This invention relates to machines for winding springs of spiral form from strip material having a rectangular cross-section, and more particularly to machines which do not include a mandrel for forming the springs. This application is a continuation-in-part of an earlier application "Methods of and Machines for Winding Spiral Springs," Serial No. 222,973, filed April 26, 1951, and issued December 18, 1956, as Patent No. 2,774,407.

An object of this invention is to provide an improved apparatus for winding springs by forcing a flat band of strip material against and tangentially along spaced surfaces of a shaping tool to bend the band into spiral shape.

Another object of my invention is to provide apparatus of the character described in which the shaping tool includes at least two abutments with guiding surfaces for bending the band, and in which the abutments are moved apart during a spring winding operation to increase the radius of bending as the length of the spring is increased.

Still another object of my invention is to provide spring winding apparatus in which a flat strip or band of rectangular cross-section is forced tangentially over a plurality of guiding surfaces to bend the strip or band into a flattened spiral form such that, on relief of the bending force, the wound spring assumes the form of an Archimedean spiral.

A more specific object of my invention is to provide a spring shaping tool assembly having one abutment comprising a plurality of slidable movable shaping jaws arranged in parallel relationship so that a minimum spacing between the guide abutments is provided at the initial stage of a winding operation and a wide abutment guide face is provided at later stages.

Objects and advantages of my invention will become more apparent from a study of the following specification when considered in conjunction with the accompanying drawings, in which:

Figs. 1 and 2 are fragmentary side elevations, with parts in section, of a shaping tool assembly embodying the invention and showing, respectively, the apparatus at the start and at a subsequent stage in the winding of a spring;

Fig. 3 is a fragmentary side elevation, with parts in section, of a modified form of shaping tool assembly;

Fig. 4 shows a shaping tool assembly for making an initial bend prior to winding;

Fig. 5 shows the assembly after completion of the inner winding;

Fig. 6 shows the shaping tool assembly after the spring has been completely wound to approximately 60% of its final diameter;

Fig. 7 shows the assembly with the shaping tool in its removed position to allow expansion of the spring;

Fig. 8 is a modification of the embodiment shown in Fig. 3;

Fig. 9 is a plan view of the ejector arm means for ejecting the completed spring; and

Fig. 10 is a detailed view of the embodiment of Fig. 8 with the jaws in longitudinal alignment and the coil shaping surfaces thereof lying in the same plane.

Referring now to Fig. 1, a shaping tool is shown which includes a large number of shaping surfaces adapted for use with various types of spring material and for the formation of Archimedean spirals. The shaping tool comprises two stationary jaws 1 and 2 with guide or shaping surfaces 3 and 4, respectively, and two movable shaping members 5, 6 with shaping surfaces 7, 8, respectively.

The jaws 1, 2 are stationary and may be parts of the machine frame, and the guide face 4 coincides with the direction of material feed and constitutes a bed or track along which the spring strip is moved until, in the winding process, it is turned upward to move along the guide face 7 of the movable member 5. The member or jaw 5 is a bar with its guide surface 7 inclined or tilted back from the guide surface 4 at a somewhat greater angle than between the oppositely inclined guide surface 3 and the guide surface 7.

The jaw 6 has its inner jaw section 11 need be sleeve slidable on the jaw 5 and with its guide surface 8 approximately normal to the adjacent guide surface 7. Feed rollers 9, 10 force strip material 11 tangentially along to the several guide surfaces, and the jaw 6 is moved upwardly on the jaw 5 to the extent permitted by the jaw 12 which is fixed to jaw 6 and moves in a slot 13 of the jaw 5, as the jaw 5 is moved away from the feed rollers during a winding operation.

In winding a spiral spring, the free end of the strip material 11 is bent upwards slightly and then forced against the guide surface 7 of the jaw 5 by the feed rollers 9, 10. The strip will be bent or coiled as it is forced against and along the guide surfaces 7 and 8 until the turned-over end of the loop is momentarily arrested by the guide surface 7, see Fig. 1. The initial spacing of the shaping surfaces 4 and 8 is less than the desired starting diameter of the spiral because of the high elasticity of the material. The coefficient of reduction may be about 0.65 in the average case, and it is determined experimentally for different spring stock as it varies with the characteristics of the materials employed. When, for instance, the inner diameter of the winding is to be 5 mm., the initial spacing between the guide surfaces 4 and 8 is set at 3 mm. because the elasticity of the material will open up the winding loop to 5 mm.

The shaping jaws 5 and 6 slide between guide plates similar to those described in the parent application, having slots therethrough at an appropriate angle to receive the pin 12 and lift the jaw 6 as the jaw assembly is automatically moved away from the feed rollers by a suitable cam control mechanism. The final bending of the loops or turns is effected between the guide surfaces 3 and 4, and the guide surface 3 is spaced from the opposed guide surface 7 by substantially the winding diameter. The coiled material therefore initially has the form of an ellipse which expands to approximately circular form on release from the bending stress since the limit of proportionality is not exceeded.

For spiral springs of larger diameter, the single sliding jaw 6 is replaced by a plurality of telescoped jaw sections 14, 15 and 16 which are slidable upon the first movable jaw 17, see Fig. 3. This construction affords a minimum spacing of the jaw sections from the stationary jaw 18 at the initial stage of a winding operation, and a wide guiding face at later stages as the jaw sections 15 and 16 are moved downwardly on jaw section 14 by springs 18', 19, respectively, as the assembly moves away from the feed rollers. Only the inner jaw section 14 is subject to the automatic cam control, as previously described, since the movements of the jaw sections 15 and 16 are such that their guide surfaces align with the guide surface of jaw section 14 in their end positions.

While three telescoped jaw sections are shown in Fig.
3, it will be apparent that the number may be greater or less according to the desired ratio of the diameters of the inner and outer turns of the spiral spring.

Referring to Fig. 4, an embodiment is shown which provides an initial bend to the spring material prior to shaping by the movable abutment surfaces. As shown by the figure, the feed rollers 20, 21 feed the spring material 22 through a guide piece 23. A knife member 24 is arranged for reciprocatory movement in the vertical direction and has an opening 25 therethrough. The upper wall 26 of the opening 25 is a knife edge, and the lower wall 27 serves as a bending forming surface. When the knife 24 travels downwardly after the spring has been completely wound in the shaping tool, the strip is cut, the spiral spring is ejected, and the forming of a new spring is commenced. On the upward motion of the knife 24 a small portion 28 of the strip 22 is fed into the opening 25, which portion is bent upwardly by bend forming surface 27 about guide surface 29 of the guide piece 23. After the knife 24 has moved upwardly to cause the initial bend 28 of the strip, the knife moves slightly downwardly to allow uninterrupted feed of the strip material 22 through the opening 25.

Slidably mounted upon the work table 30 is ejector arm 31 (Fig. 4) which functions to remove the completed coil from the shaping jaw 32. As shown in Fig. 9, the arm is pivotally movable in the horizontal plane about fixed pivot 31b so that the coil contacting surface 31c of the head 31c moves transversely to the direction of strip feed during ejection to the position shown in phantom lines in Fig. 9.

As the winding of the spring progresses as shown in Fig. 5, the spring material is further advanced by feed rolls 20 and 21 so that the bent portion 28 is fed along the guide surface 33 of work table 30 and up the inclined guide surface 34 of the jaw 32. As the strip material is further fed to the shaping tool, the bent portion 28 is so directed by guide surfaces 35 and 36 of the telescopic jaw sections 37 and 38, and by guide surface 29 of guide piece 23 that one complete inner turn of the coil is formed. The inclination between the guide surface 34 of jaw 32 with the surface 33 of the work table 30 is such that the included angle is somewhat greater than the included angle between the guide surface 35 and the guide surface 34. Due to the frictional resistance between the surface of the strip material and the guide surfaces, a somewhat permanent set in the spring is effected.

Fig. 6 shows the apparatus when the spring material is wound to approximately sixty percent of its final diameter. The movable shaping jaw 32 has advanced in the longitudinal direction of initial strip travel and the telescopic jaw sections 37, 38 have travelled up the guide surface 34 of the movable shaping jaw 32 to allow for increase in diameter of the wound coil.

Fig. 7 shows the shaping apparatus when the shaping jaw 32 has been further advanced in the longitudinal direction of initial strip travel to allow the spring to advance to its full diameter. Knife 24 then moves downwardly to cut the strip material, and the ejector arm 31 is actuated to remove the completed spring from the shaping apparatus.

Fig. 8 shows an embodiment of the shaping tool of Fig. 3 which is preferred in actual use. In this embodiment the jaw 39 is rigidly secured to a supporting frame 40 which is slidably movable in the direction of initial strip travel. Slidably mounted upon the jaw 39 and within the chamber 41 in frame 40 are auxiliary shaping jaws 42, 43 and 44. Jaw 44 is keyed to member 45 which is guided by wall 46 of chamber 41. Member 45 slides between transverse guide plates similar to those described in the preferred application. These guide plates have slots therethrough at an appropriate angle to receive the pin 47 secured to member 45 and to lift said member as the jaw assembly is automatically moved away from the feed rollers by a suitable cam mechanism.

Auxiliary jaws 42 and 43 are also provided with pins 48 and 49 which ride upon the inclined surface 50 of control arm 51. As the frame 40 is moved from a position with the head of the fastener 52 in the same plane as the spring it is apparent that this construction affords a minimum spacing of the jaw sections from the bending surface 29 of guide piece 23 at the initial stage of a winding operation, and a wide guiding face at later stages as the jaw sections 42 and 43 are moved downwardly on jaw 39. Only the member 45 of the first jaw 44 need be subject to the automatic cam control since the movements of the jaw sections 42 and 43 are such that their guide surfaces adhere with the guide surface of jaw 44 in their end positions.

Thus it is apparent that my invention provides an apparatus which is suitable for forming flat spiral springs from strip material having a high degree of elasticity, as for example, in the manufacture of fine springs for use as hair springs in watches and restoring springs in delicate measuring instruments.

While I have described the preferred embodiment of my invention, I have illustrated and described the best form of embodiment of my invention known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus described without departing from the spirit of my invention as set forth in the amended claims.

I claim:
1. In an apparatus for coiling spiral springs from a strip of spring material of rectangular cross-section including shaping means for bending the strip reversely to the direction of strip feed to form the strip into circular or circular-linear form of progressively larger diameter and means for feeding said strip against said shaping means, said shaping means including a series of successively arranged shaping abutments having flat frictional surfaces inclined with respect to each other, so that the frictional resistance of the surfaces causes the strip limit of elasticity to be surpassed resulting in permanent deformation of said strip to curvilinear form, a plurality of said abutments being automatically movable with relation to the others of said series and in synchronism with the strip feed to increase the radius of curvature of the bent strip as the coiling operation proceeds; the invention comprising means for progressively increasing the width of the flat frictional surface of one of the movable shaping abutments as the diameter of the spiral spring increases, said one of the shaping abutments comprising a plurality of parallel auxiliary shaping jaws slidably movable along their longitudinal axes relative to each other and having coil shaping surfaces which are coplanar when said jaws are in longitudinal alignment.

2. Apparatus for coiling spiral springs as defined in claim 1 wherein said shaping means comprise a stationary first shaping abutment having a guide surface in the initial direction of strip feed, and a second shaping abutment having a coil forming surface at an obtuse angle to the guide surface of said first shaping abutment, said second shaping abutment being movable in the direction of strip feed during the strip coiling operation, and where in the abutments included in said auxiliary shaping jaws are slidably movable adjacent said second shaping abutment in a direction parallel to its coil forming surface so that the coil shaping surfaces of said auxiliary jaws will constitute a third abutment surface at an angle with respect to the coil forming surface of said second abutment.

3. Apparatus as defined in claim 2 wherein the shaping surface of one of the auxiliary jaws of the third abutment contiguous with the second abutment is initially spaced
from the guide surface of said first shaping abutment by substantially 60 percent of the diameter desired to be imparted to the first coil of the spring strip.

4. Apparatus as defined in claim 2 wherein the shaping means includes a stationary fourth abutment intermediate and angularly arranged with respect to said first and third abutments, and further including a reciprocatory bending member adapted to be inserted intermediate said first and fourth abutments to bend a portion of the leading edge of the strip to be coiled from the initial direction of strip travel against said fourth abutment.

5. Apparatus as defined in claim 4 wherein said reciprocatory bending member includes knife means for severing the completed coil spring from the strip feed, said knife means being so arranged that upon movement of said bending member in one direction a completed spring is severed by said knife means from said strip material and upon movement of said bending member in the other direction a portion of the leading edge of the strip is bent prior to forming another spring.

6. Apparatus as defined in claim 2 and further including spring means associated with each of said auxiliary shaping jaws for independently urging the same toward said first shaping abutment.

7. Apparatus as defined in claim 6 wherein the shaping means includes a stationary fourth abutment intermediate and angularly arranged with respect to said first and third abutments and further including means for raising at least one of the third abutment auxiliary shaping jaws from the first abutment guide surface when the second abutment is adjacent the stationary fourth abutment during the initial stages of the coil spring winding.

References Cited in the file of this patent

UNITED STATES PATENTS

238,417 Miller Mar. 1, 1881
711,130 Seymour Oct. 14, 1902
1,020,767 Luebke Mar. 19, 1912
1,099,543 Fargo June 9, 1914
1,660,051 Sargent Feb. 21, 1928
1,821,894 Otaka Sept. 1, 1931
2,107,217 Salsman Feb. 1, 1938
2,393,804 Nigro Jan. 29, 1946
2,600,628 Evans June 17, 1952
2,609,191 Foster Sept. 2, 1952
2,609,192 Lermont Sept. 2, 1952
2,774,407 Jansen Dec. 18, 1956

FOREIGN PATENTS

590,410 Germany Jan. 2, 1934