United States Patent

Teraoka

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[45] Mar. 7, 1972

[54] DEVICE FOR MANUFACTURING A HELICALLY PREFORMED ELEMENT

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June 9, 1969 Japan.....44/45564

[52] **U.S. Cl.**.....**72/137**, 72/177, 72/181
[51] **Int. Cl.**.....**B21f 35/02**, B21b 15/00, B21d 5/08
[58] **Field of Search**.....72/137, 177, 181, 251; 83/436

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Primary Examiner—Charles W. Lanham
Assistant Examiner—R. M. Rogers
Attorney—Jacobs & Jacobs

[57] **ABSTRACT**

The invention relates to a device for continuously manufacturing a helically preformed element of any desired length by unwinding a flat bar from a drum on which the bar is wound in coils, feeding the bar between a group of rolls and into a first die and extruding the same therefrom into a flat bar of arcuate section and forming the flat bar thus formed arcuate in section into a helix by extruding same from a second die.

13 Claims, 20 Drawing Figures

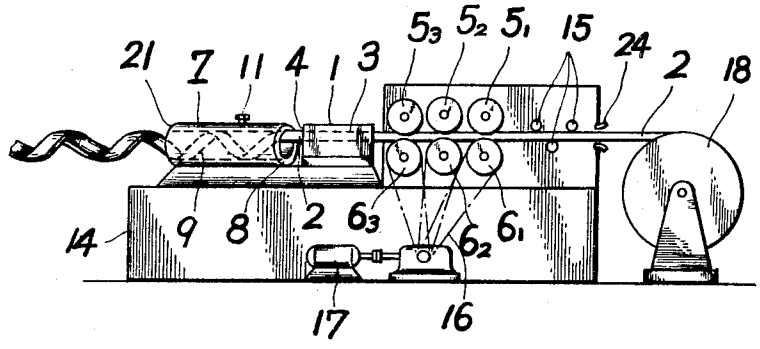


Fig 1

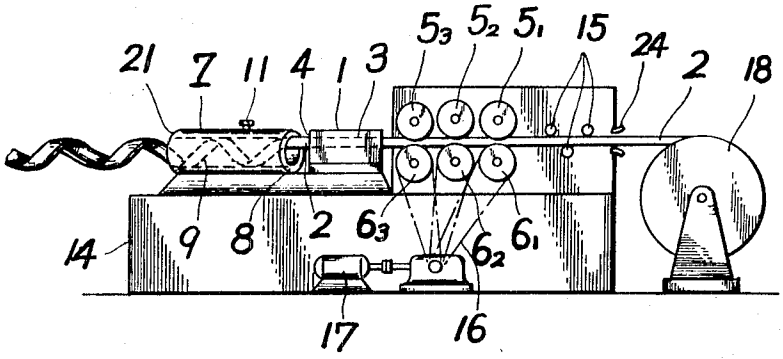


Fig 2

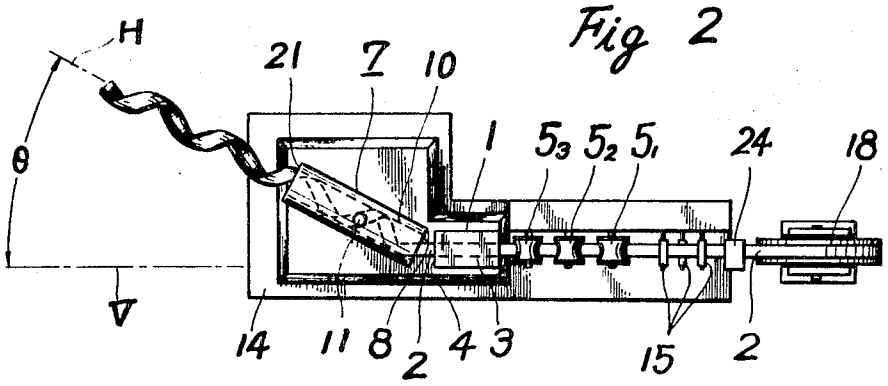


Fig 3

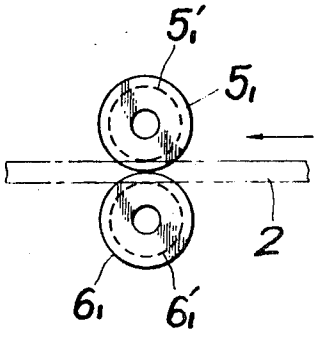


Fig 4

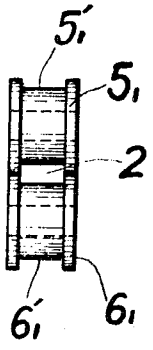


Fig 6

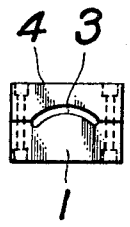


Fig 5

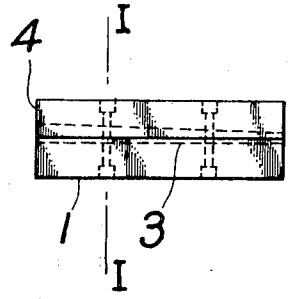


Fig 7

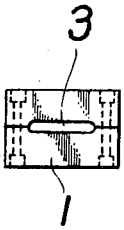


Fig 8

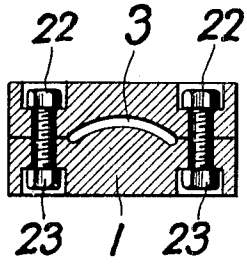


Fig 9

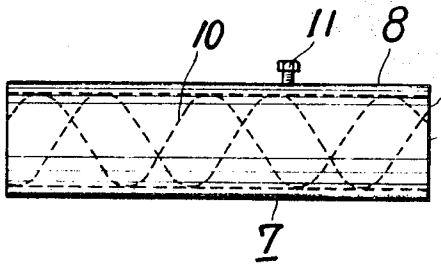


Fig 10

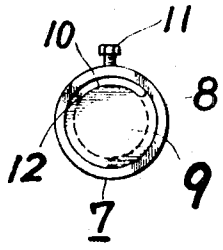


Fig 11

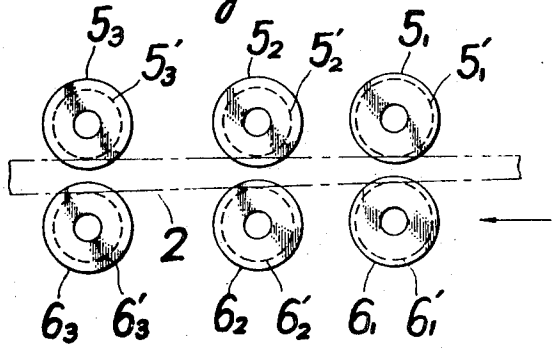


Fig 12

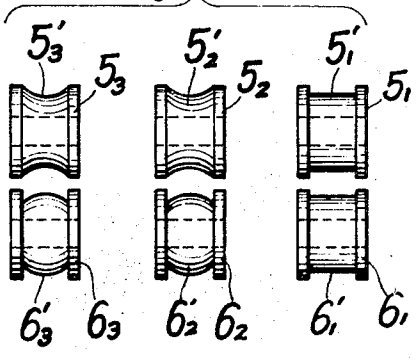


Fig 15

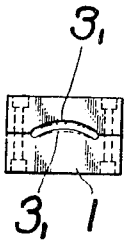


Fig 13

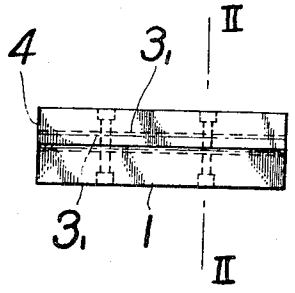


Fig 14

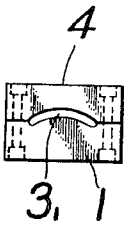


Fig 17

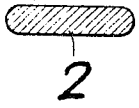


Fig 18

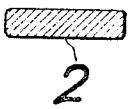


Fig 19

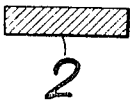


Fig 16

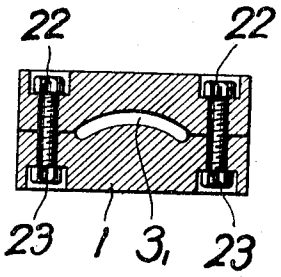
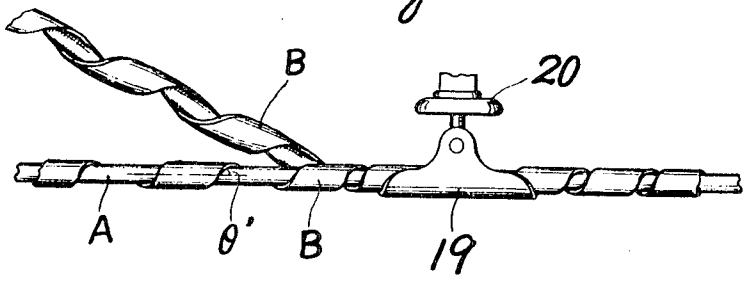


Fig 20



DEVICE FOR MANUFACTURING A HELICALLY PREFORMED ELEMENT

This invention relates generally to a device for continuously manufacturing a helically preformed element for use in armored rods, splices, dead ends and the like and more particularly to a device for continuously manufacturing a helically preformed element made of a flat bar (a bar of flat section) which is used for reinforcing the points at which, for example, electric wires are suspended from overhead transmission and distribution lines or wound on pin-type insulator clamping means or the necessary portions or submarine cables. By the flat bar referred to in the following disclosure of this invention is meant a metal wire material having a sectional shape shown in FIGS. **17**, **18** and **19** of the accompanying drawings.

As well known, the helically preformed element for use in armored rods, splices, dead ends (to be hereinafter represented by the armored rods as an illustrative example) which is conventionally used is generally made of a metal wire of circular section, and it is comparatively easy to preform such a circular metal wire into a helix. As an example of such a product may be mentioned the product provided by a device disclosed in the Japanese Pat. No. 452,060, according to which a circular metal wire is inserted into a die having a helical groove on the circumference thereof, thus making it possible to reduce working resistance by the use of a long circular metal wire and to continuously obtain a product substantially uniform in quality.

The advantage of the use of the flat bar as a material of the helically preformed element is that the flat bar makes it possible to bring itself into contact with the outer circumference of a linear body (to be hereinafter represented by an electric wire or wires as an illustrative example) to be gripped by the helically preformed element through a large area of contact, thereby reducing contact pressure per unit area with respect to the electric wire and that accordingly the stress given to the electric wire can be reduced, allowing the life of the wire to be prolonged. But from the viewpoint of the art of production it is no easy task to make the flat bar into a bar of arcuate section for enlarging the area of contact with respect to the wire and further to form the bar of arcuate section into a helix with the bar being kept arcuate in section. In the production of a conventional helically preformed element from a flat bar, the preformed element is produced in the manner that a flat bar material as of an aluminum alloy of a desired length is manually wound helically on a round forming bar having a diameter substantially equal to the diameter of an electric wire to which the flat bar is applied, the flat bar is deformed by applying pressure thereto from outside so that the flat bar may be brought into even contact with the outer circumference of the round forming bar, and is thereafter rewound, or alternatively in the manner that the flat bar is preformed into a bar of arcuate section, and the flat bar thus preformed arcuate in section is formed into a helix by being forced into a die having a helical groove on the circumference thereof according to the above-described device for making a helically preformed element of circular metal wire. But the former has the drawback that its dependency on manual production makes it difficult to produce a uniform quality bar on a mass production system, and the latter is not free either from the disadvantage that, because the flat bar is preformed into an arcuate shape in the latter, the outer force of feed is applied with different uniformity to the middle portion of the arcuate surface and to both ends thereof (difference of clamping force of feed rolls changes peripheral speed) and smooth feed of a material becomes difficult and under such circumstances it is also difficult to push forward the flat bar into the helical groove of a die and accordingly a flat bar to be worked is limited in length.

A primary object of this invention is to provide a device in which a process of automatically forming a flat bar material into a bar of arcuate section is linked with a process of forming the flat bar of arcuate section into a helically formed bar.

Another object of the invention is to provide a device by which a long flat bar also can continuously be formed into a helical element without any limit being placed on the length of the flat bar in working.

Yet another object of the invention is to provide a device by which, when a flat bar of arcuate section is pushed into a die, the flat bar can smoothly and with small working resistance be formed into a helix.

These and other objects and advantages of the invention will become more apparent from a description below taken of the invention with reference to the accompanying drawings in which:

FIG. **1** is a front view of a preferred embodiment of this invention;

FIG. **2** is a plan view of FIG. **1**;

FIG. **3** is a front view of feed rolls in the first embodiment of FIG. **1**;

FIG. **4** is a side view of the feed roll of FIG. **3**;

FIG. **5** is a front view of a first die used in the first embodiment of FIG. **1**;

FIG. **6** is a left side view of the first die of FIG. **5**;

FIG. **7** is a right-side view of the first die of FIG. **5**;

FIG. **8** is an enlarged sectional view taken along line **1—1** of FIG. **5**;

FIG. **9** is a front view of a second die used in the first embodiment of FIG. **1**;

FIG. **10** is a side view of the die of FIG. **8**;

FIG. **11** shows front views of feed and forming rolls used in the second embodiment;

FIG. **12** shows side views of the feed and forming rolls of FIG. **11**;

FIG. **13** is a front view of the first die used in the second embodiment;

FIG. **14** is a left-side view of said first die of FIG. **13**;

FIG. **15** is a right-side view of the first die of FIG. **13**;

FIG. **16** is an enlarged sectional view taken along line **2—2** of FIG. **13**;

FIGS. **17** through **19** are sectional views of a flat bar used in the invention; and

FIG. **20** is a front view showing an example of application of the helically preformed element made of flat bar provided by this invention.

The invention shown in FIG. **1** is a device of the construction in which a flat bar **2** unwound from a winding drum **18** is fed between rolls 5_1 . . . and rolls 6_1 . . . of any number and pushed forward and while being forced into a first die **1**, it is successively formed into a bar arcuate in section and is then passed through a second die **7** and formed into a helix. According to a first embodiment of the invention shown in FIGS. **1** through **10**, forming of the flat bar **2** into a bar of arcuate section is carried out by passing the bar through the first die **1**, and the rolls 5_1 . . . and 6_1 . . . are used simply as feed rolls for the flat bar **2**, and a second embodiment shown in FIGS. **11** through **16** is shown as forming of the bar **2** into a bar of arcuate section being carried out by a certain group of rolls 5_1 . . . and 6_1 . . ., and the first die **3** being used merely as a guide for feeding the arcuate flat bar to the second die **7**. The flat bar **2** shown in these two embodiments is shown as an example of the bar shown in FIG. **17***a* which is of a flat rectangle having semicircular edges in section.

Referring now to FIGS. **1** to **10**, the first die shown in FIG. **1** is provided longitudinally of its axis portion with a forming opening **3** to pass a flat bar **2** therethrough and is fixedly secured to a frame **14**. The opening **3** is so formed at one end (inserting end) as to be fitted to the sectional shape of an almost square bar before forming (FIG. **7**), but it is gradually formed arcuate as it is nearer to the other end, and is completely formed into such a bar of arcuate section as to have a curvature fitted to the outer circumference of an electric wire A (FIG. **6**). The first die **1** is split into upper and lower parts along the opening **3** and the split parts are connected integrally by bolts **22** and nuts **23**. Feed rolls 5_1 . . . and 6_1 . . . are provided on the circumference with flat grooves $5_1'$ . . . and $6_1'$ . . ., and the flat bar **2** is fed into the grooves $5_1'$ . . . and $6_1'$ . . . and pushed forward in the direction of the die

(FIGS. 3 and 4). The feed rolls 5_1 . . . and 6_1 . . . are horizontally journaled to the frame **14** through bearings and are rotated in a specified direction as by chain belts **16** driven in cooperation with a reduction gear (infinitely variable reduction gear is preferable). The second die shown by the numeral **7** is made up of an outer metal cylinder **8** and a cylindrical metal core **9**, said metal core **9** being longitudinally provided on the outer circumference with a helical groove **10** of arcuate section and being fitted into the outer metal cylinder **8**, both cylinders being secured to each other by a setscrew **11** (FIGS. **9** and **10**). This die **7** is disposed adjacently to the end **4** of said first die **1** and securely mounted on the frame **14** so that the direction in which the helically preformed element B is extruded may be oblique with respect to the axis V of the first die **1** and an angle θ substantially equal to the helical angle θ' which the helically preformed element B has (FIG. **2**). It is desirable that the angle θ be in the range of 20° to 30°, and for example, 24° is proper in the case of a helically preformed element for 33 mm.² ACSR (Aluminum Conductor Steel Reinforced). In the drawings the numeral **24** designates a guide plate; **15** . . . straightening rolls; **17** a power source such as a motor; **19** a suspension clamp in an overhead transmission line; and **20** designates a porcelain insulator.

In the device according to the above first embodiment the feed rolls 5_1 . . . and 6_1 . . . are rotated in a specified direction and thus the flat bar **2** wound on the drum **18** is fed into the first die **1**, whereupon the bar **2** is gradually formed into a bar of arcuate section according as it is advanced through the die **1**. And when it has passed through the first die, it is formed into a flat bar of completely arcuate section. Next, the arcuate flat bar **2** thus produced is fed by forced pushing from behind into a helical groove **10** through the end **12** of an opening of the groove **10** of the second die **7** and is formed into a desired helix while being helically moved forward on the outer circumference of a metal core **9** along the helical groove **10** and is extruded from the die **7**. At this time, as the axis H of the second die **7** is disposed obliquely with respect to the axis V of the first die **1** at an angle θ substantially equal to the helical angle θ' of the helically preformed element B, the arcuate flat bar **2** extruded from the first die **7** incurs no possibility of its being bent up and down or right and left because of the bar being obstructed in its entrance into the second die **7** at the end **12** of the opening of the die **7** by the inner wall of the helical groove **10** but is smoothly fed into the helical groove **10** and then formed into a desired shape under the action of force uniformly applied to every part of its section and thus extrusion forming can be carried out with small working resistance and smoothness.

The helical angle of the helical groove **10** is the second die **7** also must be selected to be substantially equal to the helical angle θ' which the helically preformed element B has and a helical flat bar of a desired length can automatically be obtained by disposition of a travelling shear device not shown (for example, the shear device disclosed in the Japanese Pat. No. 442,552) having a set of cutters adjacently to the tail end **21** of the second die **7**. As the helically preformed element B made of the helical flat bar thus obtained has a helical shape of arcuate section having a curvature substantially equal to the curvature of circumference of an electric wire A, a desired armored rod is obtained by wrapping a plurality of helically preformed elements on the circumference of the electric wire A, and when it is held by a clamp **19** suspended from a porcelain insulator **20** as illustrated in FIG. **18**, intermediate suspension of an overhead line becomes possible.

Referring now to the second embodiment shown in FIGS. **11** to **16**, the rolls 5_1 . . . and 6_1 . . . serve both as feed rolls for feeding the flat bar **2** and as forming rolls for forming the flat bar **2**, the rolls 5_1 and 6_1 at the right end of the drawing being simply feed rollers for the flat bar **2**. The reason is that, when the rolls 5_1 and 6_1 are so disposed as to function as forming rolls, the application of uniform clamping force to the flat bar **2** in its every part of section becomes impossible as previously described. Accordingly, the rolls 5_1 and 6_1 are formed into flat grooved rolls having flat grooves $5_1'$ and $6_1'$. And the rolls 5_2 and 6_2 and 5_3 and 6_3 adjacent to said rolls 5_1 and 6_1 are disposed as forming rolls, and these rolls are provided in number sufficient to successively form the bar **2** into a bar of required arcuate section (two pairs in the embodiment shown). The rolls are closed-type arcuately grooved rolls of the construction in which the forming rolls are shaped on one side into female rolls 5_2 and 5_3 having arcuate grooves $5_2'$ and $5_3'$ and are shaped on the other side into male rolls 6_2 and 6_3 having arcuate projections $6_2'$ and $6_3'$ (but the construction of these rolls may be reversed). The flat bar **2** is fed forward while it is being clamped between the female and male rolls 5_2 . . . and 6_2 . . . and being formed successively into a bar of arcuate section. For this purpose, the arcuate grooves $5_2'$ . . . and $6_2'$ . . . of female rolls 5_2 and 5_3 and projections $6_2'$ and $6_3'$ of male rolls 6_2 and 6_3 are respectively made progressively greater in curvature from the right side to the left side in the drawing (FIGS. **11** and **12**). The embodiment herein is shown as forming the flat bar **2** into a bar of completely arcuate section only by the forming rolls 5_2, 6_2 and 5_3, 6_3, and accordingly the flat bar **2** extruded from the last rolls 5_3 and 6_3 has been formed into a flat bar of completely arcuate section having a curvature fitted to the circumference of the electric wire A and is forced forward into the first die **1** in the state of the bar being kept arcuate in section.

The first die **1** is provided longitudinally of its axis portion with an arcuate opening 3_1 to pass the flat bar of arcuate section therethrough, said opening 3_1 being exactly the same in section both at the inlet and outlet side ends and serving as a guide for feeding the flat bar **2** of arcuate section into the second die **7** without bending the bar **2** (FIGS. **13** to **16**). If it is desired to slightly change the means of forming the flat bar **2** into a bar of arcuate section shown in the second embodiment and to work the flat bar **2** into a flat bar not of completely arcuate section but of arcuate section only in a certain degree by means of the forming rolls 5_2... and 6_2..., the first die **1** serves also to form a flat bar pushed out from the last rolls 5_3 and 6_3 into a bar of more completely arcuate section. For this purpose, it is necessary for the opening **3**, to have a shape of a progressively increasing curvature of arc for forming a flat bar of gradually completely arcuate section along the length extending from the inlet side end of the first die to the outlet side end as shown in chain lines in FIGS. **13** and **15**.

Furthermore, the forming rolls 5_2... and 6_2... are normally made of metal but in a particular case the female rolls of them may be made of synthetic rubber or other elastic materials. In this case, the female elastic forming rolls may be merely flat rolls by making the other arcuate male rolls of metal and need not be of a shape concave in section. That is to say, the flat bar **2** is caused by the rigig male rolls 6_2... to bite their counterpart female rolls. The application of such an elastic material can save the trouble of working female rolls.

Since portions other than those modified in the second embodiment are the same as those in the first embodiment, a further description of the same portions of the second embodiment is omitted.

As the means referred to with reference to the second embodiment is of the construction described above, when the feed and forming rolls 5_1... and 6_1... are rotated in a specified direction, thereby to unwind the flat bar **2** wound on the drum **18** and to straighten it by straightening rolls **15** ... and to feed it between the forming rolls 5_1... and 6_1... , the flat bar **2** is gradually formed into a helix in section as it is fed forward. In the case shown, the flat bar extruded from the last rolls 5_3 and 6_3 is brought into a flat bar **2** of completely arcuate section that is adapted for the outer circumference of the electric wire A, and the flat bar **2** thus formed is guided into the first die **1**, pushed forward into the end of the opening **12** of a helical groove **10** of the second die **7**, fed through said helical groove **10** in the same manner as in the first embodiment, and while the bar **2** is helically moved forward on the circumference of a metal core **9** along the helix of the groove **10**, it is extruded from the second die **7** into a desired helix. The armored rod B

thus obtained is used in the manner shown in FIG. 20, as in the preceding case.

While the flat bar 2 that has been described and shown by way of example in the drawings in shown as an example in which it is formed into a flat rectangular bar having semicircular edges in section, it is to be understood that the flat bar 2 of the invention can likewise be used in the forms shown in FIGS. 18 and 19.

As can be understood from what has been described with reference to two preferred embodiments of the invention, this invention makes it possible to unwind a flat bar from a drum on which it is wound in coils, form it into a bar of completely arcuate section by passing it between a group of rolls and a first die, and then to form it into a helix by means of a second die while keeping it arcuate in section, and accordingly it has the advantage that, by using a continuous flat bar, a helically preformed element of long length can be produced continuously, uniformly and in large quantities. Furthermore, as the second die of the invention is disposed obliquely in a direction of extrusion with respect to the first die at an angle substantially equal to the helical angle of the helically preformed element, the flat bar of arcuate section that is extruded from the first die incurs no possibility of its being bent up and down or right and left because of the bar being obstructed by the inner wall of the second die at the end of the opening of the second die when the flat bar is about to be formed into a helix by the second die but is smoothly fed into the arcuate groove of the second die and subjected to uniform pushing pressure and forming force given to the bar in every part of its sectional area, whereby continuous forming of an exact helix is carried out under smooth feed of a material.

While this invention has been described and shown with reference to preferred embodiments thereof, it is to be understood that the invention is not limited to the embodiments shown but that many changes, modifications and additions may be possible in the construction of the invention without departing from the scope of the appended claims.

What I claim is:

1. A device for manufacturing a helical element comprising a group of rolls and a first die, said group of rolls and first die being adapted to feed forward a flat bar and to form said bar successively into a flat bar of completely arcuate section, and a second die for forming said arcuate flat bar into a helix, said second die comprising an outer metal cylinder and an inner cylindrical metal core, said metal core being provided on its outer surface with a helical groove of arcuate section, said first die being disposed along the path of travel of said flat bar and said second die being disposed with the axis of said cylindrical metal core at an angle to said path of travel substantially equal to the helical angle of the helical element

2. A device for manufacturing a helical element according to claim 1 wherein the group of rolls are rolls for feeding a flat bar and the first die is a die for forming the flat bar into a flat bar of completely arcuate section.

3. A device for manufacturing a helical element according to claim 2 wherein the group of rolls for feeding a flat bar is made up of a group of pairs of upper and lower flat grooved rolls.

4. A device for manufacturing a helical element according to claim 2 wherein the first die is provided with a forming opening, said opening being progressively sharper in arcuate angle along the length extending over the outlet side end of the first die and having a completely arcuate section equal to the curvature of the outer circumference of a linear body to be wrapped by the helically preformed element at said outlet side end.

5. A device for manufacturing a helical element according to claim 1 wherein the group of rolls is a group of rolls for feeding a flat bar and rolls for forming the bar into a bar of completely arcuate section and the first die is a die for guiding the flat bar of completely arcuate section.

6. A device for manufacturing a helical element according to claim 5 wherein the group of rolls for feeding a flat bar and rolls for forming the bar into a bar of completely arcuate section is made up in the manner that first rolls are feed rolls for a flat bar comprising a pair of upper and lower flat grooved rolls and second rolls and those disposed thereafter are a group of pairs of upper and lower arcuately grooved rolls for successively forming a flat bar into a bar of completely arcuate section.

7. A device for manufacturing a helical element according to claim 5 wherein the first die is provided at the inlet and outlet side ends for a flat bar with an opening of uniformly and completely arcuate section.

8. A device for manufacturing a helical element according to claim 1 wherein the group of rolls is a group of grooved rolls for feeding and forming a flat bar into a bar of arcuate section to a certain degree and the first die is a die for forming the flat bar into a bar of completely arcuate section.

9. A device for manufacturing a helical element according to claim 8 wherein the group of rolls for feeding and forming a flat bar into a bar of arcuate section to a certain degree is made up in the manner that first rolls are feed rolls for a flat bar comprising a pair of upper and lower flat rolls and second rolls and rolls disposed thereafter are a group of pairs of upper lower arcuately grooved rolls for successively forming a flat bar into a bar of arcuate section to a certain degree.

10. A device for manufacturing a helical element according to claim 8 wherein the first die is provided with a forming opening, said opening being arcuate in section in a certain degree at the inlet side end for a flat bar and being progressively sharper in arcuate angle along the length extending over the outlet side end and having completely arcuate section at said outlet side end.

11. A device for manufacturing a helical element according to claim 6 wherein the pair of upper and lower forming rolls for successively forming a flat bar into a bar of arcuate section are made up in the manner that one roll to be used as a female roll is a flat roll made of elastic material and the other male roll is a grooved roll made of rigid material.

12. A device for manufacturing a helical element according to claim 9 wherein the pair of upper and lower forming rolls for successively forming a flat bar into a bar of arcuate section are made up in the manner that one roll to be used as a female roll is a flat roll made of elastic material and the other male roll is an arcuately grooved roll made of rigid material.

13. A device for manufacturing a helical element according to claim 1 wherein the second die is disposed at an angle to the path of travel in the range of 20° to 30°.

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