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(54) **ROLLER-PRESS APPARATUS**

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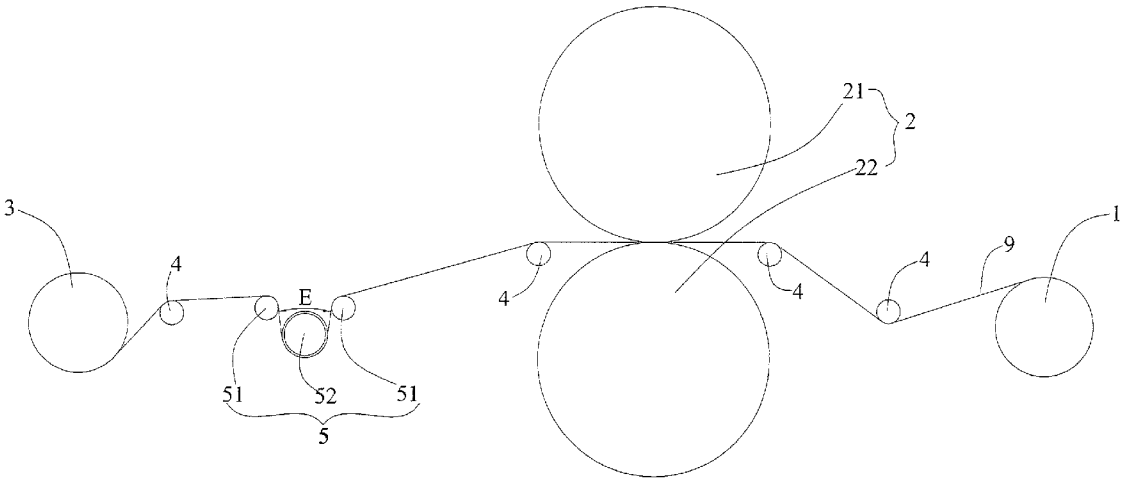
(57) **ABSTRACT**

The present disclosure provides a roller-press apparatus, which comprises: an unwinding mechanism around which an electrode plate to be rolled is wound, the electrode plate has a foil and a coating layer, the foil has at least a coated area and a blank foil area, the foil is provided with the coating layer at the coated area and is not provided with the coating layer at the blank foil area; a rolling mechanism; and a stretching mechanism. The stretching mechanism comprises: two guide rollers; and an uneven roller positioned between the two guide rollers, and forming a wrap angle with the two guide rollers, the uneven roller matches the electrode plate in size to allow a protruding portion of the uneven roller to act on the foil at the blank foil area, so as to allow the foil at the blank foil area to be plastically deformed.



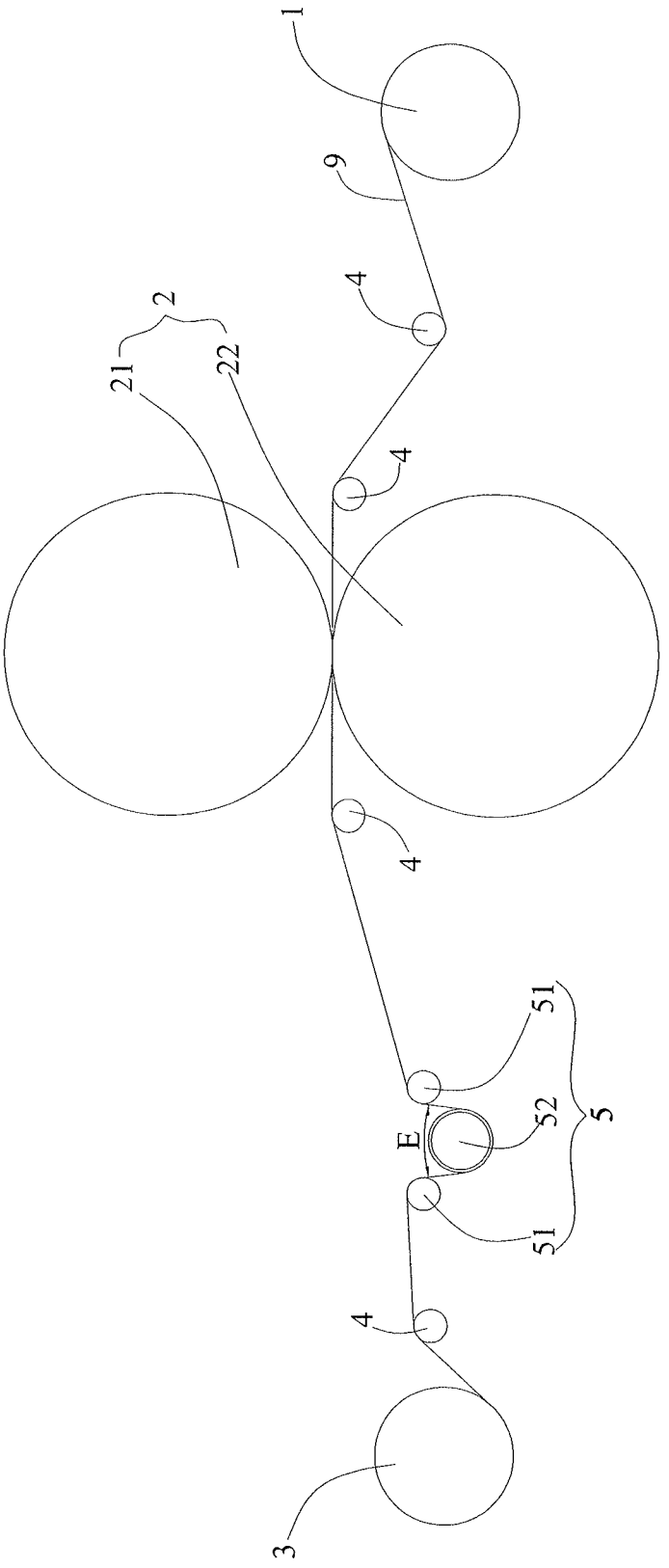


FIG.1

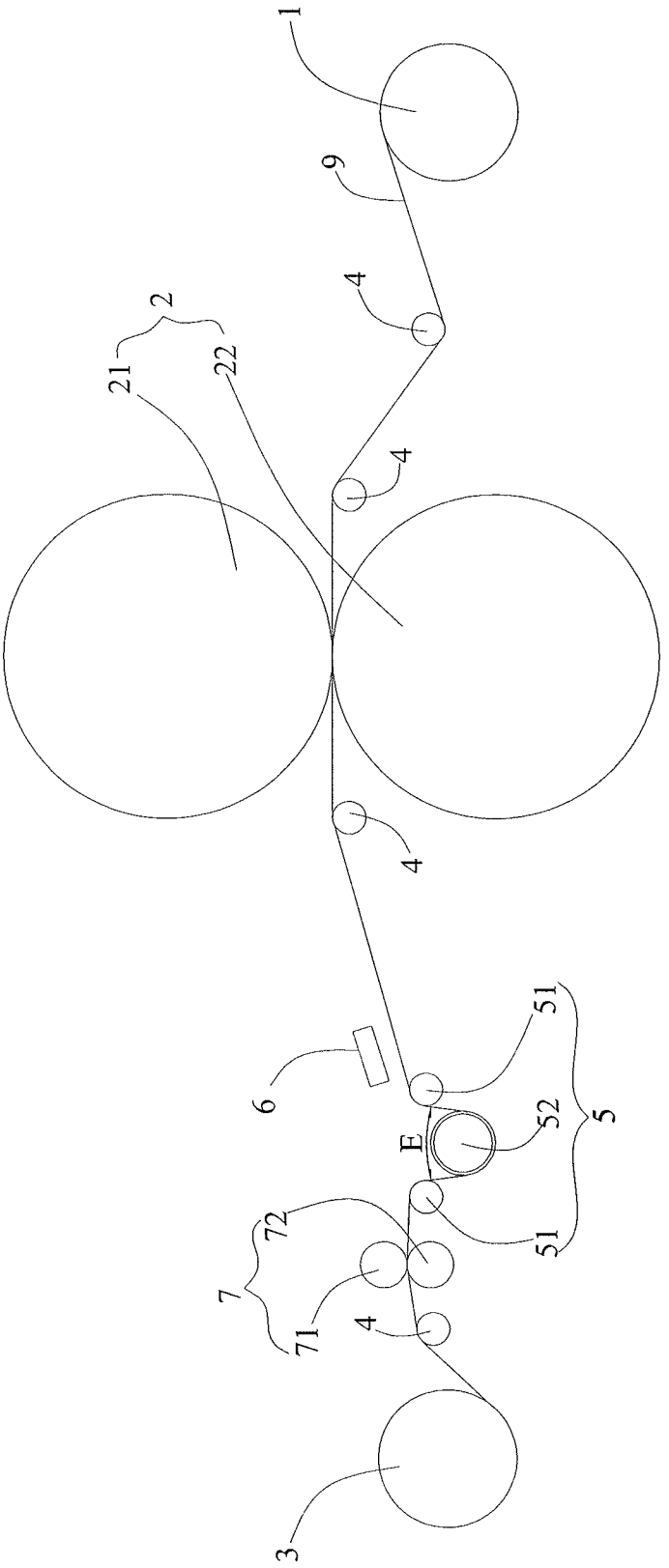


FIG.2

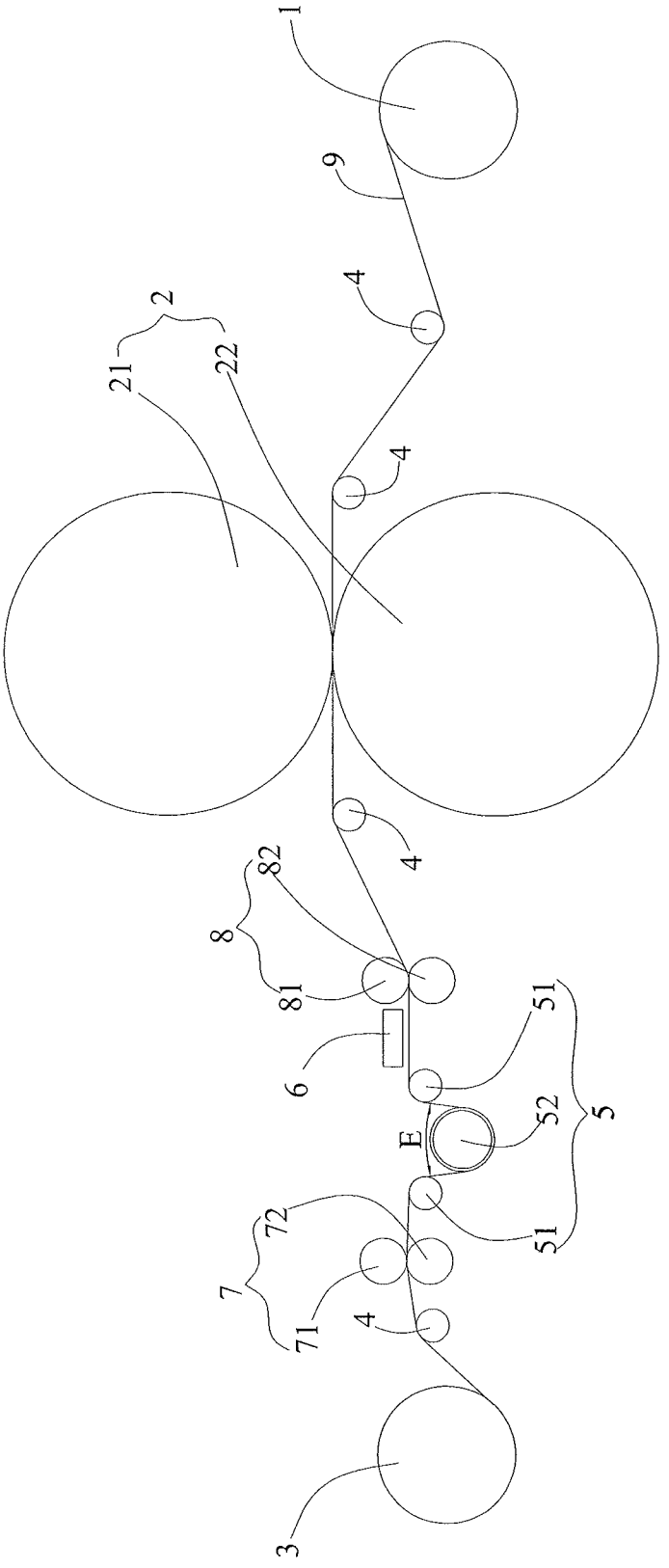


FIG.3

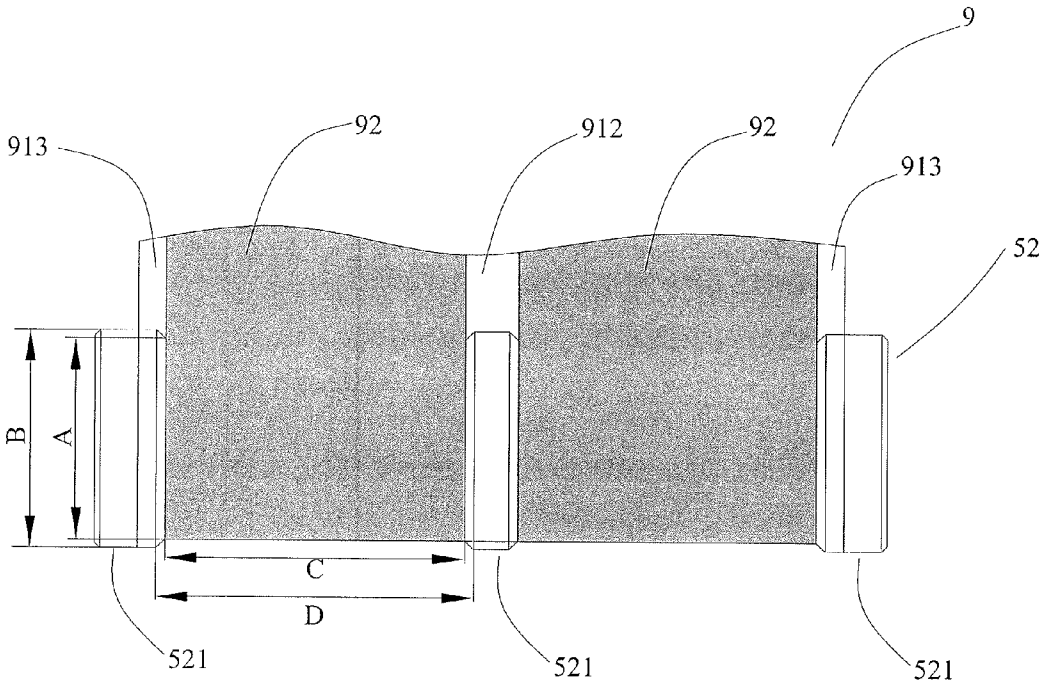

9
913
92
912
92
913
52
B
A
C
D
521
521
521

FIG.4

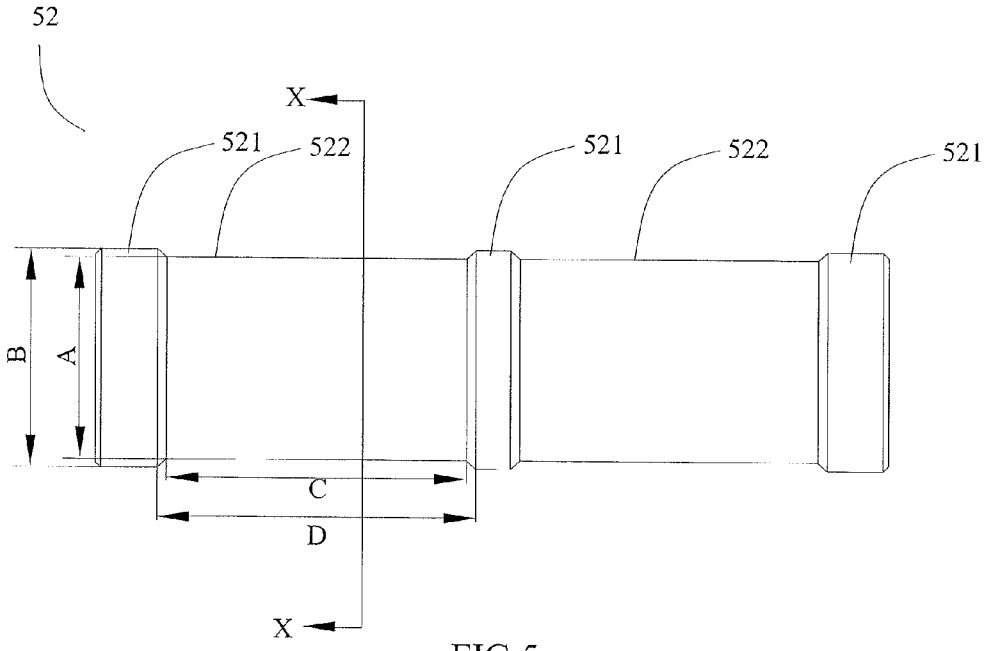

52
X
521
522
521
522
521
B
A
C
D
X

FIG.5

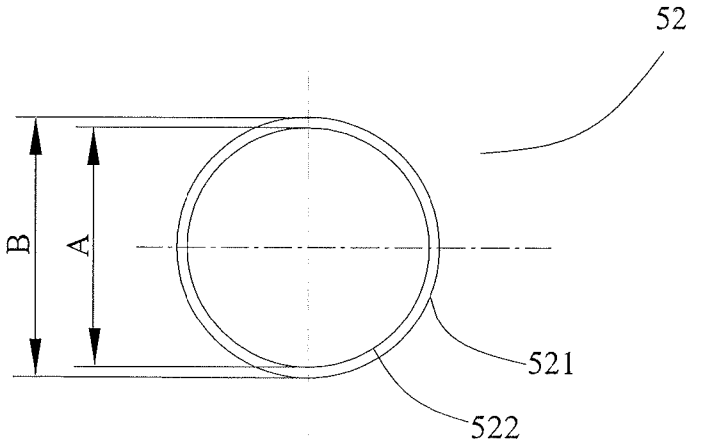


FIG.6

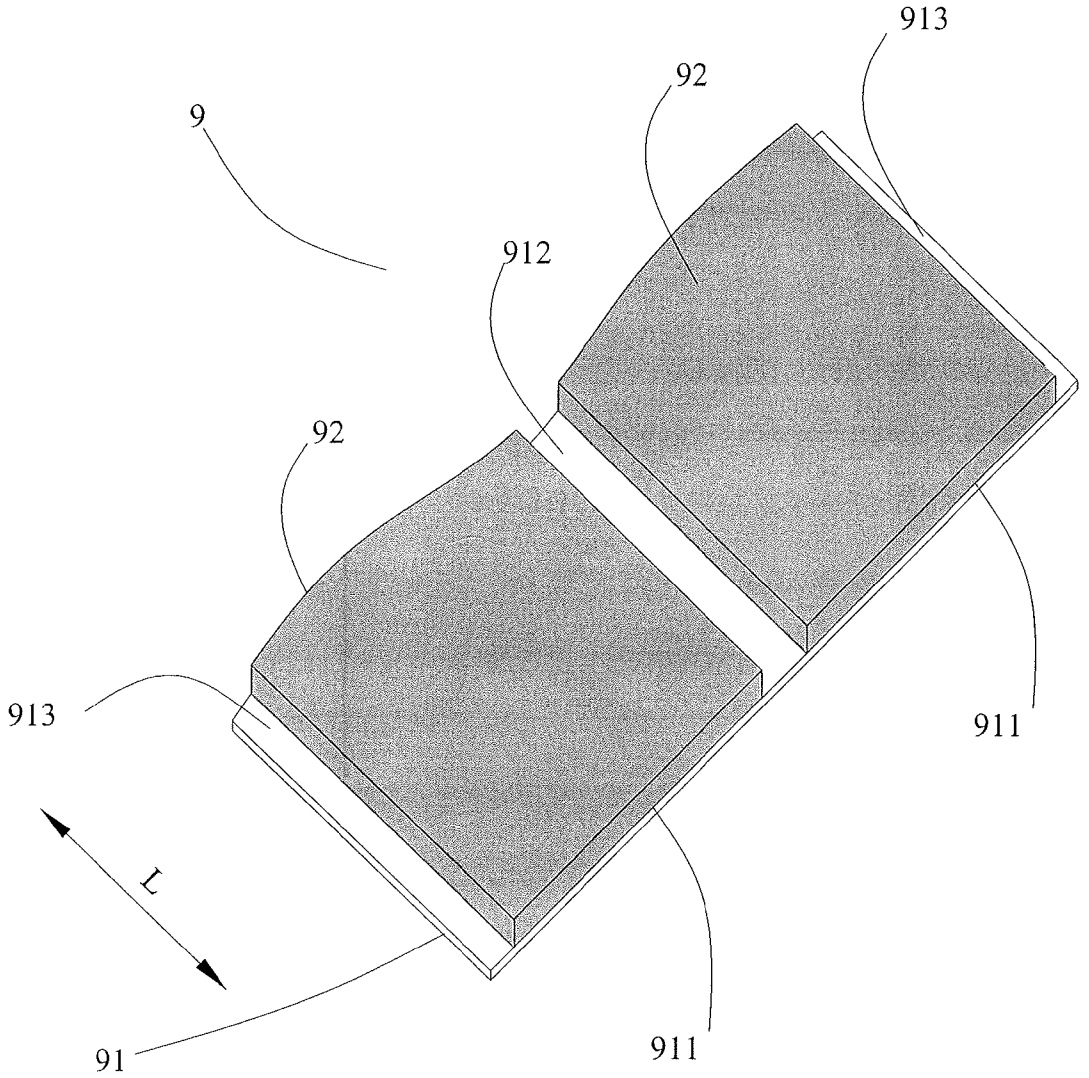


FIG.7

ROLLER-PRESS APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to Chinese patent application No. 201410259321.3 filed on Jun. 12, 2014, which is incorporated herein by reference in its entirety.

TECHNICAL FIELD OF THE PRESENT DISCLOSURE

[0002] The present disclosure relates to a field of production equipment of a lithium-ion battery, and particularly relates to a roller-press apparatus.

BACKGROUND OF THE PRESENT DISCLOSURE

[0003] A process for preparing an electrode plate of a lithium-ion battery generally includes steps of slurrying, coating, drying, rolling, cutting, and the like, although different manufacturers or different battery manufacturing processes may be varied, the step of rolling in the process for preparing the electrode plate is an essential process. The electrode plate achieves a certain compacted density after rolling, which is very important to the improvement of the capacity density of the lithium-ion battery. However, after the electrode plate which is coated is rolled, there is usually a problem that a foil of the electrode plate wrinkles at a longitudinal edge between each coated area and an adjacent blank foil area. This is mainly because that, after completion of coating for the electrode plate of the lithium-ion battery, during the rolling process, the pressure of the press roller exerted on the coating layer at the coated area would cause the foil at the coated area to extend in a longitudinal direction, and the foils at the intermediate blank foil area and the side blank foil areas on both sides (these are the foil portions at the non-coated area) do not extend because no force is exerted on the intermediate blank foil area and the side blank foil areas on both sides (these are the foil portions at the non-coated area), the foil at the blank foil area restrains the foil at the coated area from extending, so as to cause that the foil at the longitudinal edge between the each coated area and the adjacent blank foil area to wrinkle. In addition, in the production process of the electrode plate of the lithium-ion battery, the striped coating method can improve the coating efficiency and save the production cost, and the number and width of the stripes can be varied according to the requirements for the desired electrode plate. However, at present, for double roller-structure cold pressing technology adopted with respect to the striped electrode plate, there is also a problem that the foil of the electrode plate wrinkles at the longitudinal edge between the each coated area and the adjacent blank foil area.

SUMMARY OF THE PRESENT DISCLOSURE

[0004] In view of the problem existing in the background, an object of the present disclosure is to provide a roller-press apparatus, which can avoid that the foil of the electrode plate wrinkles at the longitudinal edge between the each coated area and the adjacent blank foil area in the rolling process of the electrode plate which is coated.

[0005] In order to achieve the above object, the present disclosure provides a roller-press apparatus, which comprises: an unwinding mechanism around which an electrode plate to be rolled is wound, and the unwinding mechanism unwinds the electrode plate to be rolled, the electrode plate to be rolled has a foil and a coating layer provided on at least a surface of the foil, the foil has at least a coated area extending along a longitudinal direction of the foil and a blank foil area positioned at a side direction of the coated area on the corresponding surface provided with the coating layer, the foil is provided with the coating layer at the coated area and is not provided with the coating layer at the blank foil area; a rolling mechanism comprising a press roller and a back roller which are oppositely provided, and used for rolling the electrode plate; a winding mechanism winding the electrode plate after rolled; and a stretching mechanism provided between the rolling mechanism and the winding mechanism. The stretching mechanism comprises: two guide rollers; and an uneven roller positioned between the two guide rollers, and forming a wrap angle with the two guide rollers, the uneven roller matches the electrode plate in size to allow a protruding portion of the uneven roller to act on the foil at the blank foil area, so as to allow the foil at the blank foil area to be plastically deformed.

[0006] The present disclosure has the following beneficial effects:

[0007] By that the stretching mechanism is provided in the roller-press apparatus, the foil at the blank foil area is plastically deformed, finally the extension of the foil at the blank foil area is consistent with the extension of the foil at the coated area, so that the problem in prior art, that the foil of the electrode plate wrinkles at the longitudinal edge between the each coated area and the adjacent blank foil area in the process of rolling the electrode plate which is coated, is resolved.

BRIEF DESCRIPTION OF THE FIGURES

[0008] FIG. **1** is a schematic plan view according to an embodiment of a roller-press apparatus of the present disclosure;

[0009] FIG. **2** is a schematic plan view according to an embodiment of the roller-press apparatus of the present disclosure;

[0010] FIG. **3** is a schematic plan view according to an embodiment of the roller-press apparatus of the present disclosure;

[0011] FIG. **4** is a schematic plan view illustrating an uneven roller according to an embodiment of the present disclosure acts on an electrode plate, and the electrode plate is shown in perspective for purposes of clarity;

[0012] FIG. **5** is a schematic plan view of the uneven roller of FIG. **4**;

[0013] FIG. **6** is a cross-sectional view taken along a line X-X of FIG. **5**;

[0014] FIG. **7** is a perspective view of the electrode plate of FIG. **4**.

[0015] Reference numerals of the embodiments are represented as follows:

1 unwinding mechanism
2 rolling mechanism
  21 press roller
  22 back roller
3 winding mechanism
4 guiding roller
5 stretching mechanism
  51 guide roller
  52 uneven roller

-continued

521 protruding portion
522 recessing portion
E wrap angle
6 heating element
7 stretching roller pair
71 stretching drive roller
72 stretching press roller
8 synchronizing roller pair
81 synchronizing drive roller
82 synchronizing press roller
9 electrode plate
91 foil
911 coated area
912 intermediate blank foil area
913 side blank foil area
92 coating layer
L longitudinal direction

DETAILED DESCRIPTION

[0016] Hereinafter a roller-press apparatus according to the present disclosure will be described in detail in combination with the Figures.

[0017] Referring to FIGS. **1-7**, a roller-press apparatus according to the present disclosure comprises: an unwinding mechanism **1** around which an electrode plate **9** to be rolled is wound, and the unwinding mechanism **1** unwinds the electrode plate **9** to be rolled, the electrode plate **9** to be rolled has a foil **91** and a coating layer **92** provided on at least a surface of the foil **91**, the foil **91** has at least a coated area **911** extending along a longitudinal direction of the foil **91** and a blank foil area positioned at a side direction of the coated area **911** on the corresponding surface provided with the coating layer **92**, the foil **91** is provided with the coating layer **92** at the coated area **911** and is not provided with the coating layer **92** at the blank foil area; a rolling mechanism **2** comprising a press roller **21** and a back roller **22** which are oppositely provided, and used for rolling the electrode plate **9**; a winding mechanism **3** winding the electrode plate **9** after rolled; and a stretching mechanism **5** provided between the rolling mechanism **2** and the winding mechanism **3**. The stretching mechanism **5** comprises: two guide rollers **51**; and an uneven roller **52** positioned between the two guide rollers **51**, and forming a wrap angle E with the two guide rollers **51**, the uneven roller **52** matches the electrode plate **9** in size to allow a protruding portion **521** of the uneven roller **52** to act on the foil **91** at the blank foil area, so as to allow the foil **91** at the blank foil area to be plastically deformed, thereby resolving the problem that the foil **91** wrinkles at a longitudinal edge (that is a common boundary) between the each coated area **911** and the adjacent blank foil area.

[0018] Here, it should be noted that, the protruding portion **521** of the uneven roller **52** acts on the foil **91** at the blank foil area refers to: (1) when the coating layer **92** is only provided on one surface of the foil **91**, and when the surface of the foil **91** provided with the coating layer **92** faces the uneven roller **52**, the protruding portion **521** of the uneven roller **52** acts on the foil **91** at the blank foil area on the surface of the foil **91** provided with the coating layer **92**; when the surface of the foil **91** provided with the coating layer **92** faces away from the uneven roller **52**, the protruding portion **521** of the uneven roller **52** acts on the foil **91** at an area on a surface of the foil **91** not provided with the coating layer **92** and corresponding to the blank foil area on the surface of the above foil **91** provided with coating layer **92**; (2) when two opposite surfaces of the foil **91** each are provided with the coating layer **92**, the protruding portion **521** of the uneven roller **52** acts on the foil **91** at the blank foil area on the surface of the foil **91** provided with coating layer **92** and facing the uneven roller **52**.

[0019] Here, it should be further noted that, for the recessing portion **522** of the uneven roller **52**, when the coating layer **92** is only provided on one surface of the foil **91**, and when the surface of the foil **91** provided with the coating layer **92** faces the uneven roller **52**, the recessing portion **522** of the uneven roller **52** corresponds to and may contact or may not contact the coating layer **92** at the coated area **911**; when the surface of the foil **91** provided with the coating layer **92** faces away from the uneven roller **52**, the recessing portion **522** of the uneven roller **52** may contact or may not contact the foil **91** at an area corresponding to the coated area **911** on the surface of the foil **91** provided with the coating layer **92**. When two opposite surfaces of the foil **91** each are provided with the coating layer **92**, there must be one surface of the foil **91** provided with the coating layer **92** facing the uneven roller **52**, in this case, the recessing portion **522** of the uneven roller **52** corresponds and may contact or may not contact the coating layer **92** at the coated area **911** on the surface of the foil **91** facing the uneven roller **52**.

[0020] Preferably, a recessing portion **522** of the uneven roller **52** may contact the coating layer **92** at the coated area **911** on the surface of the foil **91** provided with the coating layer **92** and facing the uneven roller **52**, or contact the foil **91** at an area on a surface of the foil **91** not provided with the coating layer **92** and facing the uneven roller **52** and corresponding to the coated area **911** on the surface of the foil **91** provided with the coating layer **92**, so as to effectively prevent the foil from fracturing which may occur when the protruding portion **521** of the uneven roller **52** acts on the foil **91** at the blank foil area.

[0021] In an embodiment, the wrap angle E may be 10°~170°.

[0022] In FIG. **7**, the foil **91** has two coated areas **911** extending along the longitudinal direction of the foil **91** and an intermediate blank foil area **912** between the two adjacent coated areas **911** and two side blank foil areas **913** at outer sides of all the coated areas **911** on the corresponding surface provided with the coating layer **92**, and herein, the one intermediate blank foil area **912** and the two side blank foil areas **913** are collectively referred to as the blank foil area.

[0023] Here, it should be noted that, when the coating layer **92** is only provided on one surface of the foil **91**, the press roller **21** or the back roller **22** contacts all the coating layer **92** on the corresponding one surface but does not contact the foil **91** at the blank foil area; when the two surfaces of the foil **91** each are provided with the coating layer **92**, the press roller **21** and the back roller **22** respectively contact all the coating layer **92** on the corresponding surface but do not contact the foil **91** at the blank foil area on the corresponding surface.

[0024] Corresponding to FIG. **4** and referring to FIG. **7**, in FIG. **4**, an electrode plate **9** to be rolled has a foil **91** and the coating layers **92** provided on two opposite surfaces of the foil **91**, three protruding portions **521** of the uneven roller **52** (from left to right in FIG. **5**) respectively act on the side blank foil area **913**, the intermediate blank foil area 912, the side blank foil area **913** (in a sequence from lower left to upper right in FIG. **7**) facing the uneven roller **52** of the foil **91**; and the two recessing portions **522** of the uneven roller **52** respectively correspond to the coating layers **92** at the two coated

areas **911**, in this case, the two recessing portions **522** of the uneven roller **52** may respectively contact the coating layers **92** at the two coated areas **911**, of course may not either contact the coating layers **92** at the two coated areas **911**, which may be determined based on the actual situation.

[0025] Specifically, in the examples as shown in FIGS. **1-7**, the electrode plate **9** passes through and is rolled by the rolling mechanism **2** in a tensioned state due to braking force provided by the unwinding mechanism **1** and the winding mechanism **3**, so as to achieve a certain compacted density. Because a thickness of the electrode plate **9** at the coated area **911** is greater than a thickness at the blank foil area, the coating layer **92** at the coated area **911** bears the pressure of the press roller **21** and causes the foil **91** at this area to extend along the longitudinal direction L, and the intermediate blank foil area **912** and the side blank foil area **913** do not bear the pressure of the press roller **21**, that is the foil **91** at the blank foil area does not extend, therefore, the foil **91** at the intermediate blank foil area **912** and the side blank foil area **913** will restrain the foil **91** at the coated areas **911** from extending, which easily causes the foil **91** to wrinkle at the longitudinal edge (that is the common boundary) between the each coated area **911** and the adjacent blank foil area. The roller-press apparatus of the present disclosure adopts the stretching mechanism **5**, the uneven roller **52** of the stretching mechanism **5** allows plastic deformation of the foil **91** at the intermediate blank foil area **912** and the side blank foil area **913**, so that the problem that foil **91** wrinkles at the longitudinal edge between the each coated area **911** and the adjacent blank foil area is resolved.

[0026] Referring to FIG. **4**, FIG. **5** and FIG. **6**, a diameter of the recessing portion **522** of the uneven roller **52** is A, a diameter of the protruding portion **521** is B, a transition corner is between the adjacent recessing portion **522** and the protruding portion **521** on the same side, a width of the recessing portion **522** in the axial direction is C, a width between the outermost positions of corresponding transition corners of two adjacent protruding portions **521** is D. And, A and B are adjusted according to the thickness of the electrode plate **9** (including the thickness of the foil **91** and the thickness of the coating layer **92**) and an expected stretch rate, C and D are adjusted according to a width of the coated area **911** and a width of the blank foil area. In an embodiment, $D-C \leq \pm 1$ mm. In an embodiment, D−C=0.03 mm~0.80 mm. In an embodiment, B−A=0.1 mm~0.5 mm.

[0027] In order to allow the foil **91** at the blank foil area to plastically deformed better, referring to FIG. **2** and FIG. **3**, the roller-press apparatus according to the present disclosure may further comprises: a heating element **6** for heating the blank foil area of the foil **91** before the uneven roller **52** acts on the electrode plate **9**. In an embodiment, referring to FIG. **2** and FIG. **3**, the heating element **6** may face the electrode plate **9** and is provided above the electrode plate **9**. A heating temperature of the heating element **6** may be 50° C.~300° C., the above heating temperature of the heating element **6** is adjusted according to a material of the foil **91** of the electrode plate **9** which is actually used. In addition, a position and a width for heating of the heating element **6** may be adjusted according to the width of the blank foil area of the foil **91**, so as to ensure appropriate heating for the blank foil area; meanwhile, a height of the heating element **6** distanced from the electrode plate **9** may also be adjusted, so as to ensure the blank foil area of the foil **91** to achieve the appropriate heating temperature.

[0028] In order to solve the above wrinkling problem better, in an embodiment, the roller-press apparatus according to the present disclosure may further comprise: a stretching roller pair **7** close to the winding mechanism **3** and comprising a stretching drive roller **71** and a stretching press roller **72** which are oppositely provided, the stretching press roller **72** presses the entire electrode plate **9** on the stretching drive roller **71**, so as to allow a conveying speed of the electrode plate **9** to be equal to a speed of the stretching drive roller **71**, and the speed of the stretching drive roller **71** is greater than a speed of the press roller **21** of the rolling mechanism **2**, so as to allow the electrode plate **9** to be stretched in full size by virtue of a speed difference between the stretching drive roller **71** and the press roller **21**. After stretching in full size, because the blank foil area of the foil **9** may be elastically deformed easily (i.e., rebound), the uneven roller **52** acts on the foil **9** at the blank foil area after the electrode plate **9** is stretched in full size, so as to achieve better stretching effect.

[0029] In order to further improve the stretching effect, in an embodiment, the roller-press apparatus according to the present disclosure may further comprise: a synchronizing roller pair **8** close to the rolling mechanism **2** and comprising a synchronizing drive roller **81** and a synchronizing press roller **82** which are oppositely provided, the synchronizing press roller **82** presses the entire electrode plate **9** on the synchronizing drive roller **81**, so as to allow the conveying speed of the electrode plate **9** to be equal to a speed of the synchronizing drive roller **81**, and the speed of the synchronizing drive roller **81** is equal to the speed of the press roller **21** of the rolling mechanism **2**.

[0030] In an embodiment, a parallelism difference between an axial line of the synchronizing drive roller **81** and an axial line of the stretching drive roller **71** is ≤0.1 mm, so as to achieve better stretching effect, and prevent the electrode plate from fracturing.

[0031] In an embodiment of the rolling mechanism **2**, the press roller **21** and the back roller **22** of the rolling mechanism **2** may be flat steel rollers. In an embodiment, the roughness, Ra, of the steel roller is ≤0.4, the hardness of the steel roller is ≥65HRC.

[0032] In an embodiment of the roller-press apparatus according to the present disclosure, the speed of the press roller **21** and/or the synchronizing drive roller **81** is V1, the speed of the stretching drive roller **71** is V2, and V2=V1*(1+n), and $0<n\leq 0.100$.

[0033] In an embodiment, the synchronizing drive roller **81** and the stretching drive roller **71** may be steel rollers.

[0034] In an embodiment, the synchronizing press roller **82** and the stretching press roller **72** may be made of a soft material.

[0035] In an embodiment, the synchronizing press roller **82** and the stretching press roller **72** may be rubber rollers.

[0036] In an embodiment, a frictional force provided by the synchronizing press roller **82** is greater than 800N, and a frictional force provided by the stretching press roller **72** is greater than 800N.

[0037] Here, it should be noted that, in the roller-press apparatus according to the present disclosure, the electrode plate **9** may have one coated area **911**, may also be a striped electrode plate (i.e., having at least two coated areas **911**, referring to FIG. **7**). Although FIG. **7** shows an electrode plate **9** having two coated areas **911**, but is not limited to that.

[0038] In addition, the roller-press apparatus according to the present disclosure may further comprises: a plurality of

guiding rollers **4** provided between the unwinding mechanism **1** and the winding mechanism **3** for guiding and conveying the electrode plate **9**.

What is claimed is:

1. A roller-press apparatus, comprising:

an unwinding mechanism (**1**) around which an electrode plate (**9**) to be rolled is wound, and the unwinding mechanism (**1**) unwinding the electrode plate (**9**) to be rolled, the electrode plate (**9**) to be rolled having a foil (**91**) and a coating layer (**92**) provided on at least a surface of the foil (**91**), the foil (**91**) having at least a coated area (**911**) extending along a longitudinal direction of the foil (**91**) and a blank foil area positioned at a side direction of the coated area (**911**) on the corresponding surface provided with the coating layer (**92**), the foil (**91**) being provided with the coating layer (**92**) at the coated area (**911**) and being not provided with the coating layer (**92**) at the blank foil area;

a rolling mechanism (**2**) comprising a press roller (**21**) and a back roller (**22**) which are oppositely provided, and used for rolling the electrode plate (**9**);

a winding mechanism (**3**) winding the electrode plate (**9**) after rolled; and

a stretching mechanism (**5**) provided between the rolling mechanism (**2**) and the winding mechanism (**3**), and comprising:

two guide rollers (**51**); and

an uneven roller (**52**) positioned between the two guide rollers (**51**), and forming a wrap angle (E) with the two guide rollers (**51**), the uneven roller (**52**) matching the electrode plate (**9**) in size to allow a protruding portion (**521**) of the uneven roller (**52**) to act on the foil (**91**) at the blank foil area, so as to allow the foil (**91**) at the blank foil area to be plastically deformed.

2. The roller-press apparatus according to claim **1**, wherein a recessing portion (**522**) of the uneven roller (**52**) contacts the coating layer (**92**) at the coated area (**911**) on the surface of the foil (**91**) provided with the coating layer (**92**) and facing the uneven roller (**52**), or contacts the foil (**91**) at an area on a surface of the foil (**91**) not provided with the coating layer (**92**) and facing the uneven roller (**52**) and corresponding to the coated area (**911**) on the surface of the foil (**91**) provided with the coating layer (**92**).

3. The roller-press apparatus according to claim **1**, wherein a diameter of the recessing portion (**522**) of the uneven roller (**52**) is A, a diameter of the protruding portion (**521**) is B, and B−A=0.1 mm~0.5 mm.

4. The roller-press apparatus according to claim **1**, wherein a transition corner is between adjacent recessing portion (**522**) and protruding portion (**521**) on the same side, a width of the recessing portion (**522**) in an axial direction is C, a width between the outermost positions of corresponding transition corners of two adjacent protruding portions (**521**) is D, and D−C≤±1 mm.

5. The roller-press apparatus according to claim **4**, wherein D−C=0.03 mm~0.80 mm.

6. The roller-press apparatus according to claim **1**, further comprising:

a heating element (**6**) for heating the blank foil area of the foil (**91**) before the uneven roller (**52**) acts on the electrode plate (**9**).

7. The roller-press apparatus according to claim **1**, further comprising:

a stretching roller pair (**7**) close to the winding mechanism (**3**) and comprising a stretching drive roller (**71**) and a stretching press roller (**72**) which are oppositely provided, the stretching press roller (**72**) pressing the entire electrode plate (**9**) on the stretching drive roller (**71**), so as to allow a conveying speed of the electrode plate (**9**) to be equal to a speed of the stretching drive roller (**71**), and the speed of the stretching drive roller (**71**) being greater than a speed of the press roller (**21**) of the rolling mechanism (**2**).

8. The roller-press apparatus according to claim **7**, further comprising:

a synchronizing roller pair (**8**) close to the rolling mechanism (**2**) and comprising a synchronizing drive roller (**81**) and a synchronizing press roller (**82**) which are oppositely provided, the synchronizing press roller (**82**) pressing the entire electrode plate (**9**) on the synchronizing drive roller (**81**), so as to allow the conveying speed of the electrode plate (**9**) to be equal to a speed of the synchronizing drive roller (**81**), and the speed of the synchronizing drive roller (**81**) being equal to the speed of the press roller (**21**) of the rolling mechanism (**2**).

9. The roller-press apparatus according to claim **8**, wherein a parallelism difference between an axial line of the synchronizing drive roller (**81**) and an axial line of the stretching drive roller (**71**) is ≤0.1 mm.

10. The roller-press apparatus according to claim **7**, wherein the speed of the press roller (**21**) and/or the synchronizing drive roller (**81**) is V1, the speed of the stretching drive roller (**71**) is V2, and V2=V1*(1+n), and, 0<n≤0.100.

11. The roller-press apparatus according to claim **8**, wherein the speed of the press roller (**21**) and/or the synchronizing drive roller (**81**) is V1, the speed of the stretching drive roller (**71**) is V2, and V2=V1*(1+n), and, 0<n≤0.100.

* * * * *