March 8, 1966 S. L. ALBRIGHT ETAL 3,238,754

METHOD AND MACHINE FOR MAKING NON-CUMULATIVE FORCE SPRINGS

Filed May 16, 1963 2 Sheets-Sheet 1

Fig. 2

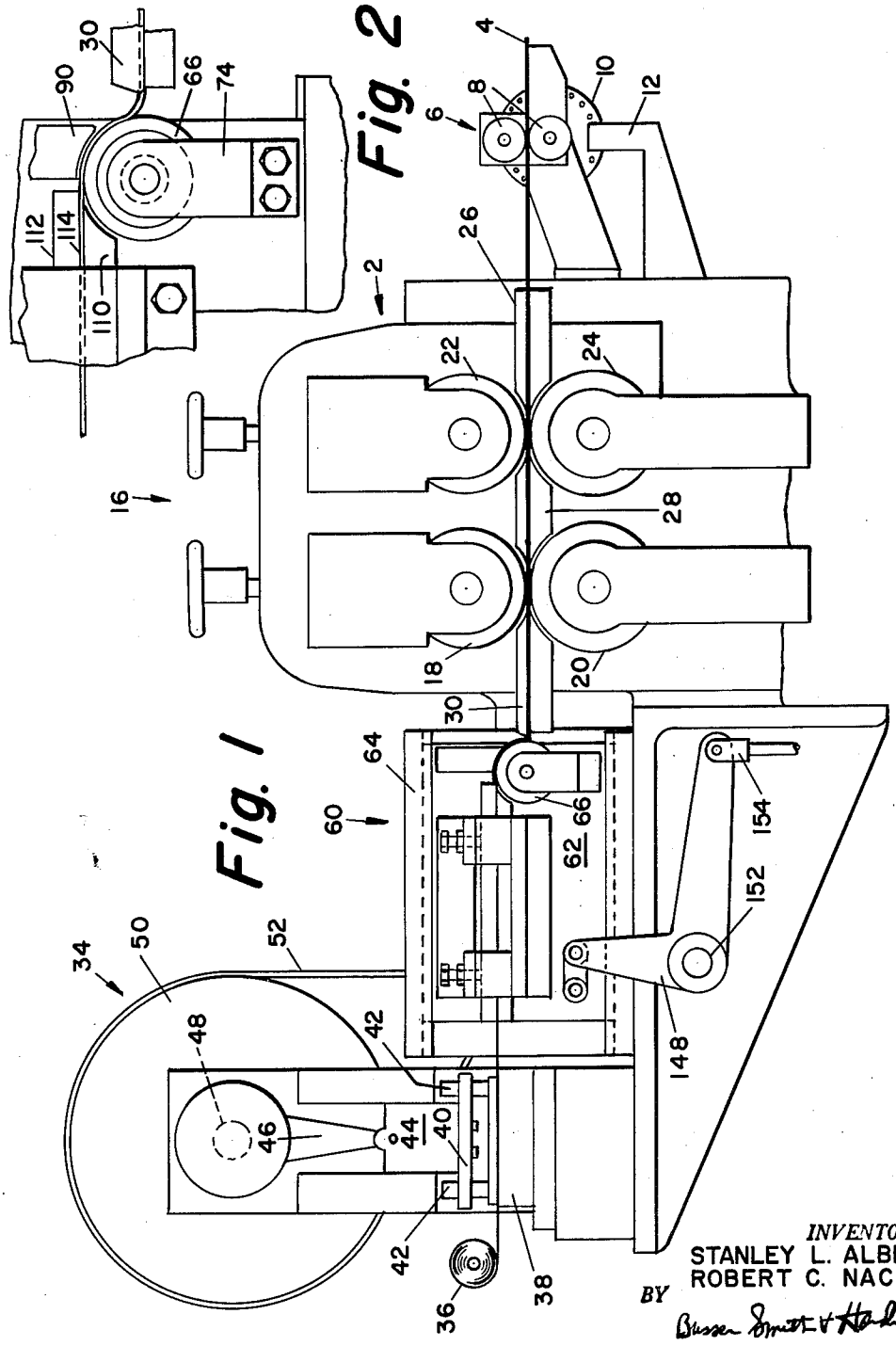


Fig. 1

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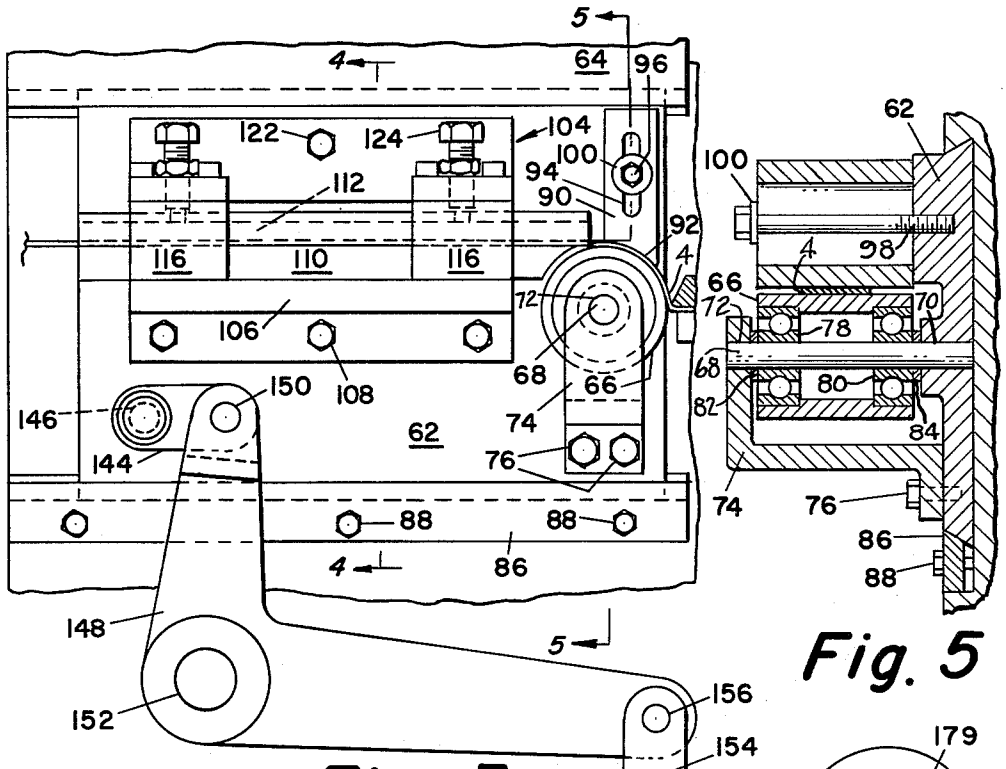


Fig. 3

Fig. 5

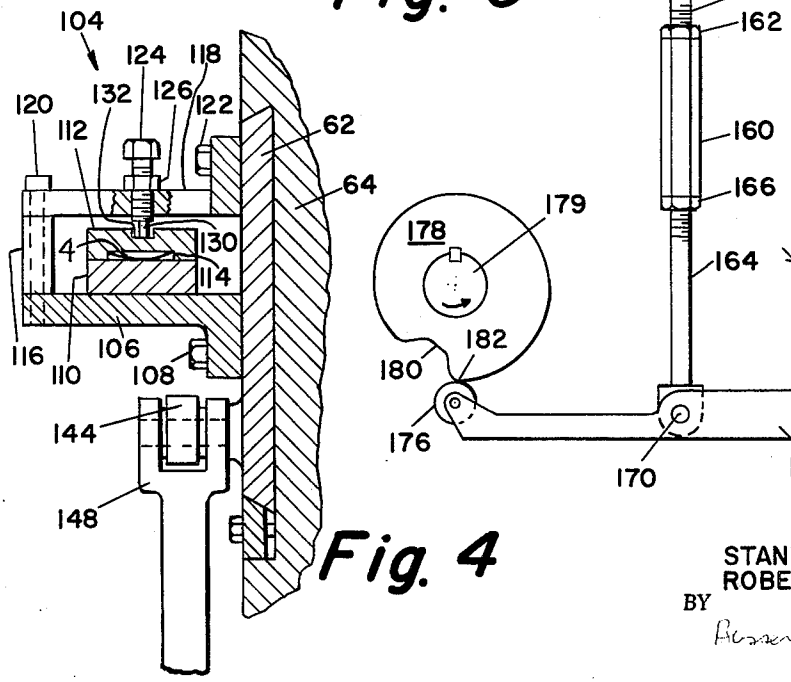


Fig. 4

Fig. 6

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United States Patent Office 3,238,754 Patented Mar. 8, 1966

3,238,754

METHOD AND MACHINE FOR MAKING NON-CUMULATIVE FORCE SPRINGS

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Filed May 16, 1963, Ser. No. 280,943
7 Claims. (Cl. 72—146)

This invention relates to an improvement in a spring coiling machine and method used to make tightly coiled non-cumulative force spiral springs.

It is well known to make tightly coiled non-cumulative force spiral springs such as those disclosed in Foster No. 2,609,191 and in Lermont Patent No. 2,609,192 from a strip of spring metal. Before this invention, such springs were made commercially by feeding the spring stock against a bending abutment and then feeding the bent stock past a back-bending tool in the nature of a finger projecting into the path of the spring stock in order to introduce the desired residual stresses. Such a machine is disclosed in Franks Patent No. 2,923,343 issued February 2, 1960. Machines of this type have been found deficient in that they provide an uncertain control of back bending due to the difficulty of controlling the precise position of the stock as it passes the back bending tool.

It is, therefore, an object of this invention to improve the conventional machines for forming tightly coiled non-cumulative force spiral springs by providing improved means for bending and back bending the spring stock.

It is a further object of this invention to provide an improvement in machines for coiling tightly coiled non-cumulative force spiral springs in which there is provided a wide flexibility as to where the end product spring is cut off and coiled.

It is an additional object of this invention to provide a simple and effective method for forming non-cumulative force spiral springs.

These and other objects will become apparent on reading the following description in conjunction with the drawings in which:

FIGURE 1 is a side elevation of a coiling machine incorporating the invention;

FIGURE 2 is a side elevation partially broken away of the forming roller and associated elements of FIGURE 1;

FIGURE 3 is a side elevation detailing the operating cam control means;

FIGURE 4 is a vertical section taken on the plane indicated by the line 4—4 in FIGURE 3;

FIGURE 5 is a vertical section taken on the planes indicated by the line 5—5 in FIGURE 3; and

FIGURE 6 is a side elevation of an alternative control cam.

As will be evident from the following description, the coiling machine 2 containing the improvement of this invention is the same as the coiling machine of Franks Patent No. 2,923,343 with the exception of the strip bending means to be described later.

Coiling machine 2 is supplied with a strip of spring steel 4 which passes through a measuring device 6 which has conventional measuring rolls 8, 8, notched disc 10 and photoelectric detector 12.

Coiling machine 2 has a feed roll section 16 having driven feed rolls 18, 20, 22 and 24 for advancing strip 4 which is guided by guides 26, 28 and 30.

Coiling machine 2 is also provided with a wire cutting device or press 34 for severing strip 4 when the coiled spring indicated at 36 has reached the desired size. Press 34 may also be utilized in the conventional manner to die out and opening in one or both ends of the spring as a means for securing the spring. Press 34 has a die indicated at 38 and a punch mechanism indicated at 40 mounted to ride up and down on pins 42. A slide 44 connected to punch member 40 is pivotally connected to connecting rod 46 which is eccentrically mounted (not shown) on a shaft 48 connected to a fly wheel 50 driven by a belt 52 which in turn is driven by a motor (not shown).

The machine as thus described is well known to the art, being disclosed in greater detail in Franks Patent No. 2,923,343.

The improvement of this invention is in the bending apparatus 60 which has a tool slide 62 mounted in slide carrier 64 for horizontal movement.

As best seen in FIGURES 3 and 5, a metal forming roller 66, preferably of steel, is mounted for free rotation on a pin 68 which is secured by a pressed fit in an opening 70 in slide 62 and in an opening 72 in a bracket 74 secured to slide 62 by machine screws 76. The mounting of roller 66 for free rotation is accomplished by means of a pair of ball bearings 78 and 80 interposed between pin 68 and roller 66. A spacer washer 82 is interposed between ball bearing 78 and bracket 74 and a spacer washer 84 is interposed between ball bearing 80 and slide 62. A beveled retainer strip 86 secured to slide carrier 64 by screws 88 holds tool slide 62 in the slide carrier.

A guide shoe 90 has a lower arcuate face 92 closely spaced to the periphery of roller 66 to act as a guide for metal strip 4 as it passes about the roller. Shoe 90 is provided with a slot 94 through which passes a machine screw 96 which threadably engages slide 62 at 98 and clamps a washer 100 against shoe 90 to hold it in the desired position.

A strip guide 104 is provided on tool slide 62. As best seen in FIGURES 3 and 4, guide 104 comprises a flange 106 secured to slide 62 by screws 108 and supporting a lower guide member 110 which in turn supports an upper guide member 112 provided with a recess 114 for the accommodation of strip 4. On its outer edge, flange 106 carries supporting members 116 which support the outer edge of a flange 118. Screws 120 are employed to secure flange 118 and supports 116 to flange 106. Flange 118 is also secured to slide 62 by means of screws 122. A pair of screws 124 each provided with a lock nut 126 are threadably secured to flange 118 and are each provided with a reduced end 130 which engages a recess 132 in the upper face of guide member 112 to hold guide members 112 and 110 in the desired position.

Referring to FIGURES 3 and 4, a link 144 is pivotally secured to slide 62 as indicated at 146 and to crank lever 148 as indicated at 150. Lever 148 is pivoted as indicated at 152 and pivotally connected to member 154 as indicated at 156. Member 154 is secured to a threaded member 158 which is engaged by adjustment nut 160 and locked by lock nut 162. Adjustment nut 160 also engages threaded member 164 to which it is locked by lock nut 166. Threaded members 158 and 164 have opposite hand threads accommodated by nut 160 to cause them to be moved away from or into nut 160 simultaneously. Threaded member 164 is pivotally secured to a lever 168 at 170. Lever 168 is pivotally secured at 172 and biased upwardly by means of an extension spring indicated at 174. Lever 168 carries a cam follower roller 176 which engages a cam 178 which is fixedly secured to cam shaft 179 which is geared to coiling machine 2 (by mechanism not shown) to rotate 360° during the period of forming a single spring, shaft 179 starting and stopping simultaneously with the drive rolls 18, 20, 22 and 24. Cam 178

has a low point indicated at 180 and as viewed in FIGURE 3, the cam surface rises in the clockwise direction at a steady rate until the high point indicated at 182 is reached.

Operation

In operation, the coiling machine 2 will be set to drive feed rolls 18, 20, 22 and 24 intermittently in order to successively feed the length of strip 4 which is proper for the desired length of springs 36. Manual starting for each spring or continuous repetitive cycles may be used as fully described in Patent No. 2,923,343.

As viewed in FIGURES 1 and 3, bending apparatus 60 is about to complete the formation of a spring to provide it with a straight unbent tail portion. With cam shaft 179 rotating counterclockwise as viewed in FIGURE 3, cam follower roller 176 is moving towards the low point 180 of cam 178 which will cause lever 168 to be pivoted clockwise as viewed in FIGURE 3 to elevate threaded members 164 and 158 and adjustment nut 160 towards lever 148 to move it counterclockwise as viewed in FIGURE 3 urging lever 144 and tool slide 62 to the left as viewed in FIGURE 3 to position forming roller 66 at its maximum distance from guide 30 which is the position illustrated in FIGURE 2. In this position the roller 66 is spaced so far from guide 30 that the strip 4 will not be bent sufficiently sharply to be permanently set. The diameter of the roller 66 is such that the reverse bending under these circumstances will not permanently set strip 4 and hence a straight tail portion is formed. By way of specific illustration, when using material having a yield point of over 250,000 p.s.i. and a modulus of elasticity of 30×10^6, roller 66 is withdrawn so that the radius of initial bending is at least 60 times the strip thickness and the radius of the roller is at least 60 times the strip thickness so that no set is imparted during the initial bending and the backbending of the strip, the computation being as follows:

$$\frac{\text{Radius}}{\text{Strip thickness}}=\frac{E}{2S}=\frac{30\times10^6}{2\times250{,}000}=60$$

After the straight tail portion of spring 36 has been formed, the formation of a new spring immediately commences. Roller 176 is engaged by the portion of cam 178 which is beyond the low point to reposition roller 66 adjacent guide 30 to cause a permanent setting of strip 4. As the cam 178 continues to rotate counterclockwise as viewed in FIGURE 3, it causes the gradual lowering of roller 176 which in turn will, through lever 168, threaded members 164 and 158, adjustment nut 160, lever 148, lever 144 and pin 70, cause forming roller 66 to be advanced at a steady rate towards guide 30. The feed rolls advance strip 4 through guide 30 and into contact with roller 66 in a plane passing through or just above the axis of roller 66 causing strip 4 to be bent upwardly and set to the desired radius. Generally the radius of bending will be of the order of 10 to 15 times the thickness of the strip. In the case under discussion the desired radius of set as the spring is formed is gradually reduced by virtue of the movement of the forming roller 66 towards guide 30. Thus bent and set, strip 4 follows the periphery of forming roller 66 which bends strip 4 in the reverse of the initial direction to reverse bend strip 4 sufficiently to introduce residual stresses in the strip.

This operation follows the method taught in Patent No. 3,007,239, issued November 7, 1961, which teaches the initial bending of a strip of spring material so that it tends to coil tightly on itself in one direction and reverse bending the material to set each increment of the material so that it still tends to coil tightly on itself in the same direction but on a radius larger than the radius of initial set. By the same token, the bending and reverse bending carried out in the operation described above are the same generally as that carried out in Patent No. 2,923,-343. However, the apparatus of this invention is highly superior in that by keeping the strip 4 in contact with roller 66 complete control of strip 4 and its reverse bending is achieved.

In the above described operation, shoe 90 functions to insure that strip 4 does not deviate from its contact with forming roller 66. Roller 66 being free to rotate, its periphery rotates at the linear rate of movement of the strip 4.

The thus formed strip 4 moves through guide 104 the recessed portion 114 of which is tangent to roller 66 and past press 34 to form a tightly coiled spring indicated at 36. When the tail of the spring reaches the appropriate position with relation to press 34, the feed rolls and cam shaft 179 are arrested and the press operates to sever the completed spring from strip 4 and form any desired openings in the tail which in the specifically described operation above will be straight and in the leading end of the next spring.

It will be appreciated that by variations in cam 178, a wide variety of different tightly coiled noncumulative force springs can be formed by the invention with highly superior control of the backbending operation to place a residual stress in the formed spring. Any desired set of the initial portion of the spring and any desired increase or decrease in the radius to which the spring is set can be readily achieved by varying the cam design. There is illustrated in FIGURE 6, by way of example, a cam 178A which can be substituted for cam 178 on cam shaft 179 to produce a spring having each increment of length including the tail set to the same radius, cam 178A having a constant radius. Further, the cam shaft 179 may be rotated continuously as is the practice in many spring making machines provided a constant radius "dwell portion" is provided on the associated cam to be effective during the period the spring strip is arrested for cut-off in order that the position of roller 66 remains unchanged while the strip is not moving with relation to it.

It will further be obvious that the invention is further advantageous since it permits leading off the spring from the bending apparatus in a wide variety of different directions. Contrast, for example, the convenience of the apparatus lay-out shown in FIGURE 1 as against the necessity for the positioning of the press above the bending apparatus in the machine of Patent No. 2,923,343. It will be apparent that formed strip 4 can be led off from forming roller 66 at any point after it has been in contact with the roller for about 20° of arc or travel. Thus, for example, press 34 could be positioned where it is shown in FIGURE 1 or substantially above bending apparatus 60 as in Patent No. 2,923,343 or substantially below bending apparatus 60.

The method of making a non-cumulative force spring in accordance with this invention comprises successively sharply bending to a predetermined radius successive increments of a strip of material having spring characteristics such as, for example, spring steel to effect an initial set of the material so that it tends to coil tightly on itself in one direction by forcing the strip through a guide and against an arcuate surface such as, for example, a roller or a comparable non-movable surface. The thus set material is then reverse bent about the arcuate surface to introduce residual stresses so that the material still tends to coil tightly on itself in the original direction but on a radius larger than the radius of initial set.

It will be appreciated that the above specifically described embodiments of the invention are by way of illustration only and that it is not intended to be limited except as set forth in the claims.

What is claimed is:

1. In a machine for coiling tightly coiled noncumulative force spiral springs having feed rolls for feeding a strip of spring metal and a guide means following the feed rolls to guide the strip along a predetermined path

after leaving said feed rolls, the improvement comprising: strip bending means providing an arcuate surface adjacent the discharge end of the guide means, the plane of the path provided by said guide means adjacent its discharge end intersecting said arcuate surface to cause the bending and setting of the strip and guide means to cause the bent strip to conform to a portion of the arcuate surface to backbend the strip to impart residual stresses therein.

2. A machine in accordance with claim 1 in which there is provided means to adjust the distance between the end of the guide means and the means providing the arcuate surface.

3. In a machine for coiling tightly coiled noncumulative force spiral springs having feed rolls for feeding a strip of spring metal and a guide means following the feed rolls to guide the strip along a predetermined path after leaving said feed rolls, the improvement comprising: strip bending means comprising a roller adjacent the discharge end of the guide means, the plane of the path provided by said guide means adjacent its discharge end intersecting said roller to cause the bending and setting of the strip and guide means to cause the bent strip to conform to a portion of the periphery of the roller to backbend the strip to impart residual stresses therein.

4. A machine in accordance with claim 3 in which there is provided means to adjust the distance between the end of the guide means and the roller.

5. In a machine for coiling tightly coiled noncumulative force spiral springs having feed rolls for feeding a strip of spring metal and a guide means following the feed rolls to guide the strip along a predetermined path after leaving said feed rolls, the improvement comprising: strip bending means comprising a slide mounted for substantially horizontal movement adjacent the guide, a roller, means mounting said roller on said slide and adjacent the discharge end of the guide means, a guide shoe secured to the slide overlying a portion of the roller

to cause the strip to conform to a portion of the periphery of the roller, guide means secured to the slide to guide the strip after it leaves the roller and means to move the slide to vary the distance between the roller and the first-mentioned guide means.

6. The method of making a noncumulative force spring which comprises successively sharply bending to a predetermined radius successive increments of a strip of material having spring characteristics to effect an initial set of the material so that it tends to coil tightly on itself in one direction by forcing the strip through a guide and against means providing an arcuate surface, reverse bending the thus set material so that it still tends to coil tightly on itself in the original direction but on a radius larger than the radius of initial set by guiding the strip to follow at least a portion of said arcuate surface.

7. The method of making a noncumulative force spring which comprises successively sharply bending to a predetermined radius successive increments of a strip of material having spring characteristics to effect an initial set of the material so that it tends to coil tightly on itself by forcing a strip through a guide and against the surface of a roller, the axis of which is parallel to the plane of the guide and reverse bending the strip to said each increment so that it still tends to coil tightly on itself in the original direction but on a radius larger than the radius of initial set by guiding the initially bent strip to follow a portion of the periphery of the roller.

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