

[54] **METHOD AND MACHINE FOR MAKING A SLIP LATCH IN A PISTON RING EXPANDER**

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[22] Filed: **July 6, 1971**

[21] Appl. No.: **160,040**

[52] U.S. Cl. **29/200 B, 29/200 P, 29/241**

[51] Int. Cl. **B23p 19/00, B23p 19/04**

[58] Field of Search **29/200 B, 200 P, 29/241, 433**

[56] **References Cited**

UNITED STATES PATENTS

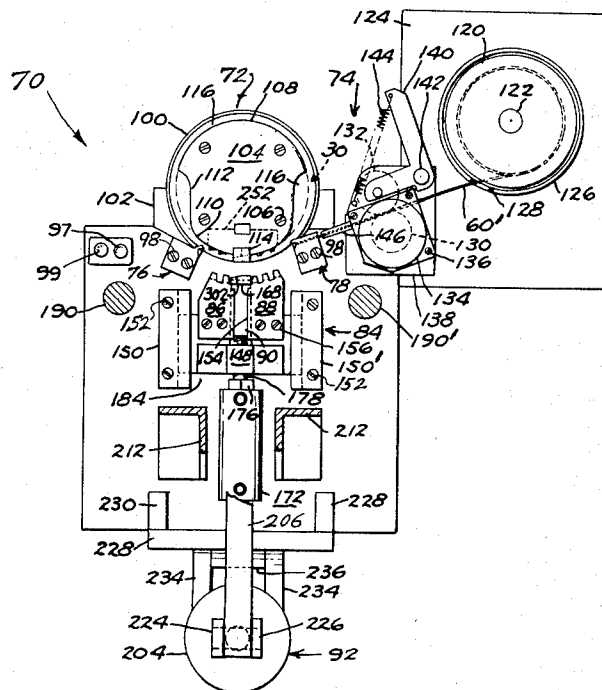
3,339,261 9/1967 Van Der Voo 29/241 X

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[57] **ABSTRACT**

A method of making a slip latch in a parted corrugated piston ring expander with normally abutting ends and apertured legs in which guides are inserted into selected corrugations to provide a guideway through which the free end of a curved filament is pushed. A machine for performing the method has a locator to hold the expander and a plurality of inner and outer guides extending into the expander to guide the curved filament through the apertures in some of the legs. A feed mechanism pushes a free end of the filament through the expander in cooperation with the guides and into circumferentially spaced left and right hand dies which shear the filament to form a rod of the latch and coin stops on the opposite ends of the rod. The stops retain the latch within the expander and limit the extent to which the opposed ends of the expander can be separated.

22 Claims, 26 Drawing Figures



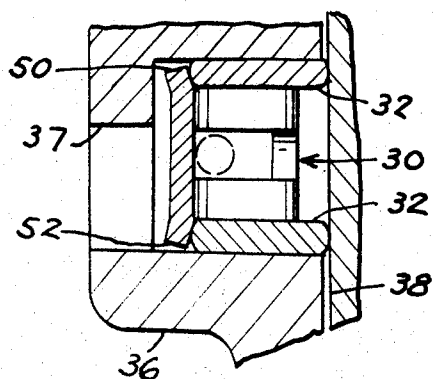


FIG. 1

FIG. 2

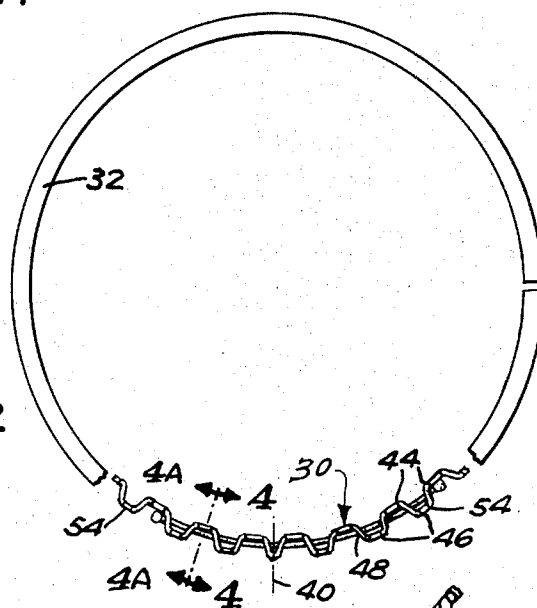


FIG. 3

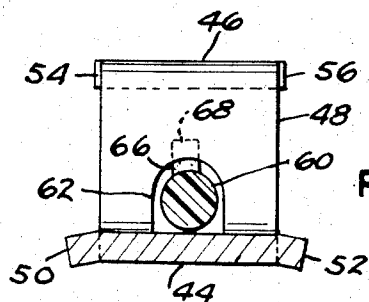
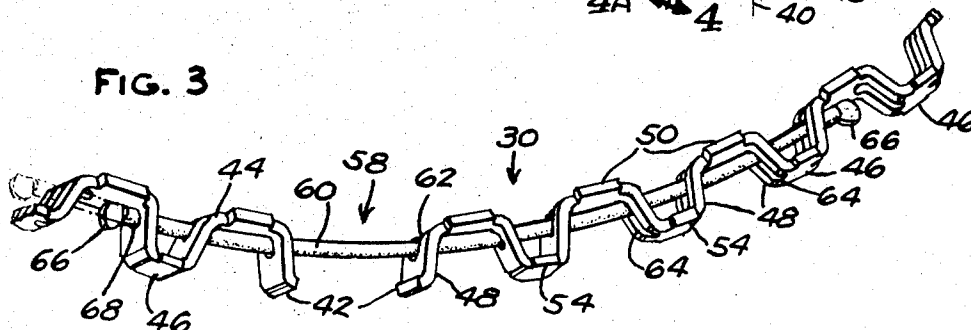


FIG. 4

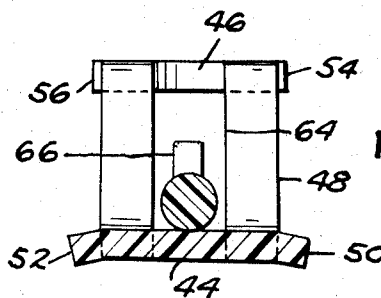


FIG. 4A

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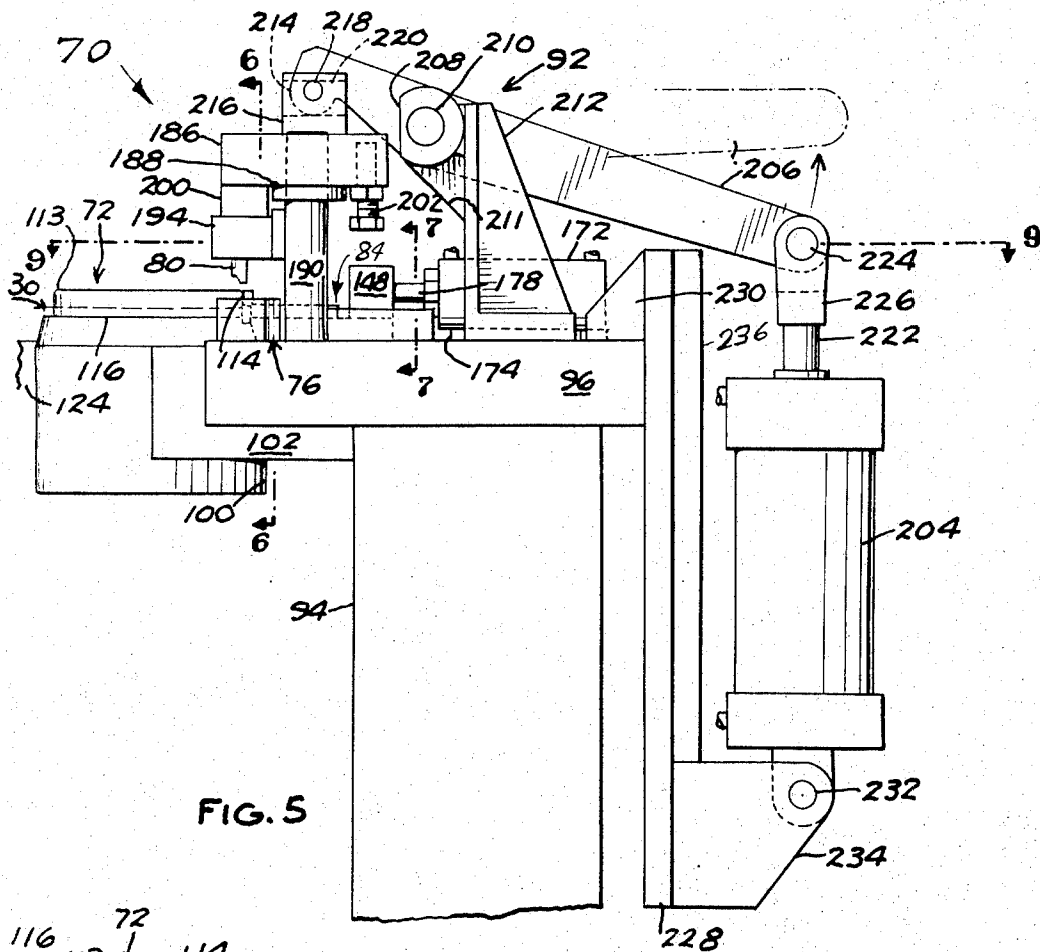


FIG. 5

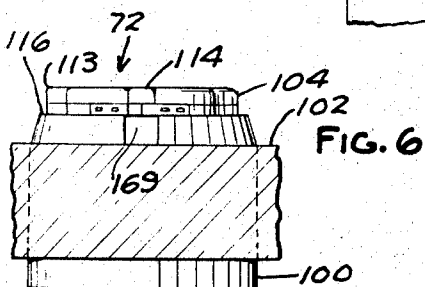


FIG. 6

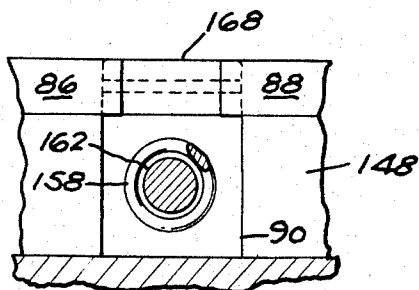


FIG. 8

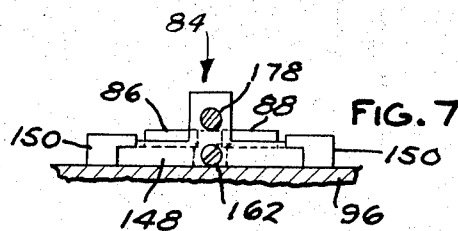


FIG. 7

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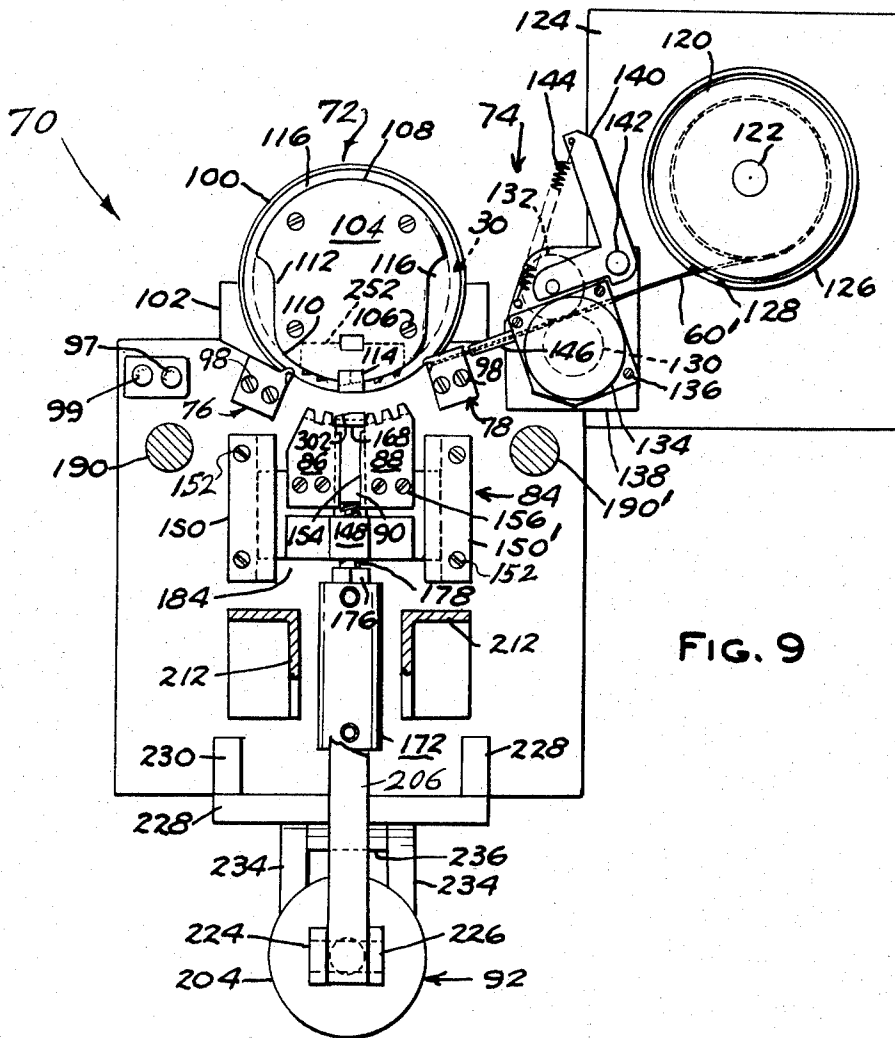


FIG. 9

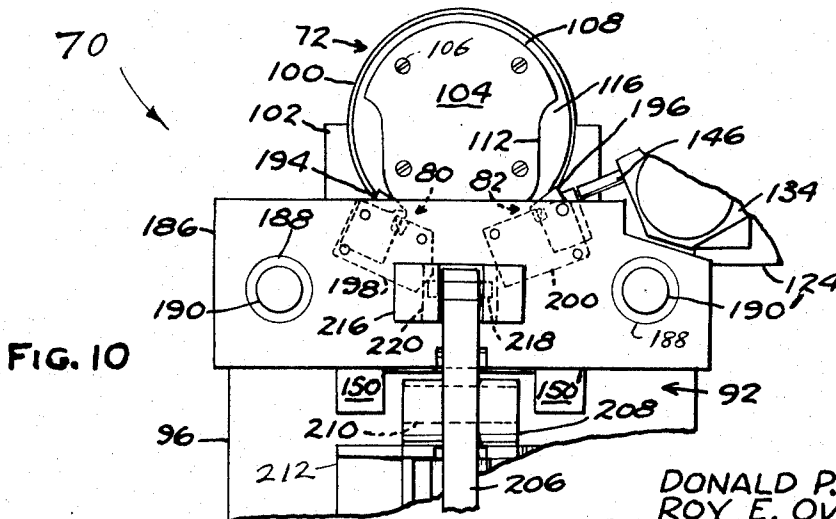


FIG. 10

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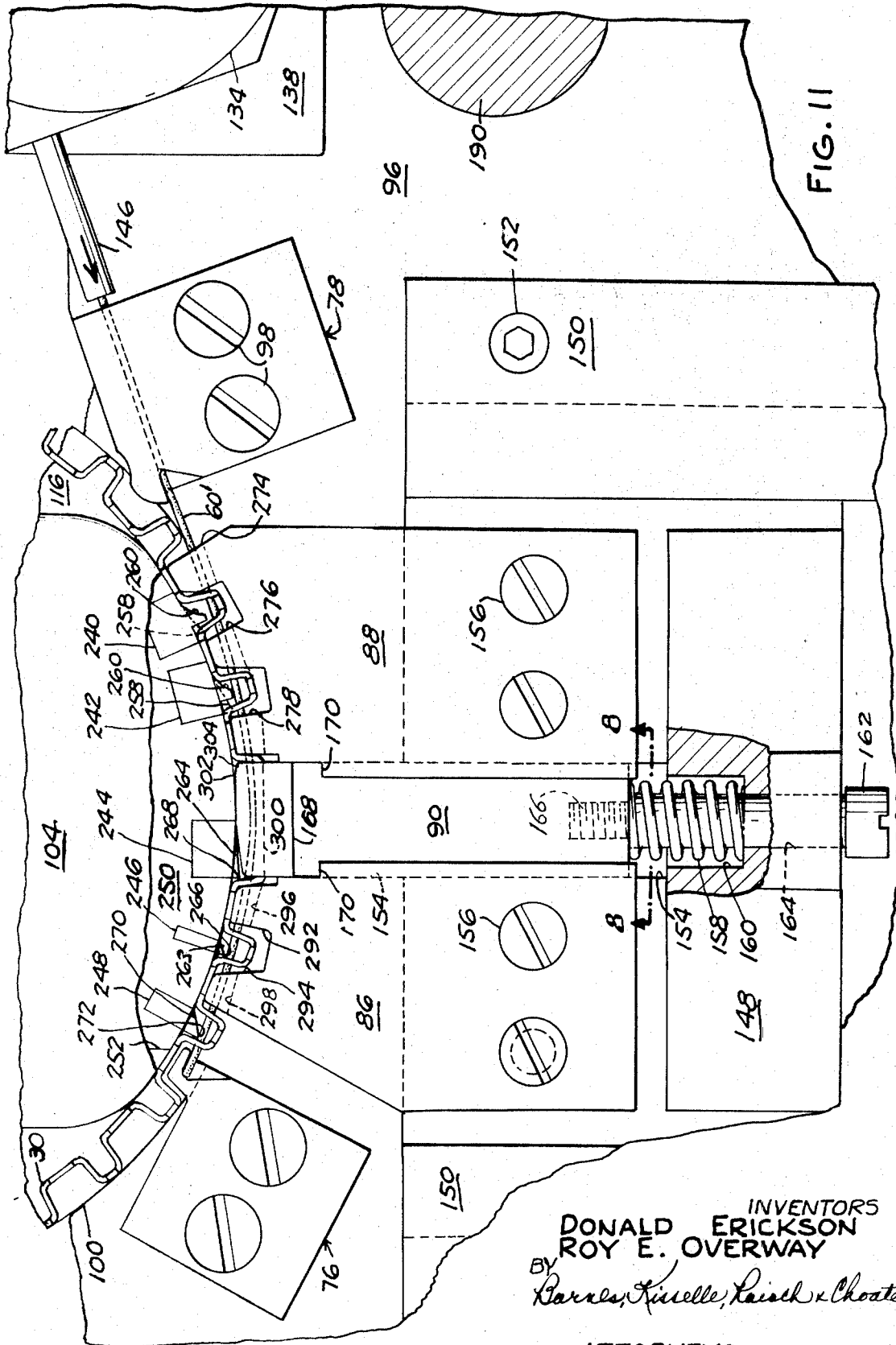


FIG. 11

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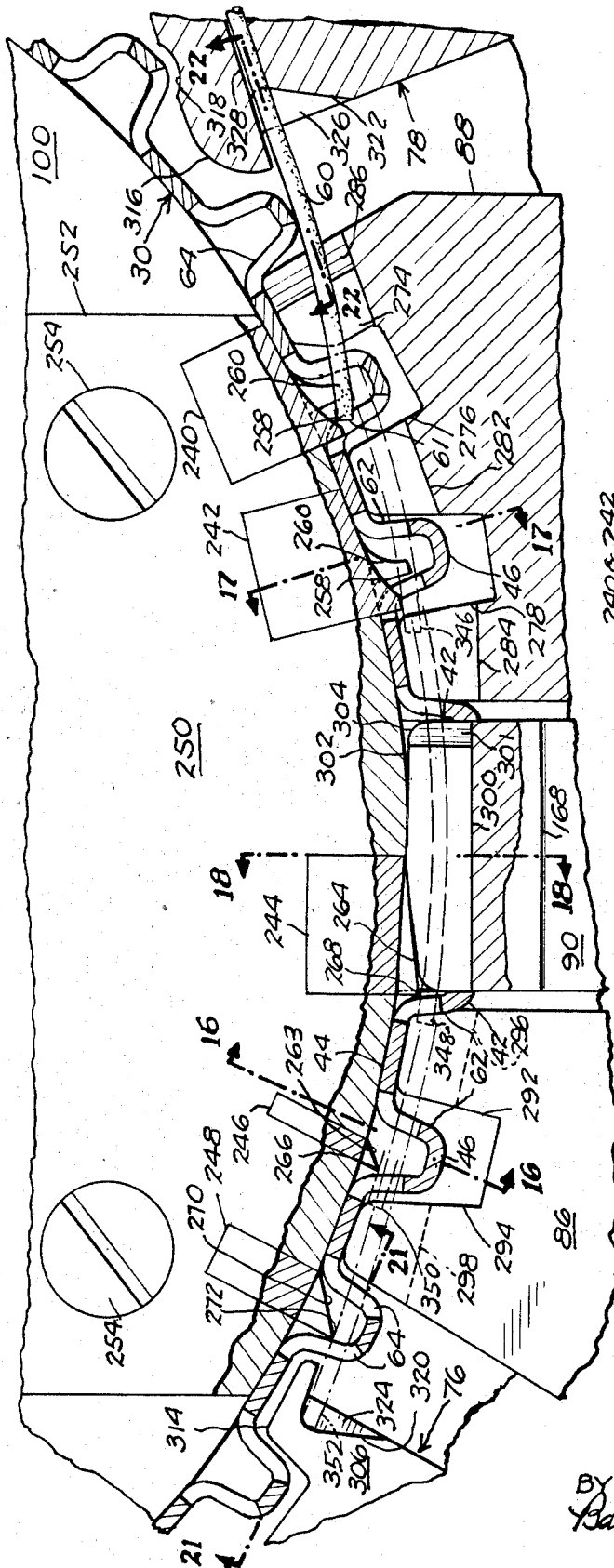


FIG. 12

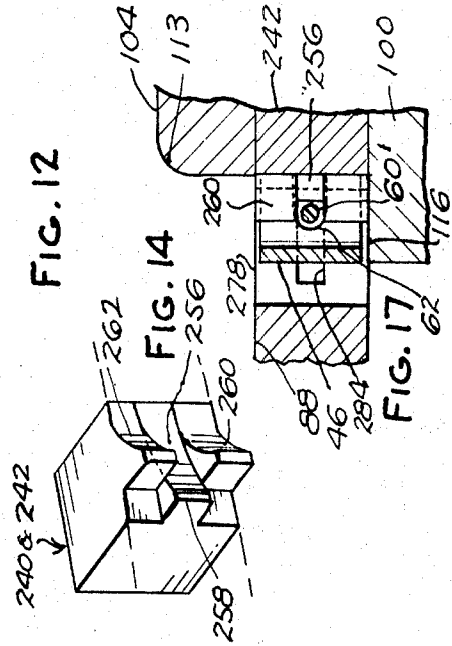


FIG. 14

FIG. 17

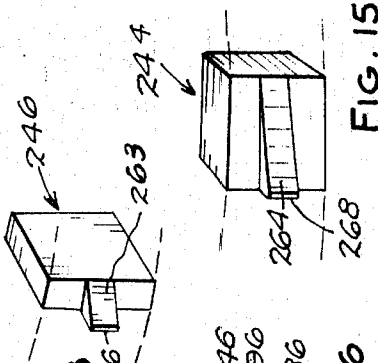


FIG. 15

FIG. 13

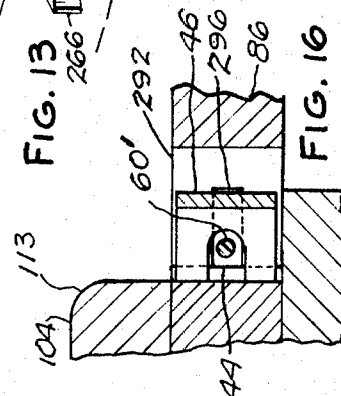
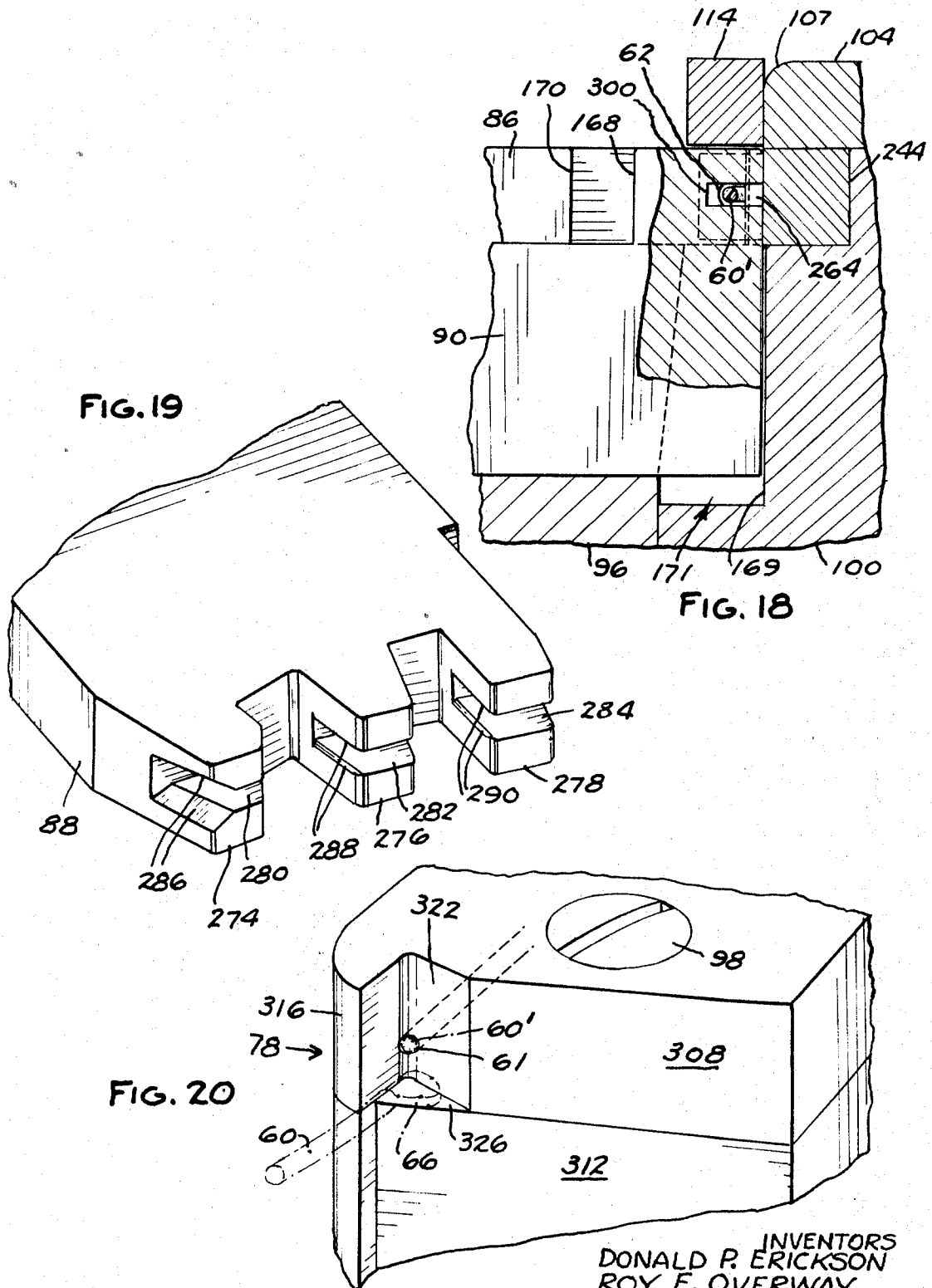


FIG. 16

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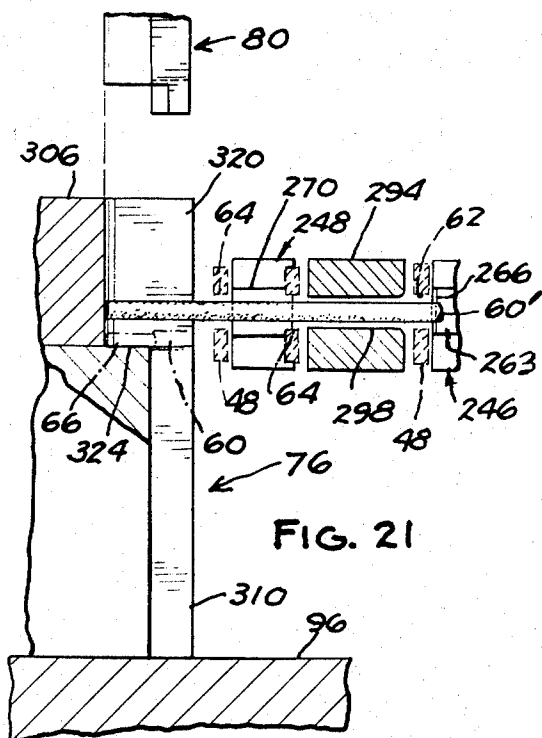


FIG. 21

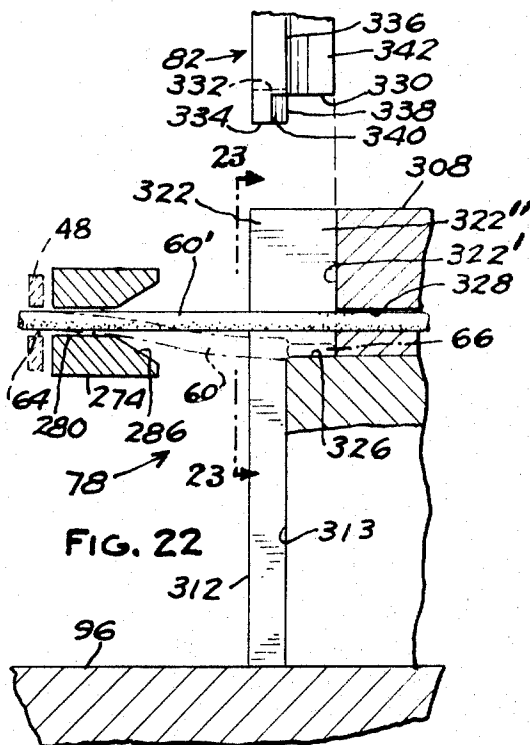


FIG. 22

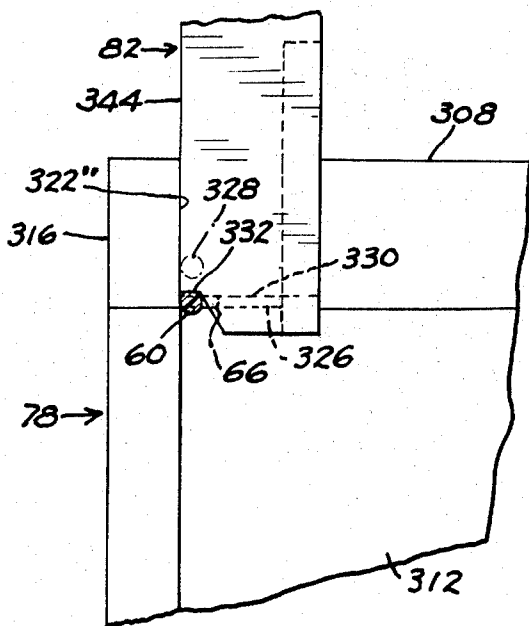


FIG. 23

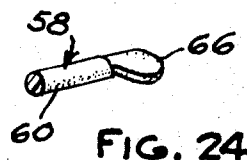


FIG. 24

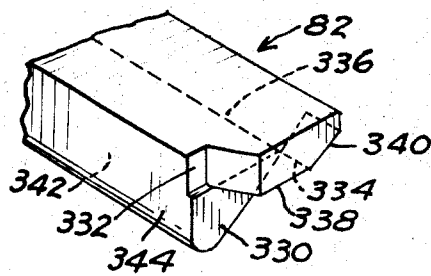


FIG. 25

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METHOD AND MACHINE FOR MAKING A SLIP LATCH IN A PISTON RING EXPANDER

This invention relates to piston ring expanders with slip latches and more particularly to a method and machine for making slip latches in piston ring expanders.

The normally abutting ends of a parted corrugated spacer-expander of the nonbottoming type are separated when assembling the spacer-expander into a ring groove of a piston, and when the spacer-expander is received in the groove the ends sometimes overlap rather than returning to their normal abutting relationship. This overlapping can be prevented by using a slip latch in the spacer-expander to retain the ends thereof in opposed alignment. One example of such a slip latch is disclosed and claimed in a copending application of Davis et al., Ser. No. 99,571, filed Dec. 18, 1970, and assigned to assignee of record herein. This slip latch is a flexible rod made from filamentary material such as nylon monofilament fishing line with a predetermined radius of curvature. The rod passes through the ends of the spacer-expander and extends generally circumferentially in a portion thereof for sliding movement in relation to the ends. To limit the extent to which the ends of the spacer-expander can be separated from each other and to prevent the rod from disengaging or falling out of the spacer-expander, the rod has a stop on one end or stops on both of its opposite ends adapted to abut with portions of the spacer-expander. This slip latch can be made by manually threading the rod through a plurality of slots or openings in the corrugated spacer-expander to extend generally circumferentially therein and then forming the stops on the opposed ends of the rod. However, this technique is costly and unsuited to mass production of such slip latch expanders.

Objects of this invention are to provide improved method and apparatus for installing and forming in situ a latch of the aforementioned type wherein curved flexible filamentary material is fed into an arcuate portion of a piston ring expander economically, rapidly, and without materially affecting the preset radius of curvature of the material and to provide apparatus for automatically, rapidly, and economically forming such material into a slip latch in assembled relation in the piston ring expander.

These and other objects, features and advantages of this invention will be apparent from the following description, appended claims and accompanying drawings, in which:

FIG. 1 is a fragmentary sectional view of a piston ring with two rails and a radially corrugated spacer-expander assembled in a groove of a piston in a cylinder of an engine.

FIG. 2 is a top view of the piston ring of FIG. 1 with a portion of the rails broken away to expose a parted spacer-expander with a slip latch assembled therein.

FIG. 3 is an enlarged fragmentary perspective view of a slip latch assembled in a spacer-expander with its normally abutting opposed ends separated.

FIGS. 4 and 4A are enlarged sectional views on lines 4—4 and 4A—4A respectively of FIG. 2.

FIG. 5 is a fragmentary side view of apparatus embodying this invention for making a slip latch in assembled relation in a piston ring expander.

FIG. 6 is a fragmentary view partially in section on line 6—6 of FIG. 5 showing an expander locating plug of the apparatus.

FIG. 7 is a fragmentary view partially in section on line 7—7 of FIG. 5 showing a slide mechanism for the outer guides of the apparatus.

FIG. 8 is an enlarged fragmentary sectional view on line 8—8 of FIG. 11 showing a movable yieldably biased outer locator and guide.

FIG. 9 is a view partially in section on line 9—9 of FIG. 5 showing the coining dies, inner and outer guides and filament storage and feed mechanism of the apparatus.

FIG. 10 is a fragmentary plan view of the apparatus showing a portion of the mechanism for actuating the die punches.

FIG. 11 is an enlarged fragmentary top view partially in section showing the inner and outer guides of the apparatus.

FIG. 12 is a further enlarged fragmentary top view partially in section showing the inner and outer guides of the apparatus.

FIGS. 13, 14 and 15 are perspective views of some of the guides shown in FIG. 12.

FIGS. 16, 17 and 18 are fragmentary sectional views on lines 16—16, 17—17 and 18—18 respectively of FIG. 12 showing where some of the guides position the end of the filament in relation to the spacer-expander.

FIG. 19 is a fragmentary perspective view of the outside right-hand (as viewed in FIGS. 9, 10, 11 and 12) guide insert of the apparatus.

FIG. 20 is an enlarged fragmentary perspective view of a right-hand shearing and coining die of the apparatus.

FIGS. 21 and 22 are fragmentary sectional views on lines 21—21 and 22—22 respectively of FIG. 12 showing the filament in the dies just prior to coining stops on the opposite ends thereof.

FIG. 23 is a fragmentary side view on line 23—23 of FIG. 22 of the right-hand coining die shown in closed position.

FIG. 24 is a fragmentary perspective view of one end of a slip latch showing a stop coined thereon.

FIG. 25 is a fragmentary perspective view of a punch of the right-hand coining die.

Referring to the drawings, FIG. 1 illustrates a spacer-expander 30 with parted rails 32 in assembled relation in a circumferentially extending ring groove 34 of a piston 36 in a cylinder 38 of an internal combustion engine. Rails 32 are retained in axially spaced relation in groove 34 and urged radially outwardly into firm sealing and wiping engagement with cylinder wall 38 by spacer-expander 30. An oil passage 37 connects groove 34 with the interior of piston 36 to allow oil collected in the groove to drain therefrom.

As shown in FIGS. 2 and 3, spacer-expander 30 is a one-piece radially corrugated metal annulus parted as indicated by broken line 40 (FIG. 2) with generally opposed normally abutting ends 42. Ends 42 can be separated to slip the spacer-expander over the end of piston 36 and insert it in groove 34 of the piston. Spacer-expander 30 has a plurality of circumferentially alternating inner and outer crowns 44 and 46 interconnected by integral legs 48 diverging generally radially outwardly from inner crowns 44. Rails 32 are urged

radially outwardly by axially inclined integral upper and lower tabs 50 and 52 on inner crowns 44. Adjacent their outer edge, rails 32 bear on axially extending upper and lower bosses 54 and 56 integral with outer crowns 46.

A slip latch 58 comprising a flexible rod 60 extends generally circumferentially in spacer-expander 30 through a series of small guide slots 62 in each of the three legs 48 immediately adjacent each opposed end 42. As shown in FIG. 4, each slot 62 extends from the bottom of its associated inner crown 44 only part way up its associated leg 48 to slidably receive and retain rod 60 closely adjacent the outer surface of its associated inner crown. Slots 62 closely confine rod 60 in the spacer-expander to retain opposed ends 42 in alignment with each other. Each of the remaining legs 48 has a larger slot 64 (FIG. 4A) therein to provide passages to allow oil to flow inwardly through spacer-expander 30 when it is received in a ring groove of a piston. Slots 64 are longer than slots 62 and extend as shown in FIG. 4A from inner crown 44 to outer crown 46.

To retain slip latch 58 within spacer-expander 30 and to limit the extent to which opposed ends 42 can be separated, integral stops 66 are provided on the opposite ends of rod 60. As shown in FIGS. 3 and 4, stops 66 limit the expansion of spacer-expander 30 and prevent removal of slip latch 58 by abutting with portion 68 adjacent the radially outer end of the shorter slot 62 of the third leg 48 from each opposed end 42. When opposed ends 42 of spacer-expander 30 are brought into abutting relation (as shown in FIG. 2) rod 60 and stops 66 are free to move through the other legs 48 due to the clearance provided by longer slots 64 as shown in FIGS. 3 and 4A. To facilitate free movement of rod 60 of latch 58 through slots 62 and 64, rod 60 is formed with a radius of curvature about equal to or preferably three-eighths to one-half of an inch less than the radius of spacer-expander 30 so that rod 60 will tend to ride against the outer surface of inner crowns 44. Also, stops 66 are formed as tabs with rounded edges and which extend generally radially outwardly from rod 60 so that they will not become caught or hung up on the inner crowns 44 or slots 64. Rod 60 can be made of a flexible filamentary monofilament material such as spring steel or preferably a plastic material such as nylon. The structure and function of spacer-expander 30 with a slip latch 58 is explained in more detail in the aforementioned copending Davis and Hesling United States patent application Ser. No. 99,571, filed Dec. 18, 1970, which is incorporated herein by reference.

Apparatus in the form of a semi-automatic machine 70 embodying this invention for making slip latches 58 in spacer-expanders 30 is shown in FIGS. 5, 9 and 10. Machine 70 comprises a locator 72 for receiving and positioning a spacer-expander 30 and a storage and feed mechanism 74 (FIG. 9) for intermittently advancing or feeding a flexible continuous filament 60' from which rod 60 is made. Machine 70 has left- and right-hand coining dies 76 and 78 (as viewed in FIGS. 9, 10, 11 and 12) with left- and right-hand punches 80 and 82 (FIGS. 5 and 21) for forming stops 66 on the opposite ends of rods 60. As filament 60' is advanced by storage and feed mechanism 74, it is guided through slots 62

and 64 of a spacer-expander 30 received on locator 72 by a plurality of inner guides mounted on the locator and by outer guides advanced and retracted by a slide mechanism 84. Punches 80 and 82 are vertically reciprocated by a mechanism 92 to shear or cut off a segment of filament 60' to form rod 60 and to coin stops 66 on its opposite ends to form a slip latch 58 in assembled relation in spaced-expander 30. Machine 70 has a pedestal base support 94 with an upper mounting plate or table 96 fixed thereto on which coining dies 76 and 78 are mounted by flush screws 98. Cycle start and emergency stop control switch buttons 97 and 99 are mounted on the left-hand front corner of table 96 (as viewed in FIG. 9).

Locator 72 positions a spacer-expander 30 in machine 70 with its normally abutting opposed ends 42 separated and its normal inside diameter enlarged. Locator 72 has a locating plug 100 fixed to pedestal support 94 by an arm 102. An expander plate 104 is secured to the top of plug 100 by screws 106 and has an outer edge with a generally circular portion 108 and a bell-shaped portion 110 provided by relieved areas 112. As shown in FIG. 6, the top and side surfaces of plate 104 are blended together by a comparatively large radius rounded edge 113 extending about the entire periphery of the plate to facilitate slipping a spacer-expander 30 downwardly about the plate. The opposed ends 42 of spacer-expanders 30 are disengaged and separated by a dome-shaped spreader guide 114 fixed to plate 104. Spreader guide 114 also serves to circumferentially locate spacer-expanders 30 on locating plug 100. Spacer-expanders slipped over plate 104 are received by a circular shoulder 116 extending about the entire outer periphery of the upper end of plug 100 and having an inner edge with the same configuration as expander plate 104.

As shown in FIG. 9, filament storage and feed mechanism 74 has a reel 120 journaled for free rotation on an upright shaft 122 mounted on a support plate 124 fixed to table 96. The filament 60' coiled on reel 120 is protected by a shield 126 fixed to support plate 124 and having an exit slot 128 therein. A friction drag clutch (not shown) is operably connected with reel 120 to prevent the reel from unwinding without a slight pull being applied to filament 60'. Filament 60' is unwound from spool 120 and advanced through coining die 78 by a drive wheel 130 urged into frictional engagement with filament 60' by an idler wheel 132. Drive wheel 130 is intermittently advanced or rotated counterclockwise (as shown in FIG. 9) by a driving motor 134 secured by screws 136 to a mounting plate 138 fixed to table 96 and reel support plate 124. Idler wheel 132 is mounted for free rotation on one leg of a bell crank 140 which is provided on a shaft 142 fixed to mounting plate 138. Idler wheel 132 is yieldably urged toward wheel 130 by a spring 144 connected at one end to the other leg of crank 140 and at its other end to mounting plate 138. After the leading free end of filament 60' passes between driving and idler wheels 130 and 132, the free end is pushed through a guide tube 146 supported by mounting plate 138 by the wheels, engaging and advancing successive portions of the continuous filament.

Slide mechanism 84 extends and retracts left- and right-hand outer guides 86 and 88 and a locator and

outer center guide 90. As shown in FIGS. 7 and 9, mechanism 84 has a slide block 148 mounted for reciprocating motion on table 96 by ways 150 and 150' fixed to the table by cap screws 152. Center locator and guide 90 is received for longitudinal sliding movement in a slot 154 through block 148 and is retained in the slot by the overlapping edges of outer guides 86 and 88 which are secured to block 148 by flush head screws 156. As shown in FIGS. 8 and 11, locator and guide 90 is yieldably urged toward plate 104 (radially of expander 30) by a coil compression spring 158 received in a counterbore 160 in the rear portion of slide 148. The movement of locator 90 toward expander 30 is limited by bolt 162 slidably received in a bore 164 through the rear portion of slide 148 and secured to locator 90 by a threaded shank portion 166. The extent to which locator 90 can be retracted in slot 154 is limited by a projection 168 thereof engaging shoulders 170 of outer guides 86 and 88. As shown in FIG. 18, when locator 90 is extended, it slides under spreader guide 114 and bears on a wall 169 of a pocket 171 in locating plug 100. Slide block 148 is reciprocated by a pneumatic cylinder 172 connected to a mounting plate 174 (FIG. 5) fixed to table 96. The piston rod of cylinder 172 is connected by a coupling nut 176 to one end of a shaft 178 threaded at the other end into slide block 148 (FIG. 9).

As shown in FIGS. 5 and 10, punch actuator mechanism 92 has a movable platen 186 journaled by bushings 188 for vertical reciprocation on upright guide posts 190 and 190' fixed to table 96. Punches 80 and 82 are received in left- and right-hand (as viewed in FIG. 10) punch holders 194 and 196 connected to holder mounting blocks 198 and 200 fixed to platen 186. An adjustable stop 202 (FIG. 5) is threaded in platen 186 to bear on slide block 148 and thereby limit the extent of downward travel of the platen. Platen 186 is reciprocated on guide posts 190 by a pneumatic cylinder 204 acting through a lever arm 206. Lever arm 206 is pivotally connected intermediate its ends to a pair of axially spaced journals 208 on opposite sides of the arm by a transverse trunnion pin 210 received in the journals. The pair of journals 208 are fixed by gussets 211 to a pair of spaced support brackets 212 fixed to table 96. One end of arm 206 has a semi-cylindrical portion 214 on its lower edge which is connected to platen 186 by a yoke 216 fixed to the platen. End portion 214 is received in a central slot in yoke 216 and retained therein by a transverse pin 218 slidably received in axially spaced generally opposed horizontal slots 220 in yoke 216. The other end of lever arm 206 is pivotally connected to a piston rod 222 of cylinder 204 by a pin 224 and clevis 226 threaded to the piston rod. Pneumatic cylinder 204 is mounted on table 96 by a mounting plate 228 fixed to table 96 by gussets 230. The lower end of cylinder 204 is connected by a pivot pin 232 to axially spaced plates 234 fixed to the lower end of a bar 236 secured to mounting plate 228.

As shown in FIGS. 11 and 12, filament 60' is guided free end first through slots 62 and 64 of spacer-expander 30 by a plurality of inner and outer guides. First and second right-hand (as viewed in FIGS. 11 and 12) inner guides 240 and 242 respectively and first, second and third left-hand inner guides 244, 246 and 248 respectively made of a material such as carbide are

fixed to a steel carrier plate 250 as by cementing with epoxy adhesive. Carrier plate 250 is received in a recess 252 of plug 100 and is secured therein by flat head screws 254. As shown in FIG. 14, first and second right-hand inner guides 240 and 242 each have a generally radially outwardly extending arcuate ramp 256 with a small land 258 at its tip, and upper and lower generally radially outwardly extending arcuate fingers 260 and 262 axially spaced from one another adjacent and flanking the ramp (the terms "axially" and "radially" being used with reference to expander 30 in loaded position). Arcuate ramps of guides 240 and 242 are slightly narrower in width than and extend into the associated leg slots 62 and 64 respectively of spacer-expander 30. The vertical (axial) space between fingers 260 and 262 is slightly less than the axial width of associated slots 62 and 64 respectively of the spacer-expander.

As shown in FIGS. 13 and 15, left-hand inner guides 246 and 244 have wedges or straight ramps 263 and 264 respectively which extend generally radially outward with small lands 266 and 268 on their outer ends. Similarly, left-hand inner guide 248 has a radially outwardly extending ramp 270 with a small land 272 on its outer end. Preferably the width of ramps 264, 263 and 270 of inner guides 244 and 246 and 248 is slightly larger than the width of their associated leg slots 62 and 64 of spacer-expander 30. As illustrated in FIGS. 16 and 17 and 18, the ramps of the inner guide inserts 240, 242, 244, 246 and 248 provide a series of guide surfaces inclined radially outwardly relative to the final assembled position of latch 58 which the leading free end of filament 60' sequentially slidably engages during assembly, the free end being cammed radially outward by each ramp to align the end of the filament for passing through slots 62 and 64 of spacer-expander 30 as it is advanced by feed and storage mechanism 74.

As shown in FIGS. 11, 12, 18 and 19, each of outer guides 86, 88 and 90 has one or more projections with slots therethrough for restraining the vertical movement (axially of expander 30) of filament 60' so that the end of the filament is aligned with the slots in spacer-expander 30 as the rod is advanced by feed mechanism 74. As shown in FIG. 19, right-hand outer guide 88 has three generally radially extending projections 274, 276 and 278 with transverse slots 280, 282 and 284 therethrough. To assure that each slot 280, 282 and 284 picks up the free leading end of filament 60', its leading edges have a pair of generally opposed inclined chamfers 286, 288 and 290 respectively thereon. Similarly, left-hand outer guide 86 has two circumferentially spaced radial projections 292 and 294 with transverse slots 296, 298 therethrough as shown in FIGS. 11 and 12, and partially in FIG. 21. Center locator and guide 90 has a transverse slot 300 in projection 168 (FIG. 18) and opposed chamfers 301 on its leading edges to guide the leading end of filament 60' between spaced opposed ends 42 of spacer-expander 30. Locator 90 has inclined front faces 302 and a comparatively large radius 304 around its periphery to facilitate insertion of locator guide 90 between opposed ends 42 of spacer-expander 30 (FIG. 12). Each slot in the projections of outer guides 86, 88 and 90 is slightly smaller in width than the axial width of its associated leg slots 62 or 64 of spacer-expander 30 to limit the vertical dis-

placement (axially of expander 30) of the leading end of filament 60' so that it is aligned vertically with the associated slots for passage therethrough.

As shown in FIGS. 21 and 22, left- and right-hand dies 76 and 78 have steel cavity plates 306 and 308 respectively with anvil plates 310 and 312 respectively underlying the associated cavity plates. As shown in FIG. 12, cavity and anvil plates 306 and 310 of die 76 have a radial projection 314 which extends into the space radially outwardly of the third inner crown 44 to the left of ends 42 of spacer-expander 30 (as viewed in FIG. 12) and between the second and third outer crown 46 to help position and confine the spacer-expander on locator 72, and align the die cavity to receive filament 60'. Cavity and anvil plates 308 and 312 of die 78 have a projection 316 which extends into the space radially outwardly of the fourth inner crown to the right of ends 42 of spacer-expander 30. Die 78 has a groove 318 adjacent to the fourth outer crown to provide clearance for the spacer-expander. Projection 316 serves as a guide as well as a portion of the die cavity to feed the free end of 61 of filament 60' into the entrance of the guideway which controls the path of travel of filament 60' through the spacer-expander. Cavity plates 306 and 308 each have generally V-shaped slots 320 and 322 therethrough extending parallel to the axis of expander 30 providing a cavity for receiving filament 60' and punches 80 and 82. The upper surfaces 324 and 326 of anvils 310 and 312 respectively underlie slots 320 and 322 to provide a bottom coining surface in the cavities. Filament 60' is fed into die 78 through a guide bore 328 (FIGS. 12 and 22) extending horizontally through cavity plate 308 of die 78.

As shown in FIGS. 22, 23 and 25, punch 82 has a generally triangular-shaped flat surface 330 with a sharp peripheral edge which travels into the cavity of die 78 to cut off filament 60' to form rod 60 and coin the end thereof. Punch 82 has a generally rectangular relief area 332 immediately adjacent coining surface 330 to provide clearance for the portion of rod 60 which extend beyond the area to be coined toward the leading end of rod 60. Punch 82 is guided in the cavity of die 78 by a generally axially depending tank 334 immediately adjacent coining surface 330 and an axially extending surface 336. Inner side surface 338 of tank 334 slidably engages a portion of the side surface 313 (FIGS. 22 and 23) of anvil plate 312 immediately adjacent the cavity of die 78 to guide punch 82 into and out of the die cavity. Tang 334 has a chamfer 340 on one corner to provide clearance between punch 82 and anvil plate 312 of die 78. The vertically extending side surface 342 and 344 of punch 82 are complementary respectively to the side surfaces 322' and 322'' defining cavity slot 322 to slide against these respective surfaces to likewise guide punch 82 in its travel between the raised and lowered positions thereof shown in FIGS. 22 and 23 respectively. Punch 80 is the opposite hand or mirror image of punch 82 and, therefore, its construction and configuration will not be described in detail.

In operating machine 70, a spacer-expander 30 is slipped over plate 104 of locator 72 with its opposed ends engaging spreader guide 114 and pushed downwardly to rest on shoulder 116 as shown in FIG. 5. As spacer-expander 30 is inserted on locator 72, the

right-hand end portion thereof adjacent guide 114 is moved radially outwardly and then released to spring radially inwardly to assure that the ramps of right-hand guides 240 and 242 extend into the respectively adjacent leg slots of the spacer-expander. This radially outward movement is preferably achieved by squeezing the spacer-expander into the relief areas 112 of top plate 104 and then releasing the squeeze force. The cycle start button 97 is pressed which, through appropriate control means (not shown), actuates pneumatic cylinder 172 toward locator 72 to thereby move slide block 148 and thus extend outer guides 86, 88 and 90 from the retracted position shown in FIG. 9 into firm engagement with spacer-expander 30 as shown in FIGS. 11 and 12. As slide 148 is advanced, locator and guide 90 first engages opposed ends 42 of spacer-expander 30 to accurately circumferentially position the spacer-expander on locator 72. When guide 90 abuts locator 72, the lost motion connection between guides 86, 88 and guide 90 permits continued movement of guides 86, 88, and hence they are advanced with respect to locator 90 to firmly engage spacer-expander 30 and retain the spacer-expander on locator 72. The control means then actuates drive motor 134 to unwind filament 60' from storage reel 120 and advance the filament through guide 146 and coining die 78 as shown in FIGS. 11 and 12.

Assume that the leading end 61 of filament 60' is initially positioned at the outlet of guide bore 328 of plate 308 as shown in FIG. 20, as a result of the shearing operation of a previous cycle. It is to be noted that coining die 78 is positioned so that the free leading end 61 of filament 60' first slidably engages and rides over the third outer crown to the right of ends 42 of the spacer-expander, then passes through slot 280 of projection 274 of outer guide 88, and then passes through the right leg slot 64 of the second outer crown 46 to the right of ends 42 of spacer-expander 30. The lands 286 and slot 280 of projection 274 of outer guide 88 vertically align end 61 of filament 60' to pass through this large leg slot in the spacer-expander.

As filament 60' continues to be advanced, end 61 is pushed between vertically spaced guide fingers 260 and 262 of inner insert 240 and slidably engages and is moved radially outwardly by ramp 258, so as to be guided for entry into the left slot 64 of the second outer crown 46 to the right of ends 42 of the spacer-expander, as shown by the position of end 61 in solid lines in FIG. 12. Filament end 61 then enters slot 282 of second projection 276 of outer guide 88 and rides through this slot while slidably bearing on the outer surface of the second inner crown 44 to the right of ends 42 of the spacer-expander. End 61 then passes through the smallest right leg slot 62 of the first outer crown 46 to the right of ends 42. Chamfer flats 288 and slot 282 of projection 276 of outer guide 88 guide and confine end 61 of filament 60' axially of expander 30 so that it is aligned to pass through this right slot 62 of this first outer crown. As filament 60' is advanced, end 61 passes between vertically spaced fingers 260 of inner insert 242, slidably engages and is moved radially outward by ramp 258, and then passes through left slot 62 of the first outer crown 46 to the right of ends 42 of the spacer-expander, as shown in phantom at 346 in FIG. 12. End 61 then passes into slot 284 of the third projec-

tion 278 of outer guide 88 and rides across the outer surface of the first inner crown 44 to the right of ends 42 and passes through the slot 62 in the end abutment leg of the right end 42 of the spacer-expander. Thus, lands 290 and slot 284 of the projection 278 of outer guide 88 in cooperation with this first inner crown align the free end 61 of filament 60' with the slot in the leg of left end 42 for passage therethrough.

End 61 of filament 60' next enters slot 300 of locator 90, slidably engages and is moved radially outwardly by ramp 264 of left-hand inner guide 244, and then passes through the slot 62 of the end abutment leg of the left end 42 of spacer-expander 30, as shown in phantom at 348 of FIG. 12. Thus, slot 300 of outer guide 90 cooperates with ramp 264 of inner guide 244 to align end 61 of filament 60' for passage through the small slot 62 of the end leg of expander left end 42 and hence into slot 296 of the first projection 292 of left-hand guide 86. Slot 296 in cooperation with the outer surface of the first inner crown 44 to the left of ends 42 of spacer-expander 30 aligns end 61 for passage through the right slot 62 of the first outer crown 46 to the left of ends 42. The end of filament 60' slidably engages and is moved radially outwardly by ramp 262 of inner guide 246, passes through the left slot 62 of the first outer crown 46 to the left of ends 42, and enters slot 298 of the second projection 294 as shown in phantom at 350 in FIG. 12. Slot 298 of outer guide 286 in cooperation with the outer surface of the inner crown 44 second from the left of ends 42 of the spacer-expander aligns end 61 for passage through the right leg slot 64 of the second outer crown 46 from the left of ends 42. As the end of filament 60' is advanced through this slot of this second outer crown, it slidably engages and is moved radially outwardly by ramp 270 of inner guide 248 and passes through the left leg slot 64 of this second outer crown 46 and thence into the cavity of left-hand die 76, as shown in phantom at 352 in FIG. 12. The inner guides 246 and 248 do not need any vertically spaced fingers to control the vertical position of the free end 61 of filament 60' since the portion of the filament following its leading end is by this time sufficiently confined from shifting vertically by being threaded through the substantially continuous guideway formed by the various slots of the outer guides, the various leg slots 62 and 64 of the spacer-expander and between the fingers of inner guides 240 and 242.

The filament 60' is advanced in one continuous motion through the spacer-expander and into die 76, this automatic threading having been described as a series of discrete steps merely for convenience in discussing the functions of the various guides. After filament 60' has been threaded through the spacer-expander 30 and end 61 is received in the cavity of die 76 as shown in FIG. 11, and as shown in FIGS. 21 and 22 considered in unison, the control means actuates cylinder 172 to retract guides 86, 88 and 90 and then actuates cylinder 204 to move punches 80 and 82 downwardly into dies 76 and 78. As punch 82 is advanced downwardly into the cavity of die 78, it first shears or cuts off filament 60' adjacent surface 322' to provide a predetermined length of filament which forms the flexible rod 60 of latch 58. As both the punches 80 and 82 continue to advance downwardly into the cavity of the dies 76 and 78, they coin the stops 66 on the opposite ends of rod

60, as shown in phantom in FIGS. 21, 22 and 23. After the stops 66 are coined, the control means actuates piston 204 in the reverse direction to retract punches 80 and 82 to disengage these punches from the associated dies. Expander 30 with a slip latch 58 thus threaded, formed and assembled therein is then removed from locator 72 by the operator springing open its ends and lifting it off the locator in a reverse sequence from the loading operation. Another piston expander may then be positioned on the locator and cycle button 97 depressed to begin another cycle of machine 70.

To decrease the extent of the bending or flexing of filament 60' when being inserted into the spacer-expander, it is fed into the spacer-expander with its curvature generally coinciding with the curvature of the spacer-expander. It has been found that with certain filament materials inserting a filament 60' with curvature reversed into a spacer-expander will usually so severely flex or bend the filament, due to the change in its radius of curvature locally at the entry area, that the resulting latch is over-stressed and will not function properly in the spacer-expander. For example, it has been found that filament 60' of type 6-6 nylon which has been heat set with a radius of curvature of 1.562 inches by heating to 420° F. for 30 minutes, if inserted with reverse curvature in a spacer-expander having a normal inside diameter of 3.609 inches, will jam and hang up in the spacer-expander when the ends thereof are separated and returned to abutting relation. The localized and successive overbending will cause it to assume an increased radius of curvature so that the resulting latch no longer hugs the inner crowns of the spacer-expander when its opposite ends are separated and returned to abutting relation by opening and closing of the parted ends of the expander, resulting in the latch becoming caught or bound up in the spacer-expander.

Hence, in accordance with the present invention, the filament is fed into the spacer-expander with a coinciding curvature so that the angle of attack, i.e., the angle between the path of travel of the filament where it enters the spacer-expander during threading and the position it will assume when assembled therein, is decreased at the point at which the filament enters the spacer-expander. Moreover, the entry point is moved circumferentially away from ends 42 of expander as far as possible consistent with the maximum economic length of latch 58. This threading orientation thus decreases the angle of attack and thereby reduces the extent of the flexing or bending of the filament as it is inserted in the spacer-expander. For example, when using the above-mentioned nylon type 6-6 filament and a radially corrugated spacer-expander 30 as shown to scale herein, it has been found that the filament can be satisfactorily fed into the spacer-expander if it enters the spacer-expander through the space radially outwardly of the third inner crown 44 from the ends 42 of the spacer-expander while preferably slidably bearing on the outer surface of the third outer crown from the ends, as shown in FIGS. 11 and 12. With this size spacer-expander and curvature of nylon type 6-6 filament, the filament is usually too severely flexed or bent if it enters the spacer-expander in the space of the second inner crown from ends 42 and rides on the second outer crown from the ends.

In accordance with another feature of the invention, ramps 260 of the initial inner guides 240 and 242 are preferably provided with a curved surface to provide a variable rate of outward movement of the end 61 of the filament to facilitate passage of the filament over the ramps; i.e., the curvature of ramps 260 initially provides less radial outward movement per unit of linear advancement of filament 60' when the angle of attack between the ramp and the end of the filament is greatest to prevent the filament from becoming caught or hung up on the ramp. The outward ramp curvature then increases the extent of the radial outward displacement per unit of linear advancement as the angle of attack decreases. It is also preferred to have ramps 260 of the initial inner guides 240 and 242 extend into their associated slots in the legs of the spacer-expander in order to assure that the end of the filament will be moved sufficiently generally radially outward so that it will not become caught or hung up on the downstream inner crown immediately adjacent the trailing end of the ramps of the initial guides. However, as more and more of the filament is pushed into the spacer-expander, the variance between the actual position of the end 61 of the filament during feeding and the position the filament 60' assumes in assembled relation in the spacer-expander decreases. Therefore, it is not usually necessary for the remaining inner guides 244, 246 and 248 to have either curved ramps or ramps that extend into the slots in the legs of the spacer-expander immediately adjacent the remaining guides.

In accordance with another feature of the invention, feeder mechanism 74 is adjustable so that it can be set up to feed a length of filament 60' which is equal to or slightly longer than the nominal length of the curved path traced by filament 60' as it threads through the guideway between the outlet of guide bore 328 and stop surfaces 320 of die 76. This feeder overfeed is set to insure that end 61 will always home in die 76 and abut surface 320 thereof. However, if necessary, the feeder can be set to overfeed to accommodate the slight variations in the length of filament fed by feeder 74. This overfeed is maintained while stops 66 are being coined on the opposite ends of rod 60 of the latch 58. In addition to this overfeed, or even in the absence thereof, the rods tend to become slightly elongated due to the coining action occurring at the ends of rod 60. Therefore, since the ends of filament 60' are held in the coining dies, filament 60' will bow radially outward slightly, particularly in the central portion between the separated ends 42 of the spacer-expander. Accordingly, the slots in outer guides 86 and 88 and particularly in outer center locator and guide 90 are made deep enough to provide clearance to accommodate this radially outward bowing of the filament while it is in position for shearing and coining.

By way of example and not of limitation, a machine 70 embodying this invention has been found to operate highly satisfactorily with a parted spacer-expander having normal inside diameter when its ends are abutted of 3.609 inches, and a filament of 6—6 type nylon with an outside diameter of 0.042 inch, and a preset radius of curvature of 1.562 inches. This spacer-expander is formed with 31 outer crowns 46 and 32 inner crowns 44 from a sheet metal (i.e., stainless steel) strip having a length in the flat of 15.87 inches, a width in the range of 0.177 to 0.182 inch and a thickness of 0.025 inch be-

fore forming. The slots in the legs of this piston expander have a width ranging from 0.050 to 0.060 inch, and the long slots are 0.176 inch long, and the small slots 0.091 inch long before forming. After being formed, the radial thickness from the inside to the outside diameter of this spacer-expander is approximately 0.146 inch, and the circumferential width at the median diameter of the inner crowns is 0.095 inch and the outer crowns 0.145 inch. The stops of the latch have a minimum circumferential width of 0.065 inch, a minimum axial width of 0.010 inch, and a radial width in the range of 0.070 to 0.085 inch. The overall free length of the latch is in the range of 2.750 to 2.812 inches. The ramps 260 of the guides 240 and 242 used with this spacer-expander have a radius of curvature of 0.5 inch, a rise of 0.047 inch, a land on the tip with a circumferential width of 0.010 inch, and the ramps have an axial width of 0.045 inch. The fingers 260 of inner guide inserts 240 and 242 extend radially outward approximately 0.067 inch, and each have a land with a circumferential width of approximately 0.031 inch, and a radius of curvature of approximately 0.050 inch with their trailing edge offset from the trailing edge of the ramp approximately 0.093 inch and 0.062 inch respectively. The ramp 264 of inner left-hand guide 244 has a length of 0.25 inch, a rise of 0.037 inch and an axial thickness of 0.187 inch. Similarly, the ramps 262 and 270 of inner right-hand guides 246 and 248 have respective lengths of 0.062 and 0.125 inch, rises of 0.0468 and 0.0937 inch, and an axial thickness of 0.187 inch. The slots through the various projections of outer guides 86, 88 and 90 have an axial width or thickness of 0.045 inch.

By providing a plurality of inner and outer guides extending into the spaces of some of the crowns of a corrugated piston ring spacer-expander, the machine or apparatus embodying this invention economically, rapidly, reliably and automatically feeds and threads a curved, flexible filament free end first into a generally circumferential portion of the piston-expander. By feeding the arcuate filament so that its curve is generally coinciding with the curvature of the spacer-expander, and with a minimum angle of attack, the filament is inserted into the spacer-expander without materially affecting the preset radius of curvature of the filament which in turn prevents the latch formed from the filament from becoming hung up in the spacer-expander as its ends are separated and returned to their abutting relation. The coining dies not only assist in clamping the expander, guiding and stopping the filament, but also shear off the filament to form the rod of a slip latch and coin stops on its opposite ends while the rod is in the spacer-expander, thereby further enabling the machine of the invention to rapidly and economically make a slip latch while in accurate assembled relation in the spacer-expander.

Having described a machine embodying this invention, the method of this invention may now be more readily understood. In this method guides are inserted into the spaces between the slotted or apertured legs of selected crowns of an expander to provide a guideway through a portion of the expander, including its normally abutting ends, for guiding the free end of a curved filament. The free end of the curved filament is pushed through the guideway and into the expander

through the apertures in the legs with the curvature of the filament in the same direction as the curvature of the expander. The filament is severed or sheared to provide a rod in the expander extending through the abutment ends thereof. Stops are formed on the opposed ends of the rod while these ends are received in the expander to provide a slip latch in assembled relation therein. This method provides a way of reliably, rapidly and economically threading a rod of a slip latch into an expander without overflexing and adversely affecting the operation of a latch made therefrom. This method also provides a way of reliably, rapidly and economically making a slip latch in assembled relation in an expander.

We claim:

1. A machine for making a slip latch in the parted ends of a corrugated piston ring expander of the type having a series of circumferentially spaced apertured connecting legs defining a space between each circumferentially adjacent pair of legs accessible to a peripheral surface of said expander comprising locator means for supporting the expander in a predetermined position with its ends generally circumferentially aligned, and first and second guide means projecting into said corrugations in the vicinity of said ends and defining with the apertures in said legs a circumferential guideway extending from a first space between an adjacent pair of said legs disposed adjacent one of said parted ends and on the side thereof remote from the other of said parted ends to a second space between another pair of said legs disposed adjacent the other of said ends and on the side thereof remote from said one end, at least said first guide means being movable from a retracted position clear of said expander to an extended position wherein said first guide means completes said guideway, said guide means being adapted to receive and guide a filament therethrough for movably connecting the parted ends of said expander.

2. The machine as set forth in claim 1 further including feeding means for pushing a filament having a free leading end into said first space and into said guideway such that said free end is slidably guided along in said guideway, thereby sequentially threading through said first space, said leg apertures disposed between said first and second spaces and into said second space.

3. The machine as set forth in claim 1 including means for forming a retaining stop at one end of said filament to convert the same to a slip latch having limited circumferential movement relative to said parted ends.

4. The machine as set forth in claim 3 including means for forming a retaining stop at an end of said filament opposite said one end and disposed on the side of said parted ends remote from said one end.

5. The machine as set forth in claim 1 including feeding means for feeding filamentary material having a free leading end and a length which is a multiple of the length of said guideway into and through said guideway leading end first, and further including means for severing said material in the vicinity of said first space, and means for operating said severing means when said free end is in the vicinity of said second space.

6. The machine as set forth in claim 5 wherein said filamentary material has a preset curvature and said

feeding means is oriented relative to said locator means to feed said material with its curvature oriented in the same direction as the curvature of said expander when in said predetermined position.

7. The machine as set forth in claim 6 wherein said severing means comprises a guide block having a feed passage aligned with the entrance to said guideway with an outlet in an end surface thereof spaced from the entrance to said guideway and extending transverse to the direction of feed of said material, and shearing means movable adjacent and along said end surface past said outlet for severing said material protruding from the outlet.

8. The machine as set forth in claim 7 wherein a forming surface is disposed transverse to said end surface adjacent said outlet and said feed passage outlet is disposed in advance of said forming surface relative to the shearing motion of said shearing means to thereby form said stop at the severed end of said material subsequent to said shearing means passing said outlet during its shearing motion.

9. The machine as set forth in claim 5 including stop means disposed in the vicinity of said second space for receiving the free end of said filament against an abutment thereof, means for halting said feeding means after said free end engages said abutment, said stop means having a forming surface disposed adjacent the path of travel of said free end, and further including forming means movable transverse to the direction of feed of said filament toward said forming surface and cooperable therewith to form a stop in said filament adjacent said free end thereof.

10. The machine as set forth in claim 1 wherein said first guide includes means movable into and out of the space between the parted ends of said expander to maintain said ends in spaced relation during feeding of said filament.

11. The machine as set forth in claim 1 wherein said expander is radially corrugated and has alternating inner and outer crowns joined by said connecting legs, and wherein said second guide means comprises a series of stationary members disposed radially inwardly of said outer crowns and said first guide means comprises a series of movable members movable between said extended position wherein said first guide means engages at least two of said inner crowns disposed on opposite sides of the parted ends of said expander and said retracted position disposed clear of said expander.

12. The machine as set forth in claim 1 wherein one of said first and second guide means comprises a series of projections positionable in the spaces between a successively adjacent series of said legs located on both sides of said parted ends between said first and second spaces, said projections cooperating with the apertures in said legs to define first and second guide surfaces spaced apart within the confines of said expander to thereby form portions of said guideway for guiding and restraining movement of said filament transversely of the direction of feed of said filament in said expander.

13. The machine as set forth in claim 12 wherein said one guide means constitutes said first guide means and is disposed for reciprocating travel in generally the same direction in which said expander is corrugated.

14. The machine as set forth in claim 13 wherein said second guide means is disposed in said locator means

and comprises a plurality of ramps interdigitally juxtaposed to said first guide means and being disposed on the opposite side of said expander from said first guide means.

15. The machine as set forth in claim 14 wherein said ramps project into spaces in said expander which alternate circumferentially with the spaces into which said projections of said first guide means are positioned.

16. The machine as set forth in claim 14 wherein said ramps are inclined at an angle to the path of travel of the filament through said guideway so as to converge toward said guideway in the direction of feed of the filament.

17. The machine as set forth in claim 15 wherein said ramps are disposed on both sides of said parted ends of said expander between said first and second spaces and one of said ramps is disposed between said parted ends of said expander spacer.

18. The machine as set forth in claim 14 wherein said expander is radially corrugated and comprises a series of circumferentially extending inner and outer crowns alternating with one another circumferentially of the ring and joined by said connecting legs, each of said ramps being disposed adjacent an associated one of said inner crowns and projecting radially of said expander into the space defined by the one of said outer crowns and its associated connecting legs located immediately adjacent and on the side of said one inner crown closest to the entrance to said guideway, the radially outermost portion of said ramp terminating at a point radially outwardly of the radially outermost surface of said inner crown.

19. The machine as set forth in claim 17 wherein said expander has a radially extending end abutment portion at each of said parted ends adapted to abut one another in the operative condition of said expander, and wherein the crowns immediately adjacent said ends comprise inner crowns, said first space being defined by the space between the second and third outer crown from said one parted end, one of said projections of said first guide means being positionable in said first space to define an entrance to said guideway located circumferentially between said third crown and said second crown, said second guide means having a first one of said ramps disposed between the second and

third inner crowns flanking said second outer crown and a second one of said ramp means disposed in the space between the first and second inner crowns flanking said first outer crown to thereby define a portion of said guideway extending along a path beginning radially outwardly of said third outer crown and adjacent thereto and converging in the direction of travel of the filament along said guideway toward the approximate median diameter of said expander and passing through the leg apertures between said second and third inner crowns.

20. The machine as set forth in claim 19 wherein said first and second ramps each include projections spaced axially from one another on opposite sides of the associated ramp and forming portions of said first and second guide surfaces of said guideway.

21. The machine as set forth in claim 19 wherein said first guide means includes a member movable into and out of the space between said end abutment portions of said expander to maintain said end abutment portions in circumferentially spaced relation during feeding of the filament through the guideway.

22. The machine as set forth in claim 21 including first and second dies flanking said first guide means, said first die having a filament feed passageway aimed at the entrance to said guideway, said passageway having an outlet disposed radially outwardly of said third outer crown and located circumferentially of said expander on the side of said third outer crown remote from said parted ends of said expander, said first die having a shearing surface defining said outlet and a coining surface disposed adjacent said outlet and extending in the direction of filament feed between said outlet and the entrance to said guideway, a first punch cooperable with said first die to shear the filament at said outlet and to coin the severed end of the filament against said coining surface of said first die, said second die having an abutment surface located within said second space for stopping travel of the free end of the filament, said second die also having a coining surface disposed adjacent said abutment surface in said second space and extending in the direction of filament feed, and a second punch cooperable with said second die to coin the free end of the filament against said coining surface of said second die when the free end is abutted with said abutment surface.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,727,281 Dated April 17, 1973

Inventor(s) Donald P. Erickson and Roy E. Overway

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 2 - "locat-ing" should be --locating--

Column 4, line 56 - "provided" should be --pivoted--

Column 9, line 20 - before "guide" insert --outer--

Column 10, line 29 - "3,609" should be --3.609--

Signed and sealed this 18th day of December 1973.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

RENE D. TEGTMEYER
Acting Commissioner of Patents