

April 17, 1962

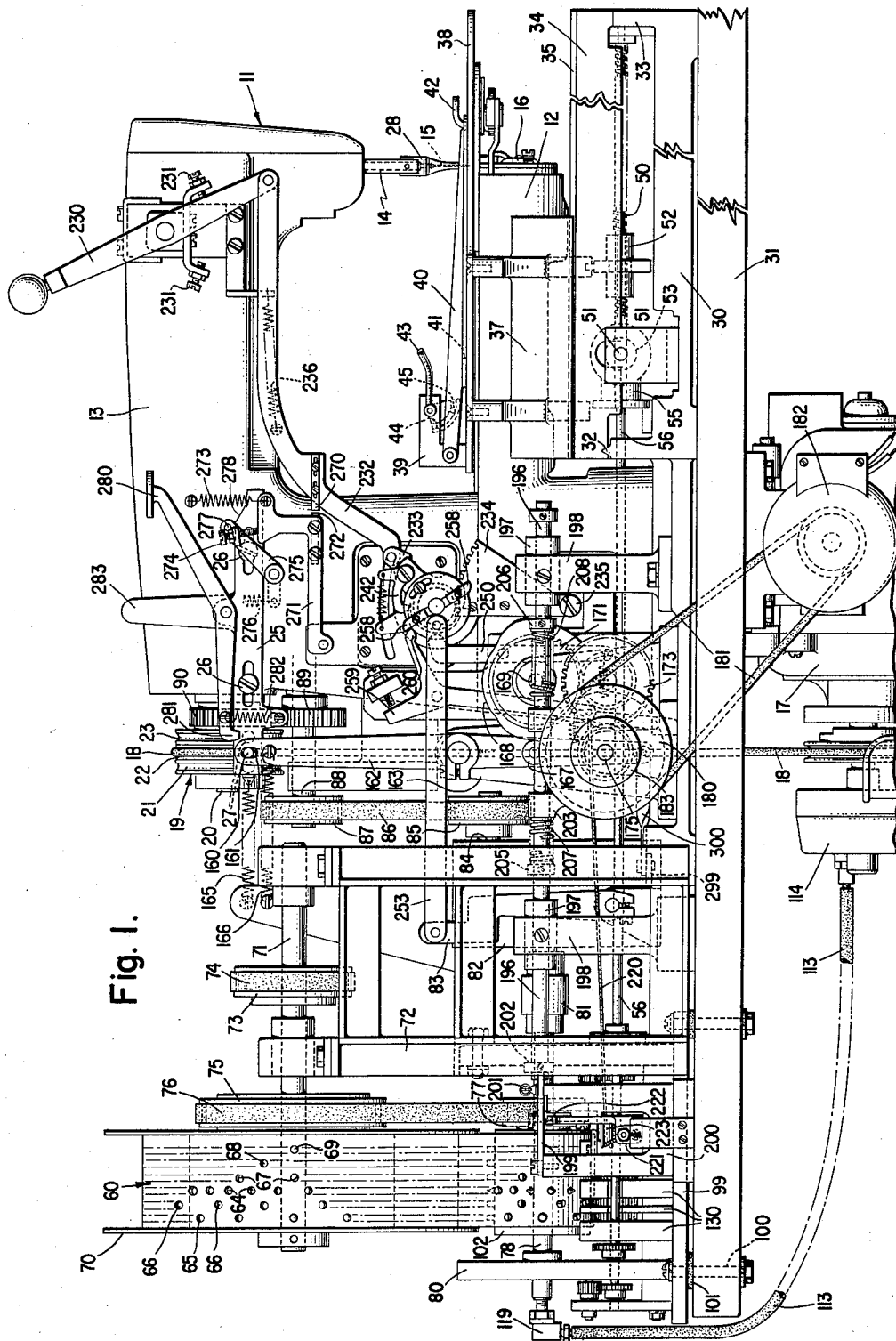
H. J. HURME ETAL

3,029,758

PROGRAM CONTROL FOR SEWING MACHINES

Filed July 22, 1960

6 Sheets-Sheet 1



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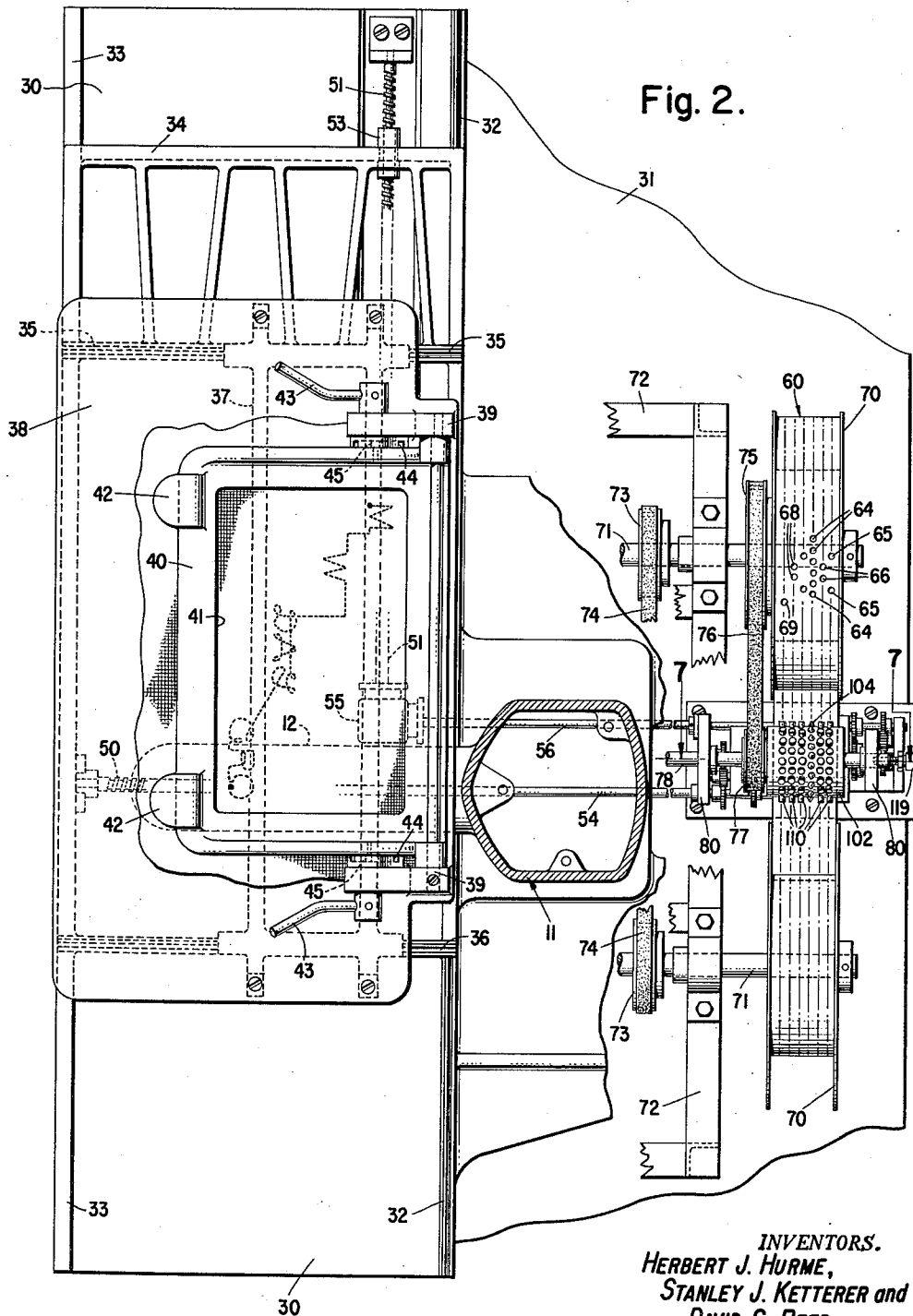
H. J. HURME ETAL

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PROGRAM CONTROL FOR SEWING MACHINES

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6 Sheets-Sheet 2



INVENTORS.
HERBERT J. HURME,
STANLEY J. KETTERER and
DAVID S. REED.
BY
Marshall J. Breen
ATTORNEY

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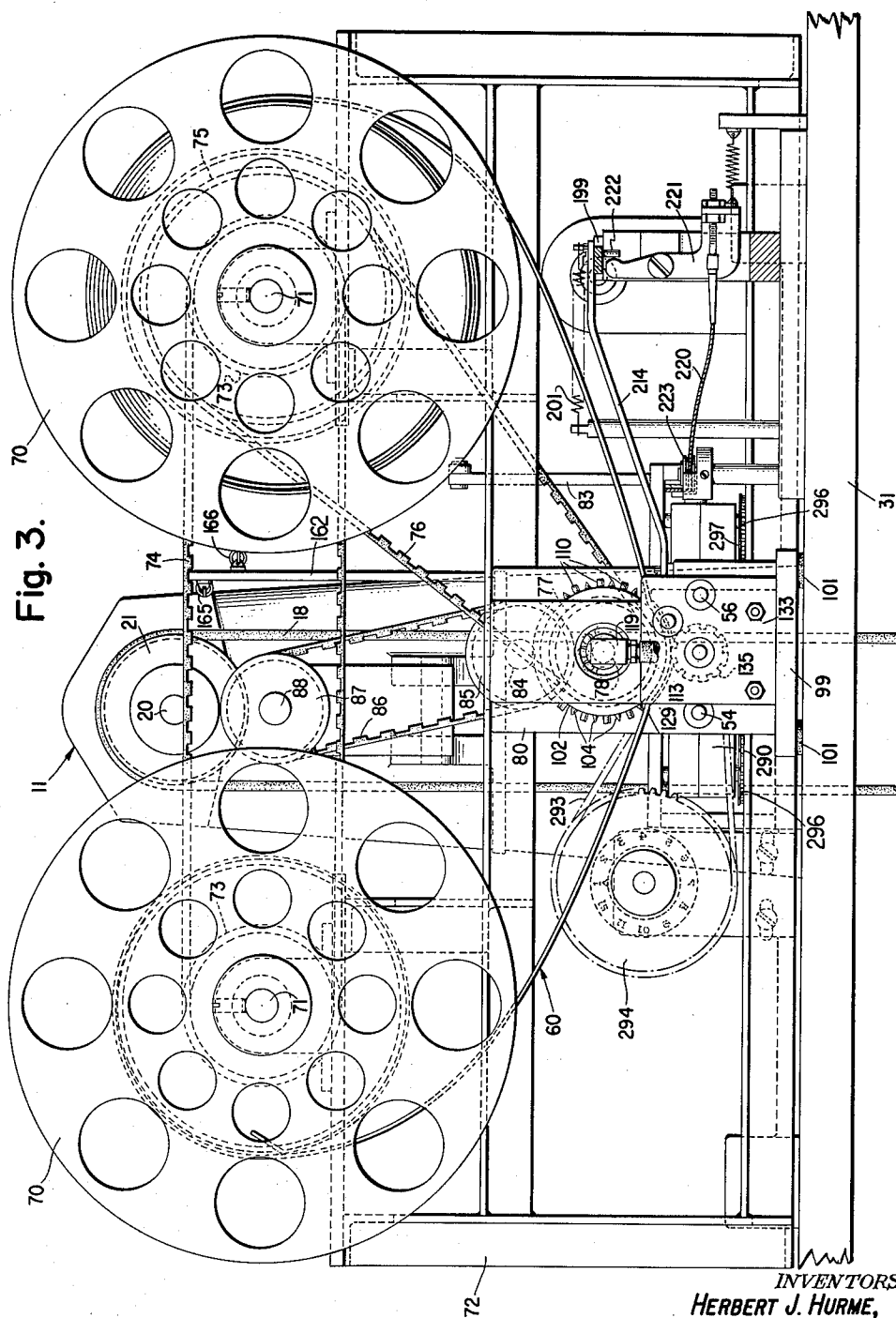
H. J. HURME ET AL

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PROGRAM CONTROL FOR SEWING MACHINES

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6 Sheets-Sheet 3



INVENTORS.

**HERBERT J. HURME,
STANLEY J. KETTERER
and DAVID S. REED.**

BY *Marshall J. Breen* and DAVID S. REED.
ATTORNEY

April 17, 1962

H. J. HURME ETAL

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Fig. 5.

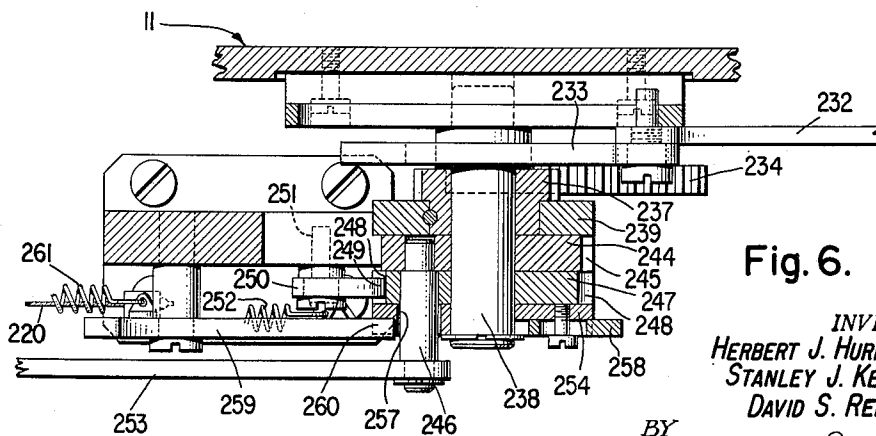
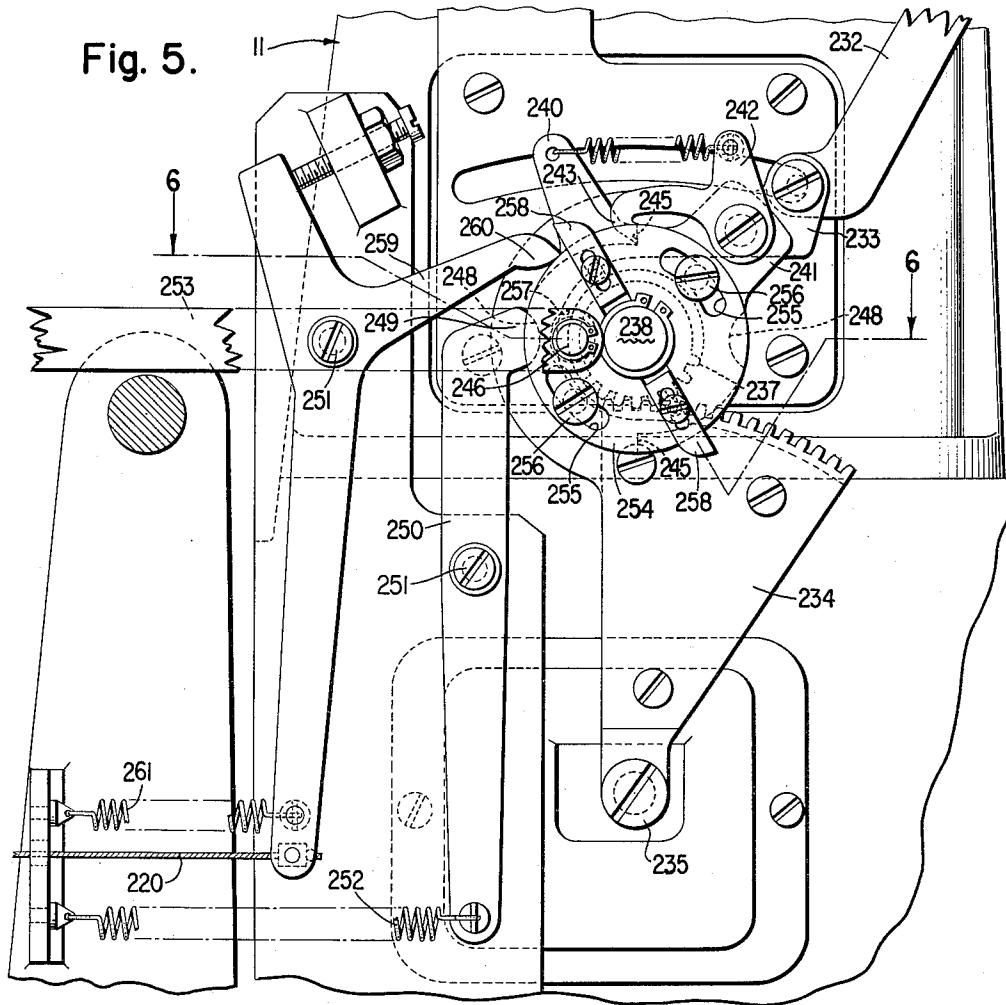


Fig. 6.

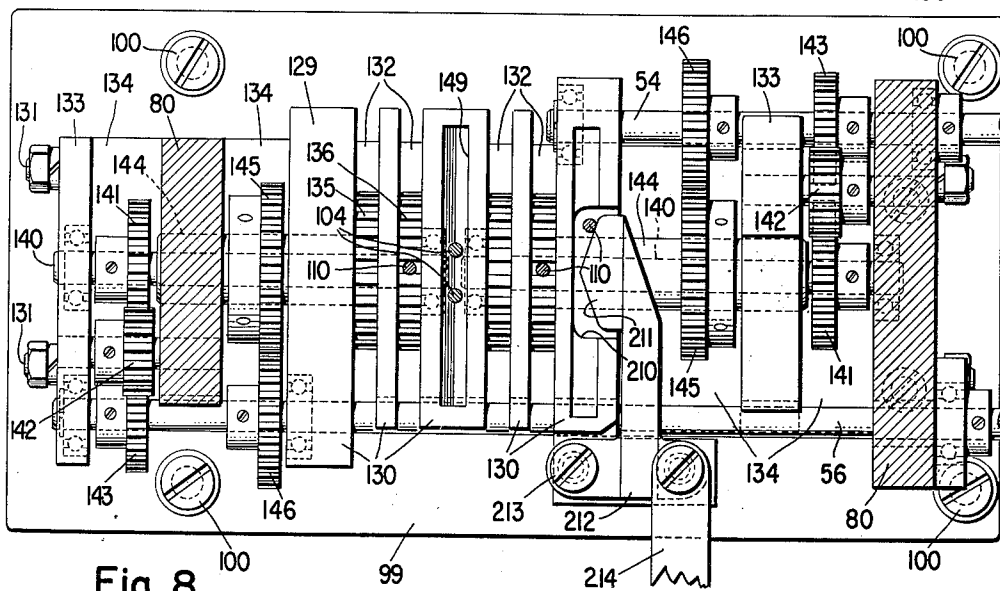
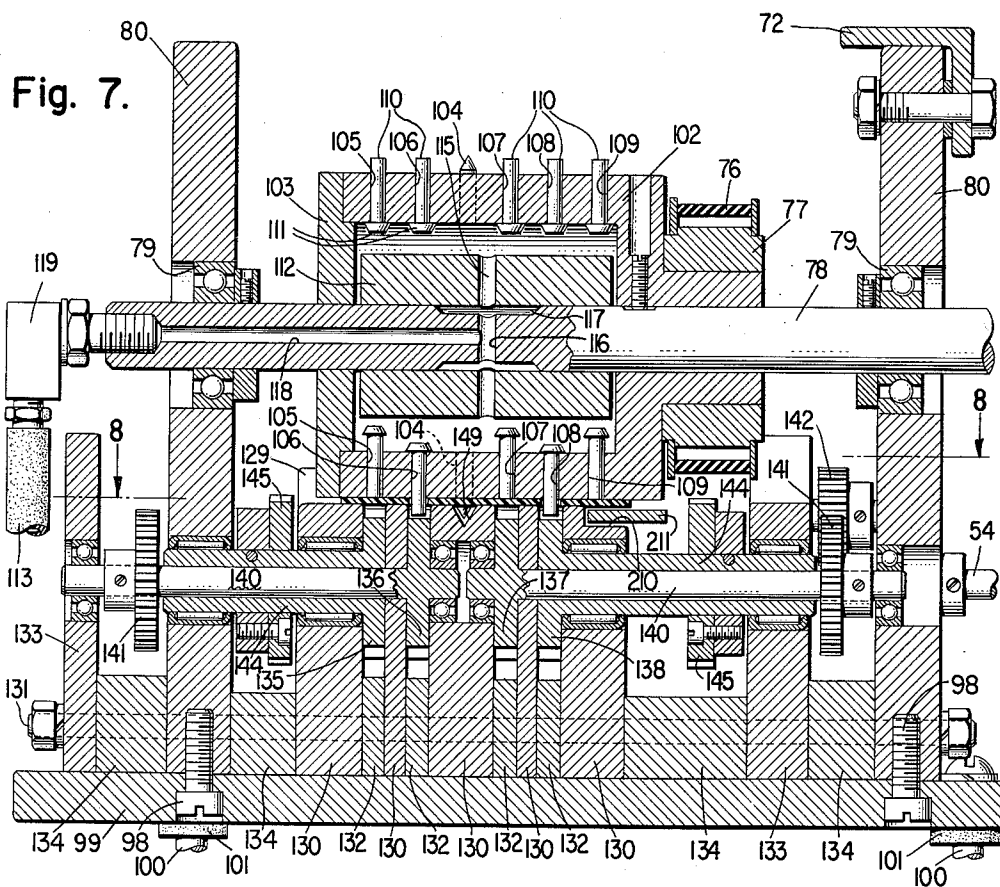
INVENTORS.
HERBERT J. HURME,
STANLEY J. KETTERER and
DAVID S. REED.

BY *Marshall J. Brown*
ATTORNEY

H. J. HURME ETAL

PROGRAM CONTROL FOR SEWING MACHINES

6 Sheets-Sheet 6



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3,029,758

PROGRAM CONTROL FOR SEWING MACHINES

Herbert J. Hurme, Elizabeth, N.J., and Stanley J. Ketterer and David S. Reed, Stratford, Conn., assignors to The Singer Manufacturing Company, Elizabeth, N.J., a corporation of New Jersey

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15 Claims. (Cl. 112—102)

This invention relates to sewing machines, and more particularly to an integrated sewing unit for automatically controlling the operation of a sewing machine and a work supporting and feeding mechanism in accordance with a predetermined program whereby complete sewing operations, such as the fabrication of collars, the attaching of pockets, the stitching of embroidery patterns and the like, may be accomplished automatically and with operator attention only for insertion and removal of work pieces.

It is an object of this invention to provide an automatic sewing unit in which the feed of the work fabrics relatively to the stitching point of the stitch forming instrumentalities is controlled by a punched tape on which an entire sewing operation may be programmed.

Another object of this invention is to provide a novel mechanism for sensing the information programmed on a punched tape and for translating said information into useful feed motion of a work fabric.

Still another object of this invention is to provide an automatic sewing unit in which the speed of operation of the sewing machine during a programmed sewing operation as well as the means for stopping the sewing unit at completion of a programmed sewing operation is controlled by the punched tape on which the entire sewing operation is programmed.

It is an object of this invention to provide a means for frictionally braking the punched tape controlled work feeding mechanism to prevent overthrow thereof and to provide a means controlled by the punched tape for selectively varying the frictional drag applied by the braking means during the programmed sewing operation.

A further object of this invention is to provide a punched tape driving and sensing arrangement of the above character with means for reversing the direction of movement of the punched tape on alternate sewing operations such that upon removal and replacement of work fabrics after each sewing operation the sewing unit is immediately readied for the succeeding sewing operation.

With the above and other objects and advantages in view as will hereinafter appear, this invention comprises the devices, combinations, and arrangements of parts hereinafter described and illustrated in the accompanying drawings of a preferred embodiment in which:

FIG. 1 represents a right side elevational view of the sewing unit of this invention,

FIG. 2 represents a top plan view of the work supporting carriage and the punched tape controlled carriage feeding mechanism with the sewing head portion of the sewing machine broken away and the sewing machine controlling mechanism omitted,

FIG. 3 represents a rear elevational view of the sewing unit of FIG. 1,

FIG. 4 represents an enlarged top plan view of the mechanism influenced by the punched tape for controlling the operation of the sewing machine,

FIG. 5 represents an enlarged side elevational view of the starting mechanism carried on the right side of the sewing machine,

FIG. 6 is a horizontal cross sectional view taken substantially along line 6—6 of FIG. 5,

FIG. 7 is an enlarged vertical cross sectional view of

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the punched tape sensing mechanism taken substantially along line 7—7 of FIG. 2, and

FIG. 8 is a top plan view of the punched tape sensing mechanism as illustrated in FIG. 7 with the pin supporting drum removed and the frame illustrated in cross section taken substantially along line 8—8 of FIG. 7.

Referring to the drawings, and particularly to FIGS. 1 and 2, the sewing unit of this invention includes a sewing machine, indicated generally at 11, having a casing comprising a bed 12 and a bracket arm 13 overhanging the bed. The stitch forming instrumentalities of the sewing machine comprise an endwise reciprocatory needle bar 14 carried in the bracket arm fitted with a thread carrying needle 15, and a loop taker 16 journaled in the bed and cooperating with the needle in the formation of lock stitches. The sewing machine casing, the stitch forming instrumentalities, and the actuating connections therebetween may be conventional and, as illustrated in the drawings, are of the type disclosed in the United States Hale et al. Patent No. 2,822,771, February 11, 1958, to which reference may be had.

The sewing machine is driven by an electric motor 17 by way of a drive belt 18 and a stop motion mechanism, indicated generally at 19, associated with a shaft 20 of the sewing machine which actuates the stitch forming instrumentalities. The stop motion mechanism is preferably of the type including three pulleys, a loose or idler pulley 21, a low speed pulley 22 operatively connected to the shaft 20 to turn at a speed greater than the shaft, and a high speed pulley 23 operatively connected to the shaft 20 to turn at the same speed as the shaft. A two part control slider 24, 25 (FIGS. 1 and 4) of which the parts are normally locked together, as will be described hereinafter, is constrained on shouldered screws 26 on the sewing machine bracket arm. One part 24 of the slider carries a pair of belt shipping rollers 27 for shifting the belt from one pulley to another and also is associated with means (not shown) known in the art providing a positive stop for the shaft 20 when the belt is shifted onto the idler pulley 21. The stop motion mechanism may be of the type disclosed in the United States patent to Wood No. 2,338,611, January 4, 1944.

The cam means which are usually associated integrally with a sewing machine of the type disclosed in the drawings for controlling the stop motion mechanism and for manipulating a work clamp relatively to the stitch forming instrumentalities are eliminated in the sewing unit of this invention. In place of the usual work clamp, the sewing machine is fitted with a conventional darning or embroidery type presser foot 28 which is preferably biased with a light spring pressure downwardly toward the sewing machine bed.

The sewing machine casing is preferably secured on a metal base member 30 which rests on a table top 31 beneath which the sewing machine driving motor 17 is supported. Referring to FIG. 2, the base member 30 is formed with spaced parallel ways 32 and 33 extending substantially perpendicular to and beneath the sewing machine bed. Slidable on the ways 32 and 33 is a frame 34 formed in turn with spaced parallel ways 35 and 36 disposed substantially parallel to and one on each side of the sewing machine bed. Slidable on the ways 35 and 36 is a work supporting carriage 37 to which is secured a substantially flat horizontal plate 38 which extends over the sewing machine bed.

The plate 38 is formed with a pair of spaced upstanding brackets 39 on which is pivoted a work holding clamp frame 40 having a central opening 41 for exposing an area of work fabric clamped on the flat horizontal plate 38 by the frame 40. Lifting tabs 42 are provided on the front edge of the work holding frame for the operator to lift the frame in removing and replacing work there-

beneath. Pivotaly secured on each of the brackets 39 is a locking lever 43 formed with a cam track 44 embracing a pin 45 on the work holding frame for locking the work holding frame in work gripping relation against the flat horizontal work supporting plate 38. It will be appreciated that different forms of the work supporting plate 38 and of the work holding frame may be substituted to accommodate the particular shape and type of work piece that is to be stitched.

The work fabrics gripped on the work supporting plate 38 by the work holding frame are fed relatively to the stitching point, as determined by the path of endwise reciprocation of the needle, by a pair of lead screws 50 and 51 journaled in bearings in the base member 30. The lead screw 50 extends substantially parallel to the sewing machine bed and is embraced by a follower nut 52 carried by the carriage 37. The lead screw 51 extends substantially perpendicular to the sewing machine bed and is embraced by a follower nut 53 carried by the frame 34. The lead screw 50 is rotationally secured to a feed shaft 54 disposed in axial alignment with the lead screw 50 and extending rearwardly through the sewing machine casing. The lead screw 51 is drivingly connected by means of a right angle drive unit 55 to a feed shaft 56 extending rearwardly through the sewing machine casing.

Work Feed Control

For imparting the requisite turning movements to the feed shafts 54 and 56 to accomplish any desired path of motion of the work clamped on the work supporting plate 38, the sewing unit of this invention provides for predeterminable programming of the feed motion on a punched tape 60. The tape may be made of any of a variety of flexible materials including metal, or synthetic plastic and, as illustrated in FIGS. 1 and 2, in the embodiment illustrated in the drawings it is provided with six rows of punched holes. A regularly spaced row of holes 64 near the middle of the tape is used to drive the tape. At one side of the drive holes 64 are two rows of holes 65 and 66 which control the motion of the feed shaft 56 for feeding the work perpendicular to the sewing machine bed; each row of holes 65 and 66 serving to control the motion in an opposite direction along the ways 32 and 33 of the base member 30. At the other side of the drive holes 64 are two rows of holes 67 and 68 which control the motion of the feed shaft 54 for feeding the work parallel to the sewing machine bed; each row of holes 67 and 68 serving to control the motion in an opposite direction along the ways 35 and 36 of the frame 34. An additional row of punched holes 69 at the edge of the tape serves to control the operation of the sewing machine as will be described later.

The tape 60 extends loosely between and is stored in loose coils on a pair of tape reels 70 fast each on a shaft 71 journaled in an open frame 72 carried on the table top 31. Pulleys 73 fast one on each of the shafts 71 are connected by a belt 74 to synchronize the drive of the tape reels. One of the tape reel shafts 71 has fixed thereon a pulley 75 connected by means of a belt 76 to a pulley 77 fast on a shaft 78. The shaft 78 is journaled in bearings 79 in the end plates 80 of a frame for the tape sensing mechanism which will be described hereinbelow. The shaft 78 is connected by means of a shaft coupling 81 to the output shaft of a conventional reversing unit 82 as illustrated in FIG. 1. An operating lever 83 of the reversing unit serves to reverse the direction of rotation of the output shaft of the reversing unit relatively to an input shaft 84 which carries a pulley 85 connected by means of a belt 86 to a pulley 87 on a stud shaft 88 journaled in the sewing machine bracket arm. The stud shaft is connected by means of gears 89 and 90 to the actuating shaft 20 of the sewing machine such that the shaft 78 and the tape reels will be turned in synchronism with the stitch forming instrumentalities of the

sewing machine and in a direction of rotation which may be reversed by a shift of the operating lever 83 of the reversing unit.

Referring to FIGS. 1, 2, 7 and 8, the tape sensing mechanism for controlling the feed of the work will now be described. The end plates 80 of the frame for the sensing mechanism are secured by bolts 98 to a base plate 99 which is fastened with bolts 100 and resilient washers 101 to the table top 31. Secured on the shaft 78 is a hollow drum 102 of which the shaft embracing hub at one end preferably accommodates the tape reel driving pulley 77. At the other end, the hollow drum 102 is closed by an end cover plate 103 providing an air tight drum interior. The exterior of the drum 102 is fitted with an annular row of fixed tape driving pins 104 formed with tapered free extremities adapted to engage in driving relationship with the drive holes 64 in the tape. At one side of the tape driving pins 104, the drum is formed with two annular rows of evenly spaced holes 105 and 106 and at the other side of the tape driving pins 104 the drum is formed with three annular rows of evenly spaced holes 107, 108 and 109. In each of the holes 105-109 is slidably fitted a pin 110 with an enlarged head 111 disposed within the hollow drum. The holes 105, 106, 107, 108 and 109 are arranged when the drive holes 64 of the tape are engaged by the tape driving pins 105 to align respectively with the rows of punched holes 65, 66, 67, 68 and 69 in the tape.

Carried on the shaft 78 within the hollow drum 102 is a collar 112 which limits inward motion of the sliding pins 110 to prevent displacement of the pins out of their respective holes. The pins 110 are urged outwardly by air pressure which is delivered by a hose 113 from an external source of air under pressure, such as for instance an air compressor 114 carried and driven by the sewing machine drive motor 17. Air under pressure is delivered into the hollow drum through a port 115 in the collar 112, a port 116 and an annular recess 117 in the shaft 78 and an axial bore 118 in the shaft 78 which communicates with a rotatable hose coupling 119 carried at the free extremity of the shaft.

As illustrated in FIGS. 3 and 7, the tape 60 is directed beneath the drum 102 and over a composite dish upper surface 129 formed on a plurality of support plates 130 secured between the end plates 80 of the supporting frame for the tape sensing mechanism by bolts 131. The bolts 131 also secure in sandwiched relation, a plurality of spacer plates 132 between the support plates 130 as well as two shaft bearing plates 133 maintained in position by spacing blocks 134.

The spacer plates 132 define upwardly open slots between the support plates 131 which slots are aligned with the rows of holes 65, 66, 67 and 68 in the punched tape and with the annular rows of holes 105, 106, 107 and 108 in the drum 102. In each of the slots is disposed one of the sprocket wheels 135, 136, 137 and 138, each sprocket wheel being formed with teeth adapted to mesh with pins 110 in the annular rows of holes 105, 106, 107 and 108, respectively.

The sprocket wheel 136 is fast on a shaft 140 which carries a spur gear 141 meshing with an idler gear 142 which in turn drives a spur gear 143 on the feed drive shaft 56. The sprocket wheel 135 is fast on a sleeve 144 journaled on the shaft 140. A spur gear 145 on the sleeve meshes with a spur gear 146 on the feed drive shaft 56. The combined gear ratio of the meshing spur gears 141, 142 and 143 is equal to that of the meshing spur gears 145, 146 such that each hole in the row of holes 65 of the tape will influence by way of a pin 110 meshing with sprocket wheel 135 the same increment of turning motion of the feed shaft 56 in one direction as that influenced in the opposite direction by one hole in the row of holes 66 in the tape.

The sprocket wheels 137 and 138 are operatively connected to the feed drive shaft 54 in the same manner as

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the sprocket wheels 135 and 136 are connected to the feed drive shaft 56, and like reference characters 140—146 have been applied to the corresponding counterparts in this train of connections.

The support plate 130 beneath the tape driving pins 104 on the drum 102 is formed with a clearance slot 149 for the pins 104. The tape as it is driven over the composite dish surface 129 of the supporting plates 130, therefore, will admit pins 110 through punched holes 65, 66, 67, 68 in the tape to mesh with the sprocket wheels 135, 136, 137 and 138, respectively, in accordance with whatever predetermined program is dictated by the arrangement of holes in the tape. Preferably the speed of the drum is made such that a plurality of successive pins can mesh with their respective sprocket wheels for each stitch of the sewing machine. In this manner smoother curved lines of stitches may be formed.

While it is preferable that each of the annular rows of pin-accommodating holes 105, 106, 107 and 108 be formed in a single drum 102 as illustrated in the drawings, it will be appreciated that each annular row of holes 105, 106, 107 and 108 in fact constitutes a separate and distinct driving device of which the pins 110 provide retractable connection elements for cooperation with the driven members 135, 136, 137 and 138 respectively of which each is operatively connected to the work feeding mechanism by way of the feed shafts 54 and 56. It is within the scope of this invention, therefore, to provide the annular rows of holes 105, 106, 107 and 108 in physically separate drums and to provide separate control tapes for each of these driving devices, however, synchronization of the rows of apertures 65, 66, 67 and 68 in the tape is greatly simplified by the use of a common drum 102 for the driving devices and by the use of a single control tape.

Sewing Machine Control

Referring to FIG. 1, one part 25 of the control slider 24, 25 by which the starting, stopping, and the running speed of the sewing machine is controlled, is provided with a pin 160 embraced by a slot 161 formed in a lever 162 journaled in a bearing standard 163 rising from a frame member 164 secured on the base member 30. Both the control slider 24, 25 and the lever 162 are biased toward the stopped position of the stop motion mechanism by springs 165 and 166. The lever 162 carries a follower roller 167 which tracks an edge cam 168 carried on a shaft 169 journaled in a bearing standard 170 of the frame member 164. The edge cam carries for turning movement with it a spur gear 171 which meshes with one gear 172 of a set of back gears 172, 173 carried by the bearing standard 170. The back gear 173 meshes with a drive gear 174 fast on a control shaft 175 journaled for turning and limited endwise sliding movement in a pair of bearing standards 176 on the frame member 164. The edge cam 168 is designed with peripheral stations having one of three radii corresponding to the stopped, the low speed or the high speed position of the stop motion mechanism. The angular spacing between peripheral stations on the cam is designed in relation to the gear drive for the cam such that one half revolution of the drive gear 174 will turn the edge cam from one peripheral cam station to the next. Furthermore, the edge cam and the gear drive associated therewith are exchangeable to provide for the use of cams of different peripheral configuration and also to provide for different numbers of cam stations per revolution of the cam. The cam may be driven one complete revolution for each cycle for sewing unit operation in which case only one cam station corresponding to the stopped position will be provided, or the cam may be driven an even fraction of a revolution for each sewing unit cycle in which case that number of stopped position cam stations must be provided equal to the denominator of the fractional rotation of the cam for each cycle. The cam stations between

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the stopped positions may correspond to high or low speed sewing machine operation in accordance with the type of stitching programmed on the punched tape. Generally, straight lines of stitching may be produced satisfactorily at high sewing speeds, while curved or diagonal lines of stitches require lower sewing speeds. The cam 168 may thus be used to program the proper sewing speed for various portions of a stitching program within each cycle of sewing unit operation.

One half revolution increments of turning motion are imparted to the drive gear 174 to turn the edge cam between cam stations by means of a half revolution clutch device associated with the control shaft 175 and illustrated in FIGS. 1 and 4. Journaled to turn freely on the shaft 175 is a belt pulley 180 driven continuously by a belt 181 from an electric motor 182 carried beneath the table 31. The belt pulley 180 also carries a clutch surface engageable with a clutch collar 183 fast on the shaft 175 when the shaft 175 is moved axially to bring the clutch surfaces together. A collar 184 fast on the shaft 175 constrains a coil spring 185 and a thrust bearing 186 against one of the bearing standards 176 to urge the shaft axially into the engaged position of the clutch. Formed on the collar 184 are two diametrically opposed stop lugs 187 and 188 disposed at different distances radially from the axis of the shaft 175. The stop lugs 187—188 cooperate alternatively with a stop cam projection 189 carried on a clutch control lever 190 fulcrumed on the frame 164. The clutch control lever 190 when turned to release one of the stop lugs 187—188 permits the shaft 175 to move axially in response to the coil spring 185 to engage the clutch and at the same time moves into the path of motion of the other of the stop lugs 187—188. Either of the stop lugs 187—188 upon engaging the stop cam projection 189 shifts the shaft 175 axially against the pressure of the coil spring 185 to release the clutch and then positively stops the shaft 175 at the completion of half a revolution of turning motion. For a more detailed description of this type of half revolution clutch, reference may be had to the co-pending United States patent application of Graham et al., Serial No. 748,401, filed March 10, 1959, now Patent No. 2,925,085.

The control lever 190 of the half revolution clutch device embraces a pin 195 fixed to extend radially from a slide rod 196 slidable lengthwise in bushings 197 carried in pillow blocks 198 carried on the table top 31. A latch lever 199 pivoted on a support bracket 200 secured to the table top 31 is biased by a spring 201 to engage on either side of a latch collar 202 fast on the slide rod 196. The latch lever 199 is dimensional such that the latch collar when stopped at opposite sides of the latch lever positions the control lever with the stop cam projection in the path of one or the other of the stop lugs 187—188 of the half revolution clutch device.

Freely slidable along the slide rod 196 is a bifurcated eccentric follower 203 which embraces an eccentric 204 fast on the clutch control shaft 175. The eccentric follower 203 slides along the slide rod between two collars 205 and 206 fast one the slide rod and coil springs 207 and 208 are arranged one between each of the stop collars and the eccentric follower 203. The eccentric 204 is timed on the shaft 175 always to compress that one of the springs 207 or 208 to spring bias the slide rod in that direction which urges the latch collar 202 toward the latch lever 199. As illustrated in FIG. 4, the parts are at rest with the latch lever 199 to the left of the latch collar 202 and the spring 207 compressed by the eccentric follower 203. When the latch lever 199 is tripped, the spring 207 will shift the slide rod 196 to the left turning the clutch control lever 190 to activate the half revolution clutch. The latch lever 199 will then engage on the right hand side of the latch collar 202 and one half revolution of the eccentric 204 will shift the eccentric follower 203 to the right. The half revolution clutch will then be stopped by engagement of the stop lug 188

with the stop cam projection 189 of the control lever 199 and the spring 203 will be compressed between the eccentric follower 203 and the slide rod collar 206 in readiness to urge the slide rod to the right when the latch lever 199 is next tripped.

The latch lever 199 may be tripped to activate the half revolution clutch by any one of the pins 110 which co-operate with the row of holes 69 in the punched tape 60. The support plate 130 over which passes the line of holes 69 in the tape is formed with a recess 210 occupied by a sensing finger 211 formed on a sensing lever 212 fulcrumed at 213 on the support plate 130. A link 214 pivoted to the sensing lever 212 and to the latch lever 119 will transfer to the latch lever 199 the motion imparted to the sensing finger 211 by a pin 110 passing through a hole in the row of holes 69 in the tape. By selecting proper location for holes in the row of holes 69 in the tape, therefore, the operation of the sewing machine may be controlled to suit the type of stitching dictated by the location and arrangement of holes in the rows 65, 66, 67 and 68 of the tape.

The latch lever 199 may also be tripped manually by means of a flexible cable 220 secured to an intermediate lever 221 which works against a pin 222, carried by the latch lever 199. The cable passes by way of an idler pulley 223 to a manually operable starting unit which is carried on the sewing machine bracket arm and which will not be described.

Manual Starting Control

Pivoted on the bracket arm 13 of the sewing machine is a starting lever 230 which operates between adjustable stops 231 serving to limit the throw of the lever. By means of a link 232 the starting lever is connected to an arched arm 233 fast on a gear segment 234 pivoted at 235 to the sewing machine bed. By means of a spring 236 connected between the link 232 and the sewing machine bracket arm, the starting lever 230 as well as the gear segment 234 are biased into the extreme position illustrated in FIGS. 1 and 5. Referring particularly to FIGS. 5 and 6, the gear segment 234 meshes with a pinion 237 journaled loosely on a stud shaft 238 supported on the sewing machine bracket arm. Fast on the pinion 237 is a plate 239 having angularly spaced radial ears 240 and 241 projecting therefrom. A latch bell crank 242 pivoted alongside the ear 241 is biased by a spring connected to the radial ear 240 to urge a latch finger 243 thereon toward the stud shaft 238. The latch finger 243 rides on the periphery of a disk 244 journaled loosely on the stud shaft and cooperates with diametrically opposed latch notches 245 formed in the disk 244 to engage one of the latch notches on the forward motion of the starting lever 230 and carry the disk 244 one half revolution when the return spring 236 urges the starting lever 230 backward. A pin 246 secured in the disk 244 extends through a hole in an adjacent disk 247 on the stud shaft rotationally locking the disks 244 and 247. The periphery of the disk 247 is formed with diametrically opposed recesses 248 entered in turn by the nose 249 of a locking lever 250 fulcrumed at 251 on the sewing machine bed and biased against the disk 247 by a spring 252. Each return motion of the starting lever, therefore, gives rise to one half revolution of the disks 244 and 247 and with them the pin 246, and the locking lever 250 will determine an at rest position of the disks after each half revolution of turning movement.

A link 253 pivoted on the pin 246 is pivotally connected to the operating lever 83 of the reversing mechanism for the tape driving mechanism such that each time the sewing unit is started, the drive for the tape reels and tape sensing mechanism will be reversed.

A plate 254 secured to the disk 247 for limited angular adjustment thereon by the slots 255 and fastening screws 256 is formed with a clearance slot 257 for the pin 246 and has secured thereon diametrically opposed cam arms

258. A follower lever 259 is formed with a follower finger 260 biased against the periphery of the plate 254 by a spring 261. The follower finger is disposed in the path of the cam arms 258 on the plate 254 and carries the extremity of the cable 220 for tripping the latch lever 199 of the sewing machine controlling unit. The cam arms 258 are preferably timed relatively to the pin 246 to trip the latch lever 199 after the reversing mechanism has been operated each time the sewing unit is started.

Safety Interlock and Emergency Stop

In order to prevent operation of the starting lever while the sewing unit is in operation, a stop dog 270 is secured to the link 232 in the train of connections from the starting lever as shown in FIGS. 1 and 4. A locking lever 271 fulcrumed on the sewing machine bracket arm carries a locking abutment 272 which is shiftable into the path of the stop dog 270 as illustrated in FIG. 1. A light spring 273 biases the locking lever 271 against a stop screw 274 carried by a lever arm 275 carried in the sewing machine bracket arm. The lever arm 275 is biased in a clockwise direction as viewed in FIG. 1 by a heavy spring 276 within the sewing machine bracket arm and carries a roller 277 which rides on an inclined cam surface 278 formed on the two-part control slider 24, 25. When the stop motion mechanism of the sewing machine is in either high or low speed running position, the cam surface 278 will shift the lever arm 275 counterclockwise as viewed in FIG. 1 allowing the locking lever 271 to turn and carry the locking abutment 272 opposite the stop dog 270. In the stopped position, the heavy spring 276 will urge the lever arm 275 clockwise depressing the locking lever 271 and carrying the locking abutment out of registry with the stop dog thus readying the starting lever for operation.

An emergency stop lever 280 carried by one part 25 of the two part control slider for the stop motion mechanism is formed with a detent 281 engaging a notch in the other part 24 of the two part control slider. A spring 282 biases the emergency stop lever into effective position with the detent 281 locking the parts together. Turning of the emergency stop lever, however, separates the parts and the stop motion mechanism will move immediately into stopped position. A handle 283 formed on the part 24 of the two part control slides may be used to re-engage the detent 281 into the notch to re-establish operation of the sewing unit.

Feed Shaft Braking

When the feed shafts 54 and 56 are being operated continuously as when a straight line of stitches parallel to or perpendicular to the sewing machine bed are being sewn, the problem of overthrow or backlash in the feed shafts is at a minimum. When the feed shafts are being operated intermittently, however, it is desirable in reducing backlash to provide a means for frictionally braking the shafts 54 and 56. Referring to FIGS. 3 and 4, the shafts 54 and 56 are embraced by a frictioning brake means which may be in the form of a spring loaded brake shoe 290 bearing equally on both shafts 54 and 56. By means of a control shaft 291 having fast thereon a sprocket 292 which engages belt chain 293 (FIG. 4) which chain extends about a sprocket 294 (FIG. 3) the sprocket 294 may be turned manually to effect adjustment of the spring loading on the brake shoe 290.

For straight stitching perpendicular to or parallel to the sewing machine bed, or in other instances where the frictional braking of the shafts 54 and 56 is not required, cam means 295 for releasing the friction brake 290 may be provided as illustrated in FIG. 4. Sprocket wheels 296 secured to the brake releasing cam means 295 may be engaged by a belt chain 297 secured at one end to a return spring 298 and fixed at the opposite end to a bell crank 299 which is operated by a link 300 connected to the stop motion control lever 162. The link 300 is slotted

as at 301 preferably to influence the bell crank 299 in releasing the friction braking only when the sewing machine stop motion mechanism is shifted into the high speed position.

This invention thus provides a sewing unit which by the application of an appropriately punched control tape is capable of completely automatic sewing of a wide variety of complicated stitching operations. The mechanism provided by the sewing unit of this invention for mechanically sensing and transmitting information from the control tape directly into work feeding movements and sewing machine speed controlling responses, provides for accurate, reliable and high speed operation of the sewing unit. The provision of tape controlled means for varying the sewing speed in accordance with the type and complexity of the stitching being performed provides for an overall time reduction of each complete sewing operation since the sewing speed throughout the entire operation need not be limited to that of the most difficult or exacting portion. The feature by which the direction of movement of the control tape is reversed on alternate cycles of operation of the sewing unit eliminates the need for time consuming readjustment of the control devices between cycles of operation.

Having thus set forth the nature of this invention, what is claimed herein is:

1. In a sewing unit including stitch forming instrumentalities defining a stitching point, actuating mechanism for operating said stitch forming instrumentalities, and work feeding mechanism for shifting a work fabric relatively to said stitching point, means for operating said work feeding mechanism comprising a driving member, means operatively connecting said driving member to said actuating mechanism to move said driving member in timed relation with the operation of said stitch forming instrumentalities, a driven member, means operatively connecting said driven member with said work feeding mechanism, a control element disposed between said driving and driven member, means for shifting said control element relatively to said driving and driven members in timed relation with the operation of said stitch forming instrumentalities, said control element being formed with one or more apertures disposed in pre-selected location on said control element, a retractable connection element carried on said driving member for movement therewith, and means effective upon movement of said control element aperture into registry with said connection element for moving said connection element through said control element aperture in engagement at one side of said control element with said driving member and in positive driving engagement at the opposite side of said control element with said driven member.

2. A sewing unit comprising a sewing machine, stitch forming instrumentalities in said sewing machine defining a stitching point, work supporting means, means shiftably supporting said work supporting means for substantially planar movement relatively to said sewing machine stitching point, means for shifting said work supporting means comprising a rotatable drum, a plurality of annular rows of retractable pins carried by said drum, means for biasing each of said pins radially outwardly of said drum, means for driving said drum and said sewing machine stitch forming instrumentalities in timed relation, a plurality of toothed sprocket wheels one corresponding to each of said annular rows of retractable pins, means for supporting said sprocket wheels each to mesh with the outwardly biased pins in one of said annular rows of pins, means permanently connecting each of said sprocket wheels to shift said work supporting means in a different direction in said planar motion thereof, a flexible control tape, means for directing said tape between said drum and said sprocket wheels, said control tape having a plurality of rows of punched holes therein each row of punched holes being arranged to register with selected ones of said retractable pins in one of said annular rows

of retractable pins, and means for moving said selected ones of said retractable pins through said apertures each in engagement at one side of said control tape with said drum, and in positive driving engagement at the opposite side of said control tape with one of said sprocket wheels.

3. A sewing unit as set forth in claim 2 in which said drum is hollow, an enlarged head is formed on each pin within said hollow drum, and said pins are biased outwardly of said drum by means of air delivered within said hollow drum from an external source of air under pressure.

4. In a sewing unit having stitch forming instrumentalities defining a stitching point, actuating mechanism for said stitch forming instrumentalities, means for feeding a work fabric relatively to said stitching point, a substantially constant speed drive means, speed control means operatively connecting said drive means with said actuating mechanism for said stitch forming instrumentalities, means driven by said actuating mechanism in timed relation with said stitch forming instrumentalities for operating said work feeding means, a control tape driven by said actuating mechanism in timed relation with said stitch forming instrumentalities for controlling said work feed operating means, and means influenced by said control tape for selectively varying said speed control means during operation of said sewing unit.

5. In a sewing unit having stitch forming instrumentalities, actuating mechanism therefor, substantially constant speed drive means for said actuating mechanism, and speed regulating means operatively connecting said drive means with said actuating mechanism, means for controlling said speed regulating means to provide a predetermined sequence of sewing speeds comprising cam means operatively connected to said speed regulating means and having a plurality of successive cam stations arranged in accordance with said predetermined sequence of sewing speeds, cam drive means for shifting said cam means between successive cam stations, means automatically effective to discontinue said cam drive means upon movement of said cam means into each successive cam station, and a control tape driven by said actuating means in timed relation with said stitch forming instrumentalities and effective to establish said cam drive means each time a change of sewing speed is required in said predetermined sequence of sewing speeds.

6. In a sewing unit having stitch forming instrumentalities, actuating mechanism therefore, substantially constant speed drive means for said actuating mechanism, and speed regulating means operatively connecting said drive means with said actuating mechanism, means for controlling said speed regulating means to provide a predetermined sequence of sewing speeds comprising cam means operatively connected to said speed regulating means and having a plurality of successive cam stations arranged in accordance with said predetermined sequence of sewing speeds, a shaft operatively connected to said cam means to turn said cam between successive cam stations in half revolution of said shaft, continuous drive means for said shaft, clutch means operable to establish driving relation between said continuous drive means and said shaft, mechanism for automatically disengaging said clutch means upon half revolution of said shaft, a control tape driven by said actuating means in timed relation with said stitch forming instrumentalities, and means influenced by said control tape for engaging said clutch means each time a change of sewing speed is required in said predetermined sequence of sewing speeds.

7. A sewing unit as set forth in claim 6 in which said means influenced by said control tape for engaging said clutch means comprises a slide rod, spring means biasing said slide rod endwise, means operatively connecting said slide rod to engage said clutch means upon endwise movement thereof, latch means constraining said slide rod against endwise movement, means controlled by said con-

trol tape for tripping said latch means to release said slide rod for endwise movement in response to said spring means and means carried by said shaft effective in half revolution of said shaft to reestablish said spring means in readiness to shift said slide rod when said latch means is again tripped.

8. A sewing unit as set forth in claim 7 in which said means controlled by said control tape for tripping said latch means comprises a rotatable driving device operatively connected to the actuating mechanism for said stitch forming instrumentalities, a plurality of radially extending pins associated with said driving device, said pins being arranged in evenly spaced angular relation in an annular row about the periphery of said driving device each pin being constrained for limited sliding movement radially thereof, a latch tripping lever disposed in the path of said pins carried by said driving device, means for directing said control tape between said driving device and said latch tripping lever, said control tape being formed with one or more pin accommodating apertures disposed in pre-selected location for movement into registry with selected ones of said pins to permit engagement of said pins with said latch tripping lever.

9. In a sewing unit having stitch forming instrumentalities, actuating mechanism therefor, substantially constant speed drive means for said actuating mechanism, and a stop motion mechanism operatively interposed between said constant speed drive means and said actuating mechanism, said stop motion mechanism having means for stopping said actuating mechanism, means for driving said actuating mechanism at an intermediate low speed from said constant speed drive means, and means for driving said actuating mechanism at a high speed from said constant speed drive means, a shiftable control member operatively connected to said stop motion mechanism for rendering selectively effective said stopping means, said low speed drive or said high speed drive, means for providing a predetermined sequence of sewing speeds comprising cam means operatively connected to said control member and having a plurality of successive cam stations arranged in accordance with said predetermined sequence of sewing speeds, and having at least one cam station influencing a stopped position of said stop motion mechanism, constantly operating means for driving said cam between successive cam stations, means driven by said actuating mechanism for said stitch forming instrumentalities for operatively connecting said constantly operating drive means to said cam means, a control tape, means driven by the actuating mechanism for said stitch forming instrumentalities driving said control tape, means for rendering said cam drive connecting means effective in accordance with a pre-selected program borne by said control tape, and manually operable means for operatively connecting said constantly operating drive means to said cam means when said shiftable stop motion control member occupies a position rendering effective the stopping means for said actuating mechanism.

10. In a sewing unit as set forth in claim 9, a reversing unit arranged in said control tape drive means, and means for operating said reversing unit during each operation of said manually operable means for operatively connecting said constantly operating drive means to said cam means when said shiftable stop motion control member occupies a position rendering effective the stopping means for said actuating mechanism.

11. In a sewing unit including stitch forming instrumentalities defining a stitching point, actuating mechanism for operating said stitch forming instrumentalities, and a work feeding mechanism for shifting a work fabric relatively to said stitching point, said work feeding mechanism including a frame shiftable supported for linear movement in either direction relatively to said stitching point, a work supporting carriage carried for movement with said frame and for linear movement relatively to said frame in either direction perpendicular to the linear

movement of said frame, a first lead screw operatively connected to impart linear movement in either direction to said frame, a second lead screw operatively connected to impart linear movement to said carriage in either direction perpendicular to the linear movement of said frame, a first and a second pair of substantially coaxial sprocket wheels, means operatively connecting said first pair of sprocket wheels to said first lead screw and the second pair of sprocket wheels to said second lead screw with the sprocket wheels of each pair connected to turn the lead screw to which they are connected in opposite directions of rotation upon rotation of said sprocket wheels in a given direction, means for shifting said work supporting carriage comprising a rotatable drum disposed on an axis substantially parallel to said coaxial sprocket wheels, means for rotating said drum in timed relation with the actuating mechanism for said stitch forming instrumentalities, a plurality of annular rows of retractable pins carried by said drum, means for biasing each of said pins radially outwardly of said drum, means for supporting said sprocket wheels each to mesh with the outwardly biased pins in one of said annular row of pins, a flexible control tape, means for driving said control tape between said drum and said sprocket wheels at the peripheral speed of said drum, and said control tape having a plurality of rows of punched holes therein each row of punched holes being oriented to register with selected ones of said retractable pins in one of said annular rows of retractable pins.

12. In a sewing unit as set forth in claim 11, a constant speed drive means for the actuating mechanism for said stitch forming instrumentalities, a stop motion mechanism operatively interposed between said constant speed drive means and said actuating mechanism, said stop motion mechanism having means for stopping said actuating mechanism, means for driving said actuating mechanism at an intermediate low speed from said constant speed drive means, and means for driving said actuating mechanism at a high speed from said constant speed drive means, a shiftable control member operatively connected to said stop motion mechanism for rendering selectively effective said stopping means, said low speed drive or said high speed drive, means for providing a predetermined sequence of sewing speeds comprising cam means operatively connected to said control member and having a plurality of successive cam stations arranged in accordance with said predetermined sequence of sewing speeds and having at least one cam station influencing a stopped position of said stop motion mechanism, constantly operating means for driving said cam between successive cam stations, means influenced by one of said plurality of annular rows of retractable pins carried by said drum for operatively connecting said constantly operating drive means to said cam means, and manually operable means for operatively connecting said constantly operating drive means to said cam means when said shiftable stop motion control member occupies a position rendering effective the stopping means for said actuating mechanism.

13. In a sewing unit as set forth in claim 12, means for applying a frictional resistance to turning movement of said first and second lead screws, and means operatively connected to the control member for said stop motion mechanism and to the means for applying frictional resistance to turning movement of said lead screws for varying the frictional resistance applied at high speed and at low speed operation for the actuating mechanism for said stitch forming instrumentalities.

14. In a sewing unit having stitch forming instrumentalities defining a stitching point, actuating mechanism for said stitch forming instrumentalities, means for feeding a work fabric relatively to said stitching point, a substantially constant speed drive means, speed control means operatively connecting said drive means with said actuating mechanism for said stitch forming instrumentalities, rotary operating means driven by said actuating

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mechanism in timed relation with said stitch forming instrumentalities for operating said work feeding means and for varying said speed control means during operation of said sewing unit, a single control tape driven by said rotary operating means at the peripheral speed thereof 5 physically separating said rotary operating means from said work feeding means and said speed control means, said control tape being formed with openings at pre-selected locations thereon for providing selective operative engagement of said operating means with said work 10 feeding means and said speed control means.

15. In a sewing unit as set forth in claim 14, manually operable means for influencing said speed control means, and means for reversing the direction of rotation of said

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rotary operating means upon operation of said manually operable means for influencing said speed control means.

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