Sept. 28, 1971 R. GREINER ET AL 3,608,349

METHOD AND APPARATUS FOR WINDING SPIRAL SPRINGS

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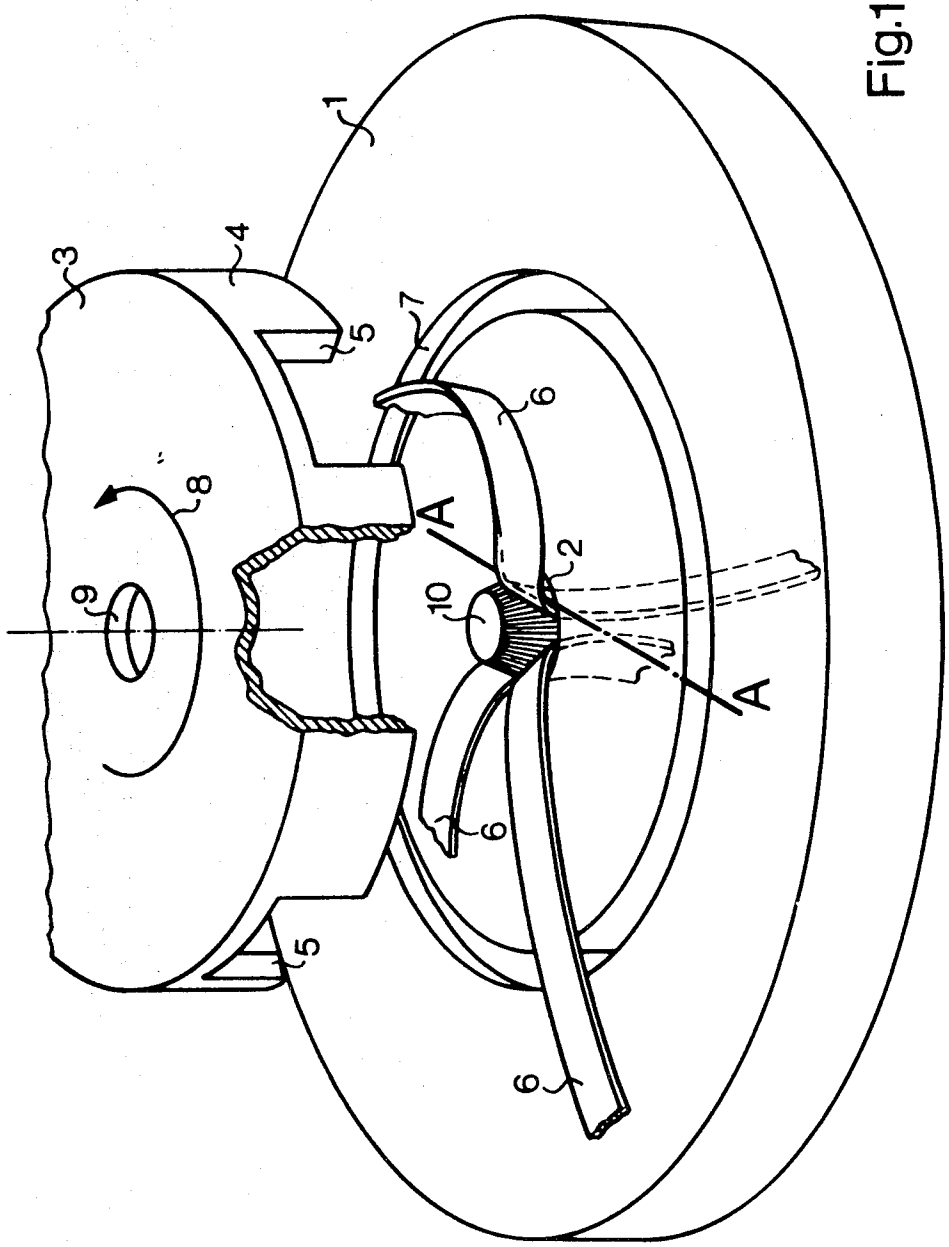
Fig.1



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METHOD AND APPARATUS FOR WINDING SPIRAL SPRINGS

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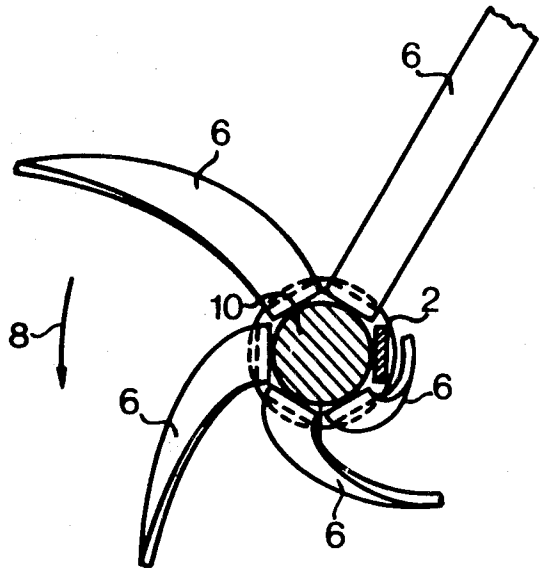
Fig. 2



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METHOD AND APPARATUS FOR WINDING SPIRAL SPRINGS

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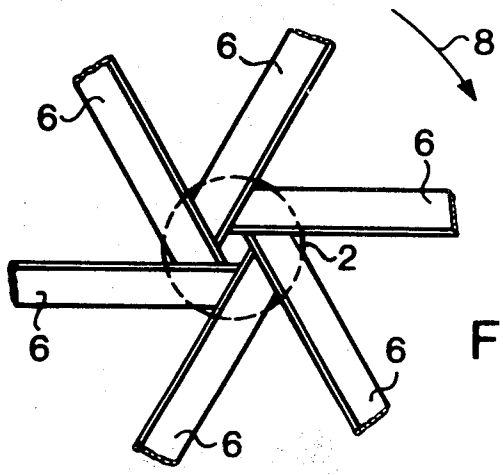

Fig. 3

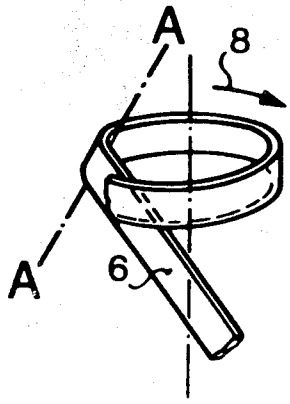

Fig. 4

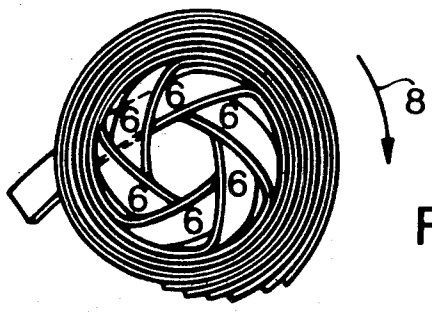

Fig. 5

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METHOD AND APPARATUS FOR WINDING SPIRAL SPRINGS

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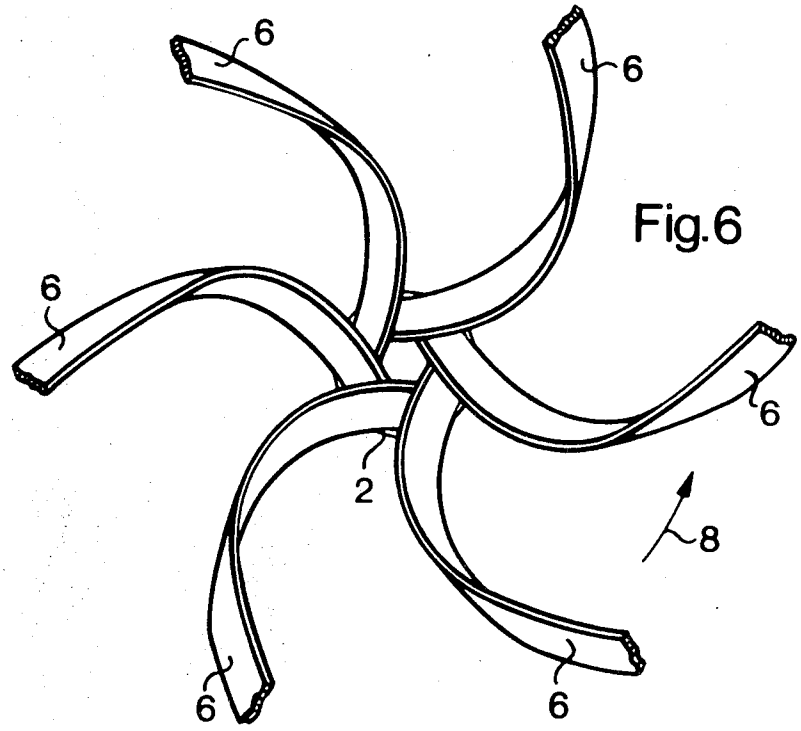

Fig.6

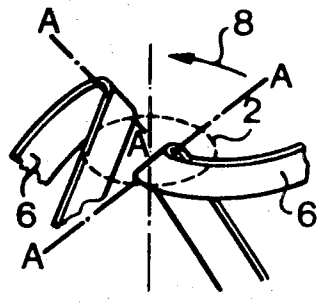

Fig.7

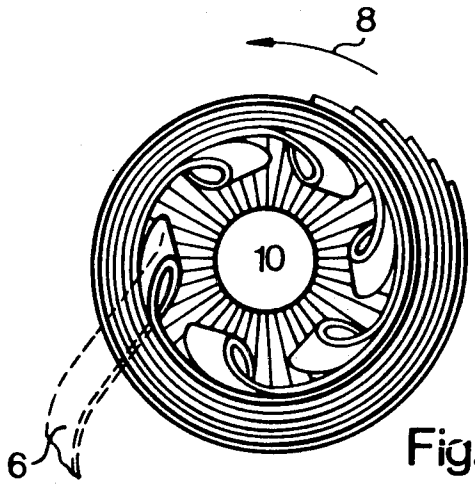

Fig.8

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METHOD AND APPARATUS FOR WINDING SPIRAL SPRINGS

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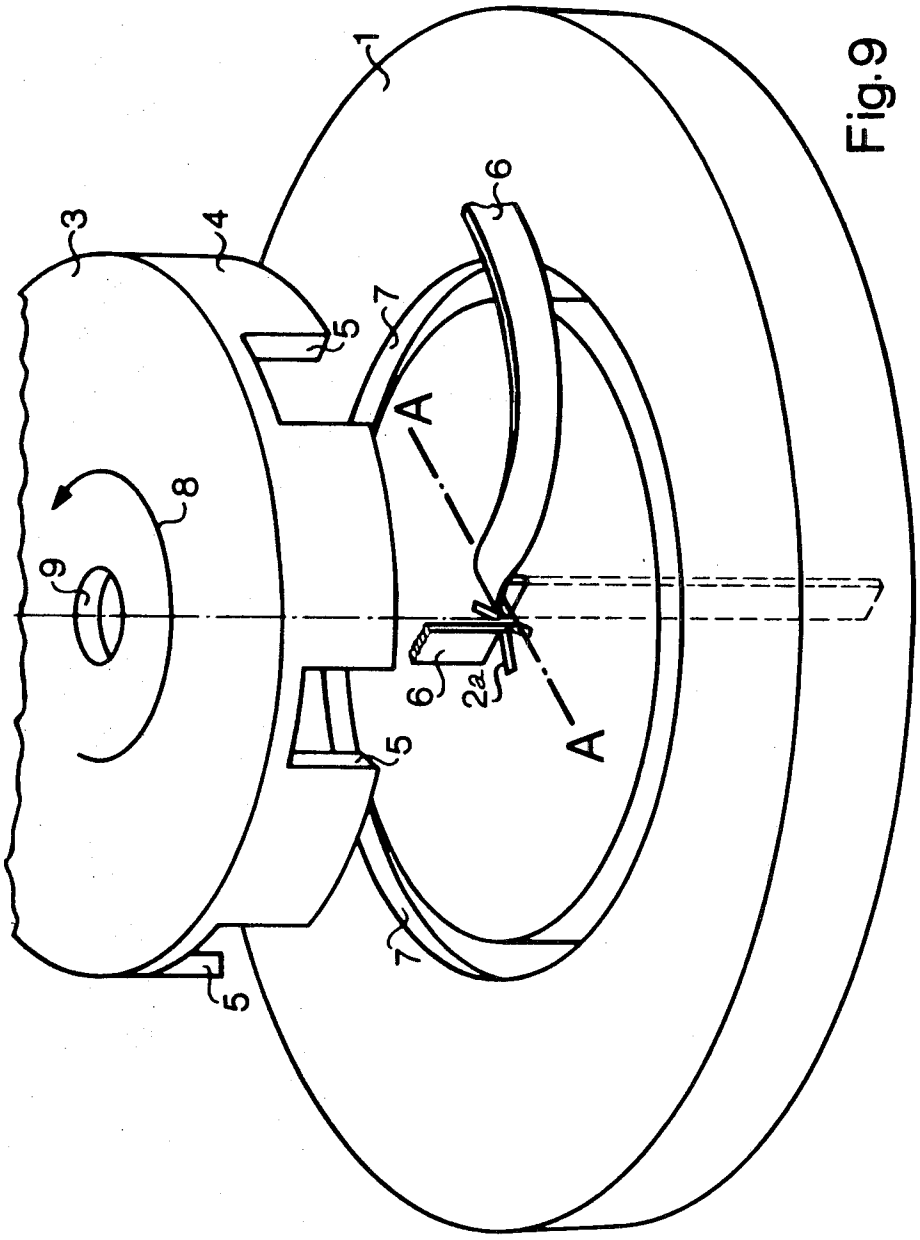

Fig. 9

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METHOD AND APPARATUS FOR WINDING SPIRAL SPRINGS

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Int. Cl. B21d *11/06, 11/10;* B21f *3/08*
U.S. Cl. 72—146 16 Claims

ABSTRACT OF THE DISCLOSURE

Method and apparatus for winding a spiral spring assembly from a plurality of lengths of spring metal bands, characterized that the band lengths are supplied through an opening contained in a base plate, each of the bands being twisted or bent about an inclined axis toward an edgewise-supported position normal to the winding face of the base plate. The leading portion of the band is then guided through an axial slit in a winding drum arranged concentrically about the supply opening, so that upon rotation of the drum relative to the base plate, the bands are wound upon themselves to form a convolute spring assembly. The bands are symmetrically discharged from the supply opening either axially or in a uniformly skewed manner. In the latter case, depending on the characteristics of the metal from which the spring bands are formed, the drum is rotated either in the direction of skew or in a direction opposite to the direction of skew. Means are provided for locking the trailing portions of the bands in the supply opening during the winding operation.

It is known in the prior art to manufacture small coil springs—such as those required for all types of measuring instruments and also for clocks—by shaping in a joint winding operation a plurality of individual spring bands which have previously been severed to a predetermined length, which bands are then wound within each other to define the coil springs. In this known apparatus, use is made of a rotatably positioned winding mandrel which is provided at its free end with a plurality of uniformly circumferentially distributed fastening slits. For each set of spring bands to be wound within each other there is provided also an enclosed winding drum which comprises a central guide aperture at the bottom of the enclosure and which is provided at the edge of the enclosure with a plurality of guide slits uniformly distributed in the circumferential direction, the number of the guide slits being equal to the number of fastening slits disposed in the winding mandrel.

In the known apparatus, before each winding operation is carried out, an initially empty winding drum is inserted, by means of the guide aperture thereof, over the winding mandrel in a manner such that the end face of the latter projects upwardly into the inner space of the spring housing. One end of a spring band is then introduced by hand into each fastening slit of the winding mandrel. Furthermore, the corresponding spring band must be placed within the corresponding guide slit of the spring housing, respectively. When the winding mandrel and the winding drum are equipped with the required number of spring bands in a concentric symmetrical fashion, the winding mandrel is rotated while the winding drum is maintained stationary until the inner space of the drum is fully coiled. The drum, together with the spring bands spirally coiled therein, is then drawn off the winding mandrel in an upward direction for subsequent thermal treatment as is customary in the art. The winding mandrel is then ready to receive a further winding drum which is likewise initially empty, so that the next set of coil springs can be made in the manner described above.

The universally used method of winding coil springs which has been briefly described above is rather inefficient and costly by reason of the fact that essential operations thereof are time-consuming and normally must be performed by hand. Moreover, with the aid of this known method it is not possible to make coil springs which have a very small inside diameter inasmuch as the winding mandrel itself must have a certain minimal diameter in order to be actually adapted to absorb the torsional moment required for the coiling operation. On the other hand, coil springs having a relatively small inside diameter are very desirable for numerous fields of application.

Accordingly, the primary object of the present invention is to provide an improved method and apparatus for winding coil springs wherein a plurality of spring bands extend, during the winding operation, through the inner space of a winding drum in a concentric symmetrical fashion and are each individually guided by means of corresponding guide slots peripherally disposed within the drum. The disadvantages and drawbacks of the prior art winding methods as outlined above can be effectively obviated, in accordance with the present invention, by virtue of the improved arrangement wherein the spring winding drum is arranged concentrically about a supply opening through which given lengths of the spring bands are supplied. The spring bands are secured against rotation within the supply opening and are introduced into the inner space of the spring winding drum in a direction either normal to or skewed relative to the opening in the winding face of the base plate. The spiral band winding operation is effected by rotary movement of the winding drum relative to the base plate, the inner end portions of each of the spring bands being initially bent upon discharge from the supply opening about an axis inclined with respect to the longitudinal extension of these spring bands.

In accordance with the preferred embodiment of the method and apparatus of the present invention, it is further proposed that the inner end portions of the coil springs be severed only after the cempletion of the coiling or winding operation from the spring bands extending through the inlet opening and that, after the removal of the spring housing filled with a set of coil springs, the remaining spring bands which still extend through the inlet opening be further supplied in the lengths necessary for making a new set of coil springs.

Other objects and advantages of the present invention will become apparent from a study of the following specification, when viewed in the light of the accompanying drawing, in which:

FIG. 1 is a perspective view of the base plate and the winding drum of a first embodiment of the invention, wherein the spring bands are initially discharged axially from the supply opening disposed in the base plate in a direction extending normal to the intended winding plane;

FIG. 2 is a detailed schematic top plan view of the supply opening in the base plate according to FIG. 1, wherein the equally illustrated inner end portions of the spring bands represent different stages at the beginning of the winding operation;

FIG. 3 is a top plan view analogous to that of FIG. 2, of a second embodiment of the invention, wherein the spring bands initially emerge from the supply opening in a skewed orientation generally parallel with the intended winding plane;

FIG. 4 is a perspective view of the inner end portion of one of the spring bands according to FIG. 3, showing the arising deflection about an inclined axis relative to the winding face of the base plate;

FIG. 5 is a top plan view of the inner end portions and the adjacent inner turns of the spirally and telescopically wound spring bands wound in the direction of skew as indicated by the arrow in FIG. 3;

FIG. 6 is a top plan view of the inlet opening disposed in the base plate from which the spring bands emerge in a skewed fashion as in FIG. 3, but wound in a direction opposite to the direction of skew;

FIG. 7 is a perspective view of the inner end portions of a pair of the spring bands according to FIG. 6, indicating the initial bending deflections of the bands about axes inclined to the winding face;

FIG. 8 is a top plan view of the inner end portions and the adjacent inner turns of the spirally wound spring bands formed by the winding operation of FIGS. 6 and 7; and

FIG. 9 is a perspective view of the base plate and the winding drum in a further embodiment wherein the spring bands emerge from the supply opening in a direction extending normal to the winding plane, as in FIG. 1, said inlet opening comprising a plurality of radially outwardly extending slits for securing the spring bands against rotation, without the aid of an additional clamping member.

The construction of the apparatus or device according to FIG. 1 includes a base plate **1** which is secured to a stationary frame or stand. This base plate **1** contains a circular supply opening **2** through which a plurality of spring bands **6** are supplied in a concentric symmetrical manner. Generally it is customary to use six such spring bands **6**, as is apparent from the top plan view of FIG. 2. In FIG. 1, on the other hand, only three of the aforementioned spring bands **6** have been shown for the sake of greater clarity of illustration. When six spring bands **6** are used, the radius of the inlet opening is chosen to be approximately equal to the width of the blades of the spring bands **6**. When it is desired to make coil springs having the usual dimensions, the spring bands **6** needed therefor have, for example, a blade width of 0.2 millimeter and a blade thickness of approximately 0.03 millimeter.

Also mounted in the afore-mentioned frame beneath the base plate **1** are the band supply means (not shown) by means of which all of the spring bands **6** are supplied simultaneously through the inlet opening **2** upwardly in a direction extending normal to the upper winding face of the base plate **1**. In the present embodiment, the spring bands **6** conveyed to the feeding device are reeled off six storage drums which are rotatably connected with the frame. The supply drums are preferably arranged symmetrically in a concentric manner with respect to the axis of the supply opening **2**.

Prior to the beginning of each winding operation, the spring bands **6** are supplied upwardly from the supply opening **2** for a distance at least as great as the length of the spiral springs to be wound. Furthermore, it is advisable and expedient to assure already during this feeding operation that each of the spring bands **6**, as viewed from the inlet opening **2**, falls outwardly in a radial direction, such as has been indicated in connection with the two spring band pieces or portions **6** directed toward the left in FIG. 1. For the sake of a clearer illustration, the drawing does not shown respectively the full required lengths of the spring band portions but only the inner parts thereof. When the necessary feed of the spring bands **6** has taken place, they are pressed against the periphery of the supply openings **2**, by means of a clamping member **10**, as shown in FIGS. 1 and 2, and thereby are secured against rotation at the base plate **1**. A pin member **10** which is provided with a conical head and is displaceable in the axial direction of the supply opening **2** serves as the clamping member. The means for axially actuating this clamping member **10** are conventional and have not been shown in detail in the drawing.

In the embodiment illustrated in FIG. 1, the base plate **1** further contains an annular groove **7** concentrically arranged relative to the supply opening **2** and adapted to receive the free tubular edge portion of the rotary winding drum **3**. While the winding drum **3** may have the customary enclosed configuration, it is preferably of the open-ended construction illustrated in FIG. 1, said drum containing guide slits **5** peripherally arranged in the lower tubular portion of the winding drum. The winding drum is normally arranged with the edge **4** thereof extending within the annular groove **7** so that each of the radially outwardly directed spring bands **6** extends through a corresponding guide slit **5** without being actually clamped at that time.

For the purpose of carrying out the winding operation, the winding drum **3** is rotated, whereby the spring bands **6** projecting out of the guide slits **5** are carried along in the winding direction **8**. At that time each of the spring bands **6** undergoes within the drum **3** a twisting effect about an axis A—A being inclined with respect to the longitudinal extension thereof, as has been illustrated in FIG. 1 for the spring band **6** pointing toward the right. Owing to the progressive rotation of the spring housing **3**, this initial twist changes into an ever more marked deflection which is produced directly at the inner end portion of the spring band emerging from or leaving the inlet opening **2**. The different stages of this bending or twisting operation and procedure have been shown in FIG. 2, starting from the spring band at the upper right and rectilinearly falling outwardly, and viewing thereafter the spring bands **6** following the winding direction **8**. Hence, the spring bands **6** are transferred, in the area or region outside of the inner end portions thereof, into an edge-supported upright position normal to the upper side of the base plate **1**, in which the winding operation is terminated. This winding operation is completed when the inner space of the winding drum **3** is filled up to the box edge **4** with interwound coil springs. Normally, also the leading end portions of the spring bands **6** which initially extended through the guide slits **5** are drawn into the inner space of the spring housing **3** immediately prior to the termination of the winding operation. Only thereafter will the inner end portions of the coil springs be separated from the spring bands **6** projecting through the inlet opening **2**. This may be accomplished, for example, by introducing through the guide aperture **9** of the spring housing **3** a corresponding cutting, punching, or boring tool which carries out this separating or severing procedure. The aforementioned separation may also be obtained, however, without the aid of a separate tool simply by further rotating, after the completion of the winding operation, the already completely filled winding drum **3** in the winding direction. The inner end portions of the coil springs will then automatically be torn off at the point of the deflections being deformed to bends proper. In most cases after the winding operation has been completed the severed end portions of the spring bands **6** emerge from the guide slits **5**.

Following separation of the coil springs from the trailing end portions of the spring bands **6** projecting out of the inlet opening **2**, the winding drum **3** together with the coil springs wound therein are lifted off the base plate **1** and subjected to the customary thermal treatment. Thereafter, subsequent given lengths of the spring bands **6** are supplied through the inlet opening **2** for a further winding operation in the manner described above. It is obvious that these operating steps are susceptible to automation to a great extent.

The method described hereinbefore may be modified, however, in various ways and thus afford further advantages. It may thus be desirable to have the spring bands **6** emerge from the inlet opening **2** in a skewed manner relative to the winding plane defined by the upper winding face of the base plate **1**, such as has been shown in the top plan view of FIG. 3. Such a skewed emergence of the spring bands **6** assures on the one hand that the bands **6** will be arranged automatically in a concentric symmetrical manner without the aid of or recourse to

specific measures and will initially be generally parallel with the base plate winding face. If desired, the supply opening may have a corresponding conical cross-sectional configuration. There will arise, however, different conditions for the winding operation depending upon the winding direction of the winding drum **3** relative to the base plate **1**.

When the winding direction **8** according to FIG. 3 corresponds with the direction of skew of the spring bands **6** as initially discharged into the winding plane, each of the bands will be bent off at the inner end portion thereof about the axis A—A inclined with respect to the longitudinal extension thereof, as shown by way of example in FIG. 4. When the winding operation is completed, the coil assembly of FIG. 5 will result for the inner end portions of the spring bands **6** and for the adjacent inner coil spring winding turns, as viewed in the top plan view. Accordingly, the inner deflections of the spring bands **6** are produced to avoid a marked bend, which is particularly desirable when the spring bands **6** are made from nonferrous metals or alloys.

For those spring bands **6**, however, which are made from ferrous metals or the alloys thereof, the winding direction **8** is opposite to that shown in FIGS. 3 to 5 (i.e., in a direction opposite to the direction of skew of the bands relative to the winding face). At the beginning of the winding operation, the spring bands **6** are twisted according to FIG. 6. As the winding operation proceeds, each of the spring bands **6** is sharply bent off about the inclined axis A—A in a manner similar to a bend or break, according to FIG. 7. The resulting coil assembly is illustrated in FIG. 8.

It is assumed for the apparatus shown in FIGS. 1 through 8 that during the winding operation the spring bands **6** are securely held against rotation within the inlet opening **2** by means of a separately actuated axially displaceable clamping member **10**. Referring now to FIG. 9, a modified construction is illustrated which does not require a clamping member **10**. This is rendered possible by virtue of the fact that the central inlet opening comprises a number of radially outwardly directed slits **2***a* corresponding to the number and cross-sectional dimensions of the spring bands **6** which are to extend therethrough. It is quite obvious that by virtue of the radial arrangement of the slits, an axial emergence of the spring bands **6** is assured which is secured against rotation without the aid of any further expedients. For clarity, only two spring bands **6** have been shown in FIG. 9. The winding operation is then accomplished by means of the rotary winding drum **3** in essentially the same manner as has been referred to in connection with FIG. 1 above. For each of the spring bands **6**, there is also a marked bent-off area or deflection at the trailing inner end portion thereof about an axis A—A inclined with respect to the longitudinal extension of the respective spring band.

An advantageous feature of the invention common to all of the various embodiments mentioned herein consists in that the inside diameter of the coil springs may be as small as possible, the only limiting criteria being the dimensions of the opening **2**.

While in accordance with the provisions of the Patent Statutes, the preferred form and embodiments of the invention have been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made without deviating from the inventive concept.

We claim:

1. Apparatus for winding a coil spring assembly from a plurality of metal bands, comprising

a base plate (**1**) having a winding face containing a supply opening through which given lengths of the bands (**6**) are supplied in a circumferentially spaced symmetrical manner;

a winding drum (**3**) including a tubular portion arranged concentrically relative to the axis of said supply opening, said tubular portion containing a plurality of circumferentially spaced axial guide slots (**5**), each of said bands immediately following discharge from said supply opening being deformed about an axis (A—A) that is inclined relative to said winding face toward a winding position normal to said winding face, the leading portions of said band lengths being then guided in said winding positions radially outwardly through corresponding ones of said guide slots, respectively;

and means for rotating said winding drum relative to said base plate to wind said band lengths to define a convolute spring assembly.

2. Apparatus as defined in claim **1**, and further including means for locking trailing portions of said band lengths within said supply opening during the spring winding operation.

3. Apparatus as defined in claim **2**, and further including means for discharging said bands from said supply opening initially in the axial direction relative to said supply opening.

4. Apparatus as defined in claim **2**, and further including means for discharging said bands from said supply opening symmetrically in an initially skewed direction relative to the axis of said supply opening and with an orientation generally parallel with the winding face of said base plate.

5. Apparatus as defined in claim **4**, wherein the direction of rotation of the winding drum corresponds with the direction in which the bands are initially skewed relative to the supply opening.

6. Apparatus as defined in claim **4**, wherein the direction of rotation of the winding drum is opposite to the direction in which the bands are initially skewed relative to the supply opening.

7. Apparatus as defined in claim **2**, wherein said supply opening is generally circular, and further wherein said means for locking portions of said bands in said supply opening comprises a clamping member (**10**) movable axially of and adapted to extend at least partially within said supply opening, whereby said band portions are clamped to the wall of said supply opening.

8. Apparatus as defined in claim **2**, wherein said supply opening comprises a plurality of radially arranged guide slots (**2***a*) through which said bands are supplied, respectively, said bands being locked in said slots upon deformation of said bands about their respective angular bending axes.

9. Apparatus as defined in claim **1**, wherein said drum is open at the end adjacent the winding face of said base plate to permit edgewise support of the bands by said winding face during the winding operation, said base plate containing a circular groove (**7**) concentric with said supply opening for receiving the free edge of the tubular portion of said winding drum.

10. The method of winding bands of spring metal to define a convolute spring assembly, comprising

feeding given lengths of a plurality of said bands in circumferentially spaced symmetrical arrangement through a supply opening contained in the winding face of a base plate;

bending each of the bands immediately adjacent the supply opening about an axis (A—A) inclined to the winding face of said base plate toward a position in which the band is normal to said winding face;

guiding the leading portions of the band lengths through guide slots contained in and extending axially of a winding drum arranged concentrically about said supply opening;

and rotating the drum relative to said base plate to wind the band lengths to define a convolute stacked assembly.

11. The method as recited in claim **10**, wherein the

bands are supported in an edgewise manner by the winding face of the base plate during the winding operation.

12. The method as defined in claim **10**, and further including the final step of severing the portions of the bands adjacent the supply opening.

13. The method as defined in claim **10**, and further including the step of locking the trailing portions of the band lengths to the base plate prior to rotation of the drum.

14. The method as defined in claim **13**, wherein the band lengths are initially discharged symmetrically from the supply opening in a skewed orientation generally parallel with the winding face of the base plate.

15. The method as defined in claim **14**, wherein the direction of rotation of the drum corresponds with the direction in which the bands are skewed.

16. The method as defined in claim **14**, wherein the direction of rotation of the drum is opposite to the direction in which the bands are skewed.

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LOWELL A. LARSON, Primary Examiner

U.S. Cl. X.R.

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