a short link 105 to a detent hook 106 which is rockably mounted upon the forward face of the mounted plate 98 by means of a pintle stud 107. The forward portion of the detent hook 106 extends laterally past the belt-shifter 76 and snaps into engagement therewith as the latter is pulled back to the position shown in FIG. 11, thereby holding the belt-shifter 76 in such position even though the solenoid 99 is de-energized. When, however, the other solenoid 103 is energized, the detent hook 106 is momentarily withdrawn, allowing the belt-shifter 76 to swing forwardly into engaged position against the stop-member 72, pushing the belt 67 back onto the idler pulley-wheel 66 and bringing the shaft 63 to a stop at the predetermined position shown in FIG. 8. As the abutment 74 strikes the stop-finger 90, the stop-arm 85 will yield slightly to absorb the shock and then the stop-finger 90 will drop into the detent notch 73 to hold the shaft in said predetermined or “indexed” position. This position is selected so that when the shift selector 63 stops, the needle shaft 60 will be at the uppermost limit of its vertical travel. As long as the solenoid 99 remains de-energized, the shaft 63 will be locked in this position. In this locked position, the detent notch 73 will be positioned substantially opposite and in line with the plunger 100 of the solenoid 99.

Also bolted or otherwise rigidly secured upon the upper face of the mounting plate 97 is a bracket 108 having vertical bracket plate 109 and supported thereon are four microswitches, namely, a clutch microswitch 110, a “stop” microswitch 111, a thread-cutter microswitch 112, and a “start” microswitch 113, all being normally closed and respectively arranged as shown in FIG. 11 for actuation by the belt-shifter 76. In other words, when the belt-shifter 76 is in rearward position, the switches 112, 113, are open and the switches 110, 111, are closed. Conversely, when the belt-shifter 76 is in forward position, all switches 110, 111, are open and the switches 112, 113, are closed.

As will be seen by reference to FIG. 10, the rear end of the shaft 63 terminates at a substantial distance forwardly from the vertical mounting plate 98, and at such rear end is provided with a plurality of uniformly spaced axial spline-slots 114 and an annular peripheral groove 115 located adjacent to the forward end of the spline-slots 114, for receiving a snap ring 116. Mounted for axially shiftable movement upon the rear splined end of the shaft 63, is a spline sleeve 117 adapted for snug-fitting slidable disposition within the spline-slots 114. At its rear end, in overhanging relation to the end face of the shaft 63, the spline sleeve 117 is integrally provided with a diametrically enlarged circular clutch plate 118 made of magnetic material. Mounted in forward spaced parallel relation to the vertical mounting plate 98 is an apertured auxiliary mounting plate 119 located in concentric relation to, and spaced rearwardly from, the shaft 63. Secured upon the forward face of the auxiliary mounting plate 119 is a cylindrical shell 120 made of non-magnetic material and having a forwardly projecting annular skirt 121 which extends loosely around the periphery of the clutch plate 118 and is interiorly provided with a plurality of electromagnetic coils m. The shell 120 and electromagnetic coils m are disposed concentrically around the centerline of the shaft 63 and are spaced rearwardly from the frame.

Journalined in and extending horizontally through the mounting plate 98 in coaxial alignment with the shaft 63 is an auxiliary shaft 122 which terminates at its forward end in closely adjacent, but nevertheless rearwardly spaced relation, to the rear end face of the shaft 63. Rigidly secured upon the forward end of the auxiliary shaft 122 is a diametrically enlarged circular clutch plate 123, which is parallel to, and of the same diametral size as, the clutch plate 118. The forwardly presented face of the clutch plate 123 is coated or otherwise provided with a suitable friction material, such as asbestos or fiber molding in a hard synthetic resin or other similar material, and is furnished with a nature as that which is commonly used for making automotive brake linings and automotive clutch facings. Whenever the electromagnetic coils m are energized, the clutch plate 118 will be pulled rearwardly into tightly bound engagement with the clutch plate 123 so that the shaft 63 and the auxiliary shaft 122 will be locked together. On the other hand, when the electromagnetic coils m are not energized, then engagement between the clutch plate 118 and the clutch plate 123 will be released and the shaft 63, and the auxiliary shaft 122, will be disengaged from each other.

Keyed or otherwise mounted upon the auxiliary shaft 122 in the space between the auxiliary mounting plate 119 and the mounting plate 98 is a relatively large diametral spur gear 124, which projects, for a segment of its peripheral surface, outwardly from the lateral edge of the aux-
iliary mounting plate 119, and meshes with an idler gear 125, which is suitably journaled upon the mounting plate 98. The idler gear 125, in turn, meshes with an auxiliary drive gear 122" of an auxiliary motor 127 conventionally supported upon the forward face of the mounting plate 98. Whenever the auxiliary motor 127 is energized, rotary movement will be transmitted from the auxiliary drive gear 126 through the idler gear 125 to the spur gear 124 and the auxiliary shaft 122. It will, of course, be evident that by means of electrical circuitry presently to be more fully described the auxiliary motor 127 can only be energized for purposes of rotating the auxiliary shaft 122 when the electromagnetic coils m are de-energized and the auxiliary shaft 122 is not engaged with the shaft 63.

The auxiliary shaft 122 extends beyond the mounting plate 98 and at its rear extremity is provided with a film sprocket 128 which is operatively located between two conventional film-guiding idler spools 129, 129', mounted on the rear end 130, 130', respectively, the latter being rigidly mounted at their inboard ends in a support-arm 131, which is, in turn, rockably mounted on the rear end of a horizontal spindle 132 rigidly mounted at its forward end on the mounting plate 98. The support-arm 131 is provided with a dent or notch 133 and a flat faced dent or finger 134. Operatively supported upon the mounting plate 98 in downwardly and laterally spaced parallel relation to the auxiliary shaft 122 is a horizontal leaf spring 135 adapted for retentive engagement optionally against the flat face of the dent or finger 134, or within the dent or notch 133. When the leaf spring 135 is flexed downward to the position shown in FIG. 17, it is engaged against the flat face of the dent or finger 134 and thereby urges the idler spools 129, 129', down into film-engaging position, as will be presently more fully discussed.

Also mounted upon the rear face of the mounting plate 98 and projecting horizontally rearwardly therefrom in downwardly spaced parallel relation to the shaft 122 is an idler shaft 136 upon which a second film sprocket 137 is operatively journaled in downwardly aligned registering position directly beneath the film sprocket 128. Moreover, the film sprocket 137 is operatively located between the idler spools 138, 138', which are respectively journaled upon the rearward free end of the idler shafts 139, 139'. At their forward ends, the idler shafts 139, 139' are rigidly mounted upon, and project from, a support-arm 140, which is swivably mounted upon the rear end of a spindle 141, the latter being rigidly mounted at its forward end on the mounting plate 98. The support-arm 140 is substantially of the same shape as the previously described support-arm 131 and includes a dent or notch 142 and a flat faced dent or finger 143. Operatively supported on the mounting plate 98 is a leaf spring 144 adapted for optional engagement against the flat faced dent or finger 43 or the dent or notch 142. Bolted or otherwise rigidly secured upon and extending from the mounting plate 98 is an L-shaped bracket arm 145 which, in turn, bolts at its outer end to the cylindrical outer face of a tabular sensing head 146, which is provided in its end face with a photoelectric cell 147 having six separate vertical sensing zones or so-called "tracks" and is conventionally connected through a multi-conductor cable 148 to a control amplifier 149 which will be presently more fully described and explained.

Along its lower margin, the mounting plate 98 is integrally provided with a rearwardly projecting horizontal shaft 149, which is provided in its upper half with three triangular jaws 150, 151, 152, and operatively journaled thereon are three vertical film-supporting idler spools 153, 154, 155, respectively. Welded or otherwise rigidly secured upon the upper face of the shelf 149 is a film-guiding arm 156 which is located approximately along the centerline of the triangular defined spindles 150, 151, 152, and projects upwardly and forwardly at an angle of approximately 45°. Similarly mounted rigidly upon the rear face of the mounting plate 98 is an auxiliary film-guiding rod 157, which is located in laterally displaced relation to the film-guiding rod 156 and extends downwardly and angularly toward the shelf 149, terminating at a substantial distance above the upwardly presented face thereof. An endless band of thirty-five millimeter film f of the so-called "moving picture" type is wrapped around the idler spools 153, 154, 155, in as many layers as may be necessary to accommodate the desired length. A portion of the film f is brought up in an endless or so-called "Möbius" loop by means of the angularly positioned film-guiding rod 156 and the film f thus formed is trained around the sprockets 128, 137, and caused to pass across the face of the photocell 147. The film f is imprinted, by conventional photographic techniques, with six "tracks" consisting of transparent and non-transparent band which, in effect, create a series of discrete non-transparent spots or sections.

Finally, a constant intensity light source L is operatively mounted on the mounting plate 98 in horizontal alignment with the sensing head 145, and on the opposite side of the film f with respect to the photocell 147 and has a guide block 158 that bears the film f and holds it firmly against the face of the photocell 147 as it travels downwardly. It will thus be evident that as the film travels downwardly past the photocell 147, each of the six "tracks" thereon will cause the photocell 147 to transmit four sets of discrete electrical pulses which are linearly spaced in terms of time in any desired manner, so as to create some predetermined and desired "program."

Rigidly secured upon the upper face of the flange 23 of the rear slide rails 22, and along the forward side of the vertical web 24, is a rack-bar 159 provided with a relatively long line of upwardly presented teeth 160. Bolted or otherwise rigidly secured on the horizontal channel 27 of the rear slide frames 26 is an L-shaped bracket 161, which mechanically supports an electrical stepping servo motor 162 having a drive shaft 163 provided with a drive pinion 164 which meshes with the teeth of the rack-bar 159.

Rigidly mounted upon the upper face of the bottom flanges 39 of the left slide rails 38, on the interior side of the vertical webs 40 thereof, is an upwardly presented rack-bar 166 and bolted or otherwise rigidly mounted centrally upon the horizontal channel 27 of the left slide frames 43 is a bracket 167 for mechanically supporting an electrical stepping servo motor 168 having a drive shaft 169 and a drive pinion 170 which meshes with the teeth of the rack-bar 166.

The stepping motors 162, 168 are identical in size, mechanical construction, and electrical configuration, and contain D.C. windings of such a nature that the rotors will advance through a single arcuate increment of rotation for each discrete electrical pulse fed into it. Moreover, the stepping servo motors 162, 168, as a result of the circuitry herein disclosed, will stop very precisely at the end of such arcuate increment after each pulse. It has been found that motors of this type are thus made to function in an extremely accurate and precise manner as to the amount of movement occurring during each pulse and are capable of receiving and reacting to a very large number of discrete closely spaced pulses occurring within a relatively small interval of time. Moreover, the stepping servo motors are reversible and will rotate in one direction or the other, depending upon whether the electrical pulse is negative or positive. The electrical stepping servo motors 162, 168 are also provided with additional two-phase synchronous windings, which, when energized instead of the stepping windings, will run the motor continuously in either direction, depending upon polarity. By energizing these two-phase synchronous windings, it is possible to index the sewing machine head 56 very rapidly to some initial or starting position whenever desired.
It will, of course, be evident that as the stepping servo motors 162, 168 are energized, it is possible to produce universal movement of the stepping machine head 56 in any direction within a horizontal plane and within an area defined by the limits of travel for which the machine is designed. In the case of the sewing machine A, shown in the drawings and described herein, the limits of travel are such that the area within which the sewing machine head 56 will move is substantially the work area 16. The stepping motors 162, 168 are bifilar wound and respectively include windings W1, W2, W3, W4, as schematically shown in Fig. 20. If, for the purposes of explanation, it be assumed that the windings W2 and W4 of the stepping servo motor 162 are energized at one selected time-increment with direct current pulses and that, in the next succeeding increment, the windings W1 and W3 are energized with direct current pulses in such a way that the moment of the motor to move one step in a clockwise direction, then, by energizing the windings W2 and W4 counterclockwise, rotation can be obtained. Thus, by successively energizing windings W2-W3, W3-W4, W4-W1, W1-W2, and continuing this sequence, the stepping servo motor 162 can be caused to step incrementally in a clockwise direction. Conversely, by successively energizing the windings W4-W2, W1-W3, W2-W4, W1-W2, and continuing this latter sequence, the stepping servo motor 162 can be caused to step incrementally in a counterclockwise direction. By appropriate sequencing of pulses into different pairs of windings, it is possible to cause the stepping servo motor 162 to step one or more increments in one direction and then step one or more increments in the opposite direction. The operation of the stepping servo motor 168 is identical in electrical principle and, therefore, need not be separately described. Accordingly, if pulses are sequentially fed to appropriate pairs of windings of the stepping servo motor 162, and no pulses are transmitted to the stepping servo motor 168, the plates 55 and the sewing machine head 56 supported thereon will move laterally in a straight line to the right or, conversely, if the pulses are transmitted to the other side of the bifilar winding, the plate 55 will move to the left (reference being made to Fig. 4), as a result of corresponding rotation of the motor 162. If, on the other hand, a series of pulses is fed to the stepping servo motor 168, and no pulses are transmitted to the servo stepping motor 162, the plates 55 and the sewing machine head 56 supported thereon will move forwardly or rearwardly in a straight line, depending upon the polarity of the pulses and the consequent direction of rotation of the stepping servo motor 168. If, on the other hand, an equal number of pulses are fed to both stepping motors 162, 168, in a given interval of time, the plate 55, and the sewing machine head 56, supported thereon, will move in a straight line which is diagonal and at 45° to the previously described straight lines of movement. It will, of course, be evident that by varying the number, timed relation, and polarity of the pulses which are simultaneously fed to the two stepping servo motors 162, 168, the plate 55 and the sewing machine head 56 supported thereon can be caused to move in any direction and follow any prescribed pattern within the work area 16. Also, by varying the lengths, intervals, and number of the pulses per revolution, it is possible to vary the length of the stitch. The "program" of pulses is controlled by the six "tracks" T1, T2, T3, T4, T5, T6, on the film f, as schematically shown in Fig. 25, and is fed to the two stepping servo motors 162, 168, through the extended flexible multi-conductor electrical conduits 171, 172, which extend to an interstitial sheet metal electrical connector box 173 bolted or otherwise rigidly mounted upon one side of the machine A between the legs 2, 3, and internally provided with a conventional terminal block 174.

Mounted preferably upon the rear bracket legs is a push button type main switch 175 which is electrically connected on one side to a conventional source of A.C. electrical power and by means of a flexible multi-wire conduit 176 to appropriate terminals in the terminal block 174. On the outwardly projecting bottom margin of the flange 39 of the side rails 38 are two angularly positioned microswitches 177, 177', which are actuated by an elongated horizontal slide shoe 178 mounted upon and carried by the left slide frame 43. Similarly mounted on, and extending horizontally between, the legs 28, 29, is a bar 179, and carried thereby are several microswitches 180, 180', which are actuated by an elongated horizontal slide shoe 181 mounted on the rear portion of the base frame 1. When brought into operation by appropriate relays, the microswitches 177, 177' function to center the plate 55 from front to rear and the microswitches 180, 180' function to center the plate 55 from right to left.

Welded or otherwise rigidly mounted upon the upper face of the medial bar 14, in uniformly spaced relation between the opposite ends thereof, are two upstanding pivot blocks 182, 182', which are of identical shape and size. Journalled at its ends in, and extending horizontally between, the pivot blocks 182, 182', is a rock shaft 183 having three identical radically outwardly projecting unitarily spaced arms 184, which are bent over at their outer ends and rigidly fastened in the left side (reference being made to FIGS. 1 and 2) of a round-cornered rectangular hold-down frame or clamp 185, which is somewhat smaller than the work area 16 and adapted to fit snugly between the opposed parallel vertical faces of lateral guide bars 186, 186', extending lengthwise across the work area 16. Also welded to, and extending radially upwardly from, the shaft 183, at an appropriate angle, is an actuating arm 187, which is biased downwardly by a spring 188 and is also pivotally connected to one end of an actuating link 189, which is, in turn, pivotally connected at its other end to the armature of a solenoid 190 rigidly mounted upon an angularly disposed bracket plate 191, which is, in turn, welded or otherwise rigidly mounted in some suitable manner within the framework of the sewing machine A. The solenoid 190 may be of any conventional type or design and is, therefore, not illustrated or described herein in detail. It is sufficient for present purposes to point out that when the coil of the solenoid 190 is energized, the armature 190' is pulled backwardly (that is to say, downwardly and to the right, since being made to FIGS. 1 and 2) and this movement is transmitted through the actuating link 189 to the actuating arm 197, thereby swinging the hold-down frame 185 upwardly to the inoperative position shown in Fig. 1. On the other hand, when the solenoid 190 is de-energized, the spring 188 will return it to "down" position. Any portion of a piece of cloth, such as a shirt front, is manually placed in more or less stretched position across the top of the guide bars 186, 186', and the solenoid 190 thereupon de-energized, the hold-down frame 185 will be pushed downwardly and clamp the fabric between the lateral guide bars 186, 186'.

Rockably mounted to the cross-bar 185' of the hold-down frame 185 is a piece-holding flap or so-called "templet" 1, which is normally biased upwardly by means of a spring s and is optionally swung downwardly within the plane of the hold-down frame 185 by means of a solenoid 192. Thus, after the hold-down frame 185 is shifted into downwardly swung horizontal position, so that a section of fabric is held in operative position for stitching, an additional piece of fabric, such as a pocket, can be placed in the right position and held in such position by causing the template t to swing down into engagement thereon. Mounted on the media bar 15 is a clamp-safety micro-switch 193 which is closed when the hold-down frame or clamp 185 is in down position. Mounted on and carried by the plate 55, adjacent to the needle shaft 60 is a thread-cutter 194 which is of conventional design and is, therefore, not shown or described herein in detail. It is sufficient for present purposes to point out that the thread-
cutter 194 is actuated upon appropriate impulse by a solenoid 195. Movable upon the floor between the front legs 2, 3, so as to be positionable for the convenience of the operator, is a foot-treadle switch 196 having a foot-treadle 197 and three switches 198, 199, 200 that close in successive order as the treadle 197 is depressed.

The mechanical, electromagnetic components and switchs are interconnected through control circuits shown schematically in the wiring diagrams, FIGS. 20, 21, 22, 23, 24. For convenience of illustration, the terminal block 174 is diagrammatically shown as a series of rectangles extending across the top and bottom of each wiring diagram. Terminals 201 to 296, inclusive, and terminals x and y which are the two main A.C. supply connectors. In each wiring diagram, such terminals are designated by the same numbers so that a component which is connected in one figure to a particular terminal is, in effect, connected to any or all other components upon the floor in any or all other figures. As shown, all relays are in de-energized position and the relay contactors are shown in retracted position. In other words, whenever a relay coil is energized, the blades will move toward the coil.

FIG. 20 shows the electromechanical components and switches. FIG. 21 shows the servo motor resistance banks B₁, B₂, the control panel P₁, the photo-cell 147, the tape-control circuits T₁, T₂, and the meter-panel P₂. FIG. 22 shows twenty-three relays 1 to XXIII, inclusive, and four power-supplies 5₁, 5₂, 5₃, 5₄. FIGS. 23 and 24 show the control circuits C₁, C₂, C₃, C₄, for driving the stepping motors 162, 168, from the programming film strip f and the tape-control circuits D₁, D₂, D₃, D₄, which receive impulses from the corresponding sensing zones of the photo-cell 147 responsive to the opaque and transparent portions of the film tracks T₁, T₂, T₃, T₄. The control circuits C₁, C₂, C₃, C₄ are substantially identical and include a number of PNP transistors, NPN transistors, and silicon controlled rectifiers. Since one or more of the silicon controlled rectifiers might not always reset themselves at the end of each sewing cycle, this is done positively by relay X₃₁.

The tracks T₁, T₂, T₃, T₄, and associated circuitry, in effect, constitute bi-stable type feedback cut-off switches that are controlled by four PNP type sensitized zones in the photo-cell 197. For example, whenever track T₁ is opaque, the sensitized zone of photo-cell 147, which corresponds thereto, has no positive output voltage, therefore, as shown in FIG. 23, the larger resistor R₁ from the transformer 300 to the base of transistor Q₁ supplies that base with enough negative voltage to drive it to condition. This tends to hold Q₁ in a non-conducting state. On the other hand, when the operating point resistor R₁ causes the base of the compound transistor Q₁ to become positively biased and, consequently, no current passes through the compound transistor Q₁.

Whenever the track T₁ becomes transparent, the associated sensitized zone of photo-cell 147 emits a voltage which is large enough to overcome the resistance of the resistor R₁ and will positively bias the base of transistor Q₁, which will then become non-conductive and will, in turn, allow the base of the compound transistor Q₁ to become negatively biased by resistor R₂. As a result, transistor Q₂ will become conductive.

Due to the bi-stable state of the amplifier D₁, this switching of power has very fast rise and fall times and thus induces enough voltage to trigger the silicon controlled rectifiers SCR₁ and SCR₂ in the control circuit C₅. The gates of the silicon controlled rectifiers SCR₁ and SCR₂ are connected to secondary windings in transformer 300 so as to be 180° out of phase with the other silicon controlled rectifier. When track T₁ is transparent, transistor Q₂ becomes conductive and current rises, inducing a positive pulse on the gate of the silicon controlled rectifier SCR₁ connected to terminal 263. When the track T₁ becomes opaque, transistor Q₂ does not conduct and the voltage falls in the transformer 300 inducing a positive voltage on their gate of silicon controlled rectifier SCR₁ connected to terminal 265. A commuting capacitor 301 is connected between the anodes of the silicon controlled rectifiers SCR₁, SCR₂, so as to be supplying a commutating voltage at twice the line frequency.

The voltage pulses from the silicon controlled rectifiers SCR₁, SCR₂, to allow maximum voltage for a specified or predetermined amount of time. As the discharge voltage in the time constant network 302 begins to decay, the voltage to the winding W₁ of the stepping servo motor 162. This results in the increasing resistance of transistors Q₁, Q₂. Resistor R₃ is connected in parallel with the series transistors Q₁, Q₂, to maintain a safe level of voltage for holding action. Silicon controlled rectifiers SCR₁ and SCR₂ supply voltage to the network 302 and are triggered by transformer 303, the primary of which is also connected between the anode of silicon controlled rectifiers SCR₁, SCR₂, and bridges the commuting capacitor 301. The secondary of this transformer 303 is connected to the gate of silicon controlled rectifiers SCR₁, SCR₂, so as to be supplying the positive voltage to the opposite silicon controlled rectifier gate. For example, when the silicon controlled rectifier SCR₁ turns on, the voltage induced will turn on the silicon controlled rectifier SCR₂ and when the silicon controlled rectifier SCR₂ is turned on, the induced voltage will turn on the silicon controlled rectifier SCR₁.

Since silicon controlled rectifiers SCR₁, SCR₂ have no commuting capacitor for turn off, shunting transistors Q₁, Q₂ momentarily shut them respectively for turn off. Transistors Q₁, Q₂ are energized by a voltage induced from the transformer 304 when silicon controlled rectifiers SCR₁, SCR₂ are turned on.

Network 302 supplies its time contact signal to transistor Q₅ which handles enough power for each output transistor Q₆, Q₇. Since one of the series transistors may shut off before the total voltage is reduced below the break over voltage of the other transistor a balancing system is used to compensate the signal voltage from transistors Q₅ to Q₇.

This consists of a transistor Q₅ in series from the collector of transistor Q₇ to the base of transistor Q₈. Transistor Q₈ is controlled by transistor Q₅ and transistor Q₈ is, in turn, controlled by the voltage differentials between the terminals and center tip of resistor R₃ (see FIG. 21). If transistor Q₇ conducts more than transistor Q₅, a negative voltage will appear on the base on which will increase the resistance of transistor Q₅ allowing more signal from network 302 to pass to transistor Q₂ to decrease its resistance and increase the current flowing through it.

If transistor Q₅ conducts more than transistor Q₇, a positive voltage will appear on transistor Q₅ which will allow current to flow on to base of transistor Q₇ which will decrease the resistance of transistor Q₇ to a point below the resistance of resistor R₃, allowing more signal of network 302 to flow to transistor Q₇.

The control circuit C₃, as will be seen by reference to FIG. 21, also includes transistors Q₁, Q₂, Q₃, Q₄, Q₅, Q₆, Q₇, Q₈, Q₉, and silicon controlled rectifiers SCR₁, SCR₂, SCR₃, SCR₄, network 312, and transistors 313, 314, which are identical with the corresponding transistors Q₁, Q₂, Q₃, Q₄, Q₅, Q₆, Q₇, silicon controlled rectifiers SCR₁, SCR₂, SCR₃, SCR₄, network 302 and transformers 303, 304 and have the same function in the other side of the control circuit C₃ except that such side of control circuit C₃ serves to feed pulses into the winding W₂ of the...
stepping servo motor 162. The control circuit C2, as will be seen by reference to FIG. 23, consists of the same components as the control circuit C1. These components are connected in exactly the same manner as just above described in connection with the stepping circuit C1. The control circuit C2, however, operates from track T4 through its associated amplifier circuit D2 and the two sides of this control circuit C2 correspondingly feed pulses into the windings W3 and W4, respectively, of the stepping servo motor 168.

The control circuits C3 and C4 are electrically identical with the control circuits C1 and C2 except that they function in response to the tracks T3 and T4 through the amplifiers D5, D6, respectively, and feed pulses to the windings W1, W2, W5, W6, respectively, to the stepping servo motor 168.

As has been above pointed out, as pulses are fed to the servo motor 162, in one sequence, such motor will step incrementally in a clockwise direction and as the pulses are fed in the other sequence, the motor will step incrementally in a counterclockwise direction. This is accomplished by the relative movements of the opaque sections on tracks T1, T2. Whenever opaque sections on track T1 are ahead of or "lead" the corresponding opaque sections on track T2 the stepping servo motor 162 will rotate in one direction and, conversely, when the opaque sections of track T2 are "follow" the corresponding opaque sections on track T1, the stepping servo motor 162 will rotate in the other direction. The same thing is true with respect to the stepping servo motor 168 and the time-sequene relationships between the tracks T1, T2.

As will be seen by reference to FIG. 21, the circuitry includes a pair of conventional rotary switches 304, 305, which are electrically connected to a conventional motor and provide means by which any one of a number of the servo motor control circuits can be optionally tested one at a time. The manual control switching device P1 affords a means by which an operator can manually position the sewing head 56 and by-pass the automatic control circuitry which functions responsive to the program established by the tracks T1, T2, T3, T4, T5, T6, T7, T8, of the tape or film f. This switching device P1 can be located either at some convenient position on the base 5 of the machine or, if desired, can be located at some remote position.

In use, the main switch 175 is turned on and this energizes the sewing machine motor 70 and the power supply circuits S1, S2, S3, S4. Relay III and XII also close, thus energizing the lamp L and resetting the silicon controlled rectifier. It will, of course, be understood that the film will be initially threaded into the machine, so that it is at a proper starting position. Thus, when the main switch 175 is closed and the lamp L is turned "on," the relay IX closes and, in turn, the relay V closes, thereby interrupting the circuit to the auxiliary motor 127. At the same time, the clamp solenoid is energized, lifting the clamp 185 to permit placement of the work in the proper position for sewing.

The operator then steps the treadle 197 of the treadle motor 196, which pushes it down successively closing switches 198, 199, 200. This first de-energizes the solenoid 190 which holds the clamp 185 in "up" or non-operative position. Next, the solenoid 192 is energized, pulling down the template t. Finally, the coil in relay XVIII receives an impulse from the capacitor and latches to activate relays XVI and XVII. This throws A.C. current on the windings of the stepping motor 162 and causes it to function as a two phase A.C. motor, thereby moving the platens 55 to a central predetermined starting position. A time-delay capacitor then actuates relay VII which then initiates the sewing cycle. Relay VII actuates relays I and II which shift from A.C. positioning current to pulse operation.

In connection with this it should be noted that when the windings of the servo stepping motors 162, 168 are changed from continuous alternating current to direct current pulses transmitted to them from the control circuits C1, C2, C3, C4, responsive to signal received from the program tape of film f, the control circuits C1, C2 operate the motor 162 forward and back, respectively, and the control circuits C3, C4 operate the motor 168 right and left, respectively.

At the same time, relay VII actuates relay III and supplies alternating current to the start solenoid 99. Relay VII also actuates relays X and XI which discount the windings of the servo stepping motors 162, 168 from alternating current and connect such windings to direct current pulses from the control circuitry. The start solenoid 99 pulls the belt shifter 76 over to latch position and the stitching mechanism of the sewing machine head 56 commences to sew according to the programmed pattern. Thereupon, the solenoid 99 is de-energized by the start microswitch 115.

Prior to energization of the solenoid 99, however, the coils m of the magnetic clutch are energized so that the shift 63 will drive the program tape or film f. This is accomplished by relay V which is normally in such a position that the current from power supply S2 is impressed immediately upon the coils m. At the same time current is fed into the capacitor and resistor network associated with the relay IV which is in effect a time delay circuit and consequently the relay IV pulls in at some small interval after the coils m are energized. This ensures that the tape f is locked in line with the shaft 63 before the sewing head 56 commences stitching. At the end of the sew-pattern program on the tape or film f, relay IX releases and, accordingly, relay V, which is interlocked therewith, becomes de-energized and drops back to initial position. This actuates the stop solenoid 103 momentarily and releases the detent hook 106, allowing the belt shifter 76 to swing forwardly again and stop the switching mechanism of the sewing head 56 at its indexed or stopping position with the needle fully withdrawn from the work. Relay V also momentarily actuates relay VI, thereby briefly energizing the cutting solenoid 195 and operating the thread cutter 194. As the stitching mechanism of the sewing head 56 stops, the magnetic clutch holding microswitch 110 opens, disconnecting the coils m and the clutch plate 118 becomes uncoupled from the clutch plate 123. Consequently, the tape of film f is no longer driven from shaft 63. However, the auxiliary motor 127 is also connected to the alternating current by relay V and begin to rotate, taking over the film-driving function and feeding the remaining portion of the film f back to starting position. Just before the film f reaches back to its original position, the sixth track will transmit an impulse through amplifier circuit D2 to reconnect the servo stepping motor 162, 168, to alternating current and pull them automatically back to initial or so-called "zero" position. This is accomplished with the aid of switches 177, 177', and 180, 180'. At this time, relay VIII is actuated and de-energizes solenoid 192 to release the template t. This, in turn, closes the circuit to solenoid 190 and the clamp 185 swings up so that the operator may remove the completed work. At this moment, the sewing cycle has been completed and the machine A is conditioned for starting the next sewing cycle. In this connection, it is important to note that the sewing pattern need not be continuous. For instance, it is easily possible to sew one seam and then shift the sewing head 56 to a new position without stitching and start the sewing again at such new position to form another and entirely separate line of stitches before ending the program and returning to the zero position. It should be understood that changes and modifications in the form, construction, arrangement, and combination of the several parts of the automatic program-controlled sewing machine may be made and substituted for those herein shown and described without departing from the nature and principle of our invention.
Having thus described our invention, what we claim and desire to secure by Letters Patent is:

1. An automated sewing machine comprising, in combination, a base having a sewing area, a sewing head having means for sewing a line of discrete stitches in successive and spaced order, said sewing head being supported for universal movement in a selected plane within said sewing area, an electric motor operatively associated with said sewing head, means for optionally connecting said electric motor to said sewing means for driving said sewing means, first motive means for moving the said sewing head within said area along a selected line, second motive means for moving said sewing head within said area along a selected line angularly disposed with respect to said first named selected line, programming means for controlling the operation of said first and second motive means whereby to cause said sewing head to move along a predetermined pattern, and means for connecting said electric motor to said programming means whenever said electric motor is connected to said sewing means.

2. An automated sewing machine comprising, in combination, a base having a sewing area, a sewing head having sewing means having a reciprocating needle movable into and away from said sewing area for sewing a line of discrete stitches in successive and spaced order, said sewing head being supported for universal movement in a selected plane within said sewing area, prime mover means operatively associated with said sewing head, means for optionally connecting said prime mover means to said sewing means for driving said sewing means, first motive means for moving said sewing head within said area along a selected line, second motive means for moving said sewing head within said area along a different selected line angularly disposed with respect to said first named selected line, programming means for controlling the operation of said first and second motive means whereby to cause said sewing head to move in a step-by-step manner during the period when said needle is above said sewing area and whereby to cause said sewing head to move in a step-by-step manner during the period when said needle is above said sewing area and whereby to cause said sewing head to move along a predetermined pattern.

3. The automated sewing machine of claim 2 wherein said first motive means moves said sewing head to and fro within said area along a selected line and said second motive means moves said sewing head to and fro within said area along said different selected line.

4. The automated sewing machine of claim 2 wherein said first motive means incrementally moves said sewing head within said area along said selected line and said second motive means incrementally moves said sewing head within said area along a different selected line angularly disposed with respect to said first named selected line.

5. The automated sewing machine of claim 4 wherein said first motive means incrementally moves said sewing head to and fro within said area along said selected line and said second motive means incrementally moves said sewing head to and fro within said area along said different selected line.

6. The automated sewing machine of claim 4 including means for holding a workpiece substantially in and parallel to said selected plane within said sewing area.

7. The automated sewing machine of claim 4 wherein said first and second motive means are electric motors of the direct current stepping type.

8. The automated sewing machine of claim 2 including means for controlling said programming means and said prime mover means, when connected to said sewing means, to operate in directly timed relation with respect to each other.

9. The automated sewing machine of claim 2 wherein said programming means is a continuous endless-ribbon programming means.

10. The automated sewing machine of claim 2 including clutch means for coupling said programming means and said sewing means so that said means will function in timed relation with respect to each other.

11. The automated machine of claim 2 wherein said programming means includes first control means for programming the operation of said first and second motive means whereby to cause the sewing head to stitch along a predetermined pattern and second control means for rapidly depositing said sewing head at a predetermined starting position when the pattern has been completed.

12. The automated machine of claim 11 wherein said first and second control means include a photoelectric cell and a translucent tape having a plurality of tracks consisting of opaque and light transmissive sections.

13. The automated sewing machine of claim 12 wherein in translucent tape is endless.

14. An automated sewing machine comprising, in combination, a base having a sewing area, a sewing head having sewing means having a reciprocating needle movable into and away from said sewing area for sewing a line of discrete stitches in successive and spaced order, said sewing head being supported for universal movement in a selected plane within said sewing area, a direct electric motor for incrementally moving said sewing head within said area along a selected line, a direct current step motor for incrementally moving said sewing head within said area along a different selected line and means for controlling the operation of said direct electric motor and said direct current step motor whereby to cause said sewing head to move in a step-by-step manner during the period when said needle is above said sewing area and whereby to cause said sewing head to stitch along a predetermined pattern.

15. An automated sewing machine comprising a base, a sewing head mounted upon the base for universal movement in one plane, means for holding the work-piece substantially in and parallel to said plane, said sewing head having the sewing means including an electric motor and needle bar for reciprocating in successive stroke toward and away from said plane whereby to push the needle through the work-piece as the needle bar during each stroke toward said plane and withdraw the needle from the work-piece during each stroke away from the plane, so that the needle is out of the work-piece during successive increments, and programmed stepping means for moving the sewing head in one direction in reference to the base and in another direction in reference to the selected line, said one direction in reference to the base, said means being operable in timed relation to the needle bar so that movement of the sewing head takes place only during the increments when the needle is withdrawn from the work-piece.

16. An automated sewing machine according to claim 15 in which the clutch means is an electromagnetic clutch.

17. An automated sewing machine having a base which affords a sewing area, a sewing head having sewing means for sewing a line of discrete stitches in successive and spaced order, an electric motor carried by said sewing head, means for optionally connecting the electric motor to the sewing means for driving the sewing means, means for supporting the sewing head for universal movement in a selected plane within the sewing area, first motive means for moving the sewing head within said area along a selected line, second motive means for moving the sewing head within said area along a different selected line and means for controlling the operation of said first and second motive means whereby to cause the sewing head to move along a predetermined pattern and means for connecting the electric motor to the programming means whenever the electric motor is connected to the sewing means.
18. An automated sewing machine according to claim 17 in which the programming means is in operation and running for a brief period of time prior to the starting of the sewing means.

19. An automated sewing machine according to claim 17, and further characterized by an auxiliary motor adapted for driving the programming means when the programming means is disconnected from the electric motor which drives the sewing means.

20. An automated sewing machine having a base which affords a sewing area, a sewing head having a reciprocating needle movable into and away from said sewing area for sewing a line of discrete stitches in successive and spaced order, a first support element operatively mounted on the base for linear movement in one selected direction, first rack and first pinion means interposed between the first support element and the base for operationally shifting the first support means with respect to the base, a second support element operatively mounted on the first support element for linear movement in another selected direction, second rack and second pinion means interposed between the second support element and first support element for operationally shifting the second support element with respect to the first support element, a sewing head mounted on and carried by the second support element, first bifilar wound motor means for rotating the first pinion means to move the first support element along said one selected direction, second bifilar wound motor means for rotating the second pinion means to move the second support element along said other selected direction, and programming means for controlling the operation of said first and second motor means whereby to cause said sewing head to move in a step-by-step manner during the period when said needle is above said sewing area and whereby to cause the sewing head to stitch along a predetermined pattern.

21. An automated sewing machine in comprising, in combination, a base, a sewing head mounted upon the base for universal movement in one plane, means for holding a work-piece substantially in and parallel to said plane, said sewing head having stitch forming means including a needle and needle-bar reciprocating in successive stroke toward and away from said plane whereby to push the needle through the work-piece as the needle bar during each stroke toward the plane and withdraw the needle from the work-piece during each stroke away from the plane, so that the needle is out of the work-piece during successive increments, motive means for moving the sewing head in one direction in reference to the base and in another direction angular with respect to said one direction in reference to the base, said means being operable in timed relation to the needle bar so that movement of the sewing head takes place only during the increments when the needle is withdrawn from the work piece, and programming means for controlling the movements of the motive means.

22. An automated sewing machine according to claim 21 in which the means for holding the work-piece is actuated by a solenoid energized in response to signals from the programming means.

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