



(51) International Patent Classification:

H01F 41/04 (2006.01) H01F 27/28 (2006.01)
H01F 5/00 (2006.01)

(21) International Application Number:

PCT/CN2017/106720

(22) International Filing Date:

18 October 2017 (18.10.2017)

(25) Filing Language:

English

(26) Publication Language:

English

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

(54) Title: FLAT COIL, MANUFACTURING METHOD THEREOF AND ELECTRONIC APPARATUS

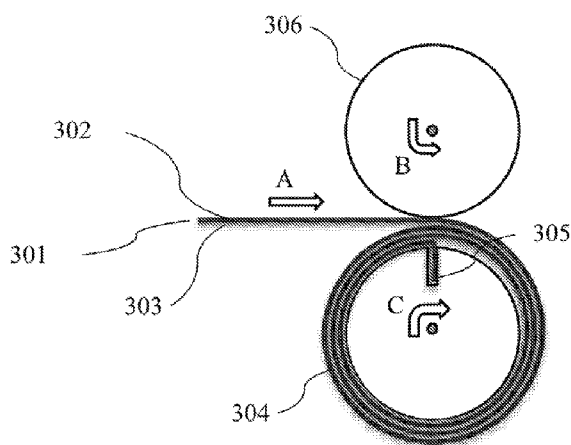


FIG. 4

(57) Abstract: A flat coil(311), a manufacturing method thereof and an electronic apparatus are disclosed. The manufacturing method comprises: rolling a metal foil lamination(301) onto a carrier roller(304) to form a foil rod(308), wherein the metal foil lamination(301) includes at least one layer of metal foil(302); sliding the foil rod(308) from the carrier roller(304); slicing the foil rod(308) into thin disks(309); and processing the thin disks(309) to form at least one flat coil(311). According to this disclosure, a new solution for a flat coil(311) is proposed.

Published:

— *with international search report (Art. 21(3))*

FLAT COIL, MANUFACTURING METHOD THEREOF AND ELECTRONIC APPARATUS

FIELD OF THE INVENTION

The present invention relates to the technical field of forming coil, more specifically, to a
5 method for manufacturing a flat coil, a flat coil and an electronic apparatus.

BACKGROUND OF THE INVENTION

Recently, wireless charging applications become more and more attractive. Some of the
leading smart phone suppliers have adopted wireless charging units in their smart phones. Other
electronic apparatus such as wearable apparatus, handheld apparatus, computers and so on are
10 also starting to adopt wireless charging unit. Generally, a wireless charging unit includes at least
one flat coil. It is desired that the flat coil has a high quality and/or efficiency, at reasonably low
cost.

In the prior art, there are two approaches for manufacturing a flat coil.

One approach is a Cu wire winding approach. Fig. 1 shows a Cu wire coil. As shown in
15 Fig. 1, a flat coil 12 is formed by winding a Cu wire. The flat coil 12 is placed on a ferrite sheet
14 via an adhesive tape 13. A magnet core 11 is provided to the flat coil 12. Since the flat coil is
formed by winding a Cu wire, its through-put is relatively low and its cost is relatively high.
Besides, the shape and diameters of the Cu wire are limited. So, it is difficult to perform a design
optimization.

20 The other approach is to form a flat coil on a printed circuit board, for example, by
lithography, Cu etching or plating on a PCB (Printed Circuitry Board), FPCB (Flexible Printed
Circuitry Board) or ceramic substrates. Fig. 2 shows a schematic diagram of a flat coil in a PCB.
As shown in Fig. 2, a coil array 22 is formed between an interface surface 21 and a shielding
layer 23. This approach may suffer manufacturing cost issue. Furthermore, the flat coil
25 manufactured by this approach typically has a degraded performance. For example, it has a high
resistance, a low Quality-factor and a low efficiency.

Therefore, there is a demand in the art that a new solution for manufacturing a flat coil

shall be proposed to address at least one of the problems in the prior art.

SUMMARY OF THE INVENTION

One object of this invention is to provide a new technical solution for a flat coil.

According to a first aspect of the present invention, there is provided a method for
5 manufacturing a flat coil, comprising: rolling a metal foil lamination onto a carrier roller to form a foil rod, wherein the metal foil lamination includes at least one layer of metal foil; sliding the foil rod from the carrier roller; slicing the foil rod into thin disks; and processing the thin disks to form at least one flat coil.

Alternatively or optionally, the carrier roller has a starting slit, and one end of the metal
10 foil lamination is inserted and fixed in the starting slit.

Alternatively or optionally, a pressing roller is pressed against the carrier roller via the metal foil lamination with a controlled pressing force during the metal foil lamination is rolled.

Alternatively or optionally, the metal foil lamination includes at least two layers of metal foils.

15 Alternatively or optionally, processing the thin disks further comprises: grinding the thin disks to a preset thickness; coating the thin disks with a passivation layer; and forming terminals of the thin disks.

Alternatively or optionally, the metal foil is a Cu foil.

Alternatively or optionally, the foil rod is sliced by using at least one of blade dicing,
20 wire cutting and wire electrical discharging machining.

Alternatively or optionally, the metal foil contains an insulation layer with adhesive.

According to a second aspect of the present invention, there is provided a flat coil manufactured by using the method for manufacturing a flat coil according to any of the embodiments of this disclosure.

25 According to a third aspect of the present invention, there is provided a n electronic apparatus comprising a wireless charging unit which includes at least one flat coil according to any of the embodiments of this disclosure.

According to an embodiment of this disclosure, a new solution for manufacturing a flat

coil is proposed. It may lower the manufacturing cost and/or provide a relatively high performance.

Further features of the present invention and advantages thereof will become apparent from the following detailed description of exemplary embodiments according to the present
5 invention with reference to the attached drawings.

BRIEF DISCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description thereof, serve to explain the principles of the invention.

10 Fig. 1 is a schematic diagram of a flat coil manufactured by a prior art approach.

Fig. 2 is a schematic diagram of a flat coil manufactured by another prior art approach.

Fig. 3-8 show a schematic diagram of a process of manufacturing a flat coil according to an embodiment of this disclosure.

Fig. 9 shows a schematic diagram of a flat coil manufactured according to another
15 embodiment of this disclosure.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Various exemplary embodiments of the present invention will now be described in detail with reference to the drawings. It should be noted that the relative arrangement of the components and steps, the numerical expressions, and numerical values set forth in these
20 embodiments do not limit the scope of the present invention unless it is specifically stated otherwise.

The following description of at least one exemplary embodiment is merely illustrative in nature and is in no way intended to limit the invention, its application, or uses.

Techniques, methods and apparatus as known by one of ordinary skill in the
25 relevant art may not be discussed in detail but are intended to be part of the specification where appropriate.

In all of the examples illustrated and discussed herein, any specific values should be

interpreted to be illustrative only and non-limiting. Thus, other examples of the exemplary embodiments could have different values.

Notice that similar reference numerals and letters refer to similar items in the following figures, and thus once an item is defined in one figure, it is possible that it need
5 not be further discussed for following figures.

Embodiments and examples will be described with reference to the figures.

The embodiments of this disclosure propose a new approach of manufacturing a flat coil, which is different from the prior art. In the embodiments, metal foils are used to manufacturing a flat coil. Compared with the prior art, this approach is more easy and/or cost-efficient.

10 Fig. 3-8 show a schematic diagram of a process of manufacturing a flat coil according to an embodiment of this disclosure.

Fig. 3 shows that a metal foil lamination 301 is rolled onto a carrier roller 304 to form a foil rod.

The metal foil lamination 301 includes at least one layer of metal foil 302. For example,
15 the metal foil is a Cu foil 302. Fig. 9 shows a metal foil lamination 301m, which includes at least two layers of metal foils. For example, the metal foil 302 contains an insulation layer 303 with adhesive.

As shown in Fig. 3, the carrier roller 304 has a starting slit 305, and one end of the metal foil lamination 301 is inserted and fixed in the starting slit 305.

20 Here, the carrier roller 304 may not be round, and may have a cross-section of other shape. This approach may provide a designer with more freedom of design.

Also as shown in Fig. 3, a pressing roller 306 is pressed against the carrier roller 304 via the metal foil lamination 301 with a controlled pressing force during the metal foil lamination 301 is rolled. During the rolling, the metal foil lamination 301 travels in the direction A, the
25 carrier roller 304 rotates in the direction C, and the pressing roller 306 rotates in the direction B, as shown in Fig. 3.

As shown in Fig. 4, the metal foil lamination 301 is rolled into a foil rod.

As shown in Fig. 5, the foil rod 308 is slid from the carrier roller 304. For example, the length of the foil rod 308 is L, which is much larger than the length of a single flat coil. The foil

rod 308 can be used to make multiple flat coils. The end 307 of the metal foil lamination 301 is one inserted in the starting slit 305, as shown in Figs. 3 and 4.

As shown in Fig. 6, the foil rod 308 is sliced into thin disks 309. The thin disk 309 is annular, for example. The thickness of a sliced thin disk may be from 100 μ m to 1000 μ m, for
5 example.

For example, the foil rod 308 is sliced by using at least one of blade dicing, wire cutting and wire electrical discharging machining.

Next, the thin disks 309 are processed to form at least one flat coil. Under the teaching of this disclosure, a person skilled in the art can conceive a lot processes for the thin disks 309.

10 For example, the sliced thin disks 309 may be placed on a large platform for processing, as shown in Fig. 7. The processing may include: grinding the thin disks to a preset thickness; coating the thin disks with a passivation layer; and forming terminals of the thin disks.

For example, the thickness of a grinded thin disk may be from 50 μ m to 900 μ m and the passivation layer on the grinded surfaces of the flat coil (such as a Cu coil) is 5-25 μ m. For
15 example, the passivation layer can be polymer, plastic, epoxy, resist, adhesive and/or glue.

Fig. 8 shows a finished flat coil 311. The flat coil 311 is manufactured from the metal foil lamination 301. The flat coil 311 has a first terminal 312 and a second terminal 313. For example, the terminals 312, 313 may be formed by laser trimming or lithography patterning.

Fig. 9 shows a schematic diagram of a flat coil 311m manufactured according to another
20 embodiment of this disclosure. The flat coil 311m is manufactured from the metal foil lamination 301m, which has at least two layers of metal foils. The flat coil 311m has a first terminal 312m and a second terminal 313m.

According to another embodiment of this disclosure, a flat coil manufactured by using the method for manufacturing a flat coil according to any of the above embodiments may also be
25 provided. The flat coil may be used in a wireless charging unit of an electronic apparatus. For example, the flat coil may be used to replace the flat coil 12 in Fig. 1.

According to still another embodiment of this disclosure, an electronic apparatus is provided. The electronic apparatus comprises a wireless charging unit, and the wireless charging

unit includes at least one flat coil according to according to any of the above embodiments. The electronic apparatus may be smart phone, an electronic tooth-brush, and so on.

Although some specific embodiments of the present invention have been demonstrated in detail with examples, it should be understood by a person skilled in the art that the above
5 examples are only intended to be illustrative but not to limit the scope of the present invention.

CLAIMS

What is claimed is:

1. A method for manufacturing a flat coil, comprising:
rolling a metal foil lamination onto a carrier roller to form a foil rod, wherein the metal
5 foil lamination includes at least one layer of metal foil;
sliding the foil rod from the carrier roller;
slicing the foil rod into thin disks; and
processing the thin disks to form at least one flat coil.
- 10 2. The method according to claim 1, wherein the carrier roller has a starting slit, and one
end of the metal foil lamination is inserted and fixed in the starting slit.
3. The method according to claim 1 or 2, wherein a pressing roller is pressed against the
carrier roller via the metal foil lamination with a controlled pressing force during the metal foil
15 lamination is rolled.
4. The method according to any of claims 1-3, wherein the metal foil lamination includes
at least two layers of metal foils.
- 20 5. The method according to any of claims 1-4, wherein processing the thin disks further
comprises:
grinding the thin disks to a preset thickness;
coating the thin disks with a passivation layer; and
forming terminals of the thin disks.
- 25 6. The method according to any of claims 1-5, wherein the metal foil is a Cu foil.

7. The method according to any of claims 1-6, wherein the foil rod is sliced by using at least one of blade dicing, wire cutting and wire electrical discharging machining.

8. The method according to any of claims 1-7, wherein the metal foil contains an
5 insulation layer with adhesive.

9. A flat coil manufactured by using the method for manufacturing a flat coil according to any of claims 1-8.

10 10. An electronic apparatus comprising a wireless charging unit which includes at least one flat coil according to claim 9.

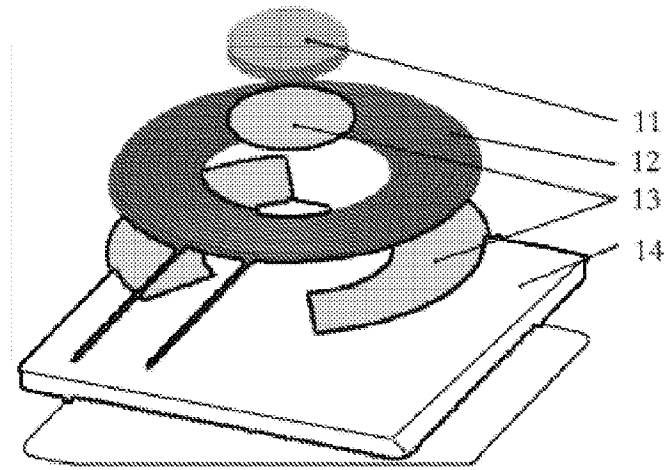


FIG. 1

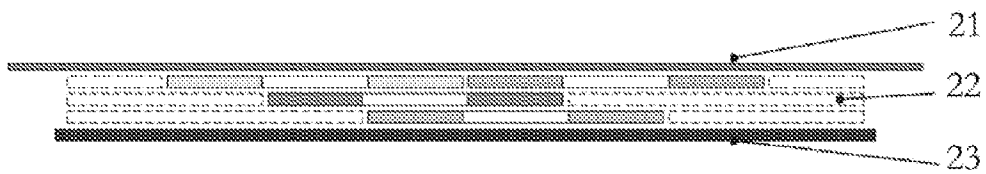


FIG. 2

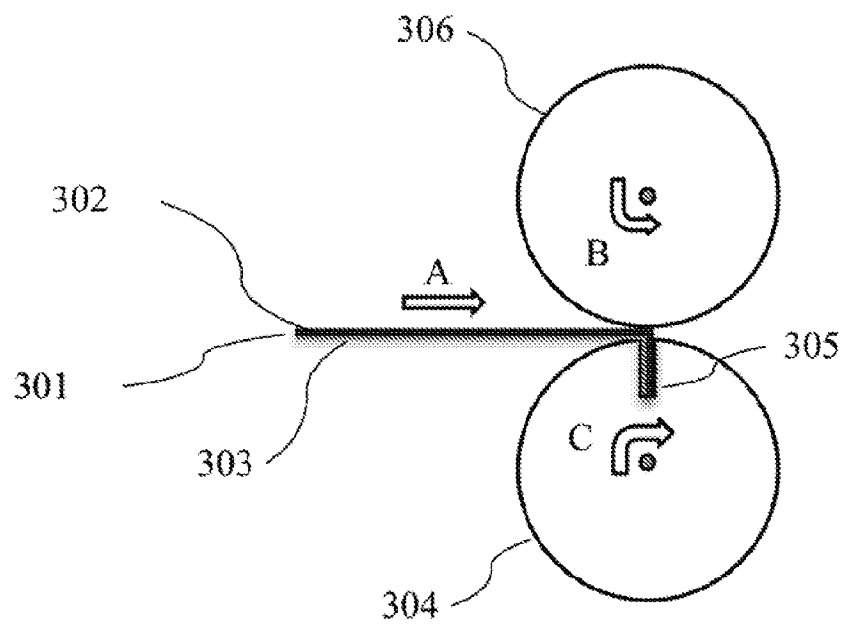


FIG. 3

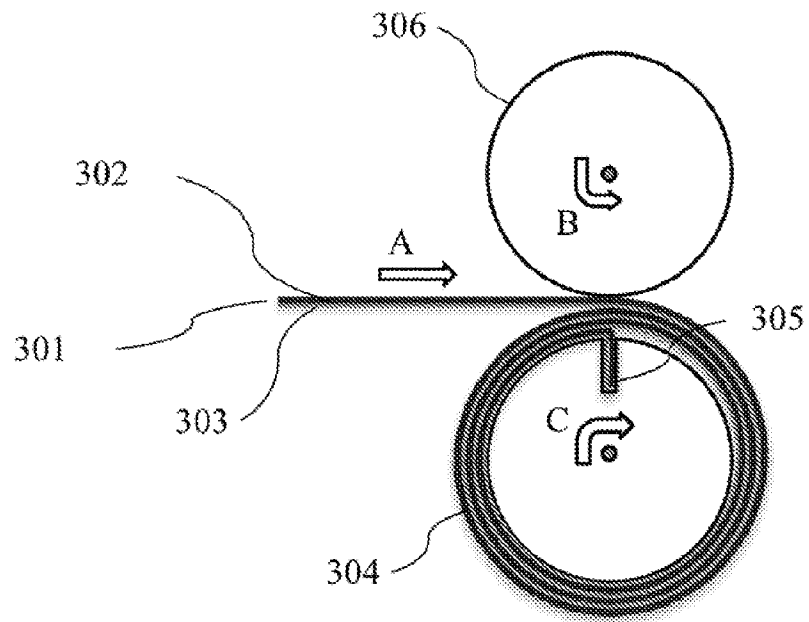


FIG. 4

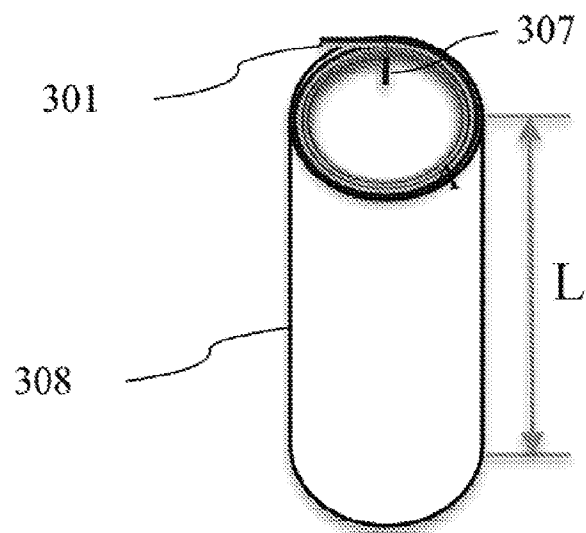


FIG. 5

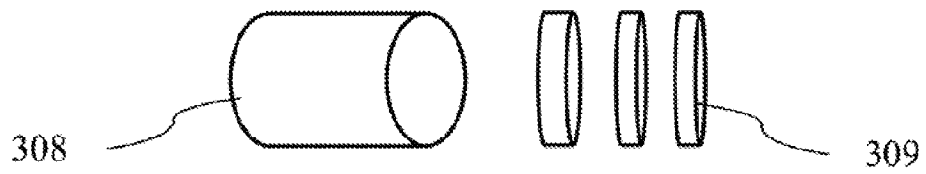


FIG. 6

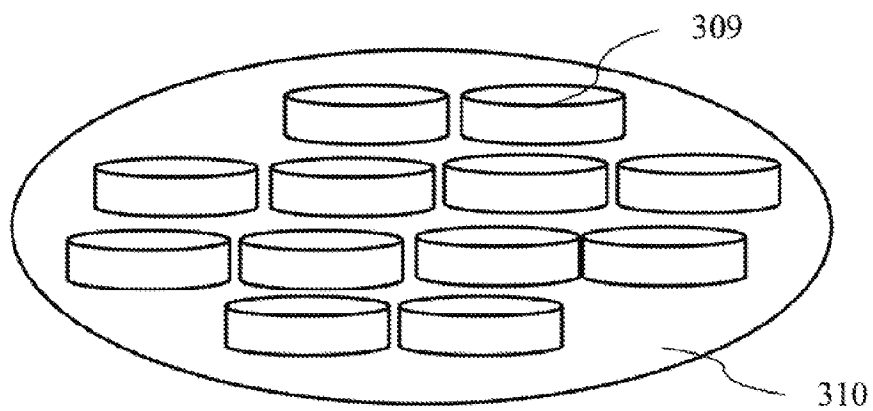


FIG. 7

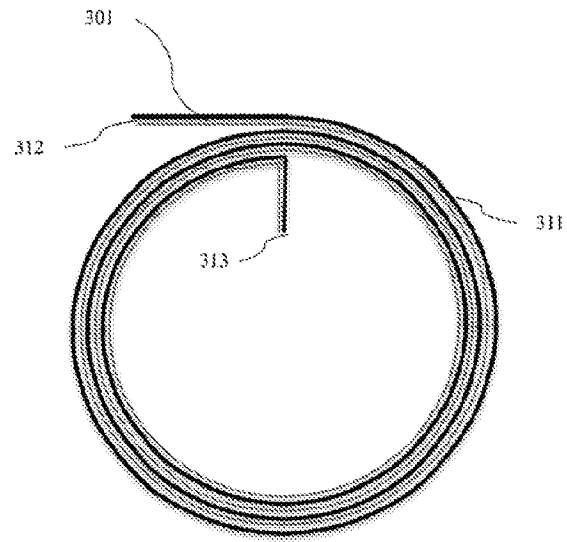


FIG. 8

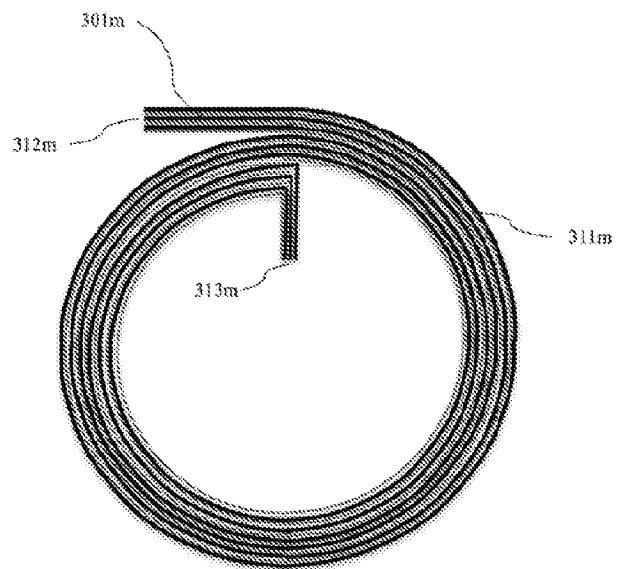


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2017/106720

A. CLASSIFICATION OF SUBJECT MATTER

H01F 41/04(2006.01)i; H01F 5/00(2006.01)i; H01F 27/28(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT,CNKI,WPLEPODOC: goertek, rod, roll+, coil, flat, foil, film, enlac+, enwind+, foul+, wind+, wingding

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP H05207710 A (SANKYO SEIKI MFG. CO., LTD.) 13 August 1993 (1993-08-13) description, paragraphs [0001]-[0019], figures 1-4	1-10
X	DE 2358398 A1 (DAINIPPON PRINTING CO., LTD.) 06 June 1974 (1974-06-06) description, pages 2-9, figures 1-7	1-10
A	JP 2000223343 A (MITSUBISHI MATERIALS CORP.) 11 August 2000 (2000-08-11) the whole document	1-10
A	CN 201749754 U (BEIJING MXH MICROELECTRONIC TECHNOLOGY) 16 February 2011 (2011-02-16) the whole document	1-10
A	CN 103400682 A (GUANGXI POWER GRID CORP. POWER SCI. RES. ET AL.) 20 November 2013 (2013-11-20) the whole document	1-10

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

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“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search

04 July 2018

Date of mailing of the international search report

20 July 2018

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2017/106720

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
JP	H05207710	A	13 August 1993	None			
DE	2358398	A1	06 June 1974	FR	2207808	A1	21 June 1974
				FR	2207808	B1	07 May 1976
				CH	563654	A5	30 June 1975
				NL	7315367	A	29 May 1974
JP	2000223343	A	11 August 2000	None			
CN	201749754	U	16 February 2011	None			
CN	103400682	A	20 November 2013	CN	103400682	B	24 August 2016