Aug. 8, 1967 W. K. BLACK 3,334,665

SPRING LACING MACHINE

Filed Jan. 21, 1965 8 Sheets-Sheet 1

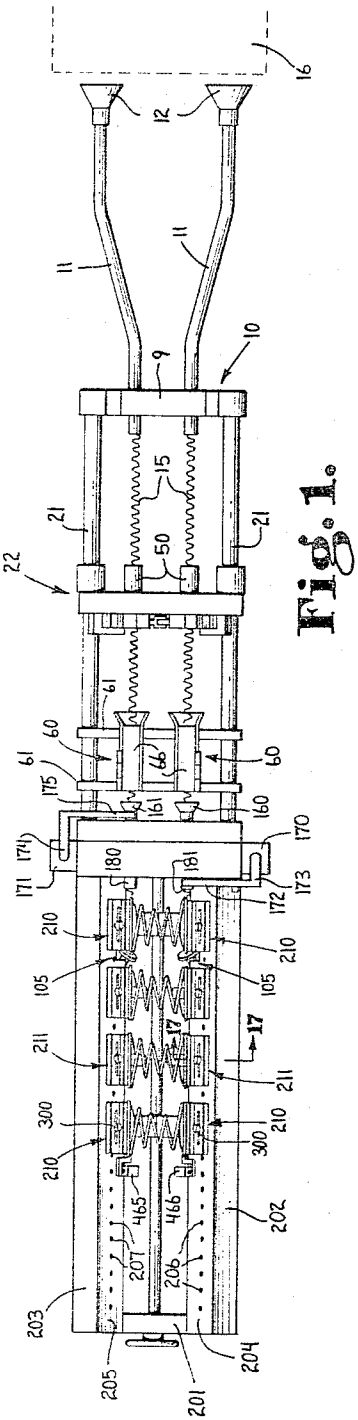


Fig. 1.

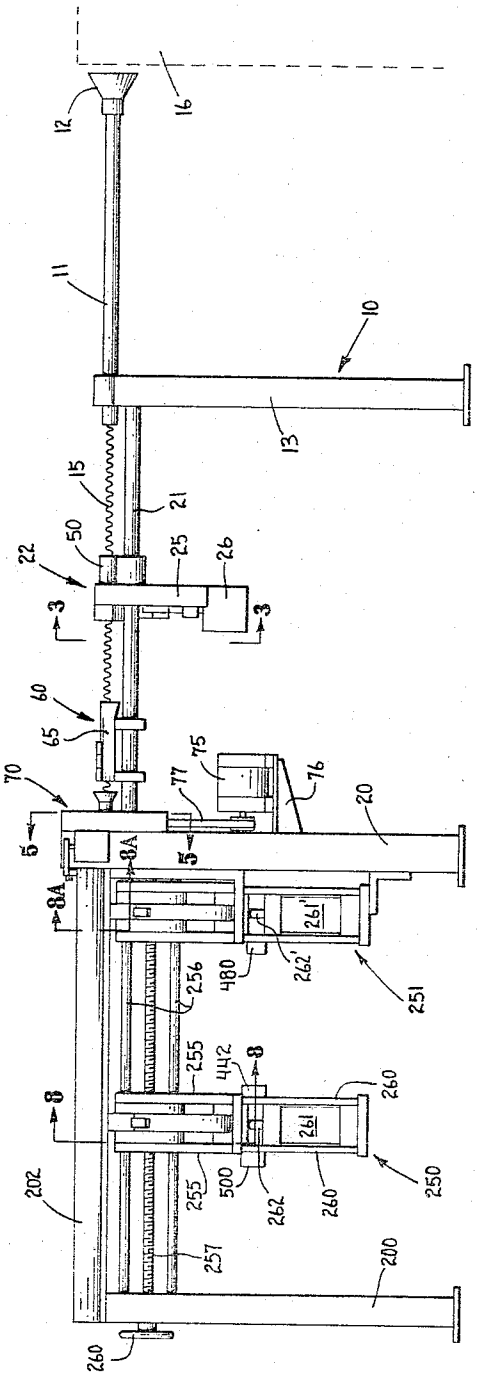


Fig. 2.

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SPRING LACING MACHINE

Filed Jan. 21, 1965 8 Sheets-Sheet 2

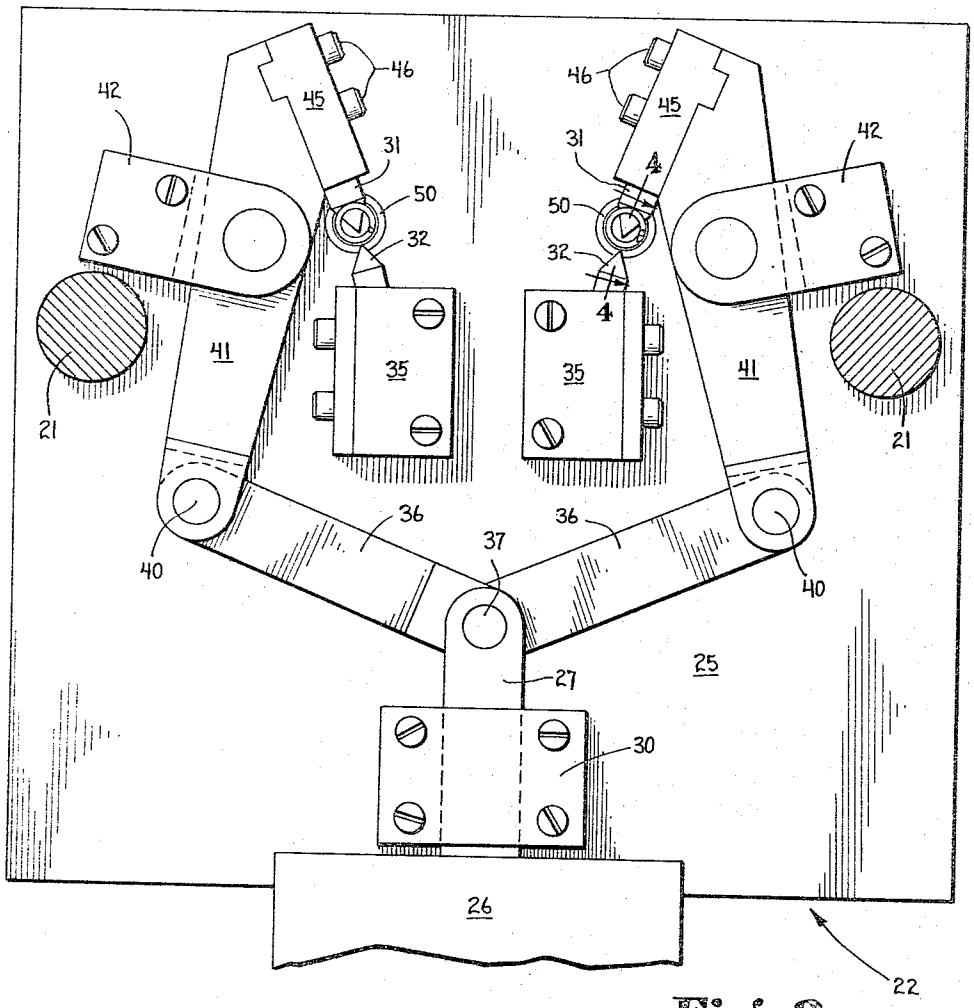



Fig. 3.

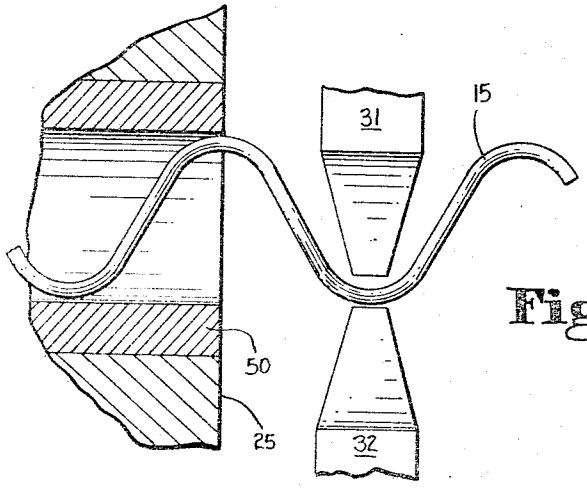



Fig. 4.

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Aug. 8, 1967 W. K. BLACK 3,334,665

SPRING LACING MACHINE

Filed Jan. 21, 1965 8 Sheets-Sheet 3

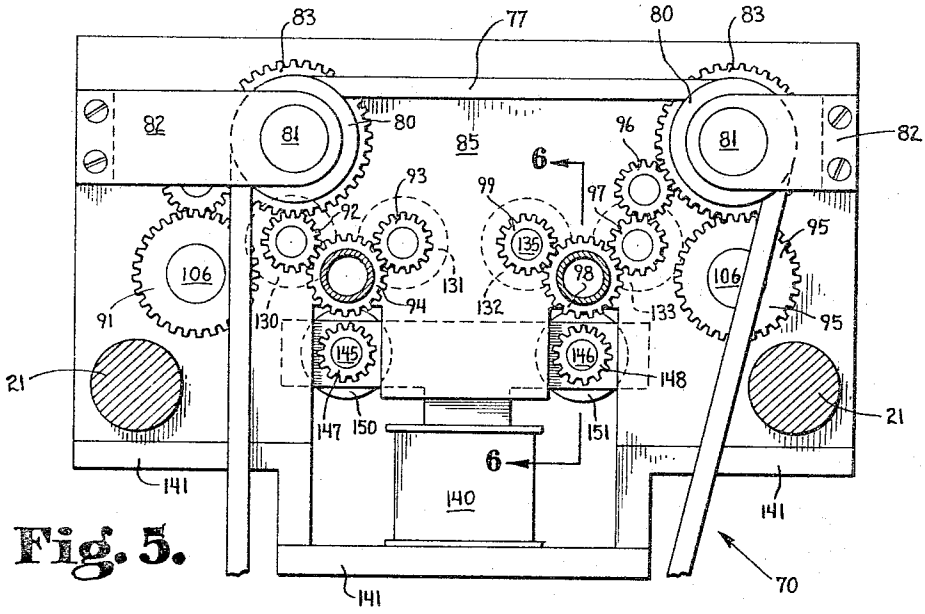



Fig. 5.

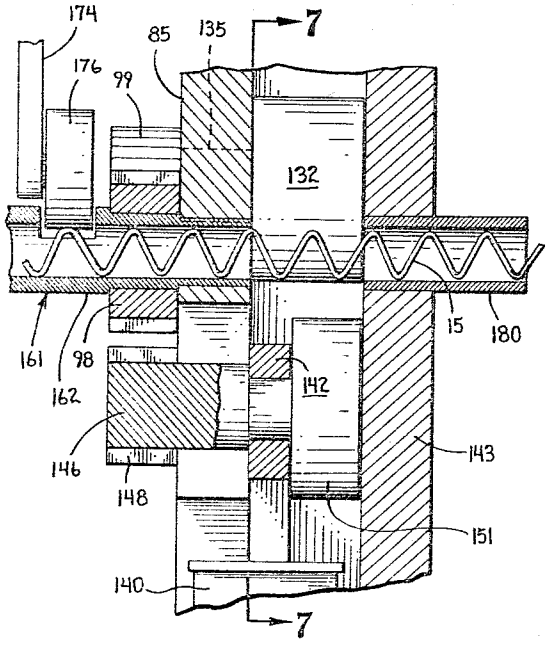



Fig. 6.

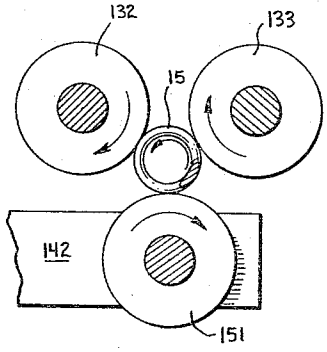



Fig. 7.

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SPRING LACING MACHINE

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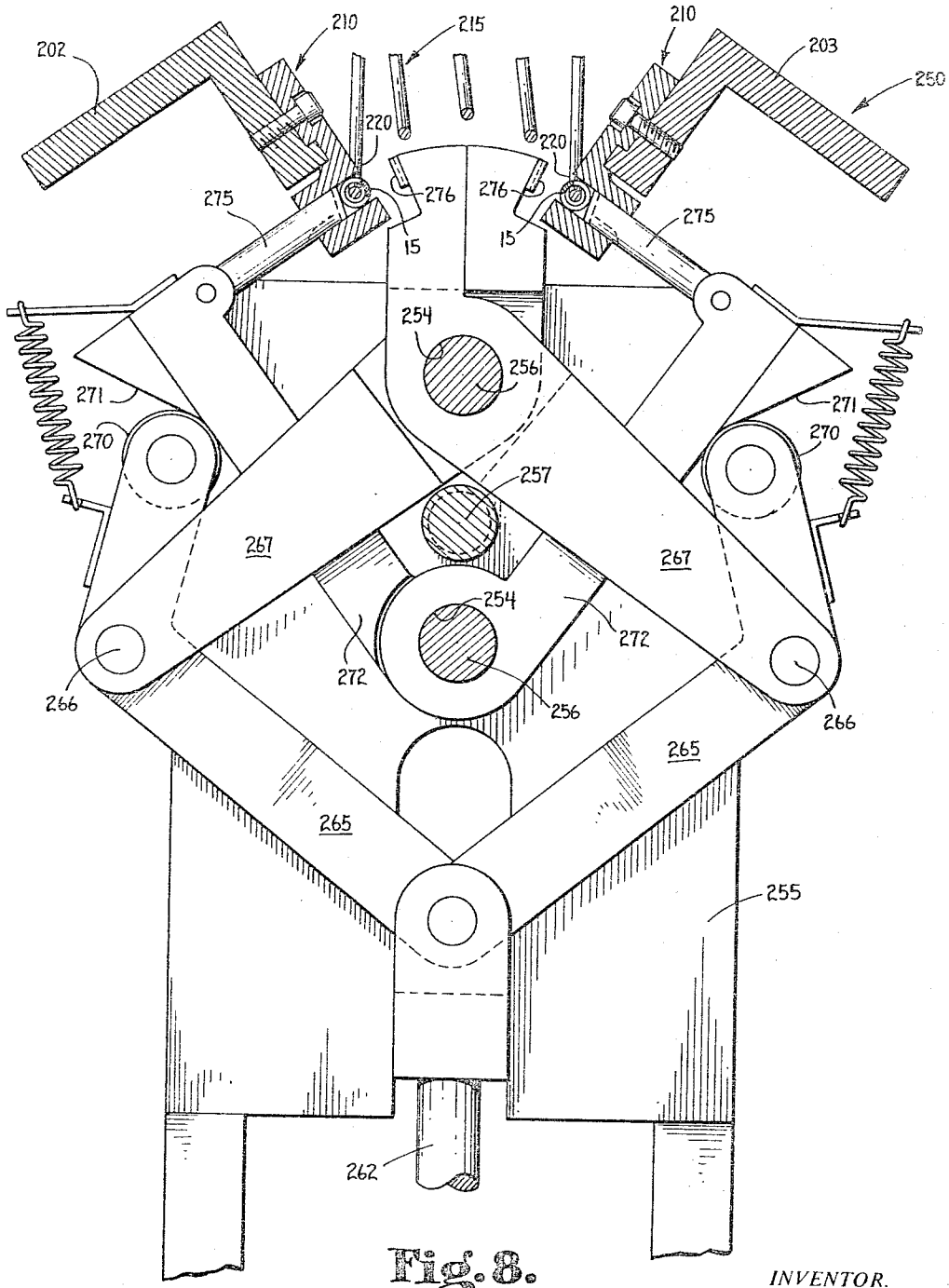



Fig. 8.

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Aug. 8, 1967 W. K. BLACK 3,334,665

SPRING LACING MACHINE

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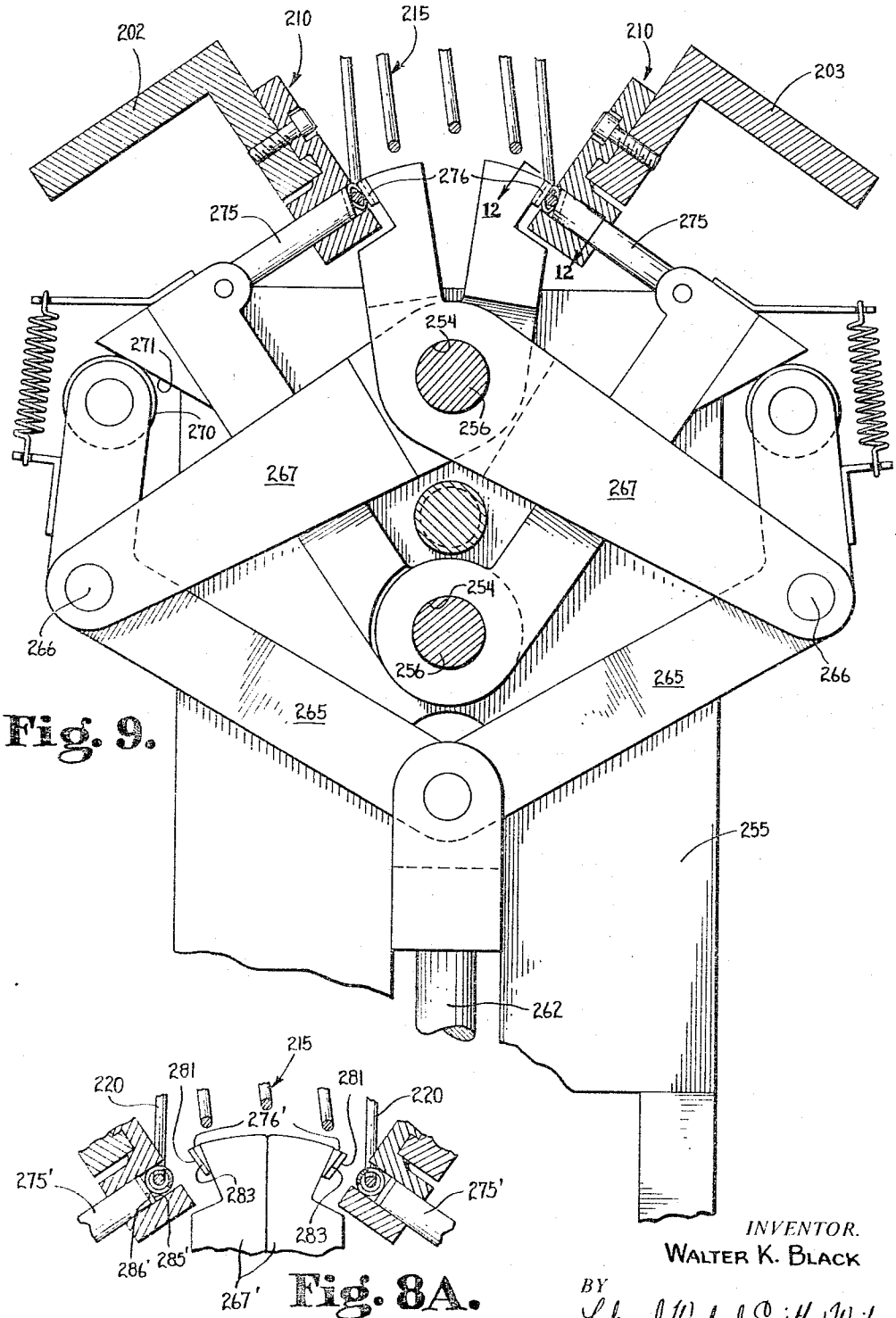



Fig. 9.




Fig. 8A.

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SPRING LACING MACHINE

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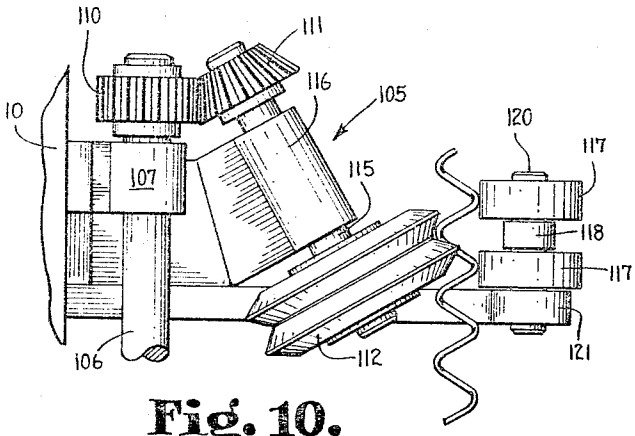



Fig. 10.

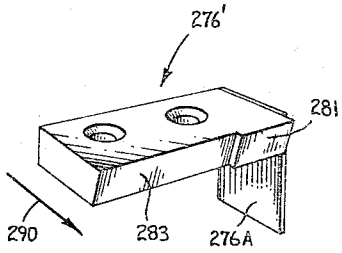



Fig. 14.

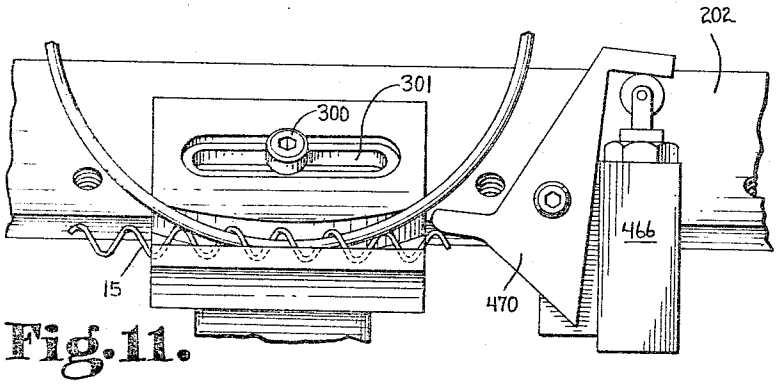



Fig. 11.

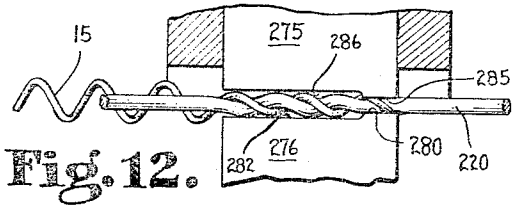



Fig. 12.

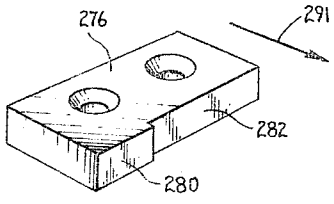



Fig. 15.

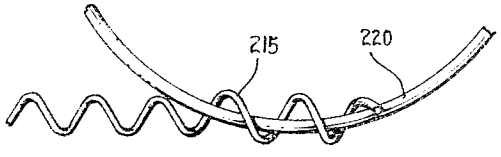



Fig. 13.

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SPRING LACING MACHINE

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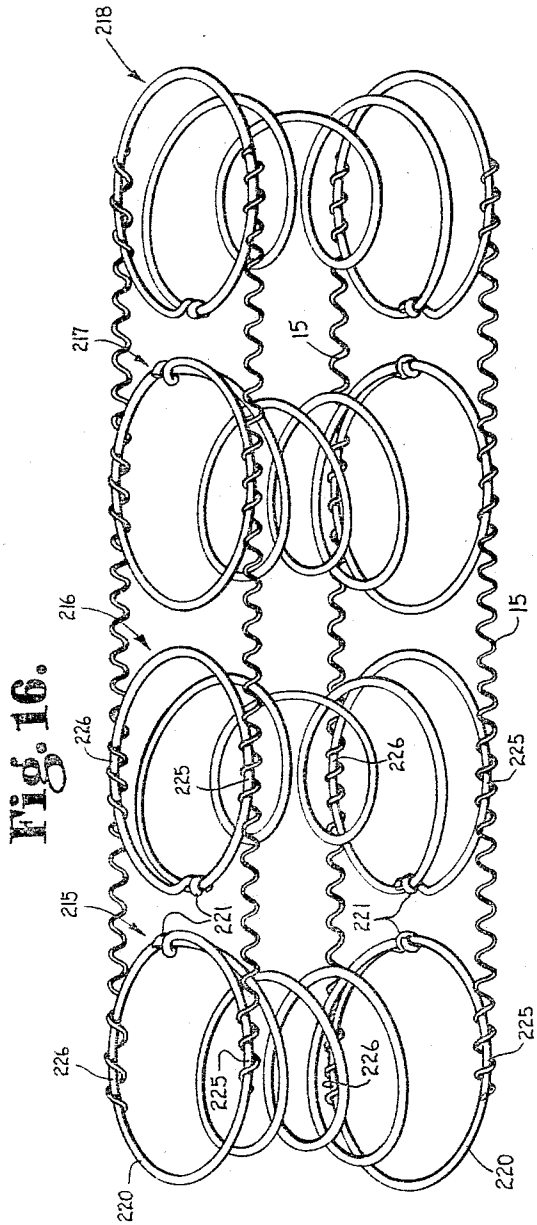



Fig. 16.

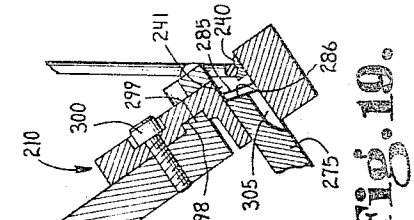



Fig. 19.

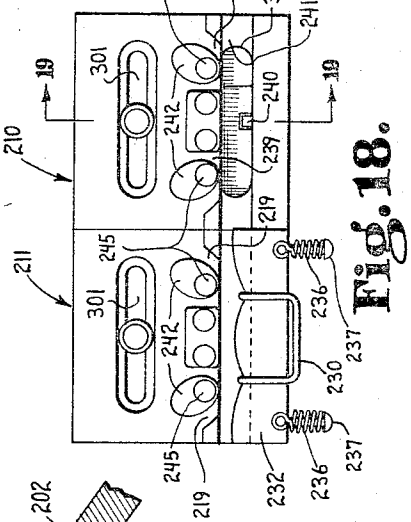



Fig. 18.

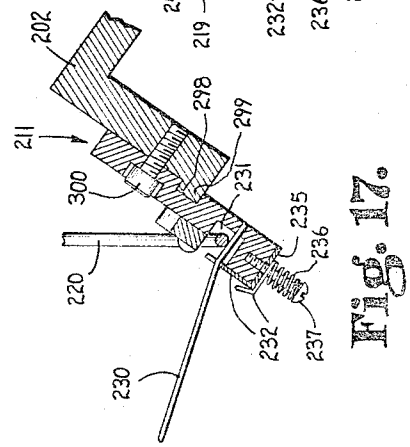



Fig. 17.

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SPRING LACING MACHINE

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Fig. 20.

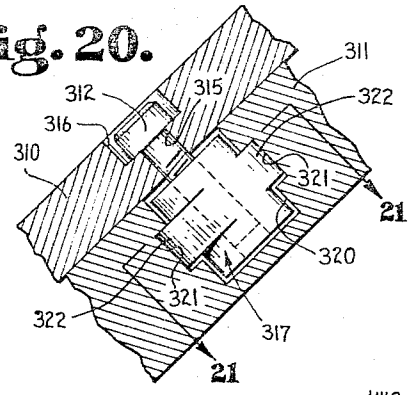
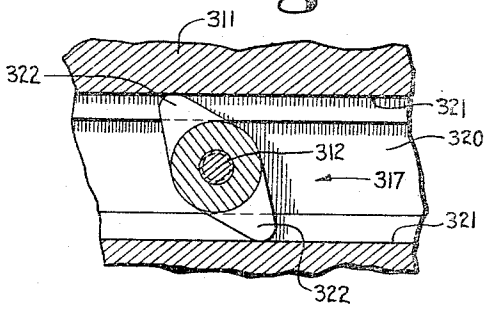



Fig. 21.



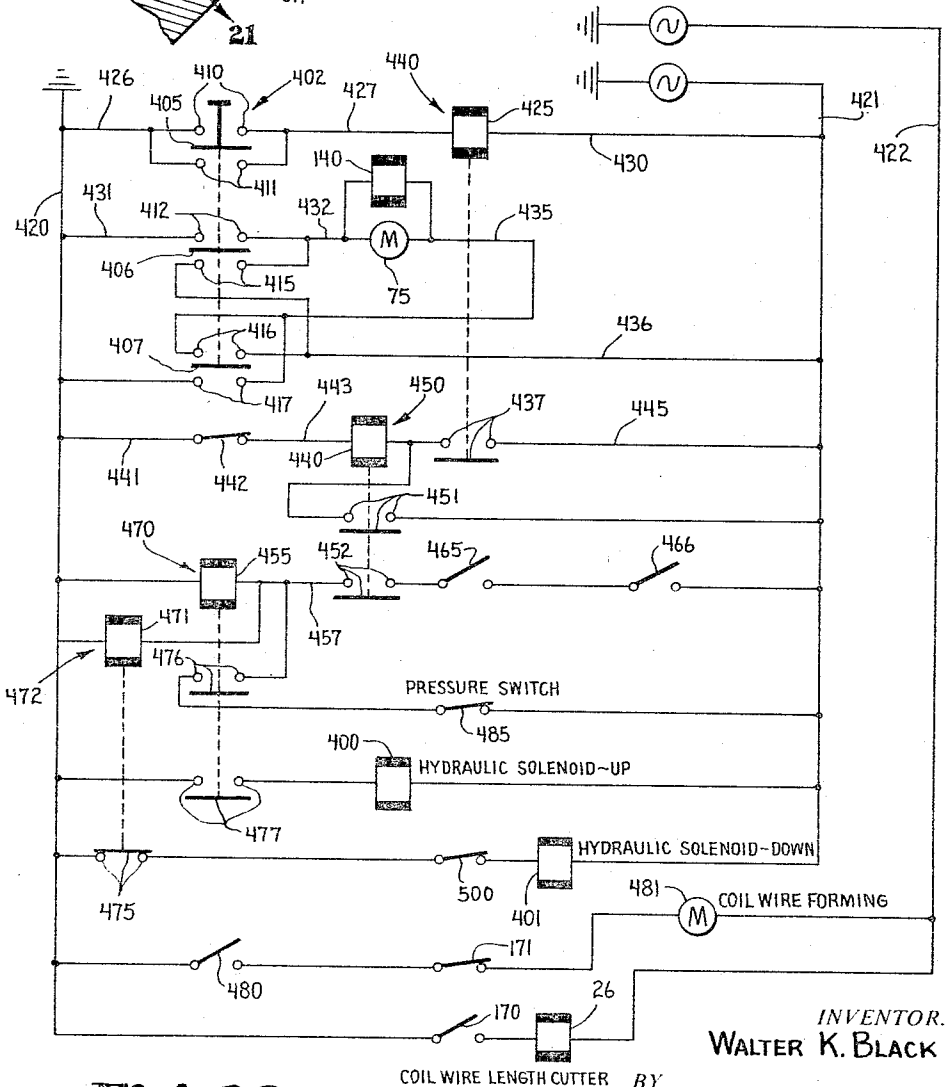




Fig. 22.

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United States Patent Office

3,334,665

Patented Aug. 8, 1967



3,334,665

# SPRING LACING MACHINE

Walter K. Black, Anderson, Ind., assignor to Barber Manufacturing Company, Inc., Anderson, Ind., a corporation of Indiana

Filed Jan. 21, 1965, Ser. No. 426,930

12 Claims. (Cl. 140—92.7)

The present invention relates to a method of and apparatus for lacing springs to make a spring laced product for use in manufacture of chairs, furniture, seats and the like and to a subcombination thereof.

In the manufacture of springs for chairs and the like, it has been found desirable to lace together a number of coil type springs otherwise known as hour glass springs. This lacing together can be accomplished in various ways one of which is by use of helical wires of much smaller diameter than the wires making up the coil springs. A primary object of the present invention is to provide an improved method and apparatus for manufacture of a spring laced product.

Another object of the present invention is to provide a spring lacing machine which produces a complete spring laced product and eliminates any necessity of manual cutting and crimping of lacing materials.

Still another object of the present invention is to provide a method and apparatus for producing a sturdier, stronger, more uniformly acceptable spring laced product.

Still a further object of the present invention is to provide an improved means for mounting an object in such a manner that the position thereof can be easily and quickly adjusted.

Related objects and advantages will become apparent as the description proceeds.

One embodiment of the apparatus of the present invention might include spring lacing apparatus comprising jig means for supporting a plurality of coil springs in side-by-side relation, said jig means including a pair of opposed seats for each of said coil springs, each of said seats including means for holding one side of one end of the coil spring, means for rotating a helix about its axis and moving it longitudinally of its axis to engage and surround the individual springs at each one side thereof, means for crimping the helix against the endmost of said coil springs and for cutting off said helix outboard of said crimped portion.

One embodiment of the method of the present invention might include supporting a plurality of coil springs in side-by-side relation, rotating a helix about its axis and moving it longitudinally of its axis to engage and surround the individual springs at one side of one end thereof, crimping the helix against the endmost of the coil springs, and cutting off the helix against the side of the end of the endmost coil springs.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims:

FIG. 1 is a top plan view of a spring lacing machine constructed according to the present invention.

FIG. 2 is a side elevation of the structure of FIG. 1.

FIG. 3 is an enlarged vertical section taken along the line 3—3 of FIG. 2 in the direction of the arrows.

FIG. 4 is an enlarged fragmentary section taken along the line 4—4 of FIG. 3 in the direction of the arrows.

FIG. 5 is an enlarged vertical section taken along the line 5—5 of FIG. 2 in the direction of the arrows.

FIG. 6 is an enlarged vertical section taken along the line 6—6 of FIG. 5 in the direction of the arrows.

FIG. 7 is an enlarged vertical section taken along the line 7—7 of FIG. 6 in the direction of the arrows.



FIG. 8 is an enlarged vertical section taken along the line 8—8 of FIG. 2 in the direction of the arrows.

FIG. 8A is a fragmentary section similar to FIG. 8 but taken along the line 8A—8A of FIG. 2.

FIG. 9 is a view similar to FIG. 8 but showing the apparatus in a different operating position.

FIG. 10 is an enlarged plan of an auxiliary drive means forming a part of the present spring lacing machine.

FIG. 11 is an enlarged detail view of holding blocks forming a part of the present spring lacing machine and also illustrated in FIG. 1.

FIG. 12 is an enlarged section taken along the line 12—12 of FIG. 9 and particularly showing crimping and cutting jaws forming a part of the illustration in FIG. 9.

FIG. 13 is a fragmentary view of a portion of a completed spring laced product manufactured by the machine of the present invention.

FIGS. 14 and 15 are perspective detail views of crimping and cutting jaws forming a part of the spring lacing machine.

FIG. 16 is a perspective view of a spring laced product manufactured by the machine of the present invention.

FIG. 17 is an enlarged vertical section taken along the line 17—17 of FIG. 1 in the direction of the arrows.

FIG. 18 is a plan view of the structure illustrated in FIG. 17 and of an additional holding block forming a part of the present device.

FIG. 19 is a section taken along the line 19—19 of FIG. 18 in the direction of the arrows.

FIG. 20 is an enlarged fragmentary view of an alternative embodiment of the present invention, FIG. 20 being taken similarly to FIG. 19 to show means for mounting a holding block.

FIG. 21 is a section taken along the line 21—21 of FIG. 20 in the direction of the arrows.

FIG. 22 is a schematic diagram of the electrical circuit of the present invention.

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiment illustrated in the drawing and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

Referring more particularly to FIGS. 1 and 2, there is illustrated a spring lacing machine which includes a frame **10** including a horizontal member **9** fixed to uprights **13**. Fixedly secured to and supported upon the horizontal member **9** of the frame **10** is a pair of hollow or tubular guide elements **11** each of which has a funnel **12** secured to its entry for guiding helicals or helically formed wires **15** into the machine. The helicals or helical wires **15** are formed into a helical shape with a desired radius and pitch by means of apparatus such as an Automatic Helical Maker machine **16** manufactured by Frank L. Wells Company of Kenosha, Wis., said machine **16** including adjustable means for controlling the diameter and the pitch of the helical.

The frame **10** also includes a pair of uprights **20** which along with uprights **13** fixedly mount horizontal rods **21**. Slidably mounted upon the horizontal rods **21** is a cutter assembly **22** which can be set at any predetermined location along the length of the horizontal rods **21**. The cutter assembly **22** includes a vertical plate **25** (FIG. 3) and a solenoid **26** fixedly mounted upon said vertical plate. The armature shaft **27** of the solenoid **26** is slidable within guide means **30** fixed to the plate **25**. When the sole-

noid **26** is actuated to cause the cutter assembly to operate, the shaft **27** moves upwardly and the knives **31** cooperate with and cut against blades **32**.

The blades **32** are mounted in position by mounting assemblies **35** which may incorporate suitable shim means and the like for accurately positioning the blades **32** and for taking up wear. A pair of links **36** are pivotally connected at one end by shaft **37** to the distal end of the armature member **27**. The links **36** are connected at their opposite ends by shafts **40** to levers **41**. The levers **41** are swingably mounted upon brackets **42** which are fixed to the plate **25**. The knives **31** are secured to blocks **45** which are fixed in position on the levers **41** by means of screws **46**.

FIG. 4 illustrates the inside of guide means **50** in the form of tubes mounted on the vertical plate **25** and the cutter knives **31** and blades **32** adjacent thereto. The operation of the cutter means of FIG. 3 can be inferred from the above description. As the helical **15** moves through the cutter means, a portion of the helical always remains between a respective knife **31** and blade **32** in the manner illustrated in FIG. 4. Thus, whenever the solenoid **26** is actuated to raise the armature **27**, the helical ins cut.

Mounted next along the path of the helical wires **15** is a pair of guide means **60** which are both mounted upon cross members **61** mounted upon and slidably adjustable along the rods **21**. The guide means **60** can be positioned in any desired location toward the cutter assembly **22** or toward the driving assembly **70** as desired and as appropriate to properly guide and support the helicals. The guide means or devices **60** each incorporate a lower trough portion **65** which is elongated, concave and upwardly opening. Hinged to each of the lower portions **65** is a top **66** permitting access into the guide means and facilitating the removal, if desired, of the helices from the respective guide means.

Mounted upon the uprights **20** of the frame **10** is the helicals drive assembly **70** which is best shown in the detail views of FIGS. 5, 6 and 7. A motor **75** is mounted upon a suitable support **76** secured to the uprights **20** and drives a belt **77** which extends around pulleys **80** fixed to shafts **81**. The shafts **81** are rotatable within bearings provided by the vertical frame plate **85** and by brackets **82** fixed to a vertical frame plate **85**. Each of the shafts **81** has a spur gear **83** fixed thereto whereby the motor **75** can drive the gears **83**.

Also mounted for rotation upon the vertical plate **85** is a series of spur gears **90–99**. The gears **90**, **91** and **95** drive a pair of auxiliary drive apparatus **105** (FIGS. 1 and 10) provided for each of the two hedical wires. Thus, the shaft **106** is fixed to the spur gear **91** and extends through the vertical plate **85** and through a bearing **107** fixed to the frame **10**. Also mounted upon the shaft **106** is a spur gear **110** which meshes with bevel gear **111** for driving the auxiliary roller **112**. The auxiliary roller **112** is fixed to a shaft **115** which extends through a bearing **116** and has fixed on its opposite end the bevel gear **111**.

Also forming a part of the auxiliary drive means **105** is a pair of rollers **117** which are spaced by a roller **118** and which are received upon a shaft **120** fixed to support member **121**. The support member **121** is fixed to the frame **10** and positions the rollers **117** in spaced relation to the roller **112** whereby they can act as idler rollers and backup supporting means for the driving function of the auxiliary roller **112**. There are two such drive means **105** provided on the opposite sides of the apparatus, one being driven by the spur gear **91** and the other by the spur gear **95**. The drive means which has not been described is substantially identical to the above described drive means **105**.

The primary drive means for each of the helices is driven by spur gears **92**, **93**, **94**, **96**, **97**, **98** and **99**. Each of spur gears **92**, **93**, **97** and **99** has a roller **130**, **131**, **132** and **133** associated therewith and fixed with relation to its respective spur gear. Each of the spur gears and associated rollers is connected by a suitable shaft fixedly secured to its respective spur gear and roller. For example in FIG. 6, the spur gear **99** is fixed to the roller **132** by shaft **135**.

It can be appreciated that as the motor **75** operates, the rollers **130**, **131**, **132** and **133** will rotate. Even so, driving action of the helix **15** is not accomplished unless the helix is held against the rollers **130**, **131** or **132** and **133**. When it is desired to drive and rotate the helices **15**, the helices must be raised and forced against the rollers **130**, **131**, **132** and **133** so that a driving action results.

Such a raising of the helices is accomplished by a solenoid **140**. The solenoid **140** is mounted upon frame members **141** and has a T-shaped member **142** fixed to its armature. The frame members **141** are fixed to one another with the L-shaped members **141** fixed between the plate **85** and a further plate **143** also forming a part of the frame. The T-shaped member **142** provides bearing support for a pair of shafts **145** and **146** each of which has a spur gear **147** and **148** fixedly mounted thereon and each of which has a roller **150** and **151** fixedly mounted thereon. It will be noted from FIG. 6 that the shaft **146** is enlarged at the end thereof upon which the spur gear is fixedly mounted. When the rollers **149** and **151** are lifted upwardly by projection of the armature member **142**, the rollers **150** and **151** engage the helices and force the helices against the rollers **130–133**. Also, the rollers **150** and **151** are driven at the same speed as rollers **130–133** through the spur gears **80**, **92**, **94** and **147** and through the spur gears **96**, **97**, **98** and **148**.

FIG. 7 shows the operating arrangement which causes each helix **15** to be moved along its path with the three rollers engaging the helix at three different sides 120° apart. FIG. 6 also shows the manner in which the spur gears **94** and **98** are rotatably mounted upon tubular members **160** and **161**. It will be noted that the tubular members **160** and **161** are fixed to the upright plate **85** and have enlarged portions **162** which retain the spur gears **94** and **98** upon the members **160** and **161**.

A pair of limit switches **170** and **171** are mounted upon the sides of the drive assembly. The actuating arms **173** and **174**, respectively, of the limit switches **170** and **171** each have rollers on the distal end thereof. The distal end of the limit switch arm **173** is located at **172** while the distal end and the actuating arm of the limit switch **171** is located at **175**. The roller **176** and slotted tubular member therefore of FIG. 6 is representative of the two rollers mounted on the distal ends of the respective actuating arms. When a helix is moving through the tubular element **161**, the roller **176** is engaged thereby actuating the arm **174** of the switch **171**. It can be appreciated that the switch **171** therefor senses a helix coming into the tubular element **161** while the switch **170** senses a helix leaving the tubular element **181**. The tubular elements **180** and **181** are fixedly mounted upon the vertical plate **143** forming a part of the fixed structure of the drive assembly and function to guide the helicals into the spring lacing portion of the present machine.

The portion of the present machine in which the actual spring lacing is effected is illustrated as the leftward portion of the machine as viewed in FIGS. 1 and 2 and includes the uprights **20** and also uprights **200**. Fixed to the upper end of the uprights **200** is a cross member **201** which supports the ends of a pair of angles **202** and **203**, the other ends of which are fixedly supported by upright plate **143** of the drive assembly. The angles **202** and **203** are arranged with their convex surfaces facing upwardly and in such a manner that the legs **204** and **205** and particularly the upwardly facing surfaces thereof taper upwardly and away from one another. The legs **204** and **205** have a plurality of screw threaded openings **206** and **207** therethrough for the mounting of holding

blocks **210** and **211** at desired locations along the length of the angles **202** and **203**.

The holding blocks **210** and **211** are shown in greater detail in FIGS. 17–19. The purpose of the holding blocks is to mount a plurality of coil springs in side-by-side relation as shown in FIG. 1 whereby a product can be produced as shown in FIG. 16. It will be noted that each of the coil springs **215–218** has its endmost coils **220** secured back upon themselves at **221**. This operation is effected previous to the use of the coils in the present device. The present spring lacing machine secures the helicals to the opposite sides **225** and **226** of the ends **220** and crimps the helicals to the endmost coils **215** and **218**. The present machine also cuts the helicals at the sides **225** and **226** of the coils **215** and **218** in such a manner that none of the respective helices protrudes beyond the endmost coils.

The inner blocks **211** need only be designed to position the coils **216** and **217** so that the helices **15** can be screwed around the sides **225** and **226**. Each of the holding blocks **211** is, therefore, provided with a U-shaped spring **230** which is fixed to the block **211** and projects from the block through a recess **231**. When the end **220** of one of the coil springs **216** or **217** is supported upon the U-shaped spring **230**, a space is provided beneath, behind and above the end **220** of the spring so that the helix has no obstruction in its path as it is rotated and moved longitudinally of its axis. Thus, the helix can move around the side **225** or **226** of the coil spring to produce the result illustrated in FIG. 16.

It will be noted that the end **220** of the coil springs **216** bears against the surface **219** of the holding block **211** which also acts to provide a space behind the end of the spring in the recess **231**. Secured to the bottom of the holding blocks **211** are sheet metal retainer members **232** which act as guide means for the helices **15**. Each of the retainer members **232** is held up against the bottom **235** of its respective block **211** by means of a compression spring **236** received upon a screw **237**. When it is desired to pull the final product **16** or a partially formed product with only two of the helices **15** away from the spring lacing device, the spring pressed retainers **232** resiliently move down and away from the blocks **211** to permit such removal.

The holding block **210** is perhaps best illustrated in FIGS. 18 and 19 and includes a small projection **240** extending from the block **210** and into an opening **241** through the block **210**. Each of the blocks **210** and **211** has swingably mounted thereon a pair of elliptical members **242**. The elliptical members **242** can be adjustably swung upon mounting screws **245** to various positions for providing mounting of the springs **215–218**. Thus, if the base **220** of a given spring has a relatively large radius or diameter, the elliptical members **242** are swung somewhat outwardly. If the base **220** of the spring has a relatively small radius or diameter, the elliptical members are swung inwardly. It can be appreciated that in the case of the holding blocks **211**, the U-shaped member **230** plus the elliptical members **242** provide a four-point support. In the case of the holding blocks **210**, the elliptical members **242** and the projection **240** provides a three-point support. It will be appreciated, however, that the projection **240** as well as the surface **239** of the block **210** does space the end **220** of the coil away from the sides of the aperture **241** so that there is space for the helix **15** to screw around the sides **225** and **226** of the coil.

As is suggested above, the product illustrated in FIG. 16 is formed by placing the various coil springs **215–218** between the pins of holding blocks **210** and **211** in the manner illustrated in FIGS. 1, 17 and 19. The drive means **70** and auxiliary drive means **105** are then operated to move the pair of helices through the mounting blocks and to a position surrounding the ends **220** of the springs **215–218** producing an assembly approximating that illustrated in the lower half of FIG. 16 but without the ends of the helices **15** trimmed off or crimped. The trimming and crimping operation is then carried out by the trimming and crimping assemblies **250** and **251**.

Referring primarily to FIGS. 2 and 8, the trimming and crimping assembly **250** is illustrated and is also representative of the trimming and crimping assembly **251**. The trimming and crimping assembly **251** is identical to the trimming and crimping assembly **250** except that the assembly **251** has its jaws arranged in a different manner as is explained below. The assembly **250** includes a pair of plates **255** each of which have a pair of apertures **254** therethrough through which extend horizontal rods **256** fixed to the frame **10** and to cross members including cross member **201** extending between the uprights **200** and the uprights **20**. The cutting and crimping assembly **250** and **251** are slidable upon the rods **256** and can be adjusted as to their position upon the rods by a screw **257** having a wheel **260** secured to the end thereof. The screw **257** is threadedly received through suitable threaded apertures in the plates **255**. Secured to the lower end of the plates **255** are rods **260** which mount a hydraulic cylinder **261** having a piston rod **262**, the distal end of which has levers **265** swingably pinned thereto. The levers **265** have shafts **266** extending therethrough centrally of the levers, said shafts **266** pivotally mounting levers **267**. The levers **265** have rollers **270** rotatably mounted at one end thereof and adapted to roll across camming surfaces **271** secured to levers **272**.

The levers **272** have pivotally secured thereto jaws **275** which cooperate with opposing jaws **276** fixedly mounted on the levers **267**. When the hydraulic cylinder **261** projects its piston **262**, the levers **265** spread to the position shown in FIG. 9 causing the shafts **266** to move apart and to pivot the levers **267** about the shaft **256** and the jaws **276** toward the helices **15** where they surround the endmost coils **220** of the endmost coil springs, for example **215**.

Simultaneously with the outward movement of the jaws **276**, the jaws **275** are moved inwardly by the rollers **270** moving across the cam surfaces **271**. The purpose of the movement of the jaws **275** is to move the helices and the coils **220** away from the holding blocks a sufficient distance so that the helices can be properly crimped and cut against the coils. FIG. 9 shows the apparatus after the crimping and cutting action and shows the helix in a crimped position. The configuration of a representative one of the jaws is best shown in FIG. 15. FIG. 14 shows a representative one of the jaws **276'** of the cutting and crimping apparatus **251**. It will be noted that jaws **276'** incorporate a shield **276A** which projects downwardly. The jaws **276** are mirror images of one another and have cutting anvils **280** and crimping surfaces **282** which are at right angles to the direction of movement of the jaws **276**. The jaws **275**, as can be seen in FIGS. 12 and 19, have a cooperating configuration to the configuration of the jaws **276**. Each of the jaws **275** have a cutting anvil **285** and a recessed crimping surface **286**. As can be seen in FIGS. 9, 12 and 19, however, the surfaces **285** and **286** are at an angle of approximately 75 degrees to the direction of movement of the jaws **275**.

Referring now to FIG. 8A, the jaws **275'** and **276'** of the cutting and crimping assembly **251** are illustrated. The jaws **275'** and **276'** also incorporate cutting anvils **281** and **285'** and crimping surfaces **283** and **286'** similar to jaws **276** and **275** but reversed because the trailing portion of the helix is to be cut while the next-to-trailing portion is to be crimped. Of course, in the case of jaws **275** and **276** the leading portion of the helix is to be cut while the next-to-leading portion is to be crimped. It should be mentioned that the 75 degree–90 degree angular relationship of the jaws **275'** and **276'** is reversed from the jaws **275** and **276**. That is the jaws **275'** have cutting and crimping surfaces **285'** and **286'** which are at right angles to the direction of movement of the jaws while the jaws **276'** have cutting and crimping surfaces **281** and

283 which are 75 degrees to the direction of movement of the jaws.

The cutting knife in the present process and apparatus is the endmost coil 220 of the coil spring either 215 or 218. The coil 220 is supported by the backup force of the cutting anvil either 285, 285', 280 or 281 while the opposite cutting anvil cooperates with the coil 220 to actually produce the cut of the helix. The present procedure might better be termed a fracture or pinching off of the helix rather than a pure cutting operation. Because of the way in which the helix 15 is fed into the cutting and crimping apparatus and primarily because of the auxiliary drive means 105, the cut or pinching of the helix is always effected at the outside with regard to the cutting and crimping apparatus 250 and at the inside with regard to the cutting and crimping apparatus 251. In other words, in the present embodiment of the device, the cutting or pinching of the helix is effected between the coil 220 and the cutting anvil 285 and also between the coil 220 and the cutting anvil 281.

The arrows 290 and 291 in FIGS. 14 and 15 show the direction of movement of the jaws 276 and 276' during the cutting and crimping process. It should also be mentioned that the blocks 210 and 211 can be repositioned at any desired location along the length of the anvils 202 and 203 and reattached by means of screws 300. Each of the blocks 210 and 211 has an elongated slot 301 therein which permits minor adjustment of the position of the blocks. The blocks 210 and 211 are maintained at the proper attitude by flanges 299 on angles 202 and 203 and by recesses 298 in blocks 210 and 211. Referring to FIGS. 18 and 19, it can be seen that the jaws 275 have rounded sides 302 and slide in a slot 241 which is similarly shaped to the jaws 275. In the lower surface of the jaws 275, there is formed a recess 305 which slides over the projection 240 during the cutting and crimping process. A fragmentary view of the product resulting from the cutting and crimping procedure is illustrated in FIG. 13.

Referring to FIGS. 20 and 21, an alternative means of mounting of the blocks 210 and 211 is illustrated. In FIG. 20, the holding block 310 may be similar or identical to the holding block 210 and 211. The holding block 310 is mounted upon a member 311 similar to the members 202 and 203. The screw 312 corresponds to the screw 300 but is not received in an elongated slot such as the slot 301 and instead is received within a bore 315 and a countersunk portion 316. The screw 312 is threaded into a member 317 which is received within an elongated slot 320 in the member 311. The slot 320 includes additional slots or recesses 321 which open into the slot 320.

It will be noted that the member 317 has a pair of projections 322 which can be moved into the slots 321 by rotation of the screw 312. Thus, even though the member 317 is threadedly received upon the screw 312, there is a certain amount of friction between the screw and member 317 which permits rotating of the member 317 into and out of the slot portions 321 by means of the screw 312. Once the projections 322 have been seated within the slot portions 321, the user of the structure of FIGS. 20 and 21 can then tighten up on the screw 312 firmly mounting the holding block 310 in position. The advantage of the illustrated construction is the fact that the holding block 310 can be moved from one end to the other of the member 311 without complete removal of the screw from the member 317. Thus, repositioning of the holding blocks 210 and 211 or 310 can be a simple, quickly accomplished operation requiring only partial unthreading of the screw 312, movement of block 310 and retightening of screw 312.

The electrical circuit of the present invention is illustrated in FIG. 22. There is a relatively simple hydraulic circuit also involved in the present machine. However, the hydraulic circuit with associated components is commercially available and consequently is not described herein. The hydraulic unit used in the present machine may be manufactured, for example, by Vickers, Inc., of Detroit, Mich., and might include a hydraulic pump PVB 5–FLS–10–C–10, the hydraulic tank T 10, a filter 650–S–20–M3–P4–42, and a valve DG 4S4–0186–43.

Each of the hydraulic piston motors, i.e. the motor 261 of the cutting and crimping assembly 250 and the motor 261' of the cutting and crimping assembly 251 is provided with two ports each opening into the hydraulic cylinder motor on the opposite side of the piston thereof. Thus, when it is desired to project the piston, hydraulic fluid is pumped into one of the ports and is removed from the other of the two ports. When it is desired to retract the hydraulic piston, hydraulic fluid is pumped into the other of the ports and removed from the one of the ports. Each of the two motors 261 and 261' is coupled in parallel to the above mentioned hydraulic systems including the pump and associated components whereby motors or cylinders 261 and 261' project and retract together. Referring to the electrical schematic diagram, there is provided a hydraulic solenoid 400 for up movement of pistons 262 and 262' and a hydraulic solenoid 401 for down movement of the pistons, said hydraulic solenoids 400 and 401 forming a part of the valve DG 4S4–0186–43. When the solenoid 400 is energized, the hydraulic cylinders are actuated to project their pistons 262 and 262'. When the solenoid 401 is energized, the hydraulic cylinders are actuated to retract their pistons.

A foot switch 402 is provided for the operator to control the motor 75 and solenoid 401. The foot switch is so arranged that it can be actuated in one direction to cause the motor to drive the helices forwardly or leftwardly as the machine is illustrated in FIGS. 1 and 2. The operator can also reverse the driving action of the motor 75 by reversing the foot pedal switch 402. For effecting the above described operation, the switch 402 incorporates contacts 405, 406 and 407. The contacts 405 can either engage contacts 410 or contacts 411. The contacts 406 can either engage contacts 412 or 415. The contacts 407 can either engage contacts 416 or 417. The wire 420 is grounded at 418 and provides one of the lines from the power source. The other lines from the power source are wires 421 and 422 which provide, respectively, 110 volt current and 220 volt current.

Assuming now that the operator desires to operate the present device to produce the product illustrated in FIG. 16, the foot switch 402 is actuated energizing the solenoid 425 through the lines 420 and 426, contacts 410 and 405 and lines 427, 430 and 421. The solenoid 140 and motor 75 are also energized to operate in a forward direction through the lines 420, 431, contacts 412 and 406, lines 432 and 435, contacts 407 and 416 and lines 436 and 421. The energization of the solenoid 425 closes contacts 437 which together with the solenoid 425 make up the relay 440.

Of course, previous to the depression of the foot pedal 402, the operator will have manually mounted the various coil springs 215–218 in the manner illustrated in FIG. 1 upon the respective holding blocks 210 and 211. Closing of the contacts 437 energizes a solenoid 440 through the line 420, line 441, limit switch 442, line 443, contacts 437, line 445 and line 421. The energization of the solenoid 440 which forms a part of the relay 450 causes the contacts 451 and 452 of the relay to close. The closing of the contacts 451 locks in the solenoid 440 even though the contacts 437 may be opened by reason of the operator removing his foot from foot pedal 402. It should be mentioned that the limit switch 442 is mounted on the crimping and cutting assembly 250 as indicated in FIG. 2 and is closed when the motor 261' has its piston 262' retracted and open when projected.

Of course the energization of the solenoid 140 raises the spur gears 145 and the rollers 147 and 148 upwardly as viewed in FIG. 6 to engage the helix 15 within each of the tubes 160 and 180 and 161 and 181. As explained above, the helices 15 are thereby caused to be driven for-

wardly or leftwardly as viewed in FIGS. 1 and 2 causing the helices to move through a screw thread path and to screw around each of the endmost coils **220** of the coil springs **215–218**. The closing of the contacts **452** has no effect until the helices have completed their movement around the coils of all of the coil springs **215–218**. This is true because of the fact that the limit switches **465** and **466** are normally open and are not closed until the helices have completed their movement. Referring to FIG. 1, the limit switches **465** and **466** are shown at the end of the path of the coils. FIG. 11 is representative of both of the limit switches and shows limit switch **466** mounted upon angle **202**. Each of the limit switches **465** and **466** is provided with a pivotally mounted lever **470** for actuation of the limit switch.

When both of the helices have completed their movement into engagement with the levers **470** of the two limit switches **465** and **466**, both of the switches are closed whereby the solenoid **455** of a relay **470** is energized as is the solenoid **471** of a relay **472**. The relay **472** has normally closed contacts **475** which are thereby opened deenergizing the solenoid **401** associated with the hydraulic valve and normally causing lowering of the pistons **462** and **462'** when solenoid **401** is energized. The energization of the solenoid **455** of the relay **470** closes the contacts **476** and **477** which locks in the solenoids **455** and **471** even though contacts **452** or the contacts of switches **465** and **466** may open.

The closing of the contacts **477** of the relay **470** energizes the solenoid **400** associated with the hydraulic valve causing the cylinders **261** and **261'** to project their pistons and causing the above described crimping and cutting operation.

The limit switch **480** is mounted upon the cutting and crimping assembly **451** and is actuated to close its normally open contacts upon the projection or the beginning of the projection of the piston rod **262'** of the hydraulic cylinder **261'**. The closing of the switch **480** energizes a motor **481** associated with the above mentioned Automatic Helical Maker machine **16**. The motor **481** operates the machine to start forming a new length of helical wire and to move the new length of helical wire through the guides **11** into the cutter assembly **22**. As the newly formed helicals move into the tubular guide members **160** and **161**, the actuating arm **174** of the limit switch **171** is actuated opening the limit switch and deenergizing the helical forming motor **481**. The motor **481** does not immediately stop but coasts to a certain extent causing the helicals moving through the tubular guides **160, 161, 180** and **181** to continue their movement until the actuating arm **173** of the limit switch **170** is actuated closing the limit switch and energizing the solenoid **26** whereby the helicals are cut to length and are ready for the next spring lacing, cutting and crimping operation.

Returning again to the cutting and crimping operation, the solenoid **400** remains energized producing pressure upon the cutting and crimping jaws until a pressure switch **485**, mounted to sense the pressure within the hydraulic cylinders **261** and **261'** is opened, at which time the circuit to the solenoid **455** is broken opening contacts **476** and **477**. The opening of the contacts **477**, of course, deenergizes the solenoid **400**.

The opening of the switch **485** also deenergizes the solenoid **471** of the relay **472** closing the contacts **475** and thus energizing the solenoid **401** operating the hydraulic valve to move the cylinder motors **261** and **261'** downwardly releasing the crimped and cut product. It can be seen that a single spring lacing, crimping and cutting operation will provide only two of the four required helices on the final product. In order to complete the product of FIG. 16, the partially completed product must be turned over and repositioned on the holding blocks **210** and **211** whereupon the above procedure is repeated. As the hydraulic pistons complete their return to the retracted position, a limit switch **500** mounted on the cutting and crimping assembly **250** is actuated opening its contacts and deenergizing the hydraulic solenoid **401** thus returning the hydraulic unit to neutral position.

From the above description it will be evident that the present invention provides an improved method and apparatus for the manufacture of a spring laced product. It will be further evident that the present invention provides a spring lacing apparatus which produces a complete spring laced product without any necessity of manual cutting and crimping of lacing materials. It can also be seen that the present invention provides a method and apparatus for producing a sturdier, stronger, more uniformly acceptable spring laced product.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirit of the invention and the scope of the claims are also desired to be protected.

The invention claimed is:

**1.** Spring lacing apparatus comprising means for rotating a helix about its axis and moving it longitudinally of its axis to engage and surround a plurality of individual coil springs at one side of one end of each spring, means for crimping the helix against the endmost of said coil springs and for cutting off said helix by pressing the helix against the one side of one end of the endmost coil springs, said last mentioned means including a pair of jaw assemblies between which said helix and coil springs are received for simultaneous cutting and crimping.

**2.** Spring lacing apparatus comprising jig means for supporting a plurality of coil springs in side-by-side relation, said jig means including a pair of opposed seats for each of said coil springs, each of said seats including means for holding one side of one end of the coil spring, means for rotating a pair of helices about their axis and moving them longitudinally of their axis to engage and surround the individual springs at each one side thereof, and means responsive to the completed longitudinal movement of said helices for crimping the helices against the endmost of said coil springs and for simultaneously cutting off said helices, said last mentioned means including a pair of jaw assemblies between which said helix and coil springs are received for simultaneous cutting and crimping.

**3.** Spring lacing apparatus comprising jig means for supporting a plurality of coil springs in side-by-side relation, said jig means including a pair of opposed seats for each of said coil springs, each of said seats including means for holding one side of one end of the coil spring, means for rotating a pair of helices about their axis and moving them longitudinally of their axis to engage and surround the individual springs at each one side thereof, means for crimping the helices against the endmost of said coil springs and for cutting off said helices against the one side of each end of the endmost coil springs, said last mentioned means including a pair of jaw assemblies between which said helix and coil springs are received for simultaneous cutting and crimping.

**4.** Spring lacing apparatus comprising a plurality of holding blocks each of said holding blocks having a face with an elongated recess therein, one-half of said holding blocks being mounted with their faces in mutually facing relation to the faces of the other half of said holding blocks, said blocks tilting upwardly away from one another whereby a coil spring can be inserted between each opposed pair of blocks, a plurality of projecting elements each secured to a respective one of said blocks and extending through the recess of said block for supporting the endmost coil of a coil spring away from the walls of said recess, said blocks being positioned with the recesses of the one-half of said blocks in alignment and the recesses of the other half of said blocks in alignment,

means for rotating a pair of helices about their axis and moving them longitudinally of their axis through said recesses to engage and surround the individual springs at the endmost coils thereof, means for crimping the helices against the endmost of said coil springs and for cutting off said helices against the one side of each end of the endmost coil springs.

5. Spring lacing apparatus comprising a pair of elongated spaced parallel supports each having a first elongated slot therein, a plurality of holding blocks, a plurality of screws each through a respective one of said holding blocks, a plurality of mounting members each threadedly and frictionally received on a respective one of said screws, said elongated spaced parallel supports each having further mutually facing elongated slots opening into said first slot, said mounting members each having oppositely extending projections adapted to be extended into said further slots upon rotation of the screw upon which the respective mounting member is frictionally mounted, said screws being further rotatable to draw up said mounting members firmly against said supports, each of said holding blocks having a face with an elongated recess therein, one-half of said holding blocks being mounted on one of said parallel supports with each face thereof in mutually facing relation to the face of a respective one of the other half of said holding blocks mounted on the other of said parallel supports, said blocks tilting upwardly away from one another whereby a coil spring can be inserted between each opposed pair of blocks, a plurality of projecting elements each secured to a respective one of said blocks and extending through the recess of said block for supporting the endmost coil of a coil spring away from the walls of said recess, said blocks being positioned with the recesses of the one-half of said blocks in alignment and the recesses of the other half of said blocks in alignment, means for rotating a pair of helices about their axis and moving them longitudinally of their axis through said recesses to engage and surround the individual springs at the endmost coils thereof, means for crimping the helices against the endmost of said coil springs and for cutting off said helices against the one side of each end of the endmost coil springs.

6. Spring lacing apparatus comprising a pair of elongated spaced parallel supports, holding blocks mounted on said supports and adjustable along the length of said spaced supports, each of said holding blocks having a face with an elongated recess therein, one half of said holding blocks being mounted on one of said parallel supports with each face thereof in mutually facing relation to the face of a respective one of the other half of said holding blocks mounted on the other of said parallel supports, said blocks tilting upwardly away from one another whereby a coil spring can be inserted between each opposed pair of blocks, a plurality of projecting elements each secured to a respective one of said blocks and extending through the recess of said block for supporting the endmost coil of a coil spring away from the walls of said recess, said blocks being positioned with the recesses of the one half of said blocks in alignment and the recesses of the other half of said blocks in alignment, means for rotating a pair of helices about their axis and moving them longitudinally of their axis through said recesses to engage and surround the individual springs at the endmost coils thereof, means for crimping the helices against the endmost of said coil springs and for cutting off said helices against the one side of each end of the endmost coil springs.

7. Spring lacing apparatus comprising a plurality of holding blocks each of said holding blocks having a face with an elongated recess therein, one-half of said holding blocks being mounted with their faces in mutually facing relation to the faces of the other half of said holding blocks, said blocks tilting upwardly away from one another whereby a coil spring can be inserted between each opposed pair of blocks, said blocks being positioned with the recesses of one-half of said blocks in alignment and the recesses of the other half of said blocks in alignment, means for rotating a pair of helices about their axis and moving them longitudinally of their axis within said recesses to engage and surround the individual springs at the endmost coils thereof, four pairs of cutting and crimping jaws, the two endmost ones of each of said holding blocks on each of said parallel supports having a passage therethrough through which one jaw of each of said pair of jaws projects, means for closing the jaws of each pair of jaws and for simultaneously moving said one jaw of each pair of jaws through said passage into said recess, one jaw of each pair of jaws having a cutting anvil thereon positioned to cut the respective helical in cooperation with the respective coil spring.

8. Spring lacing apparatus comprising a pair of elongated spaced parallel supports, holding blocks mounted on said supports and adjustable along the length of said spaced supports, each of said holding blocks having a face with an elongated recess therein, one half of said holding blocks being mounted on one of said parallel supports with each face thereof in mutually facing relation to the face of a respective one of the other half of said parallel supports, said blocks tilting upwardly away from one another whereby a coil spring can be inserted between each opposed pair of blocks, said blocks being positioned with the recesses of one half of said blocks in alignment and the recesses of the other half of said blocks in alignment, means for rotating a pair of helices about their axis and moving them longitudinally of their axis within said recesses to engage and surround the individual springs at the endmost coils thereof, four pairs of cutting and crimping jaws, the two endmost ones of each of said holding blocks on each of said parallel supports having a passage therethrough through which one jaw of each of said pair of jaws projects, means for closing the jaws of each pair of jaws and for simultaneously moving said one jaw of each pair of jaws through said passage into said recess, one jaw of each pair of jaws having a cutting anvil thereon positioned to cut the respective helical in cooperation with the respective coil spring.

9. Spring lacing apparatus comprising a pair of elongated spaced parallel supports, holding blocks mounted on said supports and adjustable along the length of said spaced supports, each of said holding blocks having a face with an elongated recess therein, one-half of said holding blocks being mounted on one of said parallel supports with each face thereof in mutually facing relation to the face of a respective one of the other half of said holding blocks mounted on the other of said parallel supports, said blocks tilting upwardly away from one another whereby a coil spring can be inserted between each opposed pair of blocks, said blocks being positioned with the recesses of one-half of said blocks in alignment and the recesses of the other half of said blocks in alignment, means for rotating a pair of helices about their axis and moving them longitudinally of their axis within said recesses to engage and surround the individual springs at the endmost coils thereof, four pairs of cutting and crimping jaws, the two endmost ones of each of said holding blocks on each of said parallel supports having a passage therethrough through which one jaw of each of said pair of jaws projects, means for closing the jaws of each pair of jaws and for simultaneously moving said one jaw of each pair of jaws through said passage into said recess, each of said jaws having a crimping anvil surface and a projected cutting anvil surface, the anvil surface of the one jaw of each pair of jaws being positioned to move toward the anvil surface of the other jaw of each pair of jaws when said

pairs of jaws close, the crimping surface of the one jaw of each pair of jaws being adapted to move toward the crimping surface of the other jaw of each pair of jaws when said pairs of jaws close.

**10.** A method of making a spring laced product comprising supporting a plurality of coil springs in side-by-side relation, rotating a helix about its axis and moving it longitudinally of its axis to engage and surround the individual springs at one side of one end thereof, crimping the helix against the endmost of the coil springs and simultaneously cutting off the helix by pinching it against the side of the end of the endmost coil springs.

**11.** A method of making a spring laced product comprising supporting a plurality of coil springs in side-by-side relation, rotating a pair of helices about their axis and moving them longitudinally of their axis to engage and surround the individual springs at one side of both ends thereof, crimping the helices against the endmost of said coil springs and simultaneously cutting off the helices by pinching it against the one side of both ends of the endmost coil springs.

**12.** A method of making a spring laced product comprising supporting a plurality of coil springs in side-by-side relation, rotating a pair of helices about their axis and moving them longitudinally of their axis to engage and surround the individual springs at one side of opposite ends thereof, crimping the helices against the endmost of said coil springs, cutting off the helices by pinching them against the one side of the opposite ends of the endmost coil springs, rotating a further pair of helices about their axis and moving them longitudinally of their axis to engage and surround the individual springs at the other side of both ends thereof, crimping the helices against the endmost of said coil springs and simultaneously cutting off the helices by pinching them against the other side of the opposite ends of the endmost coil springs.

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