

[54] METHODS OF FORMING WIRE SPRINGS AND WELDING CONTACTS TO THE SPRINGS

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[73] Assignee: **Western Electric Company, Incorporated**, New York, N.Y.

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[21] Appl. No.: **193,833**

Related U.S. Application Data

[62] Division of Ser. No. 7,029, Jan. 30, 1970, Pat. No. 3,703,029.

[52] U.S. Cl. **29/630 R**, 29/203 R, 140/119, 140/149

[51] Int. Cl. **H01r 9/00**

[58] Field of Search 29/630 A, 630 B, 29/200, 208, 200 D, 629, 628; 140/149, 119; 72/419; 74/820, 822, 825, 826, 824, 813, 817; 219/4, 79; 198/19; 53/60

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Primary Examiner—Charles W. Lanham

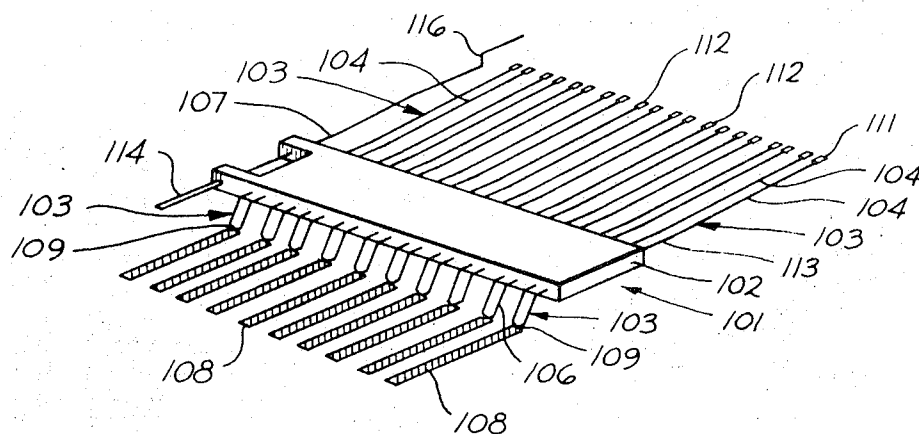
Assistant Examiner—James R. Duzan

Attorney—W. M. Kain et al.

[57] ABSTRACT

Certain types of wire spring assemblies include a plurality of parallel, spaced wires extending from opposite sides of a block formed of an insulating material. A plurality of the wire spring assemblies are loaded into a rack and the rack is attached to a dispensing mechanism for feeding serially successive wire block assemblies from the rack. Adjacent pairs of the wire springs extending from one side of the block are twisted together and coined. The opposite ends of the wire springs are coined and have contacts welded thereto. Portions of the wire springs extending from both sides of the wire block are formed at offset angles and are thereafter loaded into another rack which is attached to an unloading mechanism so that the completed wire spring assemblies may be transferred to a subsequent assembly station and used in the formation of a switching assembly.

10 Claims, 50 Drawing Figures



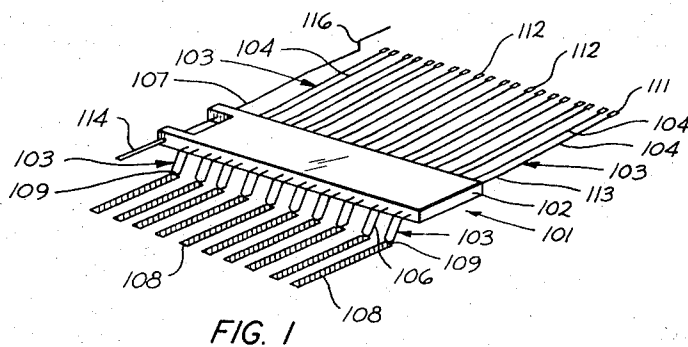


FIG. 1

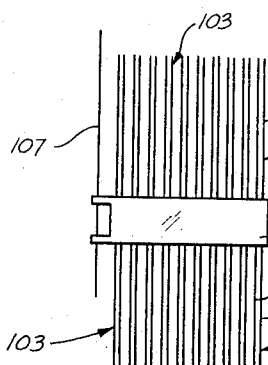


FIG. 2

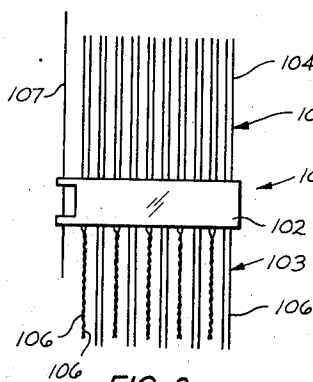


FIG. 3

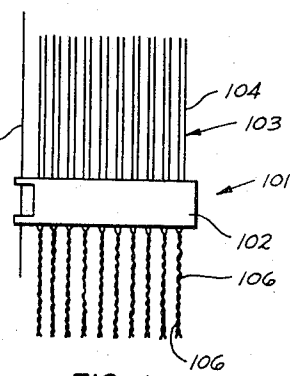


FIG. 4

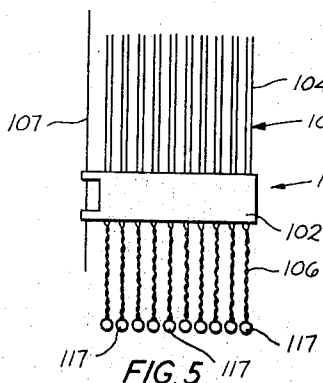


FIG. 5

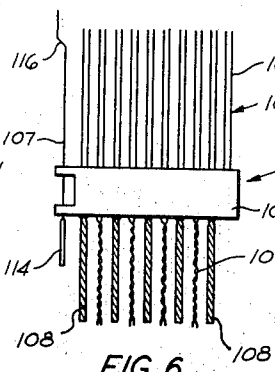


FIG. 6

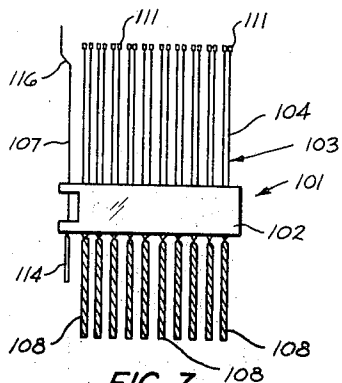
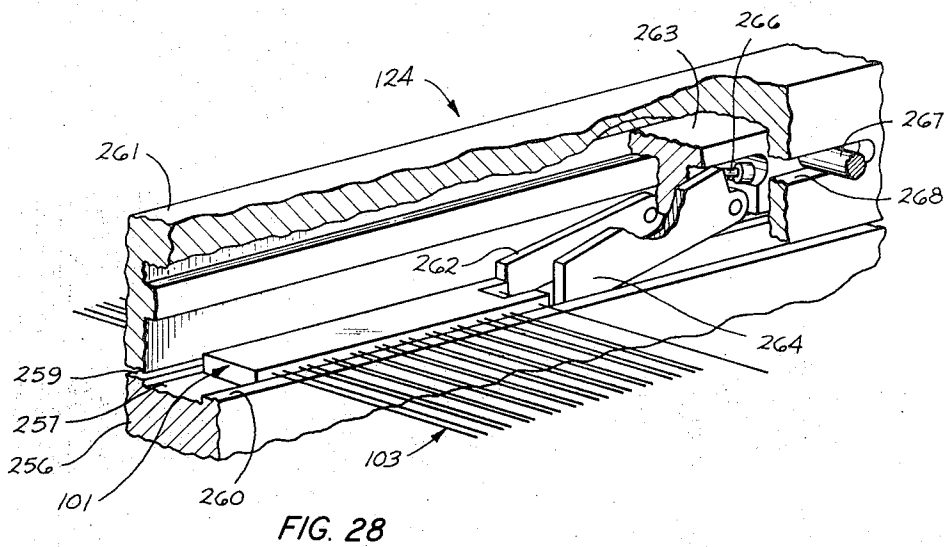
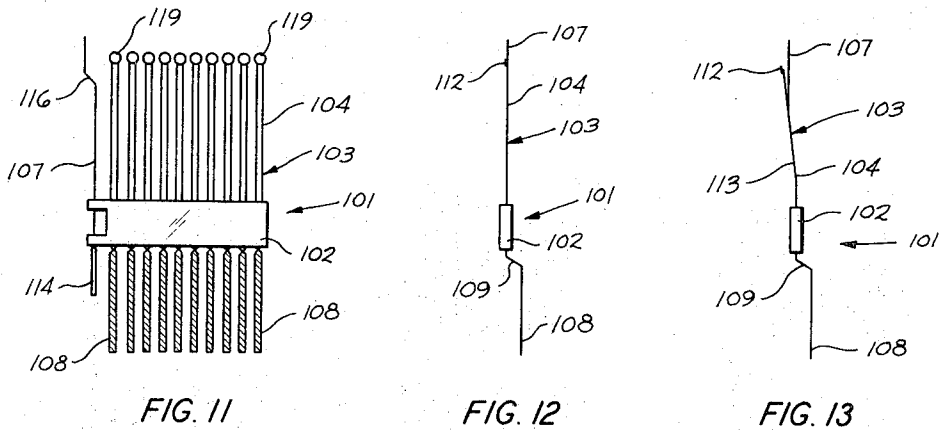
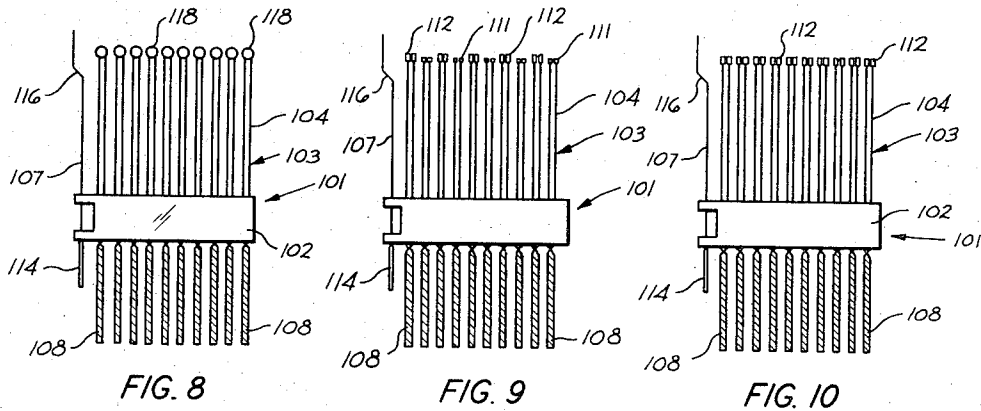
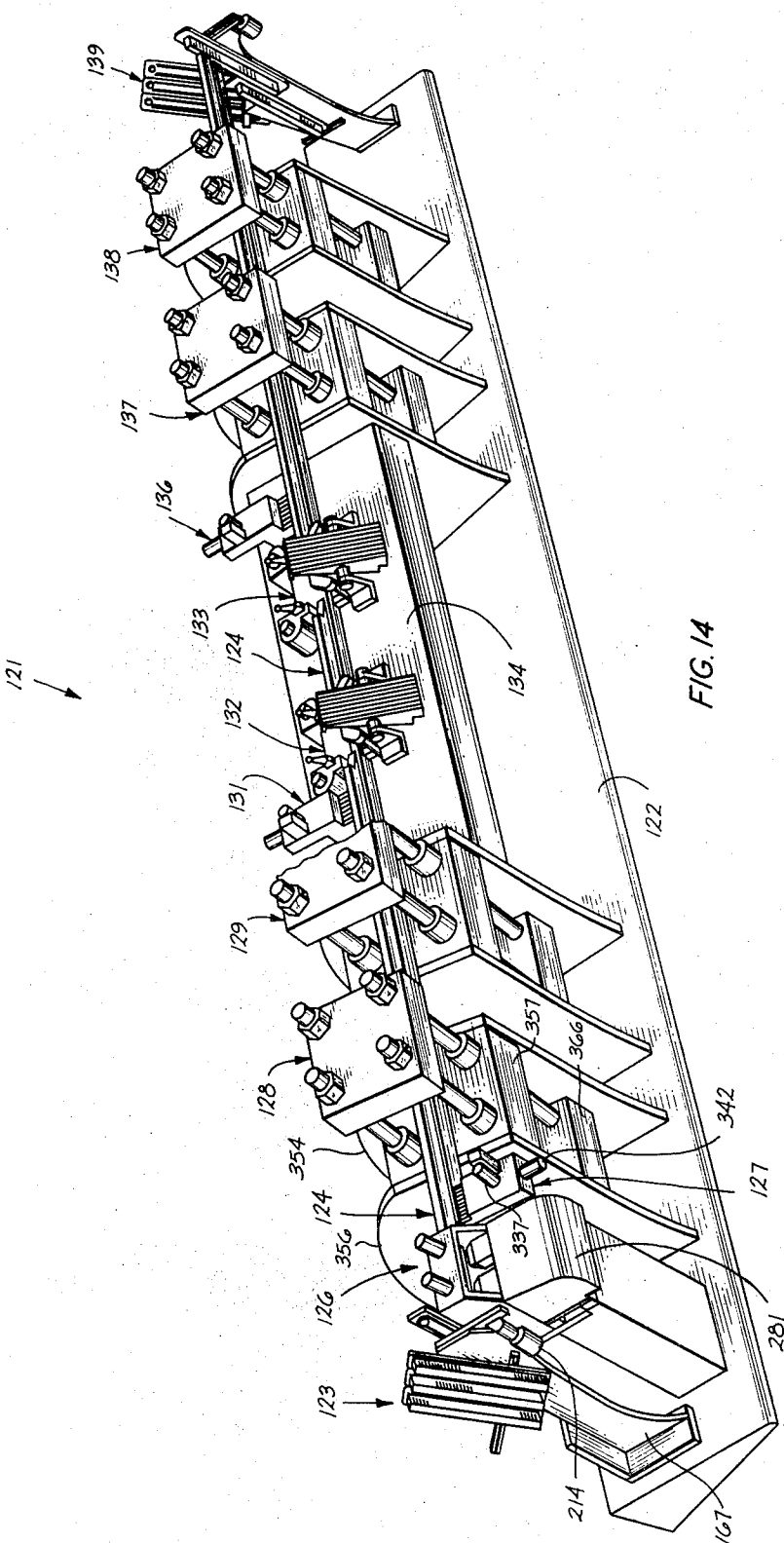


FIG. 7

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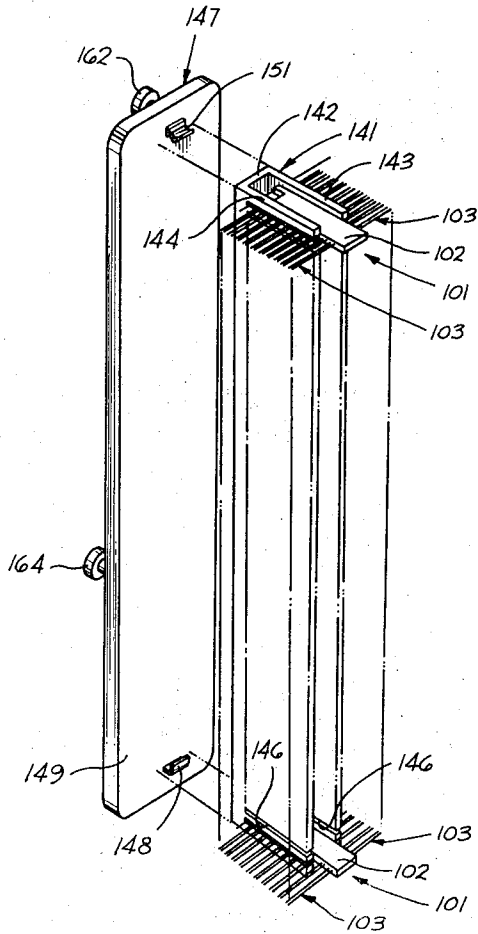


FIG. 15

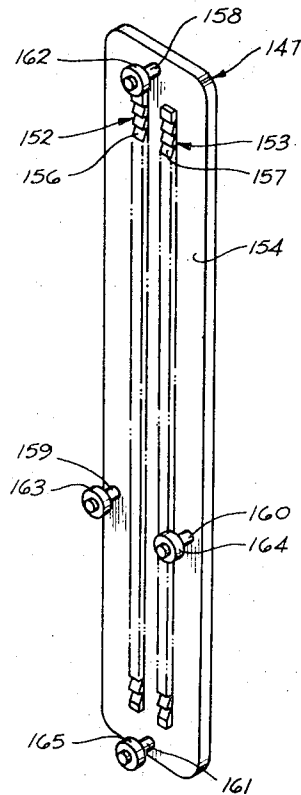


FIG. 16

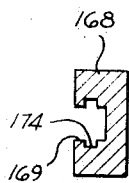


FIG. 18

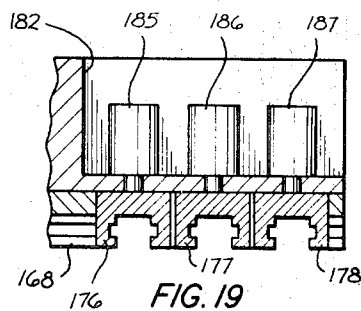


FIG. 19

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19 Sheets-Sheet 5

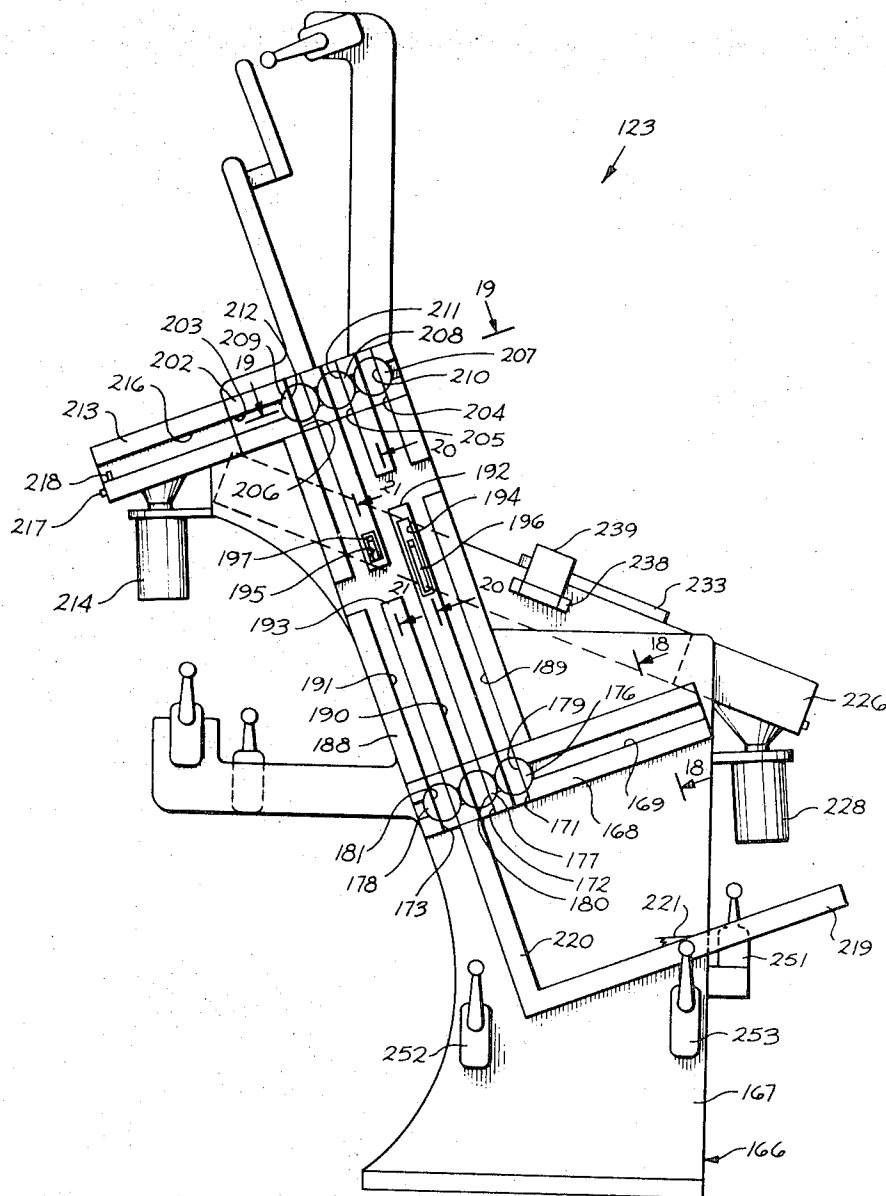


FIG. 17

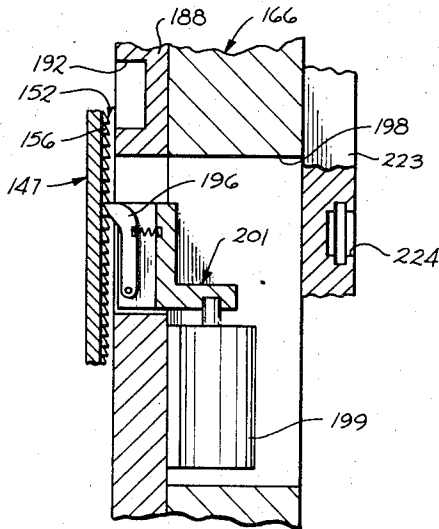


FIG. 20

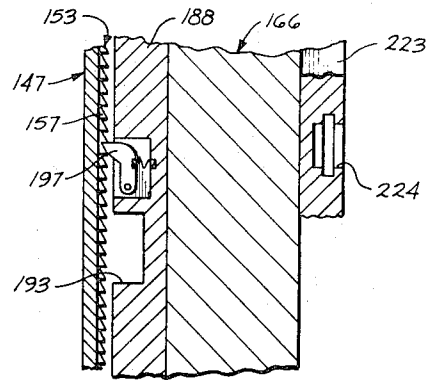


FIG. 21

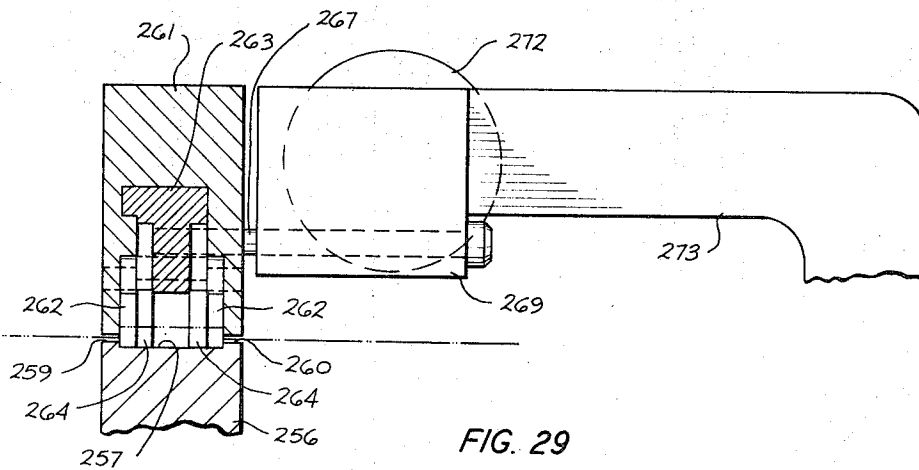


FIG. 29

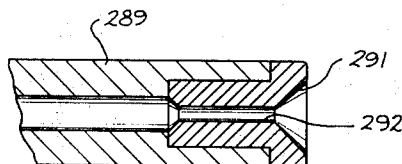


FIG. 33

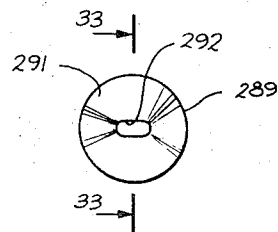


FIG. 32

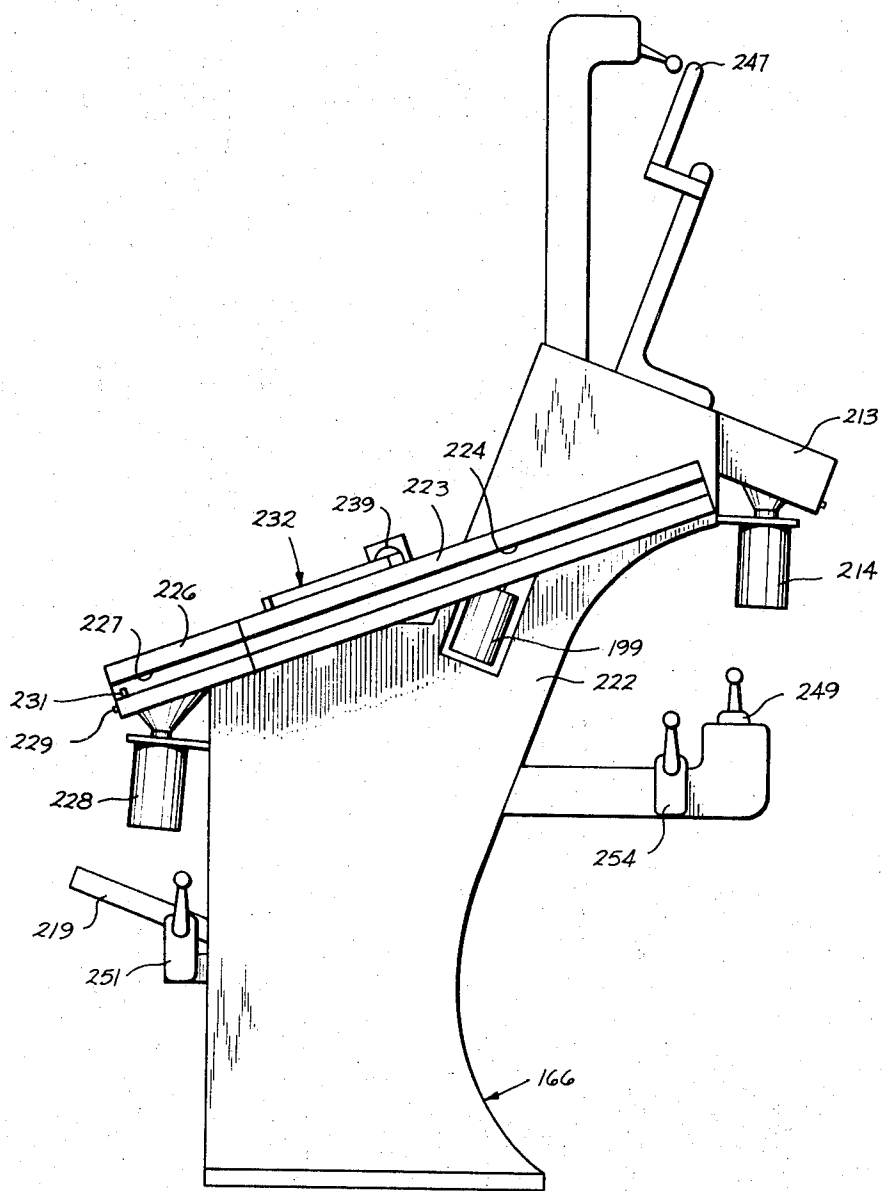


FIG. 22

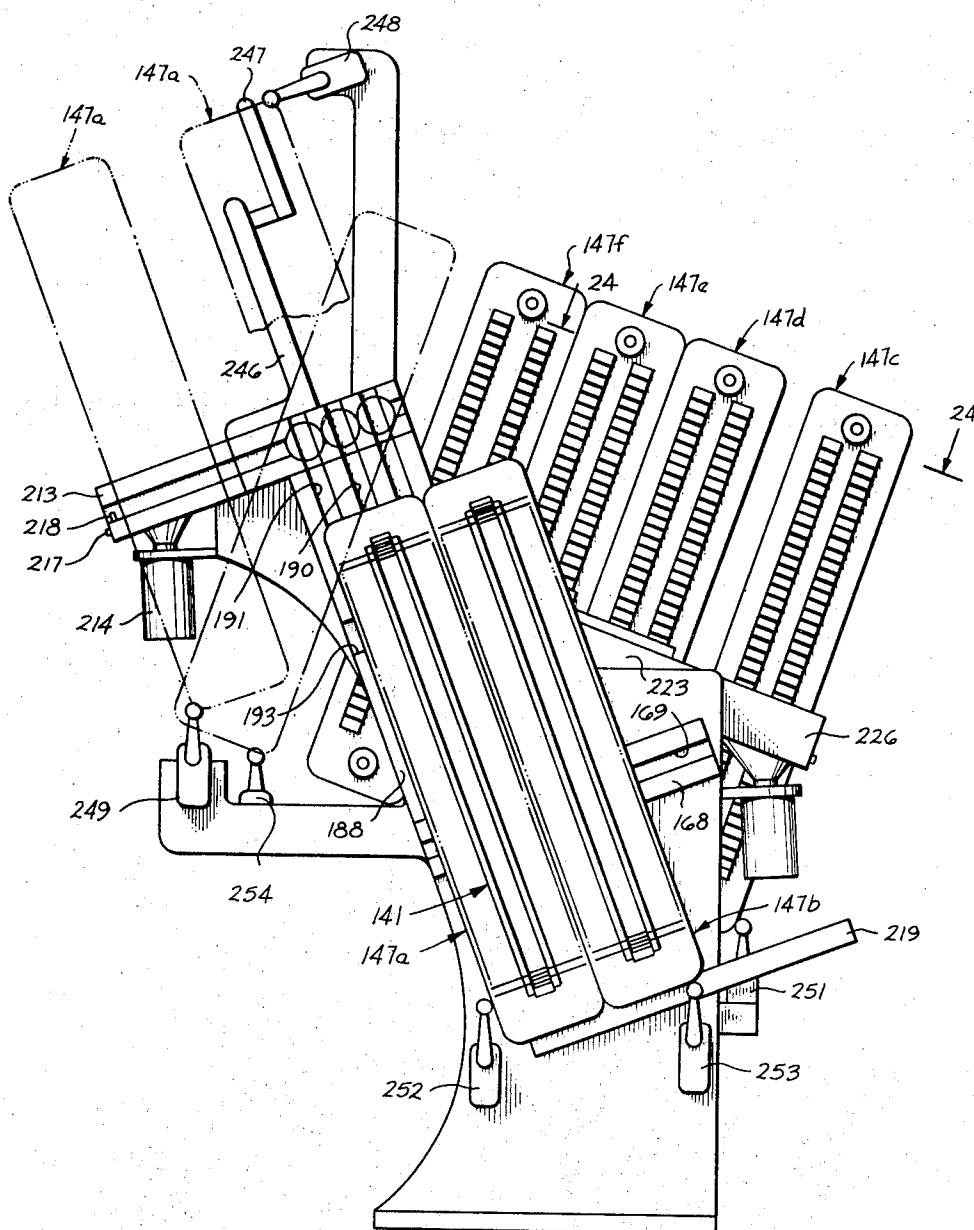


FIG. 23

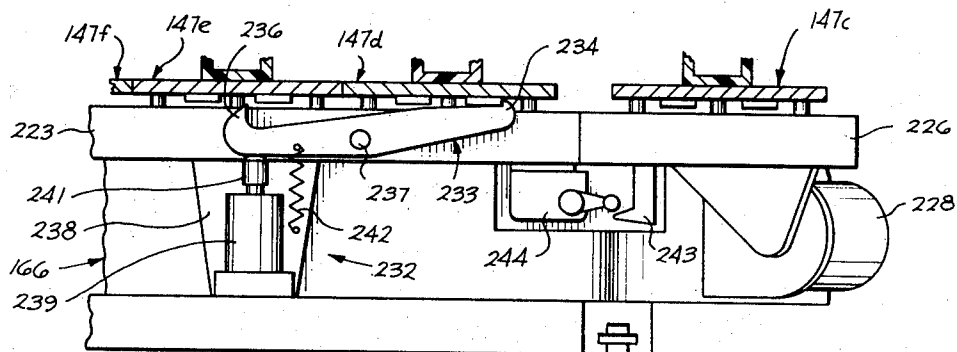


FIG. 24

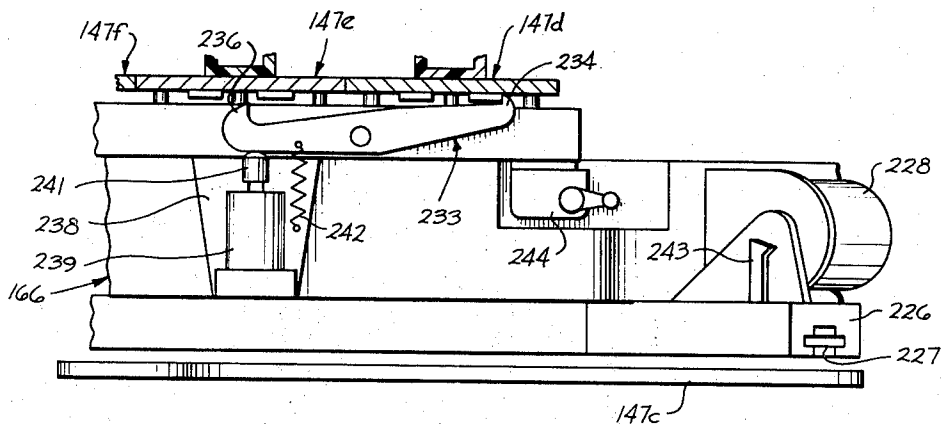


FIG. 25

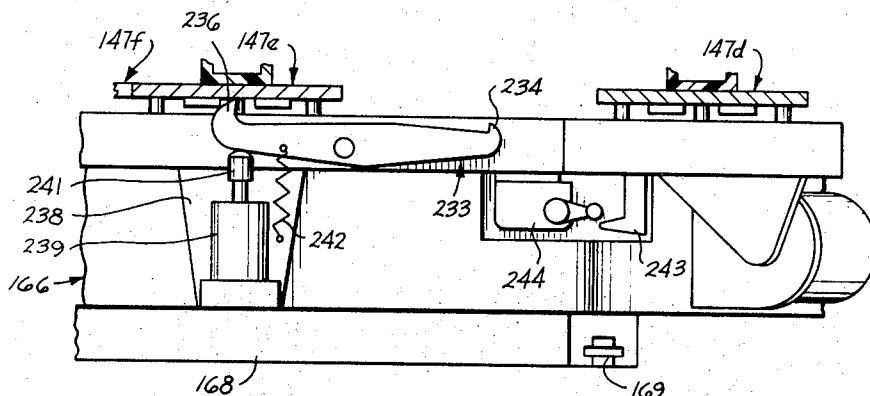


FIG. 26

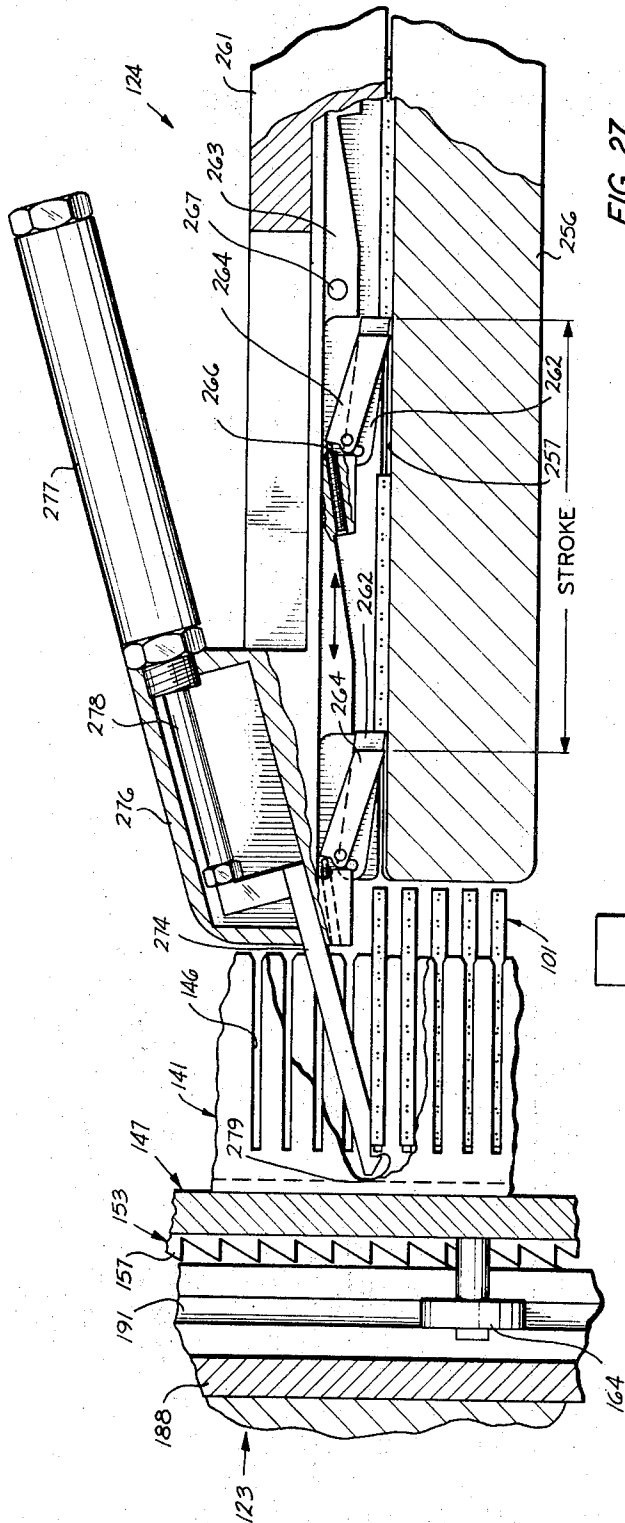


FIG. 27

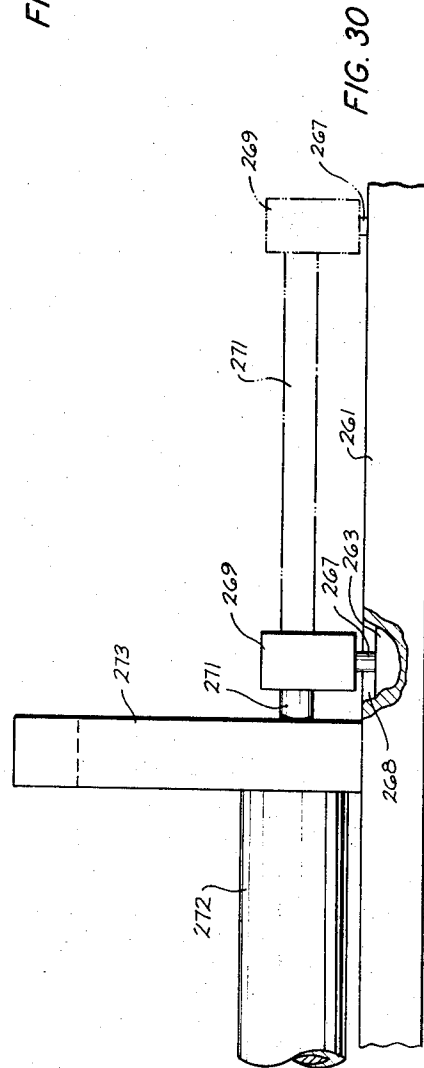


FIG. 30

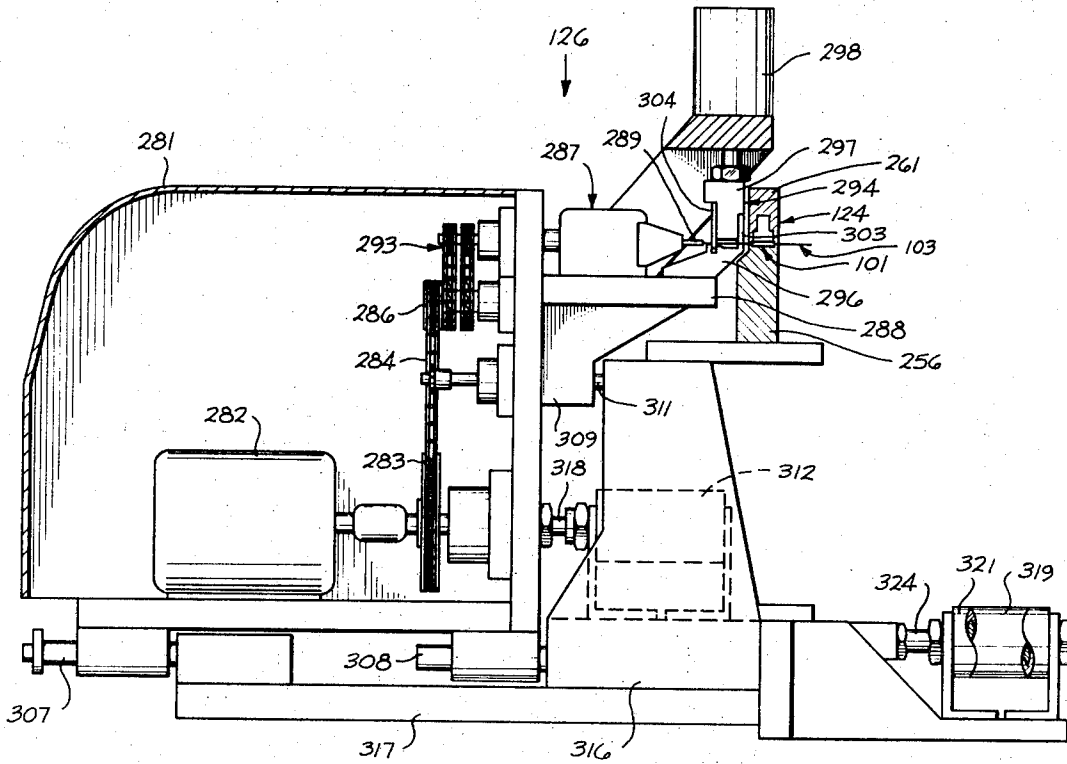


FIG. 31

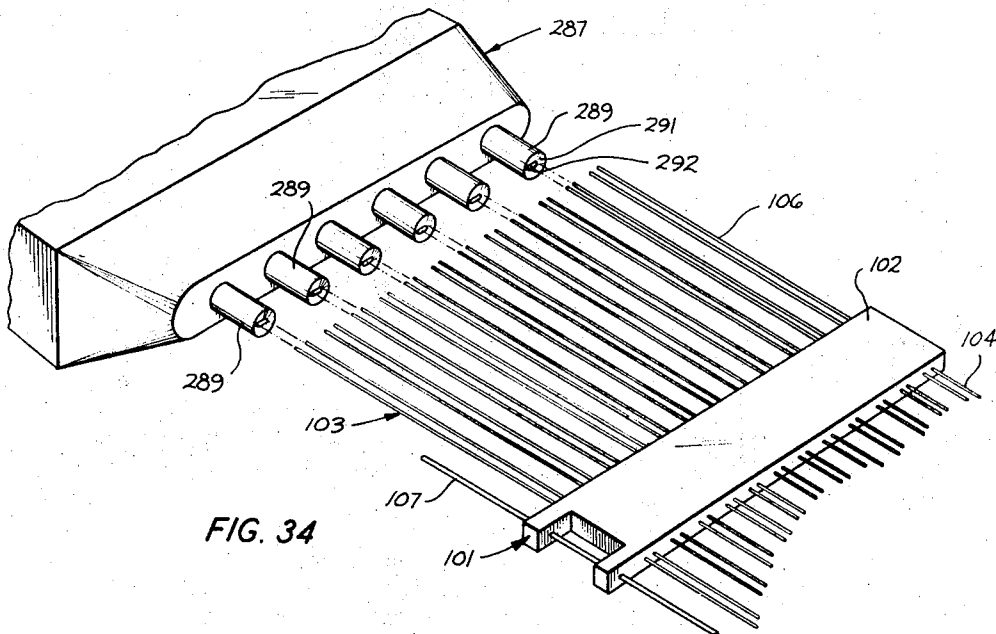


FIG. 34

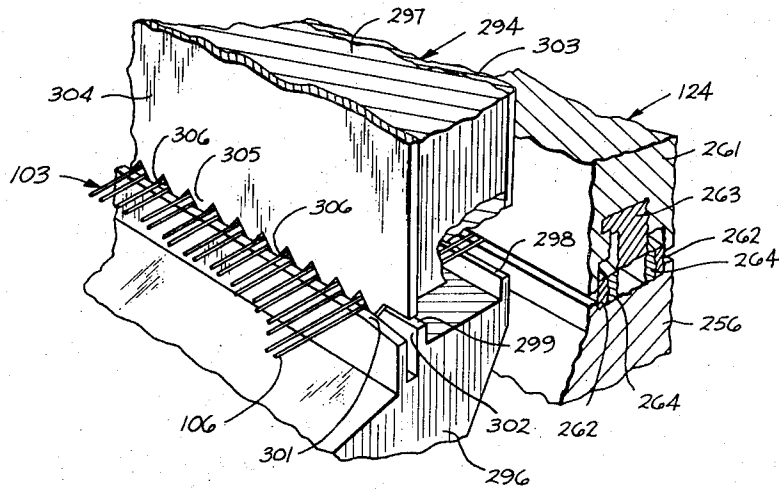


FIG. 35

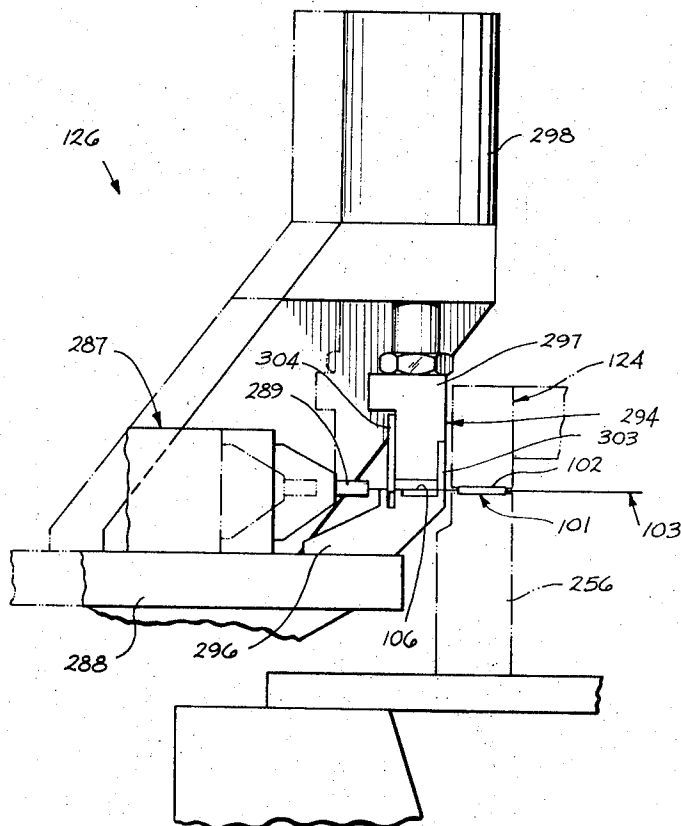


FIG. 36

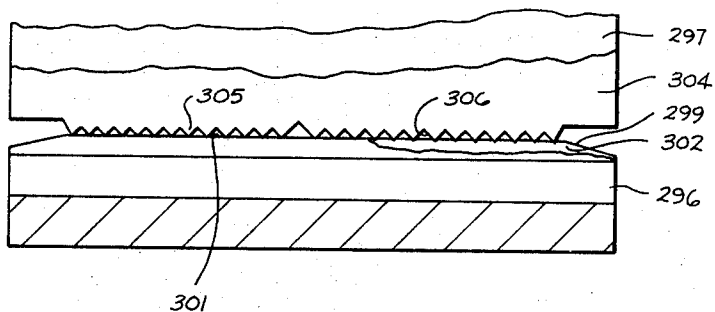


FIG. 37

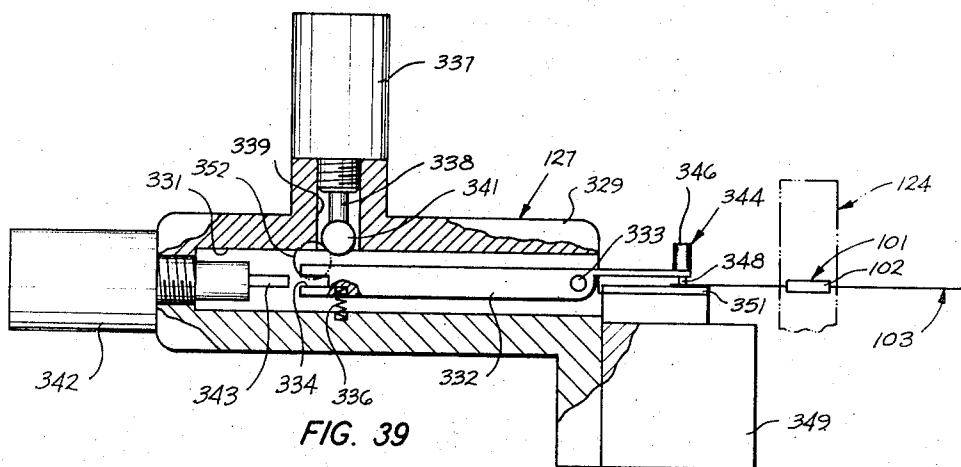


FIG. 39

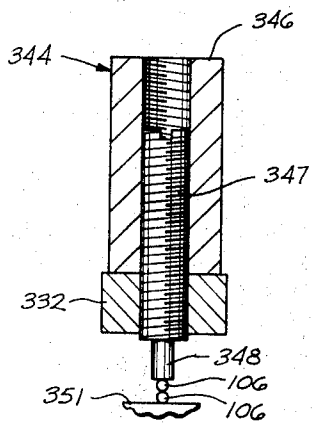


FIG. 41

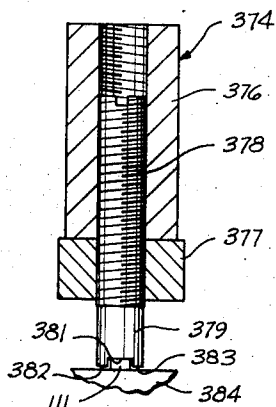


FIG. 44

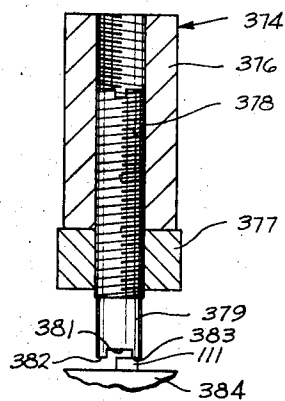
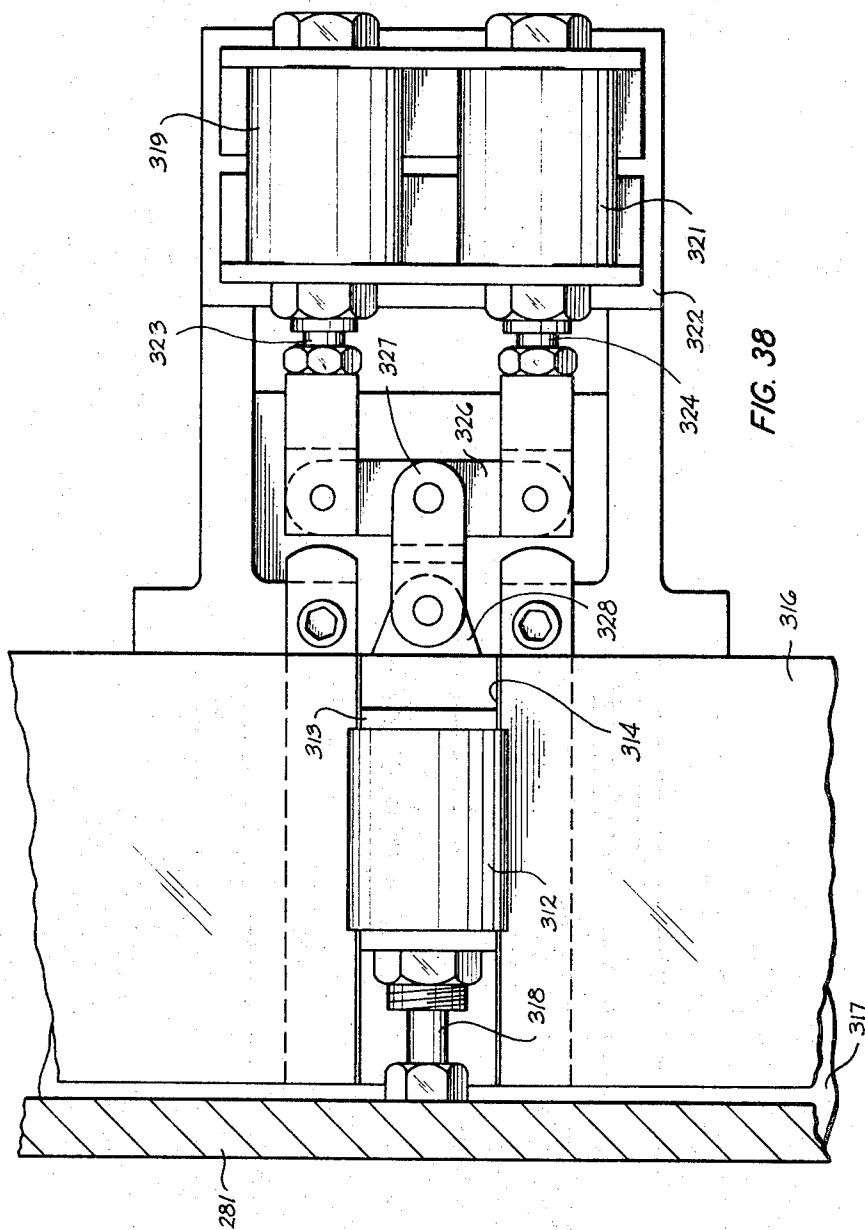
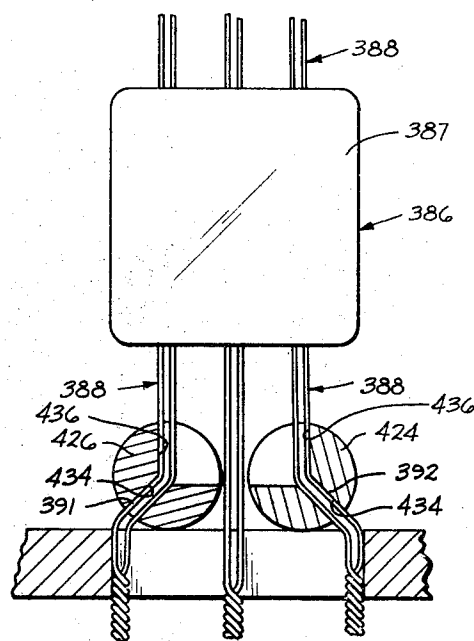
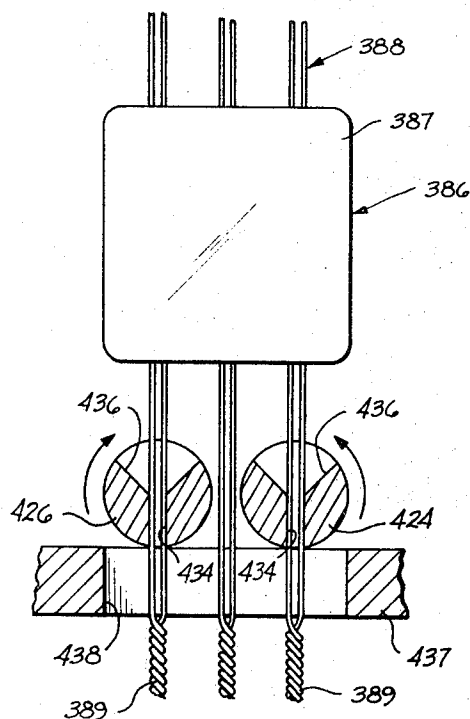
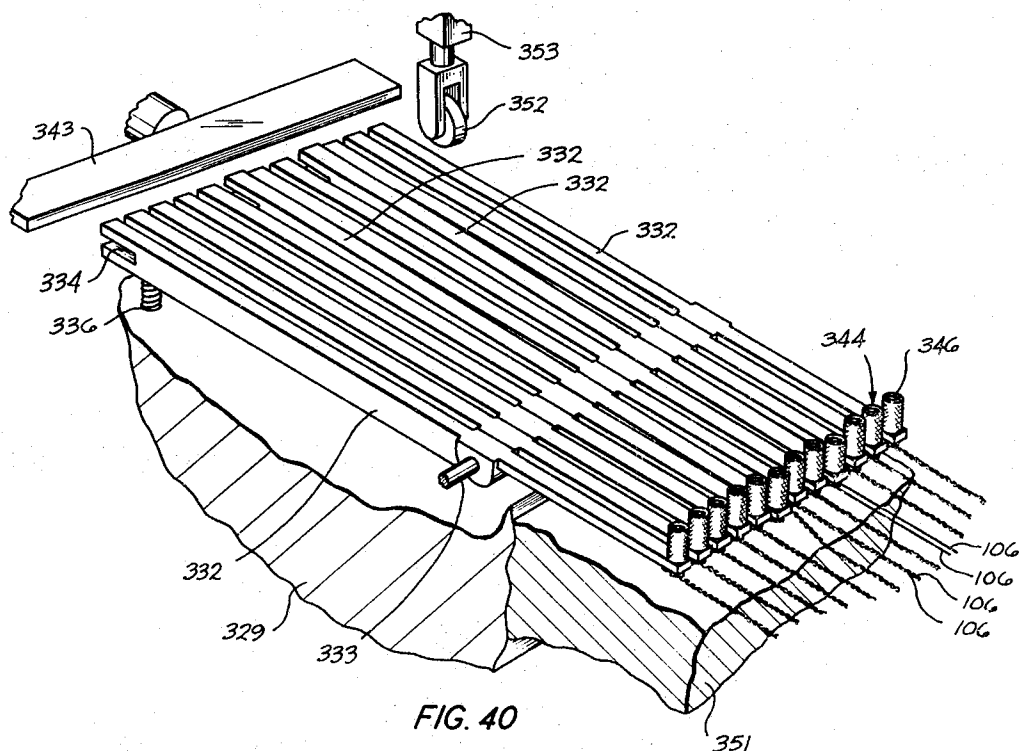


FIG. 45





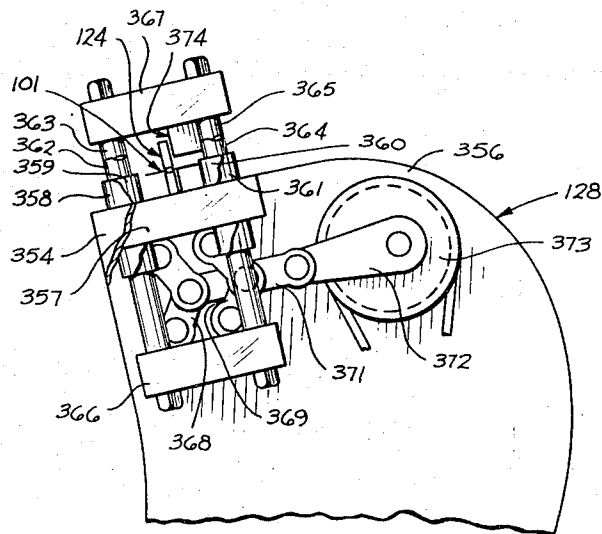


FIG. 42

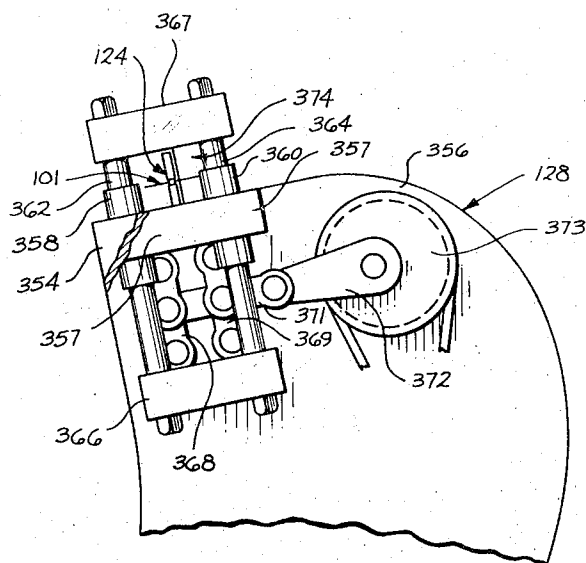


FIG. 43

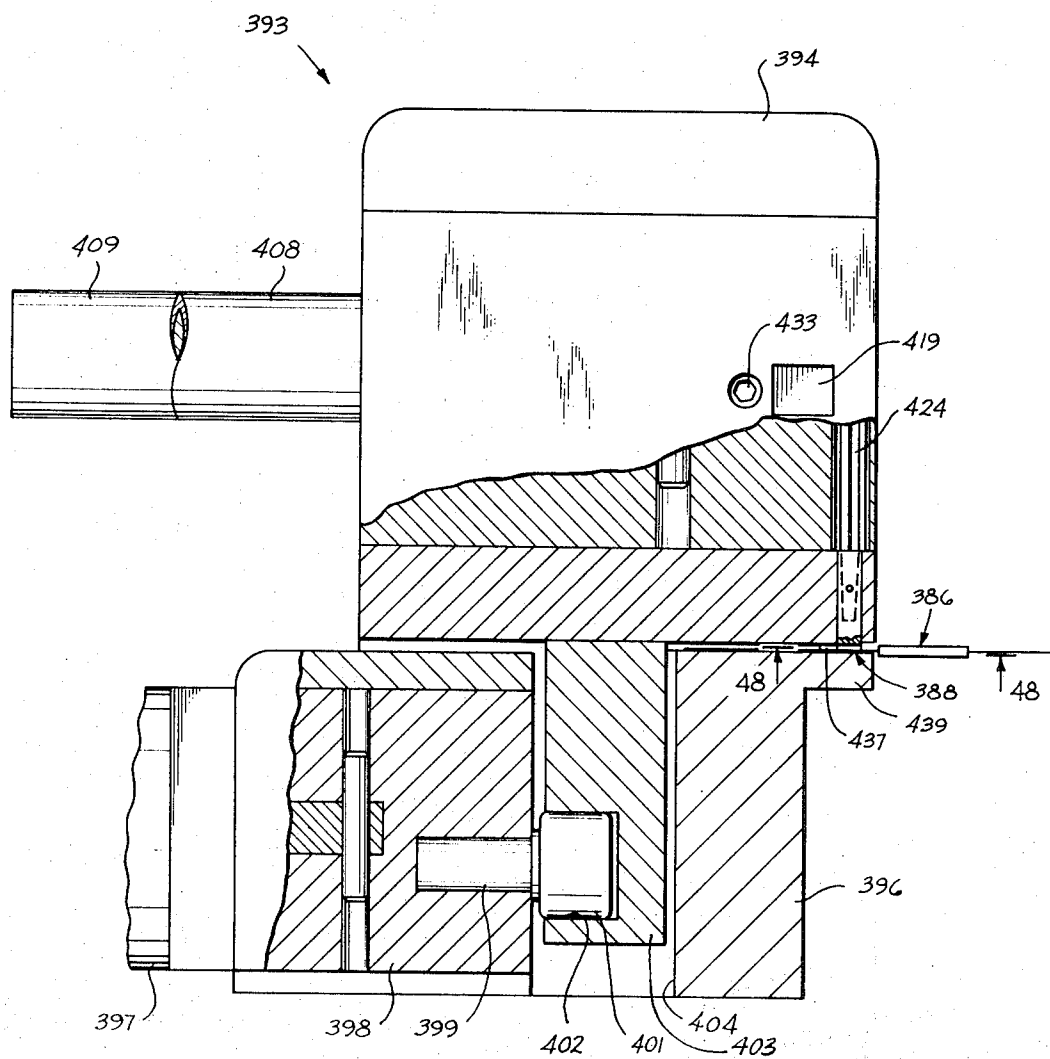


FIG. 46

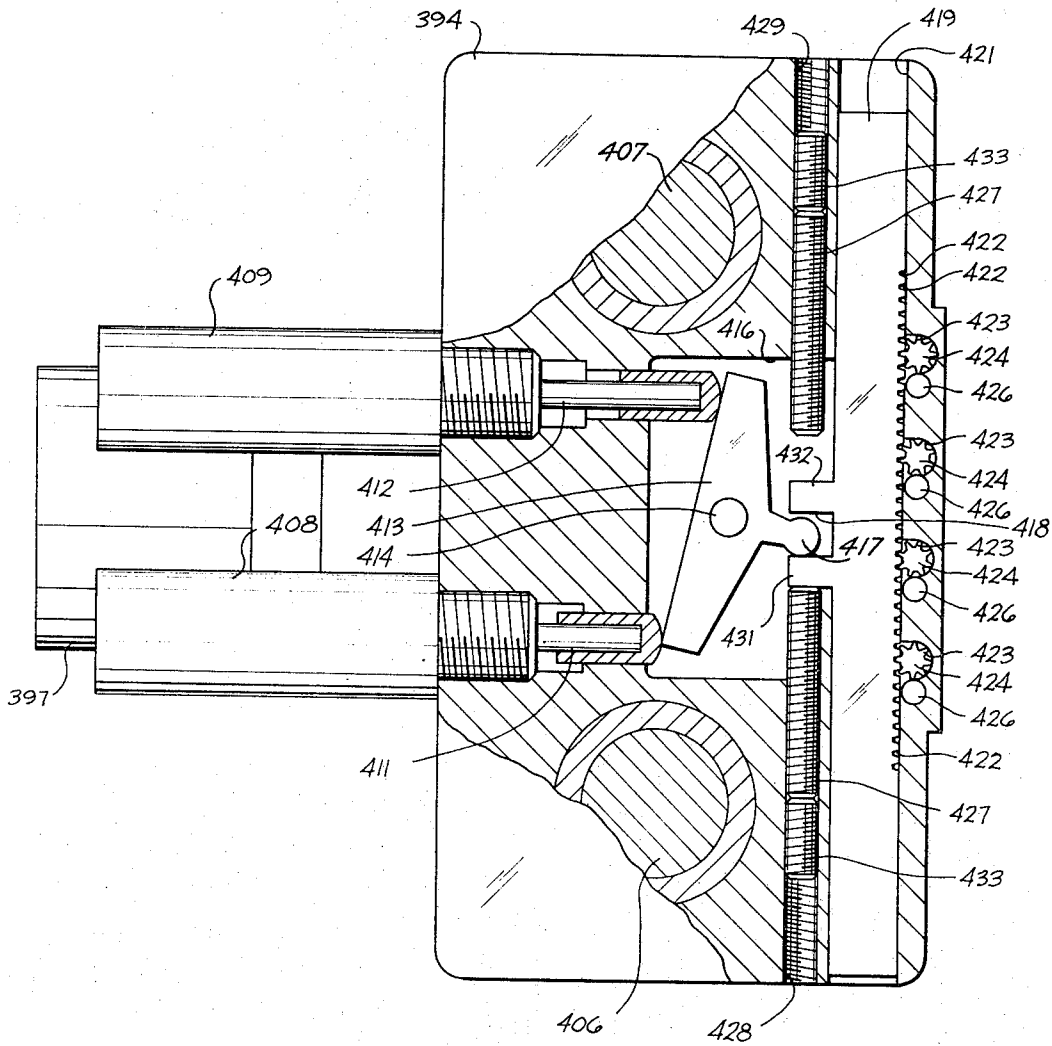
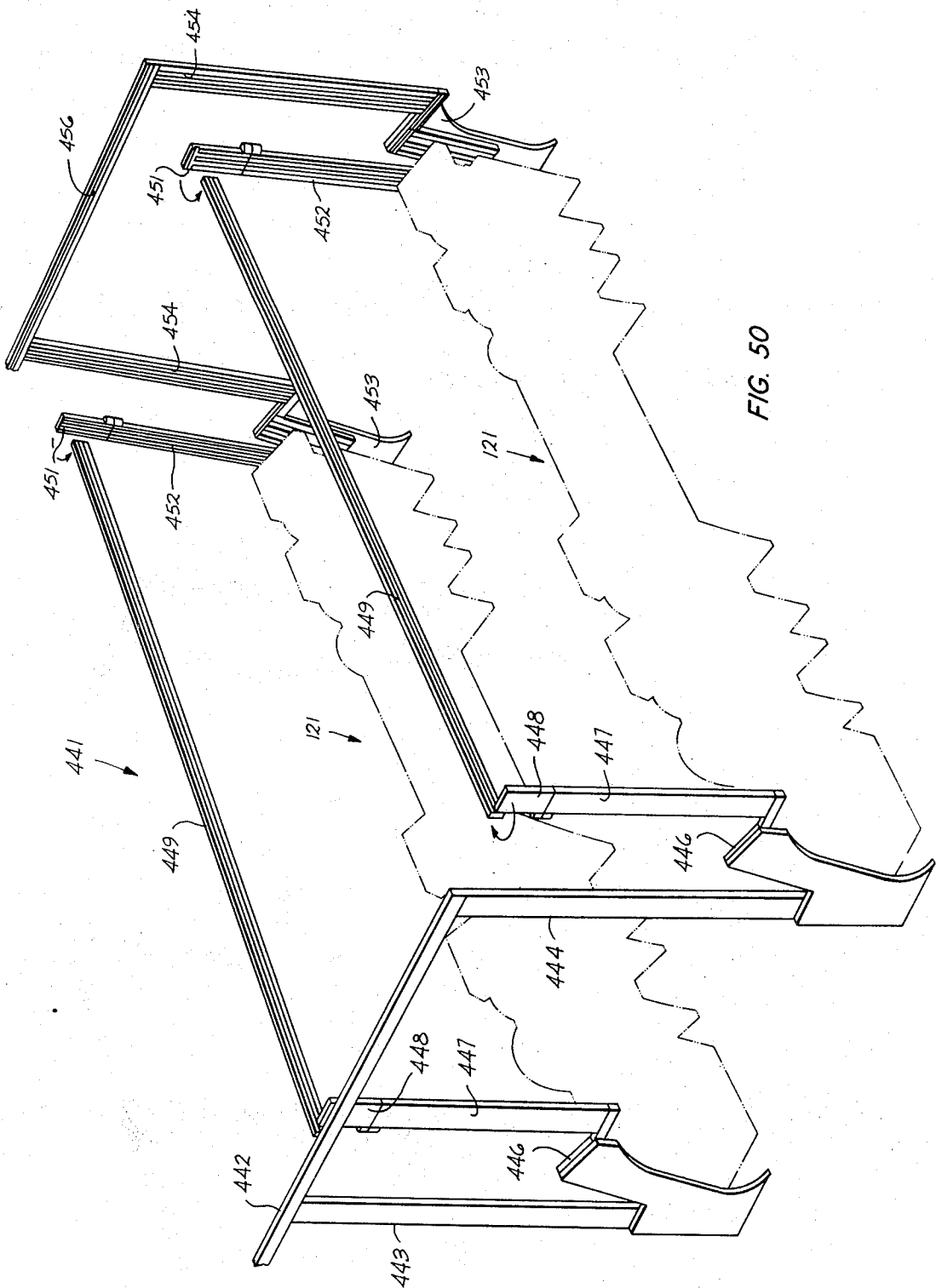


FIG. 47



METHODS OF FORMING WIRE SPRINGS AND WELDING CONTACTS TO THE SPRINGS

This is a division of application Ser. No. 7,029 filed Jan. 30, 1970, now U.S. Pat. No. 3,703,029.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to methods of forming wire springs and welding contacts to the springs and particularly to methods of feeding successive wire spring assemblies through a line whereat some of the wire springs of the assemblies are twisted together, coined and formed at desired angles and the remaining wire springs are coined, have contacts welded thereto and are formed at desired angles.

2. Description of the Prior Art

A crossbar switch, such as that described in U.S. Pat. No. 3,445,795, which issued to R. P. Holtfreter and H. E. McCullough, on May 20, 1969, includes a plurality of wire spring assemblies. Each wire spring assembly includes a plurality of parallel, spaced conductive springs extending from opposite sides of a block of insulating material. Adjacent springs extending from one side of the block are twisted to form twisted pairs of wire springs. A considerable portion of each twisted pair of wire springs is coined to facilitate the subsequent wire-wrap connection of an external circuit with elements of the crossbar switch. The other ends of the wire springs, which extend from the other side of the wire blocks, are coined and have contacts welded thereto. The twisted pairs of wire springs and the portions of the wire springs having the contacts welded thereto are formed at various angles to facilitate the stacking of a plurality of completed wire spring assemblies to form a unit of the crossbar switch.

Crossbar switches have many applications where selected crosspoint switching is required. This type of switching is utilized in the communications industry and particularly in telephone central offices. As noted in the aforementioned U.S. Pat. No. 3,445,795, with such a heavy use of crossbar switches any improvements in the switches would result in large net savings. Although manufacturing facilities were in existence for manufacturing crossbar switches in the past, modifications and improvements to the existing crossbar switches resulted in a more compact crossbar switch which resulted in savings due to easier maintenance, faster operation and lower space requirements. With the influx of the new crossbar switch as disclosed in the aforementioned U.S. Pat. No. 3,445,795, the component parts of the switch are smaller than the parts of the earlier switches and consequently created a need for new and improved manufacturing techniques and facilities in performing various operations in the assembly of components of the newer crossbar switch.

SUMMARY OF THE INVENTION

It is, therefore, an object of this invention to provide new and improved methods of forming wire springs and welding contacts to the springs.

Another object of this invention is the provision of new and improved methods of preparing wire spring assemblies for subsequent assembly with other components of a crossbar switch by twisting together selected pairs of wire springs of the assembly and welding the contacts to other selected wire springs of the assembly.

Still another object of the invention is the provision of new and improved methods of loading serially and successively a plurality of wire spring assemblies into a line whereat wire springs of the assemblies are formed selectively and have contacts welded selectively thereto.

A further object of this invention is to provide new and improved methods of selecting and twisting pairs of wire springs extending from an assembly.

Another object of the invention is the provision of new and improved methods forming wire springs of an assembly to selected angles.

A method of embodying certain principles of the invention for forming and welding contacts to terminal springs and contact wire springs of a wire spring assembly may include the steps of feeding the wire spring assembly into an indexing line whereat the assembly is moved through a series of stations, twisting together adjacent pairs of the terminal springs of the wire spring assembly, coining and forming selected portions of the twisted pairs of terminal springs and individual contact springs, welding contacts onto coined portions of the contact springs, gauging for the presence of the twisted formed pairs of terminal springs in selected locations and for the presence of contacts on the coined portions of the contact springs, and depositing the completed formed and welded wire spring assemblies into an unloading fixture.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will be apparent from the following detailed description when considered in conjunction with the accompanying drawings in which:

FIG. 1 is a perspective view showing a completed wire spring assembly;

FIGS. 2 through 13 are views showing various stages of forming and welding contacts to wires of the wire spring assembly of FIG. 1;

FIG. 14 is a perspective view of a weld and form line used to form the wires of the wire spring assembly and weld contacts to selected wires in accordance with principles of the invention;

FIG. 15 is a perspective view showing a magazine for supporting a plurality of the wire spring assemblies and a carrier for supporting the magazine;

FIG. 16 is a perspective view showing one side of the carrier shown in FIG. 15;

FIG. 17 is a front view showing a loader for positioning selected carriers for serial transfer of wire spring assemblies supported in an associated magazine;

FIG. 18 is a sectional view taken along line 18—18 of FIG. 17 of a track shown in FIG. 17;

FIG. 19 is a sectional view taken along line 19—19 of FIG. 17 showing rotary devices for rotating selected sections of tracks shown in FIG. 17;

FIG. 20 is a sectional view taken along line 20—20 of FIG. 17 showing a mechanism for indexing carriers on the loader of FIG. 17;

FIG. 21 is a sectional view taken along line 21—21 of FIG. 17 showing a mechanism for preventing retrograde movement of carriers with respect to the loader of FIG. 17;

FIG. 22 is a rear view of the loader of FIG. 17;

FIG. 23 is a front view of the loader showing a plurality of carriers mounted on the loader;

FIG. 24 is a partial view taken along line 24—24 of FIG. 23 showing transfer portions of the loader and a holding device to preclude movement of selected carriers on the loader;

FIGS. 25 and 26 are views showing the transfer portions and holding device of the loader illustrated in FIG. 24 in various positions;

FIG. 27 is a partial sectional view showing facilities for transferring wire spring assemblies from a magazine to a feed line;

FIG. 28 is a perspective view showing the feed line with parts broken away for clarity;

FIG. 29 is a partial sectional view showing another portion of the feed line;

FIG. 30 is a side view showing the mechanism for operating advancing facilities of the feed line;

FIG. 31 is a side view of a mechanism for twisting together adjacent pairs of wires of the wire spring assembly;

FIG. 32 is an end view of a twisting spindle;

FIG. 33 is a sectional view taken along line 33—33 of FIG. 32 showing the twisting spindle;

FIG. 34 is a perspective view showing a twisting head for supporting a plurality of twisting spindles;

FIG. 35 is a partial perspective view showing clamping and guiding facilities used during a twisting operation;

FIG. 36 is a partial side view of a twisting mechanism for twisting wires of the wire spring assembly;

FIG. 37 is a partial front view of a guide comb used during the twisting of the wires of the wire spring assembly;

FIG. 38 is a plan view of a mechanism for controlling the distance of travel of the twisting mechanism of FIG. 36;

FIG. 39 is a side view showing a gauging device with parts broken away for clarity;

FIG. 40 is a perspective view showing a portion of the gauging device of FIG. 39;

FIG. 41 is a partial front view showing gauging fingers of the gauging device of FIG. 39;

FIGS. 42 and 43 are partial side views of a press in two different positions;

FIGS. 44 and 45 are partial front views showing different positions of gauging fingers of a gauging device such as the device shown in FIG. 39;

FIG. 46 is a side view of a terminal forming device; FIG. 47 is a top view of the terminal forming device of FIG. 46 with parts broken away for clarity;

FIG. 48 is a partial sectional view taken along line 48—48 of FIG. 46 showing forming bits of the terminal forming device of FIG. 46;

FIG. 49 is a partial view showing the forming bits of FIG. 48 in another position, and

FIG. 50 is a perspective view of a conveyor system for a plurality of weld and form lines such as the line shown in FIG. 14.

DETAILED DESCRIPTION

Referring now to FIG. 1, there is illustrated a wire-like article such as a twin wire spring assembly, designated generally by the numeral 101. The twin wire spring assembly 101 includes a wire block 102 composed of a suitable plastic material such as a phenolic. A plurality of wire-like elements such as wires, designated generally by the numeral 103, have intermediate portions thereof embedded in the wire block 102 with

end portions, such as contact springs 104, extending from one side of the wire block and terminal springs 106 extending from the opposite side of the wire block.

A single wire 107 has intermediate portions thereof embedded within the wire block 102. Adjacent pairs of the terminal springs 106—106 are twisted together and coined to form a flattened terminal 108 sufficient to support a subsequent wire wrap connection with an external circuit. Each of the twisted pair of terminals 108—108 is formed at an offset angle at an intermediate portion 109 thereof to facilitate proper spacing between parallel rows of the terminals when a plurality of the wire blocks 102—102 are stacked to form a portion of the crossbar switch as disclosed in the aforementioned U.S. Pat. No. 3,445,795.

The tip end 111 of each of the contact springs 104—104 is coined and supports a contact 112 which is welded thereto. The wires 103—103 are made from a spring material, such as cupro-nickel, and the contacts 112—112 are made from a precious metal, such as palladium. The contact springs 104—104 are formed at an offset angle at an intermediate portion 113 thereof so that the deflected portions of the contact springs, which include the contacts 112—112, exert a force in a common direction when assembled with other components of the crossbar switch as disclosed in the aforementioned U.S. Pat. No. 3,445,795.

The single wire 107 is coined at one end to form a terminal 114 for facilitating a subsequent wire wrap connection with an external circuit. The other end of the single wire 107 is formed at an offset angle at an intermediate portion 116 thereof with the wire remaining in the plane of the wire block 102. The free end of the formed end of the wire 107 is subsequently secured electrically with a terminal bar (not shown) in the assembly of the crossbar switch as disclosed in the aforementioned U.S. Pat. No. 3,445,795.

Referring now to FIG. 2, the twin wire spring assembly 101, prior to the forming, coining and welding of contacts 112—112 thereto as shown in FIG. 1, includes the plurality of wires 103—103 extending from opposite sides of the wire block 102. The wires 103—103 are arranged in spaced pairs with the spacing between each pair being greater than the spacing between the wires of each pair. Referring now to FIG. 3, alternate pairs of the terminal springs 106—106 are twisted together. Thereafter, as shown in FIG. 4, the remaining alternate pairs of terminal springs 106—106 are twisted together.

Referring now to FIG. 5, circular areas 117—117 are monitored to determine whether associated end portions of the twisted pairs of terminal springs 106—106 are located in the particular area. If any of the end portions of the twisted pairs of terminal springs 106—106 are not located in the associated areas 117—117, the particular wire spring assembly 101 is marked to indicate this deficiency.

Referring now to FIG. 6, alternate ones of the twisted pairs of terminal springs 106—106 are coined to form the flattened terminals 108—108. In addition, the ends of the terminals 108—108 are cut to a predetermined length. The single wire 107 is coined at one end thereof to form the terminal 114 and is also formed with the offset angle at the intermediate portion 116.

Referring now to FIG. 7, the remaining alternate ones of the twisted pairs of terminal springs 106—106 are coined to form terminals 108—108. The free ends

of the newly formed terminals 108—108 are then cut to provide terminals of a predetermined length. In addition, the tip end 111 of each of the contact springs 104—104 is coined to provide a flattened surface for subsequent locating and securing of the contacts 112—112 thereon during welding operation.

Referring now to FIG. 8, the circular areas 118—118 are monitored to insure that the coined ends 111—111 (FIG. 7) of the contact springs 104—104 have been properly flattened and are properly located with respect to the wire block 102 for subsequent welding of the contacts 112—112 (FIGS. 9 and 10) thereon.

Referring to FIG. 9, contacts 112—112 are welded onto alternate adjacent pairs of the coined ends 111—111 (FIG. 7) of the contact springs 104—104. Referring to FIG. 10, contacts 112—112 are welded onto the remaining alternate adjacent pairs of coined ends 111—111 (FIG. 7) of the contact springs 104—104.

Referring now to FIG. 11, the circular areas 119—119 are monitored to determine whether the contacts 112—112 have been properly positioned and welded to the associated coined ends 111—111 of the contact springs 104—104.

Referring to FIG. 12, the terminals 108—108 are formed at an offset angle at the intermediate portion 109 thereof. Referring now to FIG. 13, the contact springs 104—104 are formed at the offset angle at the intermediate portion 113 thereof.

Referring now to FIG. 14, there is illustrated an apparatus, such as a weld and form line, designated generally by the numeral 121, for performing the various forming, welding and monitoring operations on the wire spring assembly 101 (FIGS. 2 through 13) to manufacture the completed wire spring assembly (FIG. 1). The weld and form line 121 is secured to a base 122 which is resting on a floor surface. The line 121 includes a loader, designated generally by the numeral 123, for feeding successive wire spring assemblies 101—101 (FIG. 2) into a horizontal indexing feed line, designated generally by the numeral 124.

Each successive wire spring assembly 101 (FIG. 2) is positioned adjacent to a pair of terminal-spring twisting devices, designated generally by the numeral 126, to perform the twisting of the adjacent pairs of terminal springs 106—106 (FIG. 2) in a manner as shown in FIGS. 3 and 4. Thereafter, each wire spring assembly 101 is positioned adjacent to a gauging device, designated generally by the numeral 127, for monitoring the areas 117—117 (FIG. 5) to determine whether the ends of the twisted pairs of terminal springs 106—106 are present and properly located with respect to the associated wire block 102 in preparation for subsequent coining operations.

Thereafter, the successive wire spring assemblies 101—101 are fed into a press, designated generally by the numeral 128, which coins alternate twisted terminal springs 106—106 to form the terminals 108—108 (FIG. 6). The operation of the press 128 also facilitates the coining of one end of the single wire 107 to form the terminal 114 and further forms the offset angle at the intermediate portion 116 of the single wire. The successive wire spring assemblies are then passed into a press, designated generally by the numeral 129, whereat the remaining alternate pairs of terminal springs 106—106 are coined to form the remaining terminals 108—108 (FIG. 7). In addition, the tip ends

111—111 (FIG. 7) of the contact springs 104—104 are coined in preparation for the welding of the contacts 112—112 (FIGS. 9 and 10) thereon.

A gauging device, designated generally by the numeral 131, monitors the circular areas 118—118 (FIG. 8) to determine whether the ends 111—111 of the contact springs 104—104 have been properly coined and also to determine whether the coined ends are properly positioned with respect to the wire block 102 in preparation for the subsequent contact welding operation.

A first welding station, designated generally by the numeral 132, and a second welding station, designated generally by the numeral 133, are positioned on a table 134 adjacent to the feed line 124 and are operated to weld contacts 112—112 onto alternate pairs of the coined ends 111—111 of the contact springs 104—104 as viewed in FIGS. 9 and 10. Thereafter, each wire spring assembly 101 is positioned adjacent to a gauging device, designated generally by the numeral 136, which monitors the circular areas 119—119 (FIG. 11) to determine whether the contacts 112—112 have been welded to associated coined ends 111—111 of the contact springs 104—104 and to determine whether the contacts are properly positioned on the associated coined ends.

The successive wire spring assemblies 101—101 are then fed into a press, designated generally by the numeral 137, whereat each of the welded contacts 112—112 is coined and each of the terminals 108—108 is formed at the offset angle at the intermediate portion 109 as viewed in FIG. 12. The successive wire spring assemblies 101—101 are then fed into a press, designated generally by the numeral 138, whereat each of the contact springs 104—104 is formed with the offset angle at the intermediate portion 113 (FIG. 13) to thereby complete the forming and welding operations to provide the wire spring assembly 101 as viewed in FIG. 1. The completed assemblies 101—101 are then fed from the indexing feed line 124 into an unloader, designated generally by the numeral 139.

Referring now to FIG. 15, there is illustrated a magazine, designated generally by the numeral 141, for supporting and facilitating movement of a plurality of wire spring assemblies 101—101. The magazine 141 is formed longitudinally in a U-shaped configuration having a base 142 and sides 143 and 144. A plurality of slots 146—146 are formed in the edge portions of the sides 143 and 144 so that the slots formed in each side are spaced and parallel with respect to each other and each slot formed in one side is aligned with an associated slot in the other side.

The space between the sides 143 and 144 is sufficiently wide to permit the block 102 of the wire spring assembly 101 to be positioned within the space so that the wires 103—103, which extend from opposite sides of the block, extend through the adjacent slots 146—146 to facilitate the supporting of the wire spring assembly within the magazine 141. The use of the magazine 141 for supporting the wire spring assemblies 101—101 permits the transportation of the assemblies from one location to another during various manufacturing processes.

A carrier, designated generally by the numeral 147, is provided for supporting one of the magazines 141—141 during a period when the wire spring assemblies 101—101 are being transferred from the maga-

zine to the line 124 (FIG. 14). The carrier 147 includes a U-shaped nest 148 which is secured to a lower portion of one major surface 149 of the carrier 147. A bias clip 151 is secured to an upper portion of the surface 149 and is spaced substantially from the nest 148. The lower edge of the base 142 of the magazine 141 is positioned initially into the nest 148 and the upper edge of the base is moved under the bias clip 151 and is thereby fastened to and supported by the magazine so that the wire spring assemblies 101—101 can be removed selectively from or inserted into the magazine 141.

Referring now to FIG. 16, there is illustrated a pair of spaced, parallel racks, designated generally by the numerals 152 and 153, which extend outwardly from another surface 154 of the carrier 147. The racks 152 and 153 are each formed with a plurality of teeth 156 and 157, respectively, which facilitates indexing movement of the carrier 147 with respect to the loader 123 (FIG. 17). Four support rods, 158, 159, 160 and 161, extend from the surface 154 of the carrier 147 and provide mounting support for freely rotatable rollers 162, 163, 164 and 165, respectively.

Referring now to FIG. 17, the loader 123 includes a vertical stand, designated generally by the numeral 166, which supports on one side 167 thereof a canted track 168 having a central groove 169 formed longitudinally therein. The track 168 is also formed with three transverse grooves 171, 172 and 173 which are parallel and spaced from each other and transverse to the groove 169.

Referring now to FIG. 18, there is illustrated a cross section of the track 168. The longitudinal groove 169 is formed with a lateral, longitudinal enlargement 174 to facilitate the movement of the rollers 163 and 164 (FIG. 16) of the carrier 147 therethrough. In addition, the three transverse grooves 171, 172 and 173 are also formed with similar enlargements.

Referring again to FIG. 17, three rotatable, directional elements 176, 177 and 178 are positioned within accommodating openings in the track 168 and are located at the respective intersections formed by the grooves 171, 172 and 173, respectively, with the groove 169. The elements 176, 177 and 178 are formed in one face thereof with grooves 179, 180 and 181, respectively, whereby the elements may be rotated to align the respective grooves in alignment with the groove 169 of the track 168 or individually in alignment with the grooves 171, 172 and 173, respectively, of the track.

Referring now to FIG. 19, there is illustrated a portion of the track 168 and the associated groove 169 with the rotational, directional elements 176, 177 and 178 being positioned to illustrate the cross section of the elements which facilitate movement of the selected ones of the rollers 162, 163, 164 and 165 (FIG. 16) therethrough. Also illustrated, is a portion of the vertical stand 166 formed with an opening 182. Three rotary air motors 185, 186 and 187 are positioned within the opening 182 of the vertical stand 166 and control the rotary movement of the rotatable directional elements 176, 177 and 178, respectively.

Referring again to FIG. 17, a second track 188 is attached to the side 167 of the vertical stand 166 and is formed with three parallel, spaced grooves 189, 190 and 191. The track 188 is perpendicular to the track 168. The lowr end of the track 188 is positioned adjacent to the track 168 so that the grooves 189, 190 and

191 of the track 188 are aligned with the grooves 171, 172 and 173, respectively, of the track 168. Each of the grooves 171, 172, 173, 189, 190 and 191 are formed with a cross sectional configuration identical to the configuration of the groove 169 with the enlargement 174 of the track 168 as shown in FIG. 19. A slot 192 is formed in the track 188 transversely to and contiguous with the grooves 189 and 190. Another slot 193 is also formed in the track 188 transversely to and contiguous with the grooves 190 and 191. A pair of openings 194 and 195 are formed in the track 188 to permit portions of an indexing pawl 196 and a stop pawl 197, respectively, to extend therethrough.

Referring to FIG. 20, there is illustrated the portion of the track 168 having the opening 194 formed therein to permit the indexing pawl 196 to extend therethrough. The pawl 196 is mounted pivotally between opposed side walls of the opening 194 so that a free-end portion of the pawl extends out of the opening and engages the teeth 158 of the carrier 147. Also illustrated, is a portion of the vertical stand 166 which is formed with an opening 198 therethrough. An air cylinder 199 is secured within the opening 198 of the vertical stand 166 and provides reciprocating motion for a pawl actuator, designated generally by the numeral 201, so that when the air cylinder is operated in a forward direction, the pawl 196 is moved to raise the carrier 147 in the direction of the arrow.

Referring now to FIG. 21, there is illustrated another portion of the track 188 and the opening 195 formed therein. The stop pawl 197 is pivotally mounted between the opposed walls of the opening 195 and the free end of the pawl is biased outwardly to engage the teeth 157 of the carrier 147 to prevent retrograde movement of the carrier when the indexing pawl 196 (FIG. 20) is being retracted and positioned for subsequent indexing movement of the carrier.

Referring again to FIG. 17, the loader 123 further includes a track 202 which is mounted on the side 167 of the vertical stand 166 adjacent to and transverse to the upper end of the track 188. The track 202 is formed with a longitudinal groove 203 and three parallel, spaced grooves 204, 205 and 206 which are transverse to the groove 203 and are aligned with the grooves 189, 190 and 191, respectively, of the track 188. Rotatable, directional elements 207, 208 and 209 are formed with grooves 210, 211 and 212, respectively, and are mounted at the intersections of the groove 203 and the grooves 204, 205 and 206, respectively, of the track 202. Each of the grooves 203, 204, 205, 206, 210, 211 and 212 are formed with a cross sectional configuration identical to the configuration of the groove 169 and the enlargement 174 of the track 168 as shown in FIG. 18.

The rotatable elements 207, 208 and 209 can be rotated so that the associated grooves 210, 211 and 212 are aligned serially and with the groove 203 of the track 202 or so that the grooves 210, 211 and 212 are aligned with the grooves 204, 205 and 206, respectively, of the track. The rotatable elements 207, 208 and 209 are controlled and rotated by associated rotary air motors (not shown) which are assembled with the rotatable elements in a manner similar to the assembly of the rotary air motors 185, 186 and 187 with the elements 176, 177 and 178, respectively, as illustrated in FIG. 19.

A movable track 213 is attached to a rotary motor 214 which is supported on a portion of the vertical

stand 166. The movable track 213 is formed with a longitudinal groove 216. The cross section of the track 213 is identical to the cross section of the track 168 (FIG. 18). The groove 216 of the track 213 can be positioned in alignment with the groove 203 of the track 202. A spring-biased pin 217 protrudes from one end of the track 213 and normally urges a pin 218 transversely into the groove 216. When the pin 217 is depressed inwardly into the track 213, the pin 218 is permitted to move into the associated wall of the groove 216 and, therefore, out of the groove.

Referring again to FIG. 17, a canted roller bearing platform 219 is attached to the side 167 of the vertical stand 166 and is spaced from and parallel with the track 168. The platform 219 is formed with a bearing extension 220 which is formed at a right angle thereto and is aligned with a center rib of the track 188 so that the inner surface of the bearing extension is aligned with the groove 172 of the track 168. A spring-biased plate 221 projects partially above the upper surface of the canted platform 219. The roller 165 (FIG. 16) of the carrier 147 normally rolls on the roller bearing platform 219 and engages the spring-biased plate 221 to provide a braking force for the carrier as it moves downwardly over the platform thereby slowing the momentum of the carrier.

Referring now to FIG. 22, a reverse side 222 of the vertical stand 166 is illustrated. A track 223 is attached to the side 222 of the vertical stand 166 and is formed with a longitudinal groove 224. The backside of the track 213 (FIG. 17) is shown in FIG. 22 and can be controlled for movement by the rotary motor 214 so that the groove 216 (FIG. 16) of the track 213 can be moved to a position of alignment with the groove 224 of the track 223.

Another movable track 226 is formed with a longitudinal groove 227 and is attached to a rotary motor 228 to facilitate movement of the track. The cross section of the tracks 223 and 226 is identical to the cross section of the track 168 (FIG. 18). As illustrated in FIG. 22, the groove 227 of the track 226 is positioned in alignment with the groove 224 of the track 223. However, the rotary motor 228 can be controlled to move the track 226 to another position whereat the groove 227 is aligned with the groove 169 (FIG. 17) of the track 168.

As further illustrated in FIG. 22, a spring-biased pin 229 extends from one end of the track 226 and is movable inwardly into the track when depressed externally. A top pin 231 extends into the groove 227 and is maintained in the position within the groove by the pin 229. When the pin 229 is depressed and is fully inserted into the track 226, the stop pin 231 moves into the side wall of the groove 227 and thereby out of the groove. A carrier stop mechanism, designated generally by the numeral 232, is positioned adjacent to the track 223 for controlling the movement of the carriers 147—147 adjacent to the track. As the carriers 147—147 move from the end of the track 223, which is adjacent to the track 213, to the end of the track 226 which includes the stop pin 231, the stop mechanism 232 is actuated to prevent continuous movement of the carriers 147—147 onto the movable track 226 until the movable track 226 is in the position as shown in FIG. 22.

Referring now to FIG. 23, there is illustrated a plurality of carriers 147a through 147f which are positioned adjacent to the various tracks 168, 188, 202, 223 and

226. It is noted that the loader 123 normally includes a plurality of the carriers 147—147 which assume different positions, from time-to-time, during the movement of the carriers about the loader 123. During the period when the carriers 147—147 are moving through the track 223, an operator removes the empty magazine 141 from the carriers and then attaches a loaded magazine to the carriers. For the purpose of explanation, assume that a carrier 147a is located adjacent to the lowermost portion of the track 168 and has its rollers 163 and 164 (FIG. 16) within the groove 169 of the track. The carrier 147a supports a loaded magazine 141 (FIG. 15) for indexing movement upwardly under the control of the air cylinder 199 (FIG. 20). It is noted that the roller 162 (FIG. 16) of the carrier 147a has passed through the slot 192 (FIG. 17) of the track 188 and is now aligned with the groove 190 of the track. In addition, the roller 165 (FIG. 16) is resting against the lower, inside surface of the bearing extension 220 (FIG. 17). Hence, the carrier 147a is precluded from further movement to the left as viewed in FIG. 23, due to the engagement of the rollers 162 and 165 with the walls of the groove 190 and the bearing extension 220, respectively. In addition, another carrier 147b is positioned adjacent to the track 168 and is resting against the adjacent edge of the carrier 147a. The rollers 163 and 164 (FIG. 16) of the carrier 147b are positioned within the groove 169 of the track 168 and the roller 165 (FIG. 16) of the carrier is resting on the bearing platform 219.

Another carrier 147c is positioned adjacent to the movable track 226 with the rollers 163 and 164 (FIG. 16) of the carrier being positioned within the groove 227 (FIG. 22) of the track. The stop pin 231 (FIG. 22) prevents the carrier 147c, and any subsequent carriers in the same position, from moving out of the open end of the track 226. At least three other carriers 147d, 147e and 147f are positioned serially adjacent to the track 223 so that their rollers 163 and 164 (FIG. 16) are positioned within the groove 224 of the track.

Referring now to FIG. 24, there is illustrated in detail the stop mechanism 232 which includes a rocker arm, designated generally by the numeral 233, having outwardly turned ends 234 and 236. The rocker arm 233 is mounted to the track 223 for rocking movement about a pin 237. A platform 238 extends between the track 168 and the track 223 and supports a solenoid 239 having a plunger 241. One end of a spring 242 is attached to the platform 238 and the opposite end of the spring is attached to the rocker arm 233 to normally hold the portion of the rocker arm which includes the outwardly turned end 236 against the withdrawn plunger 241 of the solenoid 239. This biasing action of the spring 242 causes the portion of the rocker arm 233, which includes the end 234, to extend outwardly over the edge of the track 223. The end 234 of the rocker arm 233 thereby engages a portion of the carrier 147d to prevent the rollers 163 and 164 (FIG. 16) of the carrier from moving into the groove 227 of the movable track 226.

Assuming that the carrier 147c is positioned adjacent to the movable track 226 and the carrier is to be moved to a position adjacent to the track 168, the rotary motor 228 is operated to move the movable track to a position as illustrated in FIG. 25. Since the end 234 of the rocker arm 233 is urged into engagement with the carrier 147d, the carrier remains adjacent to the

track 223. As the movable track 226 approaches the track 168, the pin 229 (FIG. 22) is depressed and the stop pin 231 (FIG. 22) is lowered out of the path of the roller 164 (FIG. 16) to permit the carrier 147c to move to a position adjacent to the track 168. After the carrier 147c moves to a position adjacent to the track 168, the rotary motor 228 is controlled to move the movable track 226 back to a position in alignment with the track 223 as illustrated in FIG. 26.

As illustrated in FIG. 26, as the track 226 is aligned with the track 223, an actuator arm 243 engages and closes a one way limit switch 244. When the switch 244 is closed, the solenoid 239 is controlled to move the plunger 241 outwardly. Outward movement of the plunger causes the end 236 of the rocker arm 233 to move into holding engagement with the carrier 147e and the end 234 moves out of holding engagement with the carrier 147d. This permits the carrier 147d to move, by gravity, to a position adjacent to the movable track 226.

When the carrier 147d is positioned fully adjacent to the movable track 226, the solenoid 239 is controlled to withdraw the plunger 241. The rocker arm 233 is then rocked so that the end 236 is moved out of holding engagement with the carrier 147e and the end 234 is moved into the path of subsequent movement of the carrier. Since the end 236 of the rocker arm 233 is no longer holding the carrier 147e, the carrier moves toward the movable track 226. However, the carrier 147e engages the end 234 of the rocker arm 233 and is held in the position previously occupied by the carrier 147d as illustrated in FIG. 24. The carrier 147f can now move to the position formerly occupied by the carrier 147e.

Referring again to FIG. 23, the carriers 147a through 147f initially assume a position as shown with all of the carriers supporting magazines 141—141 having wire spring assemblies 101—101 loaded thereon. The rotational, directional elements 176, 177, 178 (FIG. 17) and 207, 208 and 209 are aligned with the grooves 189, 190 and 191 of the track 188 to permit the carrier 147a to be indexed upwardly whereby the roller 162 (FIG. 16) of the carrier moves through the upper portion of the track 190. The rollers 163 and 164 (FIG. 16) of the carrier 147a move through the grooves 189 and 191, respectively. In addition, the roller 165 (FIG. 16) of the carrier 147a moves upwardly against the bearing extension 220 and eventually moves through the lower portion of the grooves 172, 180 and 190 of the track 168, the directional element 177 and the track 188, respectively. The carrier 147a is indexed upwardly under the control of the air cylinder 199 (FIG. 20) to permit the unloading of the successive wire spring assemblies 101—101 onto the line 124 (FIG. 14). As the upper portion of the carrier 147a passes transversely to the track 202, the roller 162 (FIG. 16) of the carrier bears against a bearing post 246 to prevent the carrier from moving laterally out of alignment with the track 188. As the upper portion of the carrier 147a is moved substantially away from the track 188, the roller 162 (FIG. 16) of the carrier engages another bearing post 247 which is spaced from and attached to the upper end of the bearing post 246.

Eventually, the upper right corner of the carrier 147a engages and closes a limit switch 248. When the limit switch 248 is closed, rotary air motors are operated to rotate the rotational, directional elements 176, 177,

178, 207, 208 and 209. The rotational, directional elements 207, 208 and 209 are rotated so that the associated grooves 210, 211 and 212, respectively, are aligned with the groove 203 of the track 202. The rollers 163 and 164 (FIG. 16) of the carrier 147a are permitted to move through the groove 203 of the track 202 and toward the track 213. The slot 193 which is formed in the track 188 permits the roller 165 (FIG. 16) of the carrier 147a to move out of the track so that the rollers 163 and 164 of the carrier can move into the movable track 213. Due to the pin 218, the carrier 147a comes to rest adjacent to the movable track 213 in a position shown in phantom view.

As the carrier 147a moves away from the track 188, the carrier 147b is then permitted to move into the track. Since the rotational, directional elements 176, 177 and 178 have been rotated to align the grooves 179, 180 and 181 with the grooves 169, of the track 168, the rollers 163 and 164 (FIG. 16) of the carrier 147b roll through groove 169 of the track 168 and are subsequently positioned so that the axis of the roller 163 is aligned with the axis of the rotational element 176 and the axis of the roller 164 is aligned with the rotational, directional element 178. In addition, the roller 162 (FIG. 16) of the carrier 147b moves through the slot 192 (FIG. 17) of the track 188 so that the roller is positioned within the groove 190 of the track. The roller 165 (FIG. 16) of the carrier 147b moves over the bearing platform 219 and into engagement with the lower inner surface of the bearing extension 220 (FIG. 17).

When the carrier 147a is positioned in the movable track 213, as shown in phantom view, the lower left end of the carrier engages and closes a limit switch 249. In addition, with the carrier 147c positioned in the movable track 226, the lower right end of the carrier engages and closes a limit switch 251. As the carrier 147b moves into a position to be indexed upwardly adjacent to the track 188, the lower left end of the carrier engages and closes a limit switch 252. When the limit switches 249, 251, and 252 are all closed during the same period, the rotary motors 214 and 228 are operated to move the tracks 213 and 226, respectively. As the track 213 is positioned adjacent to the track 223, the pin 218 is withdrawn from its transverse position within the groove 216 of the track 213 to permit the rollers 163 and 164 (FIG. 16) of the carrier 147a to move into the groove 224 (FIG. 22) of the track 223. The carrier 147a moves downwardly adjacent to the track 223 and assumes a position behind the next carrier, for example, the carrier 147f which is already positioned adjacent to the track 223.

When the movable track 226 is positioned adjacent to the track 168, the carrier 147c is moved from a position adjacent to the track 226 to a position adjacent to the track 168 and in engagement with an adjacent edge of the carrier 147b as previously described.

As the carrier 147c moves toward the carrier 147b, the roller 165 (FIG. 16) of the carrier 147c engages the spring-biased plate 221 which slows down the movement of the carrier 147 so that it will not engage the carrier 147b abruptly. As the carrier 147a enters the track 223 and the carrier 147c enters the track 168, two limit switches 253 and 254, respectively, are closed to facilitate the operation of the rotary air motors 214 and 228 so that the movable tracks 213 and 226, re-

spectively are returned to their original position as shown in FIG. 23.

Referring now to FIG. 16, as the movable track 226 is returned to the position of alignment with the track 223, the actuator arm 243 facilitates the closing of the switch 244. When the switch 244 is closed, the solenoid 239 is operated to move the plunger 241 outwardly and into engagement with the adjacent portion of the rocker arm 233 to move the rocker arm so that the carrier 147d is permitted to move into the track 226. In addition, the end 236 of the rocker arm 233 is moved into a position to prevent the carrier 147e from moving even though the preceding carrier 147d has moved.

When the carrier 147d is positioned within the track 226, the lower right end of the carrier engages and closes a set of contacts of the switch 251 (FIG. 23) which facilitates control of the solenoid 239 to withdraw the plunger 241 so that the end 236 of the rocker arm 233 is moved away from the carrier 147e. In addition, the end 234 of the rocker arm 233 is positioned in the path of movement of the carrier 147e so that the carrier is permitted to move from the position adjacent to the end 236 to a position adjacent to the end 234 of the rocker arm as previously described. The next carrier 147f, which follows the carrier 147e, is then permitted to move into the position previously occupied by the carrier 147e which is adjacent to the end 236 of the rocker arm 233.

Referring now to FIG. 27, there is illustrated a portion of the feed line 124 one end of which is positioned adjacent to the loader 123 to facilitate the successive removal of the wire block assemblies 101—101 from the magazine 141 and for the serial loading of the assemblies into the line. Referring now to FIGS. 28 and 29, the feed line 124 includes a lower, generally U-shaped member 256 which is formed with a base surface 257 for supporting one surface of the wire block 102 of the wire spring assembly 101. The U-shaped member 256 is also formed with a pair of spaced shoulders 259 and 260 which are separated by the width of the base surface 257 so that the wires 103—103 which extend from opposite sides of the wire block 102 extend over and beyond the shoulders 259 and 260.

Referring now to FIGS. 27, 28 and 29, the feed line 124 also includes an upper U-shaped channel member 261 which has a pair of stop pawls 262—262 mounted for pivotal movement to opposite inner side walls thereof. The free end of each of the pawls 262—262 rest on adjacent portions of the base surface 257 of the member 256. The feed line 124 also includes a T-shaped slide 263 which is movable longitudinally within the cavity formed by the U-shaped upper channel member 261. A plurality of feed pawls 264—264 are mounted pivotally to opposite side walls of the T-shaped slide 263 and are each spring biased by an associated spring-biased plunger 266 (FIGS. 27 and 28) so that the free end of each of the feed pawls are urged downwardly onto adjacent portions of the base surface 257 of the member 256 and into a plane which is the plane of movement of the wire block assemblies 101—101 which are positioned within the feed line 124.

A plurality of rods 267—267 (one shown) are connected to and extend from spaced portions of the T-shaped slide 263 and extend through associated slots 268—268 (one shown) (FIG. 28) formed in one side wall of the upper U-shaped channel member 261 to

permit external control of longitudinal movement of the T-shaped slide.

Referring to FIGS. 29 and 30, each of the rods 267—267 (one shown) is connected at one end thereof to the T-shaped slide 263 and is connected at the opposite end thereof to an associated one of a plurality of blocks 269—269 (one shown). Each of the blocks 269—269 is attached to the free end of an associated piston rod 271 (FIG. 30) which extends from an associated one of a plurality of air cylinders 272—272 (one shown). Each of the air cylinders 272—272 is mounted on an associated fixed bracket 273 which extends upwardly from fixed portions of the apparatus 121 (FIG. 14). The air cylinders 272—272 are supported in a stationary position at selected locations along the length of the feed line 124 to facilitate reciprocating movement of the T-shaped slide 263 by reciprocating the block 269 between positions shown in solid line and phantom view in FIG. 30. This movement is effected during periods when it is desirable to feed the serially arranged wire spring assemblies 101—101 along the length of the feed line 124.

Referring again to FIG. 17, a transfer member 274 is attached for sliding movement to a frame 276. The frame 276 is secured to one end of the T-shaped slide 263 which is adjacent to the loader 123. An air cylinder 277 is also attached to the frame 276 and has a piston rod 278, the free end of which is attached to a portion of the transfer member 274. The free end of the transfer member 274 is formed with a notch 279 which engages a portion of the block 102 of each wire spring assembly 101 when the assembly is withdrawn from the magazine 141 and positioned in the feed line 124.

Initially, the T-shaped slide 263 is positioned so that the transfer member 274 is located above the uppermost wire spring assembly 101 in the magazine 141 as viewed in FIG. 27. When the air cylinders 272—272 (FIGS. 29 and 30) are operated to move the T-shaped slide 263 to the right as viewed in FIG. 27, the transfer member 274 is also moved to the right with the notch 279 of the member moving in a horizontal plane. This movement of the member 274 causes the uppermost wire spring assembly 101 to be withdrawn from the magazine 141 and transferred onto the leading edge of the base surface 257 of the lower channel member 256. The transfer member 274 continues to move the wire spring assembly 101 further onto the base surface 257 until the trailing edge of the block 102 of the wire spring assembly 101 passes the free end of the first set of stop pawls 262—262 as viewed in FIG. 27. The T-shaped slide 263 is then moved to the left to return the transfer member 274 to the position as shown in FIG. 27.

At this time, the carrier 147 is indexed one step upwardly to position the next uppermost wire spring assembly 101 adjacent to the transfer member 274. When the T-shaped slide 263 is again moved to the right, the transfer member 274 transfers the adjacent uppermost wire spring assembly 101 from the magazine 141 onto the leading edge of the base surface 257 of the U-shaped channel member 256 in the same manner as the positioning of the previously unloaded wire spring assembly. In addition, each set of the feed pawls 264—264 is moved with the T-shaped slide 263 to move the previously transferred wire spring assemblies 101—101 which are adjacent thereto and positioned

on the base surface 257 to a position which is beyond the next set of stop pawls 262—262.

Each set of the pawls 264—264 pushes the adjacent wire spring assemblies 101—101 to the right as viewed in FIG. 27 and maintain a force on the edge of the associated wire spring assembly by the biasing action of the associated springs 266—266. As the wire spring assemblies 101—101 are moved into engagement with the stop pawls 262—262, the free ends of the pawls are pivoted upwardly to permit the wire blocks 102—102 of the assembly to move past the stop pawls. After the wire spring assemblies 101—101 have been moved past the free ends of the stop pawls 262—262, the T-shaped slide 263 is again moved to the left and over the adjacent portions of the blocks 102—102. As the feed pawls 264—264 move over the blocks 102—102 over the wire spring assemblies 101—101, the feed pawls are pivoted upwardly against the biasing action of the springs 266—266 and are then returned to their original position by the biasing action of the springs after the free ends have passed over the adjacent portion of the blocks of the wire spring assemblies.

The T-shaped slide 263 is moved a sufficient distance to the left, as viewed in FIG. 27, to permit the free end edge of each feed pawl 264 to be retracted a short distance beyond the next trailing wire spring assembly 101 which is to be fed in the forward direction when the T-shaped slide is again moved to the right. The forward stroke of each set of the feed pawls 264—264 then moves the adjacent wire spring assembly 101 to a position beyond the leading edge of the next pair of stop pawls 262—262. The distance of travel of each forward stroke of the feed pawls 264—264 is indicated in FIG. 27 and is slightly longer than the distance each wire spring assembly 101 travels during each forward feed motion.

Referring to FIG. 27, when it is desired to move the empty magazine 141 laterally with respect to the transfer member 274, the air cylinder 277 is operated to withdraw the transfer member out of the lateral path of movement of the magazine.

Referring now to FIG. 31, there is illustrated in detail the twisting devices 126. The twisting devices 126 are used to twist alternate pairs of terminal springs 106—106 as illustrated in FIGS. 3 and 4. A housing 281 supports therein a motor 282 for driving a sprocket wheel 283. A link chain 284 is positioned about the sprocket wheel 283 and another sprocket wheel 286 to facilitate the transmission of a force to drive commonly the twisting devices 126. The twisting devices 126 include a pair of twisters, designated generally by the numeral 287, only one of which is shown in FIG. 31. The twisters 287—287 are mounted side-by-side and are operated simultaneously with each twister twisting alternate pairs of the terminal springs 106—106 as illustrated in FIGS. 3 and 4. The twister 287 is mounted on a platform 288 which extends laterally from one side of the housing 281.

Referring now to FIG. 34, each of the twisters 287—287 includes six rotatable twisting spindles 289—289. As illustrated in FIGS. 32, 33 and 34, the tip end of each of the spindles 289—289 is formed with a cup-shaped depression 192 and a centrally located elongated opening 292. As illustrated in FIG. 34, each of the spindles 289—289 of the twister 287 is aligned with an associated alternate pair of the terminal springs 106—106. The remaining pairs of the terminal s rings

106—106 will be subsequently aligned with associated ones of the spindles 289—289 of the remaining twister 287 (not shown) after the particular wire spring assembly 101 has been indexed to the next position along the feed line 124.

Referring again to FIG. 31, each of the spindles 289—289 extends rearwardly through the associated twisters 287—287 and is linked to a driven rotary mechanism, designated generally by the numeral 293, so that when the motor 282 is operated, the spindles 289—289 of both twisters are rotated simultaneously.

A pair of spring guide and clamping devices, designated generally by the numeral 294, (one shown) are positioned on the platform 288 adjacent to the associated twisters 287—287 and are located normally adjacent to the feed line 124. For the purpose of explanation, it is to be understood that there are two spring guide and clamping devices 294—294 but that only one device will be discussed with respect to its function and cooperation with its associated twister 287. The remaining spring guide and clamping device 294 functions in the same manner.

The spring guide and clamping device 294 includes an anvil member 296 and an overhead ram member 297 which is controlled by an air cylinder 298. The anvil member 296 is located normally adjacent to the feed line 124 so that as the wire spring assemblies 101—101 are moved through the feed line and into a position adjacent to the associated twister 287, the terminal springs 106—106 are positioned over the anvil member.

Referring to FIG. 35, there is illustrated a portion of the spring guide and clamping device 294 which includes the anvil 296 and the ram 297. The anvil 296 is formed with a shoulder 298 on one side thereof adjacent to the feed line 124. As further illustrated in FIGS. 35 and 37, the anvil 296 is also formed with a pair of spaced, shoulders 299 and 301 along the opposite side thereof which forms a slot 302 therebetween.

Referring again to FIG. 5, a clamping plate 303 is attached to one side of the ram 297 and is located directly above the shoulder 298 of the anvil 296. Referring again to FIGS. 35 and 37, a guide plate 304 is attached to the other side of the ram 297 and is located directly above the slot 302 of the anvil 296. The portion of the guide plate 304, which is adjacent to the slot 302, is formed with a plurality of equally spaced, saw tooth projections 305—305 having notches 306—306 formed between adjacent projections. The cylinder 298 (FIG. 31) normally holds the ram 297 in a raised position so that the ram is spaced above the anvil 296.

Referring again to FIG. 31, the housing 281 is mounted on bearing rods 307 and 308 for sliding movement relative thereto. In addition, a support bracket 309, which extends beneath the platform 288 and is attached to the housing 281, is also positioned about a bearing rod 311 for sliding movement relative thereto. An air cylinder 312 is mounted on a slide 313 (FIG. 38) which is secured within a track 314 (FIG. 38) of a platform 316 (FIG. 38). The platform 316 is secured fixedly to a stationary stand 317 which also provides support for the rod 307.

A piston rod 318 extends from the air cylinder 312 and is attached to the housing 281 to facilitate sliding movement of the housing relative to the bearing rods 307, 308 and 311. Normally, the air cylinder 312 is controlled to extend the piston rod 317 to the left as

viewed in FIG. 31 to position the twister 287 in a position as illustrated in phantom in FIG. 36. Normally, at this time, the air cylinder 298 is controlled to hold the ram 297 in the raised position.

Referring to FIGS. 31 and 38, there is illustrated a pair of air cylinders 319 and 321 which are mounted on a fixed platform 322. The fixed platform 322 is secured to the stationary stand 317. As further viewed in FIG. 38, piston rods 323 and 324 extend from the air cylinders 319 and 321 and are connected to opposite ends of a linkage 326 for pivotal movement with respect thereto. One end of a linkage 327 is connected for pivotal movement to an intermediate portion of the linkage 326 and the other end of the linkage 327 is connected for pivotal movement to a bracket 328 which is attached to the slide 313.

By selectively controlling the operation of the air cylinders 312, 319 and 321, the housing 281 can be moved to any one of three different positions other than the normal rest position which is viewed in FIG. 31. For example, the air cylinder 312 can be operated to move the piston rod 218 inwardly toward the cylinder so that the housing 281 is moved toward the cylinder. In addition, the air cylinder 319 can then be operated to pivot the linkage 326 about its connection with the piston rod 324 thereby moving the linkage 327 a predetermined distance. When the linkage 327 is moved toward the cylinders 319 and 321, the slide 313 is moved toward the cylinders thereby moving the air cylinder 312. When the cylinder 312 is moved, the housing 281 is moved toward the air cylinders 319 and 321 but maintains its relative position with respect to the air cylinder 312 since the air cylinder 312 was not operated at this time.

Thereafter, the air cylinder 321 can be operated to pivot the linkage 326 about its connection with the piston rod 323 so that the linkage 327 is moved an additional distance toward the air cylinders 319 and 321. The movement of the linkage 327 facilitates an additional movement of the housing 281 toward the air cylinders 319 and 321 in the same manner as described previously with respect to the operation of the air cylinder 319. Thus, the housing 281 can be moved to the right as viewed in FIG. 31 to at least one of three positions by selectively controlling the air cylinders 312, 319 and 321. When the housing 281 is moved, the twisting devices 126 are also moved to position the associated twisters 287—287 and the associated spring guide and clamping devices 294—294 in a position to effect a twisting operation on the terminal springs 106—106 (FIG. 2).

Referring to FIG. 36, the platform 288, and consequently the twister 287, and the spring guide and clamping device 294 assume a rest position as shown in phantom view. In addition, the air cylinder 298 is controlled to hold the ram member 297 in the raised position. After one of the wire spring assemblies 101—101 has been moved through a portion of the feed line 124 and is positioned adjacent to the twister 287, the air cylinder 298 is controlled to lower the ram member 297 so that the guide plate 304 is moved downwardly toward the slot 302 of the anvil 296 and is subsequently positioned so that each pair of adjacent terminal springs 106—106 are guided into an associated one of the notches 306—306 whereby the free ends of the springs are moved closer together. The tip ends of the projections 305—305 are positioned within the slot

302 so that the intermediate portions of the pairs of terminal springs 106—106, which are located between associated notches 306—306, are somewhat confined by the shoulders 299 and 301 and the notches.

In addition, as the ram member 297 is lowered, the clamping plate 303 is positioned slightly above the shoulder 298 of the anvil 296 so that the portions of the terminal springs 106—106 adjacent thereto are captured therebetween. The distance between the shoulder 298 and the adjacent surface of the plate 303 is slightly greater than the diameter of the terminal springs 106—106 so that the anvil 296 and the plate 303 are permitted to move laterally along the length of the terminal springs without damaging or deforming the springs.

After the air cylinder 298 has been controlled to lower the ram member 297 as previously described, one or more of the air cylinders 312, 319 and 321 are operated to move the housing 281 toward the air cylinders as previously described. Since the platform 288 is attached to the housing 281, the twisting devices 126 are also moved from a position as shown in phantom view to a position shown in solid view in FIG. 36. As the twister 287 is moved toward the wire spring assembly 101 positioned adjacent thereto, the shoulder 298 of the anvil 296 and the clamping plate 303 are moved longitudinally over the adjacent portions of the terminal springs 106—106 and serve to retain the springs in the relative position during this movement but without mutilating or deforming the springs. In addition, the notches 306—306 of the guide plate 304 are moved longitudinally over adjacent portions of the terminal springs 106—106 to retain the free ends of the pairs of terminal springs in a position sufficient to direct the free ends of the springs into the cup-shaped depressions 291—291 and subsequently into the openings 292—292 of the associated spindles 289—289.

The spindles 289—289 are moved a predetermined distance over the free ends of the terminal springs 106—106 but are always maintained at a predetermined distance from the guide plate 304 so that the forward ends of the terminal springs are guided into the paired relationship as they enter the openings 292—292 of the associated spindles 289—289.

After the housing 281 has been moved the predetermined distance, determined by the selective operation of the air cylinders 312, 319 and 321, the motor 282 is operated to rotate the spindles 289—289. When the spindles 289—289 are rotated, the pairs of terminal springs 106—106 are twisted along those portions of the length of the springs which extend from the portion of the springs adjacent to the clamping plate 303 and the portion which is immediately adjacent to the entry side of the openings 292—292.

Thereafter, the motor 282 is controlled to stop the spindles 289—289 from rotating. The shoulder 298 is then operated to withdraw the ram member 297 to the raised position and the air cylinders 312, 319 and 321 are controlled selectively to move the housing 281 to the normal rest position as illustrated in FIG. 31. When the housing 281 is moved to the normal rest position, the twisting devices 126 are moved to the position as shown in phantom view in FIG. 36 so that the forward end of the spindles 289—289 clears the free ends of the twisted pairs of terminal springs 106—106.

The wire spring assemblies 101—101 can now be indexed along the feed line 124 to position subsequent

assemblies adjacent to the twisting devices 126. It is noted that the free ends of the terminal springs 106—106 of each pair are not twisted together. By utilizing the twisting devices 126, the rotating spindles are not required to move in a direction coincidental with the axis of the twisted pairs of terminal springs during the twisting operation but are maintained in a stationary position during the rotation thereof. Thus, the twisting of adjacent springs 106—106 is accomplished by clamping loosely the portions of the springs adjacent to the shoulder 298 of the anvil 296 and the clamping plate 303. Further, the spacing of the notches 306—306 permits relative freedom of movement of the terminal springs 106—106 as the pairs of the springs are being twisted. This manner of performing the twisting operation permits a more uniform twisted pair of terminal springs 106—106 between the forward ends of the spindles 289—289 and the loosely clamped portion of the terminal springs 106—106 adjacent to the clamping plate 303.

Referring now to FIG. 39, there is illustrated the gauging device 127 which is positioned adjacent to the feed line 124 and adjacent to the twisting devices 126 for monitoring the areas 117—117 (FIG. 5) to determine whether or not the pairs of terminal springs 106—106 have been twisted and further to determine whether or not they are positioned properly. The gauging device 127 includes a housing 329 having the chamber 331 formed therein. A plurality of rocker arms 332—332 (FIG. 40) are mounted within the chamber 331 of the housing 329 and are positioned for rocking movement about a common pin 333. Each rocker arm 332 is formed with a slot 334 at one end thereof and is positioned in engagement with a compression spring 336 which normally urges the opposite end of the rocker arm downwardly.

An air cylinder 337 is mounted on the housing 329 and moves a piston rod 338 through a chamber 339 which communicates with the chamber 331 of the housing. A longitudinal rod 341 is attached transversely to the free end of the piston rod 338 and is normally urged against the upper edges of an end portion of each of the rocker arms 332—332 to urge the ends downwardly against the biasing action of the associated compression springs 336—336. Another air cylinder 342 is attached to the housing 329 and controls the movement of a flat bar 343 which is alignable with the slots 334—334 of the rocker arms 332—332. A forward free end of each of the rocker arms 332—332 supports a sensing element 344.

Referring now to FIG. 41, the sensing element 344 includes a sleeve 346, which is attached to the free end of the associated rocker arm 332, and further includes an adjustable slug 347. The lower end of the slug 347 is formed with a sensing shank 348.

Referring again to FIG. 39, a support block 349 is attached to the housing 329 and supports a reference platform 351 which provides a resting surface for the twisted pairs of the terminal springs 106—106 positioned adjacent to the gauging device 127.

In operation, the air cylinder 342 is controlled to hold the bar 343 in the withdrawn position as viewed in FIG. 39. The air cylinder 337 is controlled to position the rod 341 onto the adjacent portions of the rocker arm 332 so that the end of the rod, which supports the sensing element 344, is raised normally. The wire spring assemblies 101—101 having the twisted

pairs of terminal springs 106—106 are indexed along the feed line 124 to a position adjacent to the gauging device 127 so that the twisted pairs are resting substantially on the reference platform 351 and beneath the associated, raised sensing element 344—344. Thereafter, the air cylinder 337 is controlled to raise the rod 341 thereby permitting the rocker arms 332—332 to be rocked by the biasing action of the associated springs 336—336. This permits the sensing elements 344—344 to be lowered toward the associated twisted pair of terminal springs 106—106.

Referring to FIG. 41, assuming that the associated twisted pair of terminal springs 106—106 have been properly twisted together and is properly positioned, the sensing shank 348 will be positioned so that the adjacent portion of the twisted pair of terminal springs are captured between the reference platform 351 and the sensing shank. It is noted that the cross sectional dimension of the sensing shank 348 is sufficient to engage at least some portion of the twisted pair of terminal springs 106—106 which are aligned in the manner shown in FIG. 41.

Referring again to FIG. 39, assuming that all of the twisted pairs of the terminal springs 106—106 are properly twisted and positioned, the slots 334—334 of the rocker arms 332—332 will assume an aligned orientation adjacent to the bar 343. Thereafter, the air cylinder 342 is controlled to move the bar 343 into the aligned slots 334—334 where one end of the bar 343 engages a roller 352 and moves the roller to actuate a switch 353 (FIG. 40) thereby indicating the acceptability of the twisted pair of terminal springs 106—106.

Referring now to FIG. 40, there is illustrated at least one pair of the terminal springs 106—106 which were not twisted together and at least one other pair of terminal springs which are not properly located. When the rocker arms 332—332 associated with these pairs of terminal springs 106—106 are rocked, the sensing shanks 348—348 associated with these rocker arms will move downwardly into engagement with the reference platform 351. The opposite ends of these rocker arms 332—332 will be raised slightly higher than the remaining rocker arms which are associated with properly twisted and located pairs of terminal springs 106—106. Therefore, the slots 334—334 of the raised rocker arms 332—332 will not be aligned with the remaining slots.

When the air cylinder 342 (FIG. 39) is controlled to move the bar 343 toward the aligned slots 334—334, the bar will not be permitted to move into those slots which are aligned because of the misalignment of the slots associated with the raised rocker arms 332—332. Therefore, the bar 343 will not engage the plunger 352 and the switch 353 will not be closed during the period when the twisted pairs of terminal springs 106—106 are being gauged. In this manner, wire spring assemblies 101—101 having improperly or untwisted pairs of terminal springs 106—106 or improperly located twisted pairs of the terminal springs can be detected and marked to indicate the unacceptability.

Referring now to FIG. 42, there is illustrated the press 128. It is to be understood that while the following explanation relates to the press 128, the presses 129, 137 and 138 (FIG. 14) are identical except for the tooling required to perform the particular forming and coining operations. The press 128 includes a pair of spaced, vertical, support plates 354 and 356. A bed

plate 357 is positioned between upper adjacent portions of the spaced support plates 354 and 356 and is secured to the support plates. Four bearings 358 through 361 are positioned within openings (not shown) formed through the bed plate adjacent to the corners thereof and are secured to the bed plate. Four rods 362 through 365 are positioned within the bearings 358 through 361, respectively, for sliding movement relative thereto.

The lower ends of the rods are secured to a lower plate 366 and the upper ends of the rods are secured to an upper plate 367. A pair of toggle linkages 368 and 369 are connected between the underside of the bed plate 357 and the upper side of the lower plate 366. An actuator arm 371 is connected to the toggle linkages 368 and 369 and is also connected to a driving arm 372. The driving arm 372 is mounted eccentrically to a drive sheave 373 which is driven by a mechanism (not shown). A plurality of dies, designated generally by the numeral 374, are secured to the upper surface of the bed plate 357 and the underside of the upper plate 367. The feed line 124 extends through the opening between the bed plate 357 and the upper plate 367.

Referring now to FIG. 43, when each of the successive wire spring assemblies 101—101 are indexed singly into the press 128, the drive mechanism is operated to rotate the drive sheave 373 whereby the drive arm 373 is moved eccentrically to extend the toggle linkages 368 and 369 to a position whereat the lower plate 366 is moved downwardly to move the rods 362 through 365 downwardly. As the rods 362 through 365 are moved downwardly, the upper plate 367 is moved downwardly toward the bed plate 357 whereby the plurality of dies 374—374 cooperate to coin alternate twisted pairs of terminal springs 106—106 to form the terminals 108—108 (FIG. 6). In addition, one end of the single wire 107 is coined to form the terminal 114 (FIG. 6) and to form the offset angle at the intermediate portion 116 (FIG. 6) of the single wire.

Thereafter the wire spring assemblies 101—101 are indexed into the press 129 (FIG. 14) whereat the remaining alternate twisted pairs of terminal springs 106—106 (FIG. 6) are coined to provide the terminals 108—108 (FIG. 7). In addition, the ends of the terminals 108—108 are cut to a prescribed length and the ends 111—111 (FIG. 7) of the contact springs 104—104 are coined.

After the wire spring assemblies 101—101 have been moved through the presses 128 and 129 (FIG. 14), each wire spring assembly is positioned adjacent to the gauging device 131. The gauging device 131 is similar to the gauging device 127 (FIG. 39) and monitors the areas 118—118 (FIG. 8) to detect missing and misaligned coined ends 111—111 of the contact springs 104—104. Referring now to FIG. 44, there is illustrated a sensing element, designated generally by the numeral 374, which resembles the sensing element 344 (FIG. 41). The sensing element 374 includes a sleeve 376 which is attached to one end of one of a plurality of rocker arms 377—377 which is identical to the rocker arms 332—332 of the gauging device 127 (FIG. 39). The sensing element 374 further includes an adjustable slug 378 which is positioned within the sleeve 376 and which supports at the lower end thereof a sensing bar 379. The sensing bar 379 is formed with a channel 381 having spaced shoulders 382 and 383. The sensing bar

379 is normally positioned above an associated portion of a reference surface 384.

As each wire spring assembly 101 is positioned adjacent to the sensing device 131 (FIG. 14), the coined ends 111—111 of the contact springs 104—104 should be aligned beneath an associated one of the corresponding plurality of sensing bars 379—379. The sensing elements 374—374 are then permitted to be lowered in the manner that the sensing elements 344—344 were lowered with respect to the gauging device 127 (FIG. 39). If each coined end 111 is properly positioned to have the contact 112 subsequently welded thereto, the channel 381 of the sensing bar 379 is lowered sufficiently so that the base of the channel will rest upon the upper portion of the coined end. Therefore, when the positions of the rocker arms 377—377 are examined in a manner identical to the insertion of the bar 343 (FIG. 39) into the slots 334—334 (FIG. 39), a switch will be operated to indicate that all of the coined ends 111—111 of the wire springs 104—104 are properly positioned to receive subsequently the associated contacts 112—112 (FIGS. 9 and 10).

If any of the coined ends 111—111 of the wire springs 104—104 are not properly positioned, as the sensing bar 379 is lowered either shoulder 382 or 383 will engage the displaced coined end. If the coined end 111 is missing or displaced out of the path of movement of the sensing bar 379 completely, the shoulders 382 and 383 will be lowered into engagement with the reference surface 384. In either instance, the slot formed in the opposite end of the associated rocker arms 377—377 will be misaligned with the bar similar to the bar 343 (FIG. 39). When the bar is moved toward the slot it is prevented from entering the slot thereby preventing the actuation of the switch associated with the gauging device 131. In this manner, the misalignment or absence of the coined ends 111—111 of the wire springs 104—104 is indicated.

Thereafter, the wire spring assemblies 101—101 are indexed along the feed line 124, as viewed in FIG. 14, and are positioned adjacent to the welding stations 132 and 133 whereat the contacts 112—112 (FIGS. 9 and 10) are welded to the coined ends 111—111 (FIG. 7). The structure of the welding facilities located at the welding stations 132 and 133 is similar to the welding facilities disclosed in U.S. Pat. No. 2,771,539, which issued to H. A. Myers on Nov. 20, 1956.

Referring now to FIG. 14, after the contacts 112—112 (FIGS. 9 and 10) have been welded onto the associated coined ends 111—111 (FIG. 7) of the wire springs 104—104 at the welding station 133, the assemblies are indexed along the feed line 124 to a position adjacent to the gauging device 136 whereat the areas 119—119 (FIG. 11) of the ends of the wire springs 104—104 (FIGS. 9 and 10) are monitored to determine whether or not the contacts 112—112 have been properly positioned and welded onto the associated coined ends 111—111. The structure of the gauging device 136 is identical to the gauging device 131 except that the channel 381 (FIG. 44) of the sensing element 374 is somewhat deeper to accommodate the additional thickness being sensed which includes the coined end 111 and the contact 112 welded thereto.

If the contacts 112—112 have been properly positioned and welded onto the associated coined ends 111—111, the gauging device 136 senses the proper alignment and the wire spring assembly 101 is permit-

ted to be indexed further through the feed line 124. However, if any one or more of the contacts 112—112 have not been properly positioned onto the associated coined end 111 of the wire springs 104—104 or if there is not contact 112 welded to any one or more of the coined ends of the wire spring, the gauging device 136 senses these conditions and the particular wire spring assembly 101 is marked to indicate the deficiency.

Referring again to FIG. 14, the wire spring assemblies 101—101 are then indexed through the feed line 124 and into the presses 137 and 138 which operate in a manner identical to the operation of the press 128. The terminals 108—108 (FIG. 12) are formed at the offset angle at the intermediate portion 109 thereof by the operation of the press 137. The contact springs 104—104 are formed at the offset angle at the intermediate portion 113 thereof by the operation of the press 138. Thereafter, the completed wire spring assemblies 101—101 are indexed through the feed line 124 and are fed into aligned slots 146—146 of one of the magazines 141—141 which is attached to one of the indexable carriers 147—147 on the unloader 139. It is noted that the unloader 139 is similar to the loader 123 and functions in a somewhat inverse manner to receive the completed wire spring assemblies 101—101 thereby loading magazines 141—141 and for transferring the loaded magazines with the associated carriers to a position whereat the operator can remove the loaded magazines from the unloader 139.

Referring now to FIG. 48, there is illustrated another embodiment of a wire spring assembly, designated generally by the numeral 386, which includes a wire block 387 composed of an insulating material. The wire spring assembly further includes a plurality of wires, designated generally by the numeral 388, extending through and from opposite sides of the block 387. Portions of the wires 388 extending from one side of the block 387 have been twisted to form twisted portions 389—389. In addition, the opposite ends of the wires 388—388 which extend from the opposite side of the block 387 are formed and have contacts (not shown) welded thereto. The twisting of the wires 388—388 and the forming and welding of contacts to the wires can be accomplished by the facilities of the line 121 (FIG. 14) including the loader 123, the twisting devices 126, selected ones of the presses 128 and 129 and 137 and 138, and the welding stations 132 and 133. In addition, the completed assembly can be unloaded from the feed line 124 (FIG. 14) into the unloader 139. However, it is desirable to form pairs of selected portions of selected ones of the wires 388—388.

As illustrated in FIG. 49, a portion 391 of a first pair of the wires 388—388 is formed at an offset angle and a portion 392 of a second pair of the wires are formed at an offset angle.

Referring now to FIG. 46, a device, designated generally by the numeral 393, for effecting the forming of the offset portions 391 and 392 of the wires 388—388 (FIG. 49) includes a vertically reciprocable housing 394 which is positioned on a stationary support 396. A rotary motor 397 is attached to the support 396 and rotates selectively a rotary drive member 398. A driving link 399 is mounted eccentrically in an open face of the rotary drive member 398 and supports at the free end thereof a roller 401. The roller 401 is mounted within an opening 402 formed in one side of a projection 403 which extends downwardly from and is secured to the

housing 394. The projection 403 extends into a slot 404 formed in the stationary support 396. When the drive member 398 is rotated, the projection 403 is reciprocated vertically within the slot 404.

Referring to FIG. 47, the housing 394 is positioned over a pair of bearing rods 406 and 407 which support the housing for vertical sliding movement relative thereto. A pair of air cylinders 408 and 409 are mounted on the rear side of the housing 394 and have piston rods 411 and 412 which extend therefrom. A rocker arm 413 is mounted about a pin 414 for rocking movement relative thereto and is located within a chamber 416 formed in the housing 394. The rocker arm 413 is formed with a rack actuator 417 which extends from an intermediate portion of one side thereof adjacent to the location of the pin 414. The rack actuator 417 is located within a slot 418 formed in a rack 419 which is positioned for sliding movement within a slot 421 formed in the housing 394.

The rack 419 is formed with a plurality of teeth 422—422 which engage longitudinal ribs 423—423 of a plurality of forming rods 424—424. The ribs 423—423 of the forming rods 424—424 engage the teeth (not shown) of adjacent associated forming bits 426—426 which are located in a plane spaced from the plane in which the rack 419 is located. Thus, when the rack 419 is moved, the forming rods 424—424 are rotated due to the meshing of the ribs 423—423 of the rods with the teeth 422—422 of the rack. The forming bits 426—426 are also rotated simultaneously due to the meshing of the teeth of the bits with the ribs 423—423 of the associated rods 424—424. It is noted that each forming bit 426 is associated with an adjacent forming rod 424 to form a set and is rotated in a direction opposite from the direction of rotation of the associated forming rod.

A pair of adjustable, stop studs 427—427 are positioned within aligned, threaded openings 428 and 429 formed in the housing 394 and are positioned so that projections 431 and 432 of the rack 419 move between adjacent spaced ends of the studs. Locking studs 433—433 are positioned within the threaded openings 428 and 429 and into engagement with one end of each of the stop studs 427—427 so that the stop studs are maintained in a predetermined position to control the lateral movement of the rack 419 and, consequently, the angular distance of travel of the forming rods 424—424 and the forming bits 426—426. As viewed in FIG. 48, the lower ends of each of the forming rods 424—424 and the forming bits 426—426 are formed with a slot 434 and a flared opening 436 communicating with the slot.

Referring to FIG. 46, an anvil bar 437 extends downwardly from a portion of the housing 394 adjacent to the lower ends of the forming rods 424—424 and the forming bits 426—426. Referring again to FIG. 48, in a view looking upwardly toward the lower ends of one set which includes the forming rod 424 and the associated forming bit 426, the anvil 437 is positioned adjacent thereto and is formed with a slot 438. As illustrated in FIG. 47, there are four sets each of which include one of the forming rods 424—424 and an associated one of the forming bits 426—426. The anvil 437 (FIGS. 46 and 48) is positioned adjacent to the four sets of forming rods 424—424 and forming bits 426—426 so that slots, such as the slot 438 (FIG. 48),

are formed adjacent to each set of one of the forming rods and the associated one of the forming bits.

For the purpose of explanation, the forming of two pairs of wires 388—388 of the three-pair, wire spring assembly 386 will be explained. It is to be understood that the two pairs of the wires 388—388 of each of four wire spring assemblies 386—386 are being formed simultaneously.

Initially, as viewed in FIG. 46, the housing 394 is in the raised position as controlled by the rotary motor 397. The wire spring assemblies 386—386 are indexed along a feed line, such as the feed line 124 (FIG. 14), to position four wire spring assemblies adjacent to the housing 394. The wires 388—388 of the wire spring assemblies 386—386 having the twisted portions 389—389 (FIG. 48) are positioned on a ledge 439 which extends from an upper portion of the stationary support 396 directly beneath the lower ends of the forming rods 424—424 and the forming bits 426—426.

Referring now to FIG. 48, thereafter the housing 394 is lowered so that the slots 434—434 of each set of the forming rods 424—424 and the associated forming bits 426—426 is positioned over an intermediate untwisted portion of the pairs of twisted wires 388—388 which extend from one side of the block 387 of the wire spring assemblies 386—386 and which are to be formed with the offset portions 391 and 392.

Referring now to FIG. 47, the air cylinder 408 is operated to move the piston rod 411 outwardly therefrom. When the piston rod 411 is moved outwardly, the rocker arm 413 is rocked about the pin 414 so that the rack 419 is moved to the right. Even though the piston rod 412 is in the extended position, the pressure has been removed from the air cylinder 409 so that the rod is permitted to be moved inwardly into the cylinder. When the rack 419 is moved to the right, the forming rods 424—424 and the forming bits 426—426 are rotated partially depending upon the distance of travel of the rack permitted by the stop studs 427—427.

Referring now to FIG. 49, when the forming rod 424 and the associated forming bit 426 are rotated, the pairs of wires 388—388 which are positioned within the slots 434—434 are bent to form the offset portions 391 and 392. In addition, the pairs of formed wires 388—388 are urged into engagement with opposed, spaced walls of the slot 438 to assist in the final forming of the wires. In this manner, the pairs of formed wires 388—388 of the wire spring assemblies 436—436 are formed in a desired manner.

Referring now to FIG. 46, the housing 394 is raised through the control of the rotary motor 395 to withdraw the forming rods 424—424, the forming bits 426—426 and the anvil 437 upwardly away from the formed wires 388—388 of the wire spring assemblies 386—386. Referring now to FIG. 47, the pressure applied to the air cylinder 408 is removed and pressure is applied to the air cylinder 409 to move the piston rod 412 outwardly so that the rocker arm 413 is rocked about the pin 414 and the rack 419 is moved to the left to rotate the forming rods 424—424 and the forming bits 426—426 to a position in preparation for the next wire forming operation. Since the pressure has been removed from the air cylinder 408, the piston rod 411 is pushed into the cylinder by the movement of the rocker arm 413 when the piston rod 412 is moved outwardly from the air cylinder 409.

Referring now to FIG. 50, there is illustrated a conveyor system, designated generally by the numeral 441, for feeding wire spring assemblies 101—101 (FIG. 2) to a plurality of weld and form lines 121—121 which are shown in phantom view outline. The conveyor system 441 includes an input track 442 having a cross sectional configuration similar to the cross sectional configuration of the track 168 (FIG. 18) with the groove 169 to receive the rollers 163 and 164 of the carrier 147 (FIG. 16). One of the magazines 141—141 having a stack of wire spring assemblies 101—101 loaded thereon is attached to the carrier 147. A chain drive mechanism (not shown) is attached to the carrier to move the carrier adjacent to the track 442.

Through a control mechanism (not shown), the carrier 147 (FIG. 16) can be selectively disengaged from the chain drive mechanism and moved downwardly by another drive mechanism (not shown) through either a track 443 or a track 444 depending upon which one of the weld and form lines 121—121 is to be utilized to perform the weld and form operation. A loader 446 is located at the bottom of each of the tracks 443 and 444 to receive the carrier 147 and move the carrier adjacent to the associated one of the lines 121—121 in a manner similar to the movement of the carriers adjacent to the lines by the loader 123 (FIG. 23). It is noted that the loaders 446—446 include only the front portion of the loader 123.

After the magazine 141 of each of the carriers 147—147 are emptied, the carriers are then moved upwardly adjacent to tracks 447—447 and transfer mechanisms 448—448 transfer the carriers to associated horizontal tracks 449—449 for moving the carriers with the empty magazines to a position above the opposite end of the associated one of the lines 121—121. Thereafter, transfer mechanisms 451—451 are operated to receive the transferred carriers 147—147 and to facilitate positioning of each of the carriers adjacent to tracks 452—452 so that the carriers and the associated empty magazines can be positioned onto unloaders 453—453 which are positioned at the other end of the lines 121—121.

The unloaders 453—453 index the carriers 147—147 adjacent to the end of the lines 121—121 so that the completed wire spring assemblies 101—101 (FIG. 1) can be inserted into the associated magazines 141—141. Thereafter, the carriers 147—147 are transferred to tracks 454—454 and then onto an outgoing track 456 to transfer the carriers with the loaded magazines to a central location for removing the loaded magazines from the carrier.

What is claimed is:

1. A method of forming wire-like articles in desired configurations, which comprises the steps of:
 - applying aligning forces adjacent to ends of adjacent selected wire-like elements to move the ends substantially together in juxtaposed, substantially parallel alignment;
 - applying clamping forces to juxtaposed portions of the adjacent selected wire-like elements at an intermediate portion thereof spaced from the ends of the elements;
 - moving the application of the aligning forces over intermediate portions of the selected elements along a mutual axis thereof and away from the aligned ends thereof while continuing the application of the aligning forces to the selected elements and si-

multaneously moving the continued application of the application of the clamping forces along the intermediate portions of the selected elements and away from the aligned ends of the adjacent selected elements to a position which is a fixed distance from the ends of the selected articles so that a selected intermediate portion of the wire-like elements are clamped at the fixed-distance position and the portions thereof which extend to the ends of the selected articles are maintained in juxtaposition and parallel with the mutual axis in preparation for and during a subsequent twisting together of the wire-like elements, and

applying torsional forces to the aligned ends of the selected wire-like elements about the mutual axis of the elements the fixed distance from the position of application of the clamping forces about the juxtaposed portions of the wire-like elements for twisting together portions of at least selected ones of a plurality of the wire-like elements to form a wire-like article.

2. The method as set forth in claim 1, which further includes the step of forming in a selected configuration a portion of at least one wire-like element of the article.

3. The method as set forth in claim 2, which further comprises the step of securing at least one contact to a portion of at least one wire-like element of the article.

4. The method as set forth in claim 1, which further comprises the step of moving successive wire-like elements into a position for the twisting of the elements to form the wire-like article.

5. The method as set forth in claim 1, which further comprises the steps of:

attaching the wire-like elements to a carrier for transporting the elements to a position whereat the elements are twisted together;

moving the carrier through a gravity-feed track which communicates with an indexing feed track;

directing the carrier for movement from the gravity-feed track into and through the indexing-feed track, and

indexing the carrier through the feed track to selectively position the article at the position whereat the elements are twisted together.

6. The method as set forth in claim 5, which further comprises the step of directing the carrier into a second gravity-feed track which communicates with the index-

ing-feed track to move the carrier to a position whereat other wire-like elements can be attached to the carrier for movement to the position whereat the elements are twisted together.

7. A method of feeding at least one article to a work station, which comprises the steps of:

attaching an article to a carrier for transporting the article to a work station;

moving the carrier through a gravity-feed track which communicates with an indexing-feed track;

directing the carrier for movement into and through the indexing-feed track which is adjacent to the work station, and

indexing the carrier through the feed track to selectively position the article at a work station.

8. The method as set forth in claim 7, which further comprises the step of transferring the article from the carrier and into the work station.

9. The method as set forth in claim 7, which further comprises the step of directing the carrier into a second gravity-feed track which communicates with the indexing-feed track to move the carrier to a position whereat another article can be attached to the carrier.

10. A method of forming wire-like articles in desired configurations, which comprises the steps of:

applying aligning forces adjacent to ends of adjacent selected wire-like elements to move the ends substantially together in juxtaposed, substantially parallel alignment;

moving the application of the aligning forces over intermediate portions of the selected elements along a mutual axis thereof and away from the aligned ends thereof while continuing the application of the aligning forces to the selected elements;

applying clamping forces to juxtaposed portions of the adjacent selected wire-like elements a fixed distance at an intermediate portion thereof spaced from the ends of the elements, and

applying torsional forces to the aligned ends of the selected wire-like elements about the mutual axis of the elements the fixed distance from the application of the clamping forces about the juxtaposed portions of the wire-like elements for twisting together portions of at least selected ones of a plurality of the wire-like elements to form a wire-like article.

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UNITED STATES PATENT OFFICE CERTIFICATE OF CORRECTION

Patent No. 3,765,084 Dated October 16, 1973

Inventor(s) W. C. Kent

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 11, after "methods" insert --of--. Column 2, line 42, "assembly" should read --assembly--. Column 5, line 3, "contct" should read --contact--. Column 5, line 43, "air" should read --pair--. Column 7, line 66, "lowr" should read --lower--. Column 8, line 20, "158" should read --156--. Column 9, line 50, "top" should read --stop--. Column 10, line 64, "thee" should read --the--. Column 11, line 26, "subsequence" should read --subsequent--. Column 11, line 36, "intially" should read --initially--. Column 11, line 62, "atached" should read --attached--. Column 13, line 3, "16" should read --26--. Column 13, line 33, "thee" should read --the--. Column 13, line 41, "th" should read --the--. Column 14, line 23, "17" should read --27--. Column 14, line 27, "attahed" should read --attached--. Column 15, line 16, "ow" should read --of--. Column 15, line 21, "hav" should read --have--. Column 15, line 38, "laerally" should read --laterally--. Column 15, line 63, "192" should read --291--. Column 15, line 67, "s rings" should read --springs--. Column 16, line 32, "illustraed" should read --illustrated--. Column 17, line 3, "cylidner" should read --cylinder--. Column 17, line 39, "movemenht" should read --movement--. Column 18, line 25, "shoudler" should read --shoulder--. Column 18, line 50, "portins" should read --portions--. Column 20, line 2, "eed" should read --feed--. Column 20, line 5, "element" should read --elements--. Column 20, line 8, "ssociated" should read --associated--. Column 20, line 25, "334-344" should read --334-334--. Column 21, line 27, "373" second occurrence should read --372--. Column 21, line 29, "postion" should read --position--. Column 21, line 56, "ther" should read --there--. Column 22, line 7, "correspnd-" should read --correspond--. Column 22, line 21, "recieve" should read --receive--. Column 23, line 5, "not" should read --no--. Column 23, line 7, "sneses" should read --senses--.

Signed and sealed this 9th day of July 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents