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Yamaguchi

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(54) **WINDING CORE FOR COIL WINDING DEVICE**

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B65H 75/08 (2006.01)
B65H 75/18 (2006.01)
H01F 41/06 (2006.01)

(52) **U.S. Cl.**
CPC ***B65H 75/18*** (2013.01); ***H01F 41/065*** (2013.01); ***H01F 41/0687*** (2013.01); ***B65H 75/242*** (2013.01)
USPC **242/573.2**; 242/604; 242/613.2; 242/118.1

(58) **Field of Classification Search**
USPC 242/600, 604, 613, 613.1, 613.2, 118, 242/118.1, 118.11, 571, 572, 573, 573.2
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

355,145 A *	12/1886	Davis et al.	242/609
2,425,155 A *	8/1947	Jarvis	242/610.2
2,714,997 A *	8/1955	Weisbart	242/118.32
2,916,226 A *	12/1959	McGraw, Jr.	242/610.4
3,189,857 A *	6/1965	Jones	336/198
3,363,210 A *	1/1968	Hollyday	336/185
3,989,200 A *	11/1976	Bachi	242/437.3
2013/0056110 A1*	3/2013	Yamaguchi et al.	140/71

FOREIGN PATENT DOCUMENTS

JP 2010-004589 A 1/2010

* cited by examiner

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(57) **ABSTRACT**

A winding core for a coil winding device having a column shape with corners each having a rounded cross-section is used for forming a coil by winding a wire around the winding core into the coil of a polygonal shape. The winding core includes a helical continuous surface extending spirally around an axis of the winding core.

5 Claims, 9 Drawing Sheets

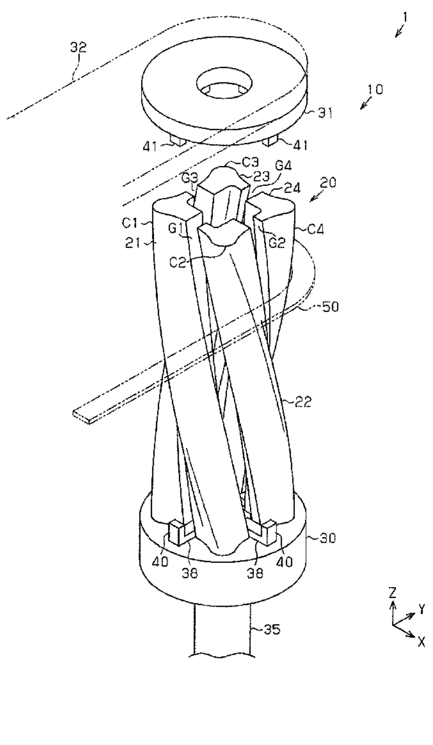


FIG. 1

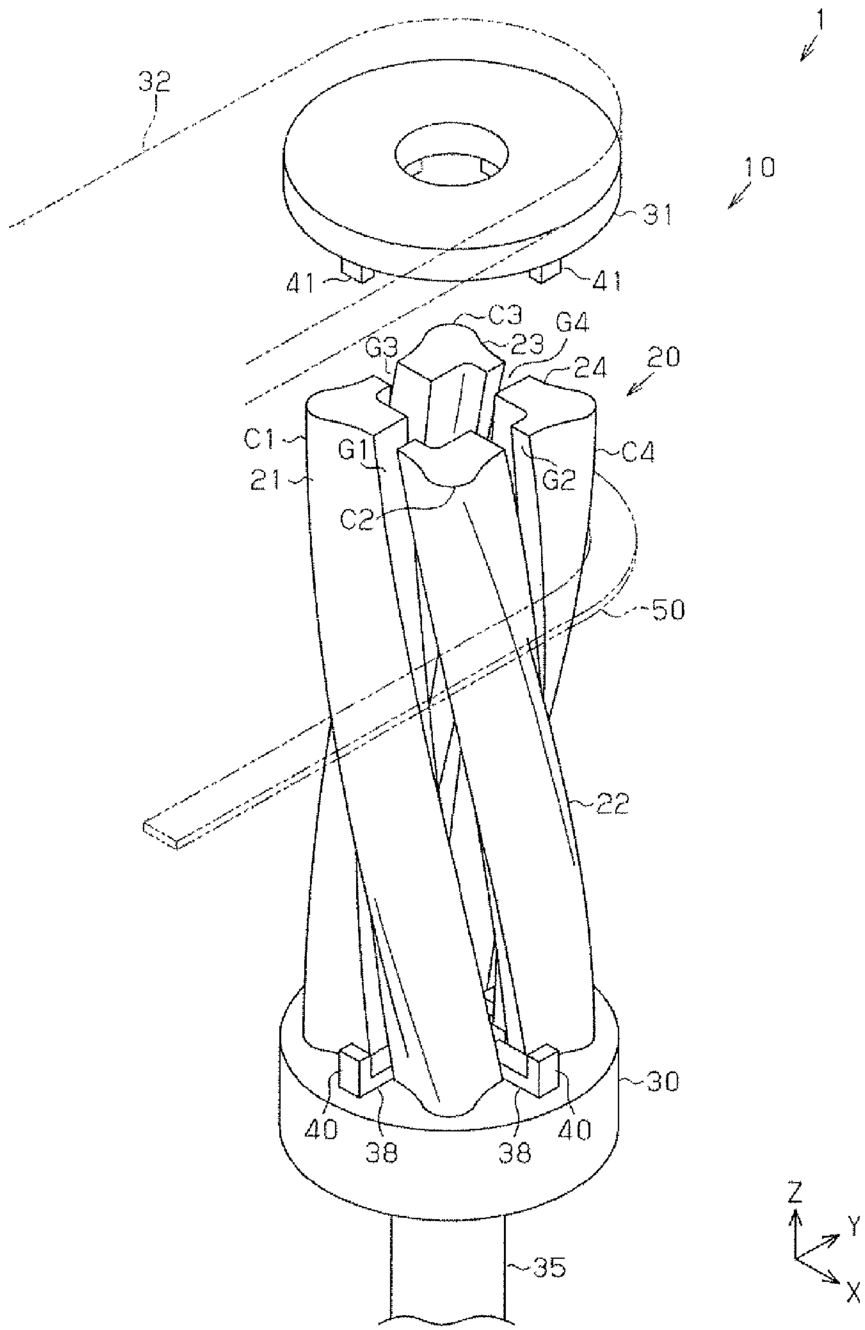

1
32
10
31
41
41
C3
G4
G3
23
24
20
C1
G1
C4
21
G2
C2
50
22
30
40
38
38
40
Z
Y
X
35

FIG. 2

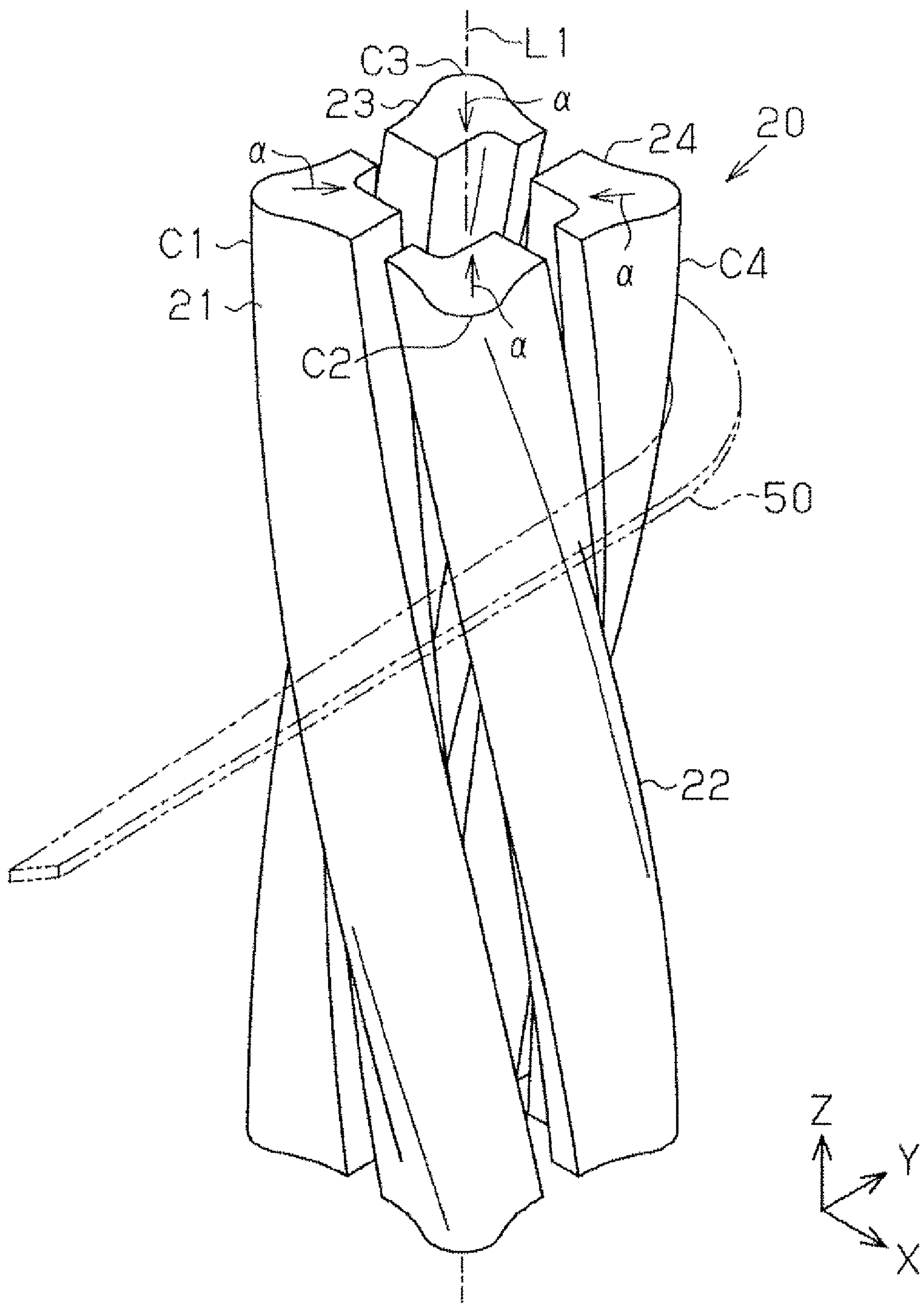


FIG. 3

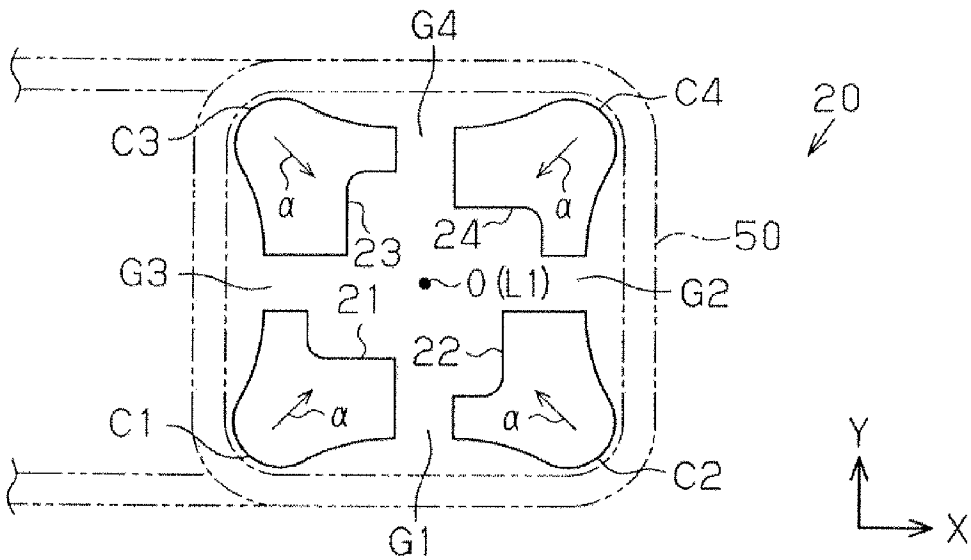
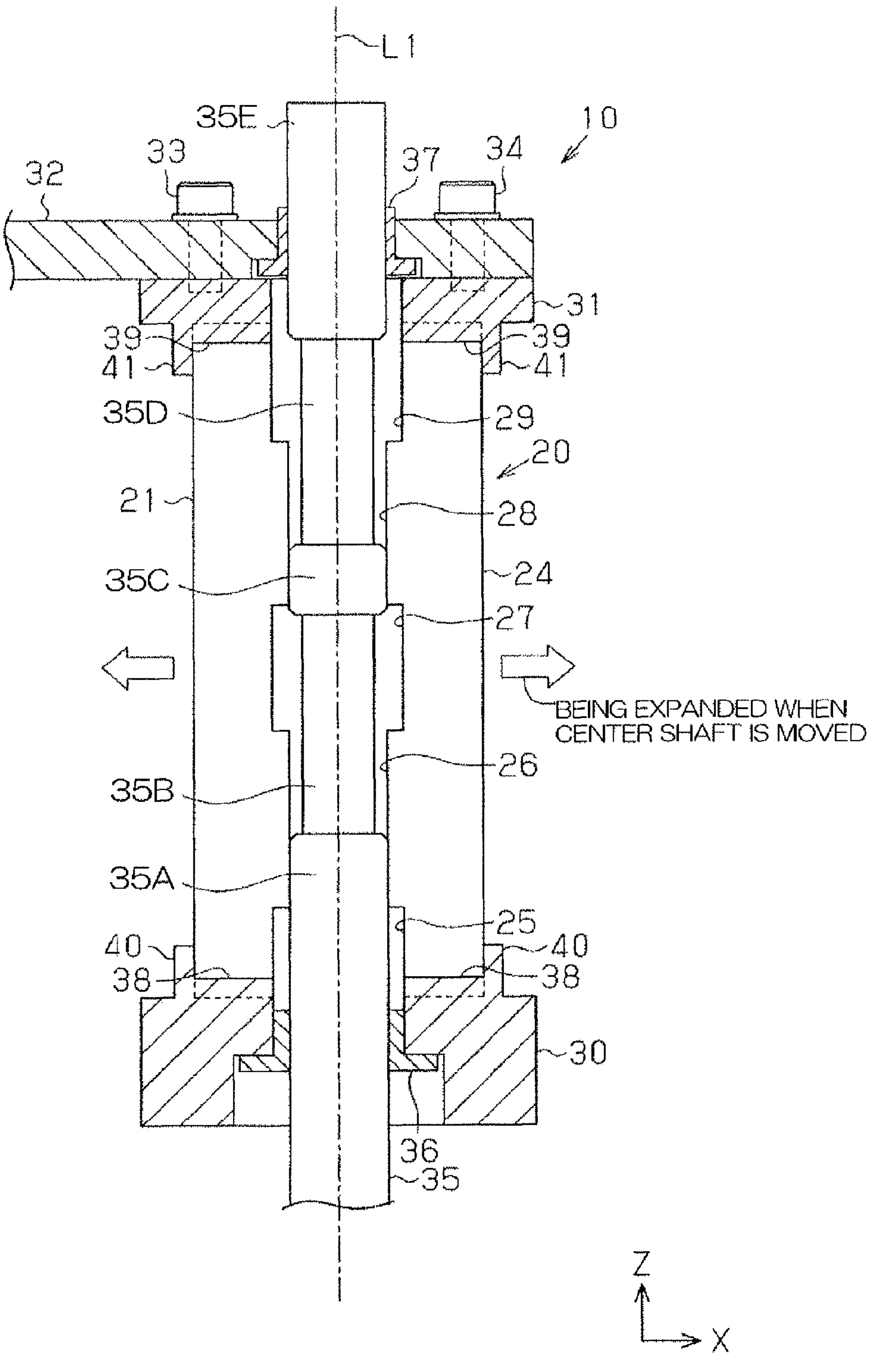


FIG. 4



L1
35E
10
33
37
34
32
31
39
39
41
41
35D
29
20
21
28
35C
24
27
BEING EXPANDED WHEN CENTER SHAFT IS MOVED
35B
26
35A
25
40
40
38
38
30
36
35
Z
X

FIG. 5

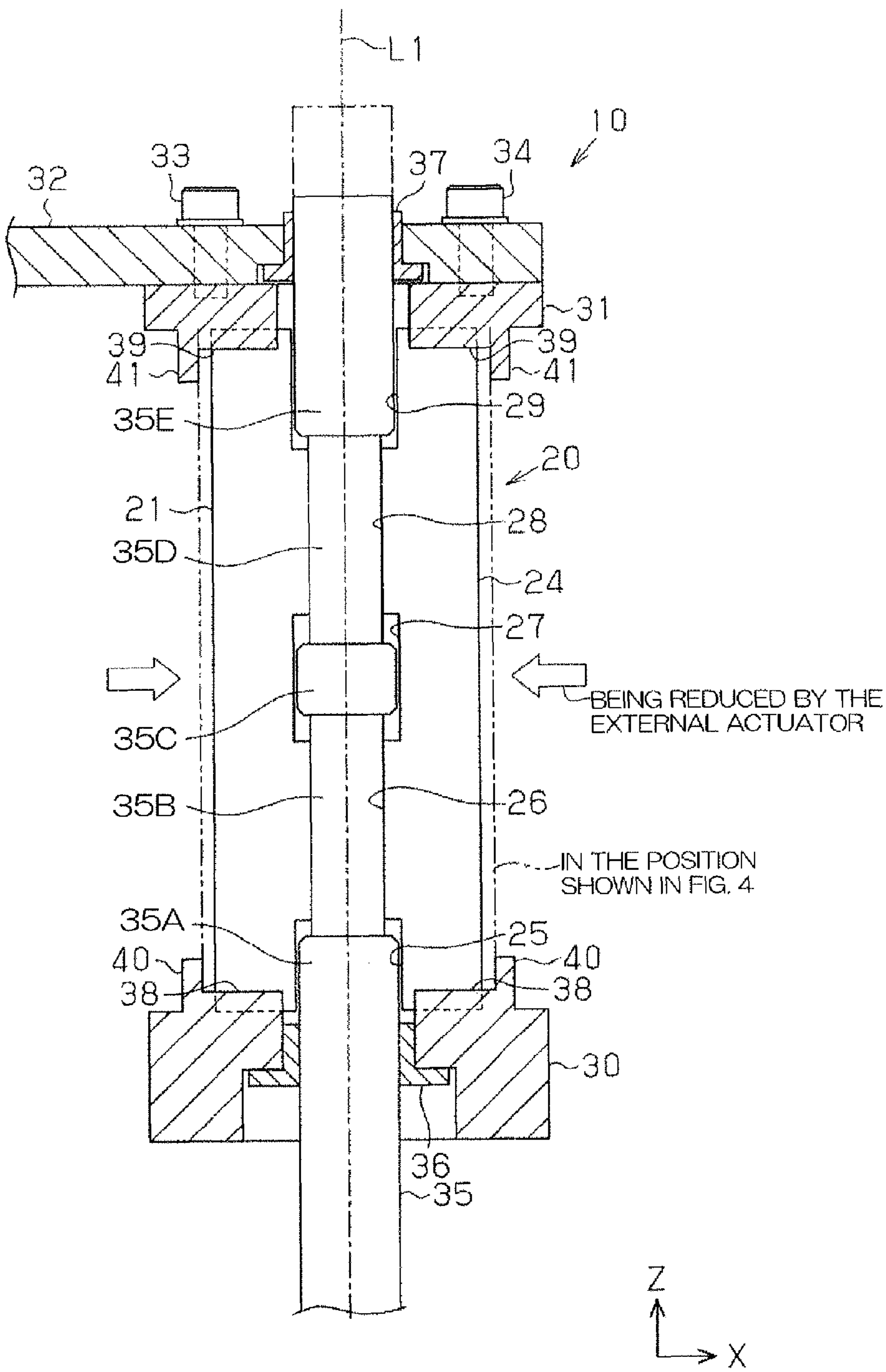

L1
10
32
33
37
34
31
39
41
39
41
35E
29
20
21
28
35D
24
27
BEING REDUCED BY THE
EXTERNAL ACTUATOR
35C
35B
26
IN THE POSITION
SHOWN IN FIG. 4
35A
25
40
40
38
38
30
36
35
Z
X

FIG. 6

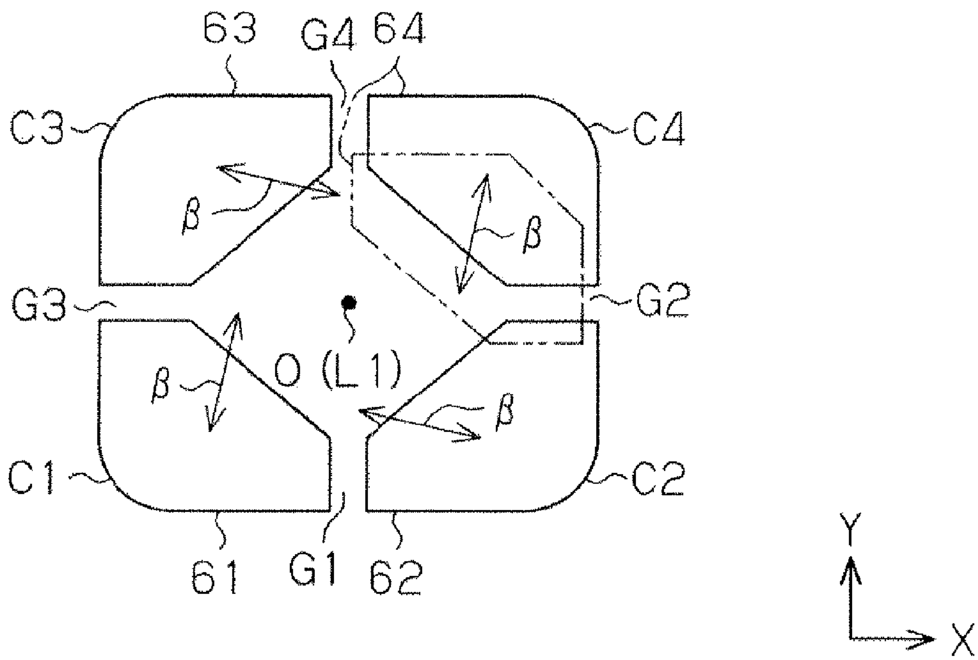


FIG. 7

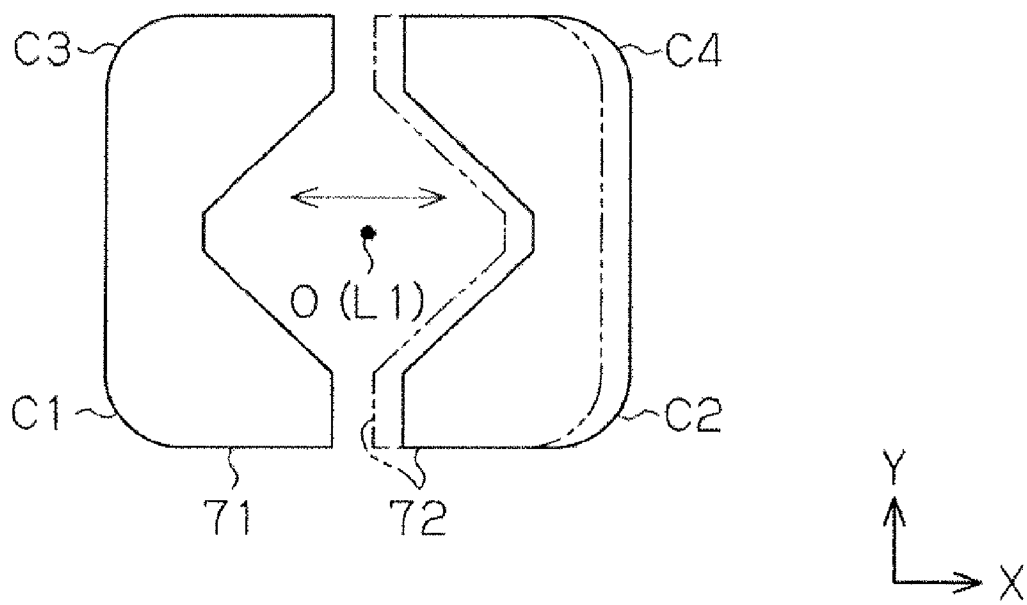


FIG. 8

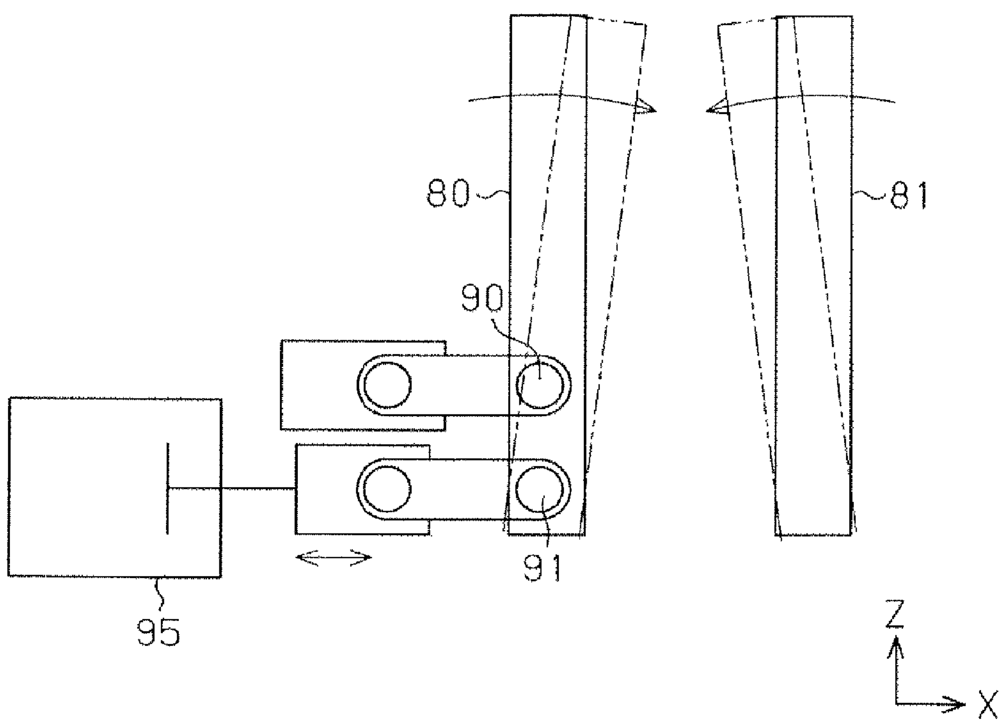
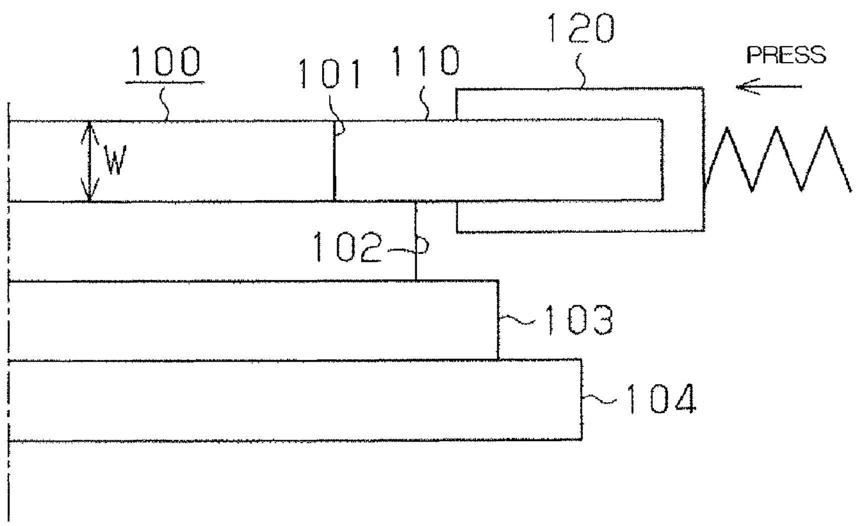
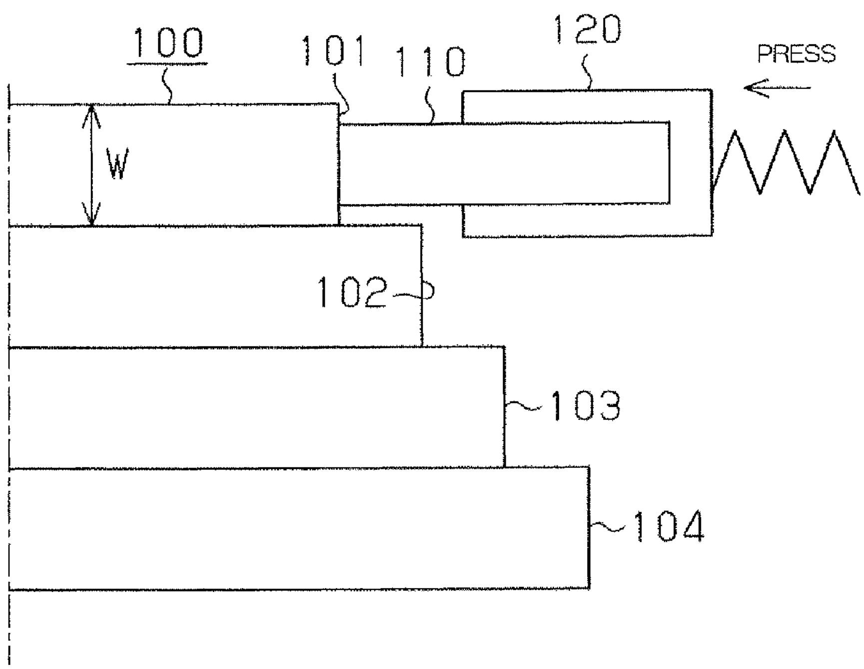


FIG. 9A



100
101
110
120
PRESS
W
102
103
104

FIG. 9B



100
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120
PRESS
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103
104

WINDING CORE FOR COIL WINDING DEVICE

BACKGROUND OF THE INVENTION

The present invention relates to a winding core for a coil winding device.

When a wire is bent into a generally square shape or any other polygonal shape in winding the wire around a winding core of a winder to form a coil, the wire is sprung back from the intended bending angle. In the coil winding device disclosed in Japanese Patent Application Publication No. 2010.4589, the winding core of the winder is formed helically with the springback taken into previous consideration. More specifically, the winding core includes four core bars each having a substantially rectangular cross-section with four rounded corners and the wire is wound around the winding core for N times (N is an integer of two or more) to form a coil. The winding core has winding tracks forming N steps for winding wire and the winding tracks are formed such that each four corners of the winding tracks are circumferentially deviated every step to make the winding core into a helical shape.

Referring to FIG. **9**A showing the background art according to the above-cited Publication No. 2010-4589, the helical winding core **100** has winding tracks **101**, **102**, **103**, **104** and a step is formed between any two adjacent winding tracks, as shown in FIG. **9**A. Each of the winding tracks **101**, **102**, **103**, **104** has a contacting surface with which the wire (flat wire) **110** is in perpendicular contact. The wire **110** is pressed against the winding core **100** by the guide member **120** of a pressing roller. The wire **110** pressed against the step by the guide member **120** is moved to the adjacent step formed between the winding tracks **101**, **102**, **103**, **104**, so that the wire **110** is damaged by the step. For preventing the above damage to the wire **110**, the winding tracks **101**, **102**, **103**, **104** may be widened or the width W of the winding tracks **101**, **102**, **103**, **104** may be increased, as shown in FIG. **9**B so that the wire **110** is not moved to the adjacent step. However, widening the tracks **101**, **102**, **103**, **104** widens the clearance between any two adjacent turns of the wire in the axial direction of the winding core **100** and increases the total length of the coil.

The present invention is directed to providing a winding core for a coil winding device by which damage to a wire hardly occurs and an increase of the total length of wound coil is prevented.

SUMMARY OF THE INVENTION

In accordance with the present invention, a winding core for a coil winding device having a column shape with corners each having a rounded cross-section is used for forming a coil by winding a wire around the winding core into the coil of a polygonal shape. The winding core includes a helical continuous surface extending spirally around an axis of the winding core.

Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

FIG. **1** is a schematic perspective view of a coil winding device having a winding core according to a first preferred embodiment of the present invention;

FIG. **2** is a perspective view of the winding core of FIG. **1**;

FIG. **3** is an end view of the winding core of FIG. **1**;

FIG. **4** is a longitudinal sectional schematic view of the winding core of FIG. **1**, showing the expanded state of the winding core;

FIG. **5** is a longitudinal sectional schematic view of the winding core of FIG. **1**, showing the contracted state of the winding core;

FIG. **6** is an end view of a coil winding device having a winding core according to another embodiment of the present invention;

FIG. **7** is an end view of a coil winding device having a winding core according to yet another embodiment of the present invention;

FIG. **8** is a schematic front view of a winding core according to still yet another embodiment of the present invention;

FIG. **9**A is a schematic front view showing a winding core of the coil winding device according to the background art of the present invention, and

FIG. **9**B is a schematic front view showing a modified over the winding core of FIG. **9**A.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following will describe a coil winding device according to a first preferred embodiment with reference to FIGS. **1** through **5**. It is noted that the arrows X, Y and Z in the drawing show three different directions in the three-dimensional coordinate system of the coil winding device.

Referring to FIG. **1**, reference numeral **1** designates a coil winding device. The coil winding device **1** includes a winder **10** having a winding core **20**. The coil winding device **1** is used for forming a coil by winding a flat wire **50** around the columnar winding core **20** into a coil of a generally rectangular shape. The flat wire **50** has a rectangular cross-section and is wound edgeways to form the coil. The winding core **20** is rotatably supported.

Referring also to FIGS. **2**, **3**, the winding core **20** is divided into four core bars, namely a first core bar **21**, a second core bar **22**, a third core bar **23** and a fourth core bar **24**.

The winding core **20** as a whole has a generally square column shape with four corners, namely first through fourth corners C**1**, C**2**, C**3**, C**4** each of which is rounded. The first through fourth corners C**1**, C**2**, C**3**, C**4** have a rounded cross-section. The first core bar **21** has the first corner C**1**. The second core bar **22** has the second corner C**2**. The third core bar **23** has the third corner C**3**. The fourth core bar **21** has the fourth corner C**4**. L**1** in FIGS. **2** and **3** indicates the axis of the square columnar winding core **20**.

The first through fourth core bars **21**, **22**, **23**, **24** have a shape of a twisted rod and the first through fourth corners C**1**, C**2**, C**3**, C**4** thereof have a helical continuous smooth surface extending spirally around the axis L**1**.

A first helical space G**1** is formed between the first and the second core bars **21**, **22**, as shown in FIGS. **1** and **3**. Similarly, a second helical space G**2** is formed between the second and the fourth core bar **22**, **24**, a third helical space G**3** is formed between the first and the third core bar **21**, **23** and a fourth helical space G**4** is formed between the third and the fourth core bars **23**, **24**, as shown in FIGS. **1** and **3**.

As shown in FIG. **3**, the first through fourth core bars **21**, **22**, **23**, **24** are slidably supported by means of a slide mechanism such that the first through fourth core bars **21**, **22**, **23**, **24** can be moved toward and away from the center O of the winding core **20**. The arrows α in FIGS. **2** and **3** show the directions in which the respective first through fourth core bars **21**, **22**, **23**,**24** are moved toward the center O. After the winding of the flat wire **50** is completed, the first through fourth core bars **21**, **22**, **23**, **24** slide inward or in the direction α, so that the contacting surfaces of the first through fourth core bars **21**, **22**, **23**, **24** with the flat wire **50** at the rounded first through fourth corners C**1**, C**2**, C**3**, C**4** are moved inward and separated away from the flat wire **50**.

The coil winding device **1** further includes a lower plate (bottom block) **30** and an upper plate (top block) **31**. As shown in FIG. **1**, the first through fourth core bars **21**, **22**, **23**, **24** are disposed upright on the lower plate **30**. The upper plate **31** is provided on the top of the first through fourth core bars **21**, **22**, **23**, **24**. In other words, the first through fourth core bars **21**, **22**, **23**, **24** are supported and held between the lower plate **30** and the upper plate **31** in an upright position.

Referring to FIG. **4**, an arm **32** is disposed above the upper plate **31** and extends horizontally. The arm **32** is fastened at the proximal end thereof to the upper plate **31** by bolts **33**, **34**. A center shaft **35** extends through the center part of the lower plate **30**. The center shaft **35** is supported at the lower part thereof by a bearing **36** so as to be movable up and down. The center shaft **35** extends also through the center of the upper plate **31** and is supported at the upper part thereof by a bearing **37** so as to be movable up and down.

The lower plate **30** has on the top surface thereof a plurality of guide members **38**. Similarly, the upper plate **31** has on the bottom surface thereof a plurality of guide members **39**. The first through fourth core bars **21**, **22**, **23**, **24** are slidable in radial direction toward and away from the center O of the winding core **20** while being guided by the guide members **38**, **39**.

The lower plate **30** has a stop projection **40** on the top surface thereof and the upper plate **31** has a stop projection **41** on the bottom surface thereof. The center shaft **35** extends through the center of the winding core **20**.

The center shaft **35** has three large-diameter portions **35**A, **35**C, **35**E and two small-diameter portions **35**B, **35**D. The large-diameter portion **35**A, the small-diameter portion **35**B, the large-diameter portion **35**C, the small-diameter portion **35**D and the large-diameter portion **35**E are positioned in this order from the bottom to the top of the center shaft **35**.

The first through fourth core bars **21**, **22**, **23**, **24** (winding core **20**) have on the inner peripheral surfaces thereof large-diameter portions **25**, **27**, **29** and small-diameter portions **26**, **28**. The large-diameter portion **25**, the small-diameter portion **26**, the large-diameter portion **27**, the small-diameter portion **28** and the large-diameter portion **29** are positioned in this order as seen from the bottom to the top of the winding core **20**. As shown in FIG. **5**, the winding core **20** is pushed inward by an external actuator (not shown) such that the inner peripheral surfaces of the first through fourth core bars **21**, **22**, **23**, **24** are brought into contact with the outer peripheral surface of the center shaft **35**. Thus, the first through fourth core bars **21**, **22**, **23**, **24** are moved inward or toward the center O, so that the diameter of the winding core **20** is reduced.

The center shaft **35** is movable up and down. When the small-diameter portions **26**, **28** of the first through fourth core bars **21**, **22**, **23**, **24** and the small-diameter portions **35**B, **35**D of the center shaft **35** are in contact with each other, the first through fourth core bars **21**, **22**, **23**, **24** are located in the contracted position, as shown in FIG. **5**. When the small-diameter portions **26**, **28** of the first through fourth core bars **21**, **22**, **23**, **24** and the large-diameter portions **35**A, **35**C of the center shaft **35** are in contact with each other, the first through fourth core bars **21**, **22**, **23**, **24** are located in the expanded position, as shown in FIG. **4**. At this time, the first through fourth core bars **21**, **22**, **23**, **24** are placed in contact with the stop projections **40**, **41** formed on the lower and the upper plates **30**, **31**, respectively.

When the center shaft **35** is moved upward, the first through fourth core bars **21**, **22**, **23**, **24** of the winding core **20** are separated by being pushed away from each other in radial direction by steps of the center shaft **35**. Thus, the coil winding device **1** is placed in the expanded position shown in FIG. **4**. When the center shaft **35** is moved downward, on the other hand, the large-diameter portions **35**A, **35**C, **35**E of the center shaft **35** are located in the large-diameter portions **25**, **27**, **29** of the first through fourth core bars **21**, **22**, **23**, **24** with clearances formed between the large-diameter portions **35**A, **35**C, **35**E and the large-diameter portions **25**, **27**, **29**, respectively. Then, the clearances are reduced by the external actuator. Thus, the coil winding device **1** is placed in the contracted position as shown in FIG. **5**.

Winding of the wire is performed around the winding core **20** in the expanded position shown in FIG. **4** and, after completion of the winding of wire, the wound wire (coil) is removed from the winding core **20** which is contracted as shown in FIG. **5**. The flat wire **50** is wound while being guided along the winding core **20** by a guide member (not shown). In the winding, the flat wire **50** is pressed at the short side of the rectangular cross-section of the flat wire **50** against the winding surface (or contact surface) of the winding core **20**. In the winding of the flat wire **50**, the relative positions of the flat wire **50** and the winding core **20** in the vertical direction is changed. Specifically, the winding of the flat wire **50** is performed while the winding core **20** is being moved downward with the flat wire **50** kept at a predetermined height.

The following will describe the operation of the coil winding device **1** (winding core **20**) constructed as described above. With the center shaft **35** placed in the raised position as shown in FIG. **4**, the small-diameter portions **26**, **28** of the first through fourth core bars **21**, **22**, **23**, **24** and the large-diameter portions **35**A, **35**C of the center shaft **35** are in contact with each other, so that the first through the fourth core bars **21**, **22**, **23**, **24** are located away from each other.

In this state of the winding core **20**, one end of the flat wire **50** is fixed to the winding core **20** of the winder **10**. The flat wire **50** is pressed against the peripheral surface of the winding core **20** and wound edgeways around the winding core **20** by rotating the winding core **20**, thereby forming a coil.

As shown in FIGS. **1** and **2**, the first through fourth corners C**1**, C**2**, C**3**, C**4** corresponding to the outer peripheral surfaces (side surfaces) of the winding core **20** around which the flat wire **50** is wound are formed helically around the axis L**1**.

The winding core **20** has a helical shape which is formed with the springback of the wound flat wire **50** taken into consideration preciously, so that the flat wire **50** removed from the winding core **20** and sprung back takes an intended shape having no distortion.

After the winding of the flat wire **50** is completed, the center shaft **35** is moved downward and the small-diameter portions **26**, **28** of the first through fourth core bars **21**, **22**, **23**, **24** and the small-diameter portions **35**B, **35**D are in contact with each other, so that the first through the fourth core bars **21**, **22**, **23**, **24** are moved to the contracted position of FIG. **5**. That is, after winding of the flat wire **50**, the first through the fourth core bars **21**, **22**, **23**, **24** are moved inwardly or toward the axis L**1**, so that the wound flat wire **50** may be removed from the winding core **20**.

The winding angle of the winding core **20** is corrected by twisting the winding core **20** around the rotation center (center axis) of the winding core **20** by an amount of the springback of the winding core **20**. The first through fourth corners C**1**, C**2**, C**3**, C**4** have a helical continuous smooth surface extending spirally around the axis L**1**, so that the wire is hardly susceptible to a damage by the steps as described with reference to FIG. **9**A and an increase of the total length of the completed coil shown in FIG. **9**B is prevented. Since the first through fourth corners C**1**, C**2**, C**3**, C**4** of the winding core **20** have a helical continuous smooth surface such that the completed coil formed by bending slips thereon in the axial direction thereof, damage to the coil by the steps hardly occurs and an increase of the total length of the completed coil and twisting caused by springback are prevented.

The formed coil caught on the winding core **20** due to springback is pulled out easily from the winding core **20** by contracting the winding core **20**. After pulling out the coil from the winding core **20**, the winding core **20** is expanded so as to move the first through fourth core bars **21**, **22**, **23**, **24** back in the expanded position.

The following advantageous effects are obtained in the embodiment.

(1) In the coil winding device **1**, the winding core **20** has a column shape having the rounded first through fourth corners C**1**, C**2**, C**3**, C**4** each having a rounded cross-section. The first through fourth corners C**1**, C**2**, C**3**, C**4** have a helical continuous smooth surface extending spirally around the axis L**1** of the winding core **20**. Thus, the wire (flat wire **50**) is prevented from damage by the steps as described earlier with reference to FIGS. **9**A and **9**B. Since damage of the wire by the steps need not to be considered, the clearance between any two adjacent turns of wire in the axial direction of the winding core **20** is reduced and an increase of the total length of the wound coil is prevented. Therefore, damage to the wire is hardly occurred and an increase of the total length of the wound coil is prevented.

(2) The winding core **20** which is divided into a plurality of the first through fourth core bars **21**, **22**, **23**, **24** movable inwardly away from the wound flat wire **50** allows the wound wire (coil) to be removed easily from the winding core **20**.

(3) The winding core **20** according to the embodiment which is divided into four core bars **21**, **22**, **23**, **24** having the rounded first through fourth corners C**1**, C**2**, C**3**, C**4** facilitate removal of wound wire (coil) from the winding core **20** by replacement of the rounded first through fourth corners C**1**, C**2**, C**3**, C**4**.

(4) The first through fourth helical spaces G**1**, G**2**, G**3**, G**4** formed between the first through fourth core bars **21**, **22**, **23**, **24** extend in a helical manner. Thus, the first through fourth corners C**1**, C**2**, C**3**, C**4** are formed in a helical shape, so that the coil is easily pulled out from the winding core **20**.

The above embodiment may be modified in various ways as exemplified below.

In the structure for contracting the winding core **20**, the path of movement of the first through fourth core bars **21**, **22**, **23**, **24** is not limited to the movement in radial direction from the center of the winding core **20**. The first through fourth core bars **21**, **22**, **23**,**24** may be moved in any way other than radially as long as they are moved inwardly. For example, the first through fourth core bars **61**, **62**, **63**, **64** may be movable in the directions that are indicated by the double-headed arrows β in FIG. **6**. Specifically, the double-headed arrows β in FIG. **6** is directed obliquely with respect to an imaginary line extending radially through the center O of the winding core **20**.

In other words, the winding core **20** may be configured so that the first through fourth core bars **61**, **62**, **63**, **64** are movable inwardly so as to allow the coil to be disengaged from the winding core **20** and to be removed therefrom.

The provision of the helically extending first through fourth helical spaces G**1**, G**2**, G**3**, G**4** allows the first through fourth core bars **61**, **62**, **63**, **64** to be moved in the β directions other than the direction toward away from the center O (or radial direction).

According to the above embodiment, the winding core **20** is divided into four core bars. Furthermore, the winding core includes more than two core bars. FIG. **7** shows an embodiment wherein the winding core **20** includes two first and second core bars **71**, **72**.

The structure for expanding and contracting the winding core **20** is not limited to the slide mechanism, but may be link mechanism or cam mechanism. Any structure that allows a coil to be removed from the winding core **20** is acceptable. FIG. **8** shows an example of the link mechanism, wherein first and second core bars **80**, **81** are pivotally supported at a position adjacent to the bottom thereof by a pin **90** and the first and the second core bars **80**, **81** are pivoted as indicated by arrows by a cylinder **95** that is operative connected to the bottom of the first and the second core bars **80**, **81** through a pin **91**.

The wire to be wound is not limited to a flat wire, but may be any other wire, such as a wire having a circular cross-section. The winding core **20** or the coil is not limited to have a rectangular shape, but may have any other shape, such as a rhombus shape or any other polygonal shape.

The winding core need not be formed by a plurality of core bars, but may be formed by a single core bar.

What is claimed is:

1. A winding core for a coil winding device, the winding core having a column shape with corners each having a rounded cross-section, the winding core used for forming a coil by winding a wire around the winding core into the coil of a polygonal shape, the winding core comprising:

the corners each having a helical continuous surface extending spirally around an axis of the winding core.

2. The winding core according to claim **1**, wherein the winding core is divided into a plurality of core bars, and contacting surfaces of the core bars with the wires at the corners of the winding core are moved inward and separated away from the wire after the winding of the wire is completed.

3. The winding core according to claim **2**, wherein the winding core includes two core bars.

4. The winding core according to claim **2**, wherein the winding core includes four core bars.

5. The winding core according to claim **2**, wherein each of spaces formed between the core bars extends in a helical manner.

* * * * *