(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 553 802 A1**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
16.10.2019 Bulletin 2019/42

(21) Application number: **19165369.0**

(22) Date of filing: **27.03.2019**

(51) Int Cl.:
H01F 41/073 *(2016.01)* ***H01F 41/082*** *(2016.01)*
B21F 1/00 *(2006.01)* ***B65H 1/00*** *(2006.01)*
G01F 1/00 *(2006.01)* ***G01N 1/00*** *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **03.04.2018 CN 201810288708**

(71) Applicants:
- **Tyco Electronics (Shanghai) Co., Ltd.**
  China (Shanghai) Pilot Free Trade Zone
  Shanghai (CN)
- **TE Connectivity Corporation**
  Berwyn, PA 19312 (US)
- **Kunshan League Automechanism Co., Ltd.**
  Kunshan City Jiangsu (CN)

(72) Inventors:
- **DENG, Yingcong**
  Xuhui District, Shanghai 200233 (CN)
- **ZHANG, Dandan**
  Xuhui District, Shanghai 200233 (CN)
- **LU, Roberto Francisco-Yi**
  Bellevue, WA Washington 98006 (US)
- **XIE, Fengchun**
  Xuhui District, Shanghai 200233 (CN)
- **WU, Haidong**
  Kunshan City, Jiangsu (CN)

(74) Representative: **Grünecker Patent- und Rechtsanwälte**
PartG mbB
Leopoldstraße 4
80802 München (DE)

(54) WIRE WINDING DEVICE AND METHOD OF WINDING WIRE

(57) A wire winding device adapted to wind a wire (20) on a pipe (10) comprises: a wire supply mechanism (100) comprising an installation frame (110) and a wire spool (120) rotationally mounted on the installation frame and coiled with the wire; a pipe clamp (210) adapted to clamp one end (10a) of the pipe; a first wire clamp (220) fixed to the pipe clamp and adapted to clamp an end of the wire; a rotation driver (200) adapted to drive the pipe clamp to rotate about a rotation axis; and a linear drive mechanism (200) adapted to drive the pipe clamp and the rotation driver to linearly move in a first direction (Y) parallel to the rotation axis (R). The wire winding device may automatically wind the wire onto the pipe, which improves the efficiency of winding the wire and ensures the quality of winding the wire.

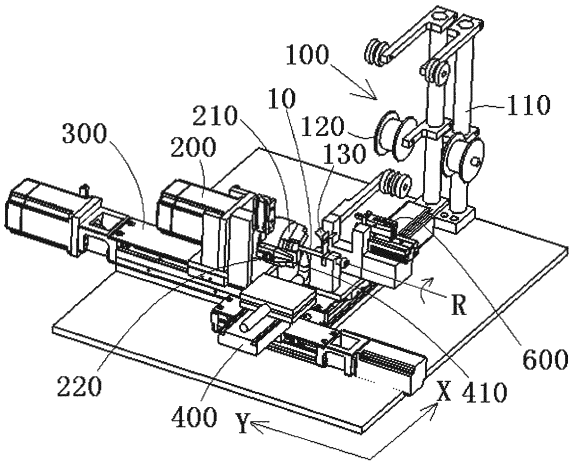

Fig.1

EP 3 553 802 A1

Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of Chinese Patent Application No. 201810288708.X filed on April 3, 2018 in the State Intellectual Property Office of China, the whole disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a wire winding device adapted to wind a wire on a pipe and a method of winding a wire on a pipe.

Description of the Related Art

[0003] In the related art, there is a sensor that includes a glass pipe and a metal wire wound on the glass pipe. During manufacturing the sensor, it needs to wind the metal wire on the glass pipe.

[0004] In the related art, the metal wire is usually wound on the glass pipe by manual. However, the efficiency of manual wire winding is very low, and the quality of manual wire winding is poor.

SUMMARY OF THE INVENTION

[0005] The present invention has been made to overcome or alleviate at least one aspect of the above mentioned disadvantages.

[0006] According to an aspect of the present invention, there is provided a wire winding device adapted to wind a wire on a pipe, the wire winding device comprising: a wire supply mechanism comprising an installation frame and a wire spool rotationally mounted on the installation frame and coiled with the wire; a pipe clamp adapted to clamp one end of the pipe; a first wire clamp fixed to the pipe clamp and adapted to clamp an end of the wire; a rotation driver adapted to drive the pipe clamp to rotate about a rotation axis; and a linear drive mechanism adapted to drive the pipe clamp and the rotation driver to linearly move in a first direction parallel to the rotation axis.

[0007] According to an exemplary embodiment of the present invention, an output rotation speed of the rotation driver and an output speed of the linear drive mechanism are adjustable, so that a pitch of the wire wound on the pipe is adjustable.

[0008] According to another exemplary embodiment of the present invention, the wire winding device is adapted to wind a plurality of different wires onto the pipe at the same time.

[0009] According to another exemplary embodiment of the present invention, the wire comprises a first wire and a second wire different from the first wire, and the wire winding device is adapted to wind the first wire and the second wire onto the pipe at the same time.

[0010] According to another exemplary embodiment of the present invention, the wire supply mechanism further comprises a wire separation device which is adapted to separate a plurality of wires drawn from the wire spool, so as to ensure that a predetermined spacing is separated between two adjacent wires wound on the pipe.

[0011] According to another exemplary embodiment of the present invention, the wire separation device comprises a plurality of wire accommodation slots for accommodating the plurality of wires, respectively. A spacing between two adjacent wire accommodation slots is equal to the predetermined spacing.

[0012] According to another exemplary embodiment of the present invention, the pipe is a glass pipe, and the wire is a metal wire.

[0013] According to another exemplary embodiment of the present invention, the wire winding device further comprises a flame burner which is adapted to burn a local area of the pipe corresponding to an end of the wire wound on the pipe until the local area of the pipe is melt, so that the end of the wire is bonded and fixed to the local area of the pipe.

[0014] According to another exemplary embodiment of the present invention, the wire winding device further comprises a translation mechanism, and the flame burner is mounted on the translation mechanism. The translation mechanism is adapted to move the flame burner to the end of the wire wound on the pipe.

[0015] According to another exemplary embodiment of the present invention, the translation mechanism is adapted to move the flame burner in the first direction and a second direction perpendicular to the first direction.

[0016] According to another exemplary embodiment of the present invention, the wire winding device further comprises a robot having a first gripper adapted to grip the end of the wire, and the robot is adapted to place the end of the wire gripped by the first gripper onto the first wire clamp by moving the first gripper.

[0017] According to another exemplary embodiment of the present invention, the robot further comprises a second gripper adapted to grip the pipe, and the robot is adapted to place the gripped pipe to or take the gripped pipe away from the pipe clamp by moving the second gripper.

[0018] According to another exemplary embodiment of the present invention, the robot further comprises a cutter adapted to cut off the wire, and the robot is adapted to cut off the wire by the cutter, so that the wire wound on the pipe is separated from the unwound wire.

[0019] According to another exemplary embodiment of the present invention, the wire winding device further comprises a second wire clamp adapted to clamp a cutting end of the unwound wire; and the robot is adapted to grip the cutting end of the unwound wire by the first gripper, and place the cutting end of the unwound wire

on the second wire clamp or take it away from the second wire clamp.

[0020] According to another aspect of the present invention, there is provided a method of winding a wire, comprising steps of:

S100: gripping a pipe and mounting the gripped pipe onto a pipe clamp by a robot;
S200: gripping an end of a wire drawn from a wire supply mechanism and clamping the end of the wire onto a first wire clamp by the robot;
S300: driving the pipe to rotate about a rotation axis and linearly move in a first direction parallel to the rotation axis, so as to wind the wire onto the pipe;
S400: stopping the pipe after the wire is wound onto the pipe;
S500: burning a local area of the pipe corresponding to the end of the wire wound on the pipe until the local area of the pipe is melt, so that the end of the wire is bonded and fixed to the local area of the pipe;
S600: cutting off the wire by a cutter of the robot, so that the wire wound on the pipe is separated from the unwound wire;
S700: gripping a cutting end of the unwound wire and placing the cutting end of the unwound wire on a second wire clamp by the robot;
S800: taking the pipe wound with the wire away from the pipe clamp.

[0021] In the above various exemplary embodiments of the present invention, the wire winding device may automatically wind the wire onto the pipe, which improves the efficiency of winding the wire and ensures the quality of winding the wire.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The above and other features of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the accompanying drawings, in which:

Fig.1 is an illustrative view of a wire winding device according to an exemplary embodiment of the present invention;
Fig.2 is an illustrative view of a robot according to an exemplary embodiment of the present invention;
Fig.3 is an illustrative view of a pipe wound with a wire according to an exemplary embodiment of the present invention; and
Fig.4 is an illustrative view of a pipe wound with wires according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE IVENTION

[0023] Exemplary embodiments of the present disclosure will be described hereinafter in detail with reference to the attached drawings, wherein the like reference numerals refer to the like elements. The present disclosure may, however, be embodied in many different forms and should not be construed as being limited to the embodiment set forth herein; rather, these embodiments are provided so that the present disclosure will be thorough and complete, and will fully convey the concept of the disclosure to those skilled in the art.

[0024] In the following detailed description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the disclosed embodiments. It will be apparent, however, that one or more embodiments may be practiced without these specific details. In other instances, well-known structures and devices are schematically shown in order to simplify the drawing.

[0025] According to a general concept of the present invention, there is provided a wire winding device adapted to wind a wire on a pipe, the wire winding device comprising: a wire supply mechanism comprising an installation frame and a wire spool rotationally mounted on the installation frame and coiled with the wire; a pipe clamp adapted to clamp one end of the pipe; a first wire clamp fixed to the pipe clamp and adapted to clamp an end of the wire; a rotation driver adapted to drive the pipe clamp to rotate about a rotation axis; and a linear drive mechanism adapted to drive the pipe clamp and the rotation driver to linearly move in a first direction parallel to the rotation axis.

[0026] Fig.1 is an illustrative view of a wire winding device according to an exemplary embodiment of the present invention; Fig.3 is an illustrative view of a pipe 10 wound with a wire 20 according to an exemplary embodiment of the present invention.

[0027] As shown in Figs.1 and 3, in an embodiment, the wire winding device adapted to wind a wire 20 on a pipe 10. The wire winding device mainly comprises a wire supply mechanism 100, a pipe clamp 210, a first wire clamp 220, a rotation driver 200, and a linear drive mechanism 300.

[0028] As shown in Figs.1 and 3, in an embodiment, the wire supply mechanism 100 comprises an installation frame 110 and a wire spool 120 rotationally mounted on the installation frame 110 and coiled with the wire 20. The pipe clamp 210 is adapted to clamp one end 10a of the pipe 10. The first wire clamp 220 is fixed to the pipe clamp 210 and adapted to clamp an end of the wire 20. The rotation driver 200 is adapted to drive the pipe clamp 210 to rotate about a rotation axis R. The linear drive mechanism 300 is adapted to drive the pipe clamp 210 and the rotation driver 200 to linearly move in a first di-

rection Y parallel to the rotation axis R.

[0029] As shown in Figs.1 and 3, in an embodiment, an output rotation speed of the rotation driver 200 and an output speed of the linear drive mechanism 300 are adjustable, so that a pitch P of the wire 20 wound on the pipe 10 is adjustable.

[0030] Fig.4 is an illustrative view of a pipe wound with wires according to an exemplary embodiment of the present invention.

[0031] As shown in Figs.1 and 4, in an embodiment, the wire winding device is adapted to wind a plurality of different wires 21, 22 onto the pipe 10 at the same time.

[0032] As shown in Figs.1 and 4, in an embodiment, the wire 20 may comprise a first wire 21 and a second wire 22 different from the first wire 21. The wire winding device is adapted to wind the first wire 21 and the second wire 22 onto the pipe 10 at the same time.

[0033] As shown in Figs.1 and 4, in an embodiment, the wire supply mechanism 100 further comprises a wire separation device 130, which is adapted to separate a plurality of wires 21, 22 drawn from the wire spool 120, so as to ensure that a predetermined spacing D is defined between two adjacent wires 21, 22 wound on the pipe 10.

[0034] As shown in Figs.1 and 4, in an embodiment, the wire separation device 130 comprises a plurality of wire accommodation slots for accommodating the plurality of wires 21, 22, respectively. A spacing between two adjacent wire accommodation slots is equal to the predetermined spacing D.

[0035] In an exemplary embodiment of the present invention, the pipe 10 is a glass pipe, and the wire 20 is a metal wire.

[0036] As shown in Figs.1 and 3, in an embodiment, the wire winding device further comprises a flame burner 410, which is adapted to burn a local area of the pipe 10 corresponding to an end of the wire 20 wound on the pipe 10 until the local area of the pipe 10 is melt, so that the end of the wire 20 is bonded and fixed to the local area of the pipe 10.

[0037] As shown in Figs.1 and 3, in an embodiment, the wire winding device further comprises a translation mechanism 400, and the flame burner 410 is mounted on the translation mechanism 400. The translation mechanism 400 is adapted to move the flame burner 410 to the end of the wire 20 wound on the pipe 10. More specifically, the translation mechanism 400 is adapted to move the flame burner 410 to one end of the wire 20 near one end 10a of the pipe 10 and the other end of the wire 20 near the other end 10b of the pipe 10, so that two ends of the wire 20 are fixed to the pipe 10.

[0038] As shown in Figs.1 and 3, in an embodiment, the translation mechanism 400 is adapted to move the flame burner 410 in the first direction Y and a second direction X perpendicular to the first direction Y.

[0039] Fig.2 is an illustrative view of a robot 700 according to an exemplary embodiment of the present invention.

[0040] As shown in Figs.1 and 2, in an embodiment, the wire winding device further comprises a robot 700 having a first gripper 710 adapted to grip the end of the wire 20. The robot 700 is adapted to place the end of the wire 20 gripped by the first gripper 710 on the first wire clamp 220 by moving the first gripper 710.

[0041] As shown in Figs.1 and 2, in an embodiment, the robot 700 further has a second gripper 720 adapted to grip the pipe 10, and the robot 700 is adapted to place the gripped pipe 10 onto or take the gripped pipe 10 away from the pipe clamp 210 by moving the second gripper 720.

[0042] As shown in Figs. 1 and 2, in an embodiment, the robot 700 further comprises a cutter 730 adapted to cut off the wire 20, and the robot 700 is adapted to cut off the wire 20 by the cutter 730, so that the wire 20 wound on the pipe 10 is separated from the unwound wire 20.

[0043] As shown in Figs.1 and 2, in an embodiment, the wire winding device further comprises a second wire clamp 600 adapted to clamp a cutting end of the unwound wire 20. The robot 700 is adapted to grip the cutting end of the unwound wire 20 by the first gripper 710, and place the cutting end of the unwound wire 20 onto the second wire clamp 600 or take the cutting end away from the second wire clamp 600.

[0044] Hereafter, it will describe in detail a method of winding the wire on the pipe with reference to Figs. 1-4. The method mainly comprises steps of:

S100: gripping a pipe 10 and clamping the gripped pipe 10 onto a pipe clamp 210 by a robot 700;

S200: gripping an end of a wire 20 drawn from a wire supply mechanism 100 and clamping the end of the wire 20 onto a first wire clamp 220 by the robot 700;

S300: starting the rotation driver 200 and the linear drive mechanism 300 to drive the pipe 10 to rotate about a rotation axis R and linearly move in a first direction Y parallel to the rotation axis R, so as to wind the wire 20 onto the pipe 10;

S400: stopping the pipe 10 rotating and moving after the wire 20 is wound onto the pipe 10;

S500: burning a local area of the pipe 10 corresponding to the end of the wire 20 wound on the pipe 10 until the local area of the pipe 10 is melt, so that the end of the wire 20 is bonded and fixed to the local area of the pipe 10;

S600: cutting off the wire 20 by a cutter 730 of the robot, so that the wire 20 wound on the pipe 10 is separated from the unwound wire 20;

S700: gripping a cutting end of the unwound wire 20 and placing the cutting end of the unwound wire 20 on a second wire clamp 600 by the robot 700;

S800: taking the pipe 10 wound with the wire 20 away from the pipe clamp 210 by the robot 700.

[0045] It should be appreciated for those skilled in this art that the above embodiments are intended to be illustrated, and not restrictive. For example, many modifications may be made to the above embodiments by those

skilled in this art, and various features described in different embodiments may be freely combined with each other without conflicting in configuration or principle.

[0046] Although several exemplary embodiments have been shown and described, it would be appreciated by those skilled in the art that various changes or modifications may be made in these embodiments without departing from the principles and spirit of the disclosure, the scope of which is defined in the claims and their equivalents.

[0047] As used herein, an element recited in the singular and proceeded with the word "a" or "an" should be understood as not excluding plural of said elements or steps, unless such exclusion is explicitly stated. Furthermore, references to "one embodiment" of the present invention are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the recited features. Moreover, unless explicitly stated to the contrary, embodiments "comprising" or "having" an element or a plurality of elements having a particular property may include additional such elements not having that property.

Claims

1. A wire winding device adapted to wind a wire (20) on a pipe (10), **characterized in that** the wire winding device comprises:

   a wire supply mechanism (100) comprising an installation frame (110), and a wire spool (120) rotationally mounted on the installation frame (110) and coiled with the wire (20);
   a pipe clamp (210) adapted to clamp one end (10a) of the pipe (10);
   a first wire clamp (220) fixed to the pipe clamp (210) and adapted to clamp an end of the wire (20);
   a rotation driver (200) adapted to drive the pipe clamp (210) to rotate about a rotation axis (R); and
   a linear drive mechanism (300) adapted to drive the pipe clamp (210) and the rotation driver (200) to linearly move in a first direction (Y) parallel to the rotation axis (R).

2. The wire winding device according to claim 1, wherein an output rotation speed of the rotation driver (200) and an output speed of the linear drive mechanism (300) are adjustable, so that a pitch (P) of the wire (20) wound on the pipe (10) is adjustable.

3. The wire winding device according to claim 1 or 2, wherein the wire winding device is adapted to wind a plurality of different wires (21, 22) onto the pipe (10) at the same time.

4. The wire winding device according to claim 3, wherein the wire (20) comprises a first wire (21) and a second wire (22) different from the first wire (21), and
   wherein the wire winding device is adapted to wind the first wire (21) and the second wire (22) onto the pipe (10) at the same time.

5. The wire winding device according to any one of claims 1-4, wherein the wire supply mechanism (100) further comprises a wire separation device (130) which is adapted to separate a plurality of wires (21, 22) drawn from the wire spool (120), so as to ensure that a predetermined spacing (D) is defined between two adjacent wires (21, 22) wound on the pipe (10).

6. The wire winding device according to claim 5, wherein the wire separation device (130) comprises a plurality of wire accommodation slots for accommodating the plurality of wires (21, 22), respectively, and
   wherein a spacing between two adjacent wire accommodation slots is equal to the predetermined spacing (D).

7. The wire winding device according to any one of claims 1-6, wherein the pipe (10) is a glass pipe, and the wire (20) is a metal wire.

8. The wire winding device according to claim 7, wherein the wire winding device further comprises a flame burner (410) which is adapted to burn a local area of the pipe (10) corresponding to an end of the wire (20) wound on the pipe (10) until the local area of the pipe (10) is melt, so that the end of the wire (20) is bonded and fixed to the local area of the pipe (10).

9. The wire winding device according to claim 8, wherein the wire winding device further comprises a translation mechanism (400), on which the flame burner (410) is mounted, and
   wherein the translation mechanism (400) is adapted to move the flame burner (410) to the end of the wire (20) wound on the pipe (10).

10. The wire winding device according to claim 9, wherein the translation mechanism (400) is adapted to move the flame burner (410) in the first direction (Y) and a second direction (X) perpendicular to the first direction (Y).

11. The wire winding device according to any one of claims 1-10, wherein the wire winding device further comprises a robot (700), the robot (700) having a first gripper (710) adapted to grip the end of the wire (20), and

wherein the robot (700) is adapted to place the end of the wire (20) gripped by the first gripper (710) onto the first wire clamp (220) by moving the first gripper (710).

12. The wire winding device according to claim 11, wherein the robot (700) further comprises a second gripper (720) adapted to grip the pipe (10), and the robot (700) is adapted to place the gripped pipe (10) to or take the gripped pipe (10) away from the pipe clamp (210) by moving the second gripper (720).

13. The wire winding device according to claim 11 or 12, wherein the robot (700) further comprises a cutter (730) adapted to cut off the wire (20), so that the wire (20) wound on the pipe (10) is separated from the unwound wire (20).

14. The wire winding device according to claim 13, wherein the wire winding device further comprises a second wire clamp (600) adapted to clamp a cutting end of the unwound wire (20); and
wherein the robot (700) is adapted to grip the cutting end of the unwound wire (20) by the first gripper (710), and place the cutting end of the unwound wire (20) on the second wire clamp (600) or take the cutting end away from the second wire clamp (600).

15. A method of winding a wire, **characterized in that** the method comprises steps of:

S100: gripping a pipe (10) and mounting the gripped pipe (10) onto a pipe clamp (210) by a robot (700);
S200: gripping an end of a wire (20) drawn from a wire supply mechanism (100) and holding the end of the wire (20) onto a first wire clamp (220) by the robot (700);
S300: driving the pipe (10) to rotate about a rotation axis (R) and linearly move in a first direction (Y) parallel to the rotation axis (R), so as to wind the wire (20) onto the pipe (10);
S400: stopping the pipe (10) after the wire (20) is wound onto the pipe (10);
S500: burning a local area of the pipe (10) corresponding to the end of the wire (20) wound on the pipe (10) until the local area of the pipe (10) is melt, so that the end of the wire (20) is bonded and fixed to the local area of the pipe (10);
S600: cutting off the wire (20) by a cutter (730) of the robot, so that the wire (20) wound on the pipe (10) is separated from the unwound wire (20);
S700: gripping a cutting end of the unwound wire (20) and placing the cutting end of the unwound wire (20) on a second wire clamp (600) by the robot (700);
S800: taking the pipe (10) wound with the wire (20) away from the pipe clamp (210).

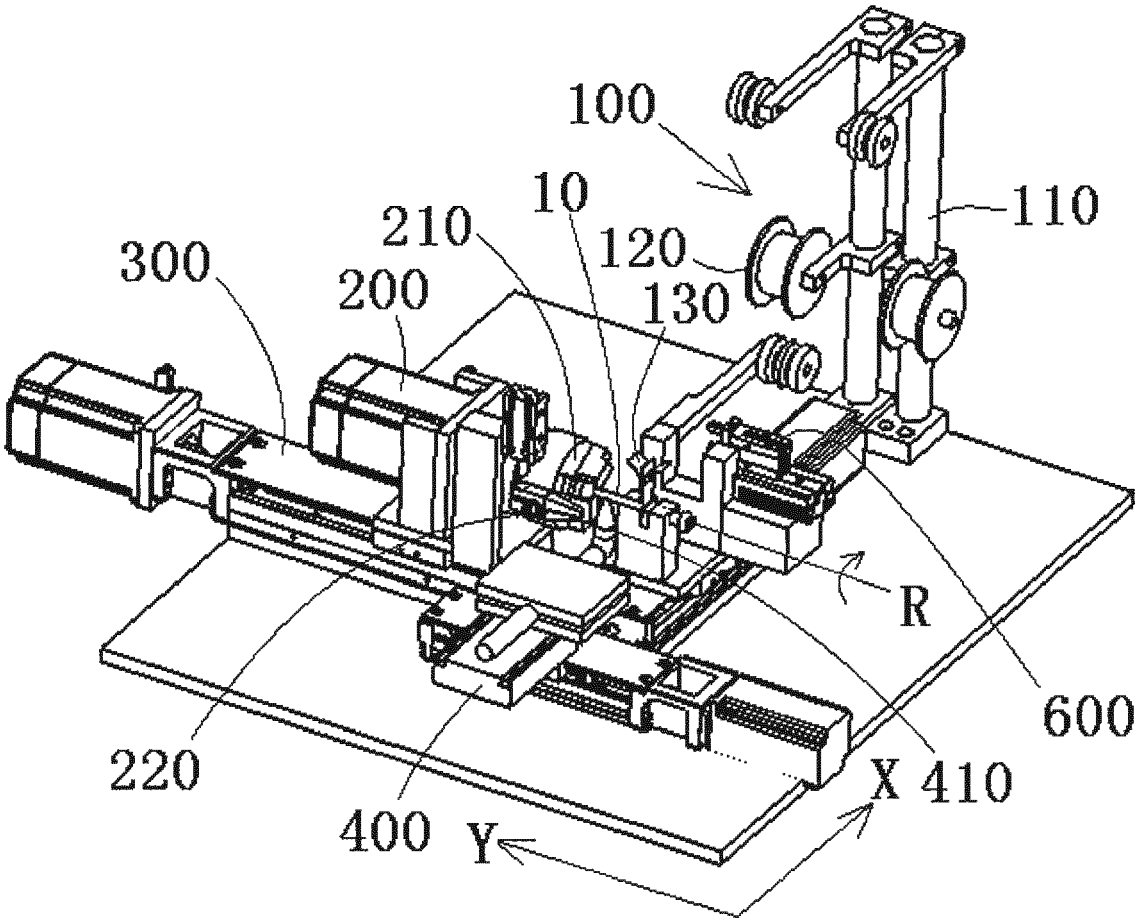

Fig.1

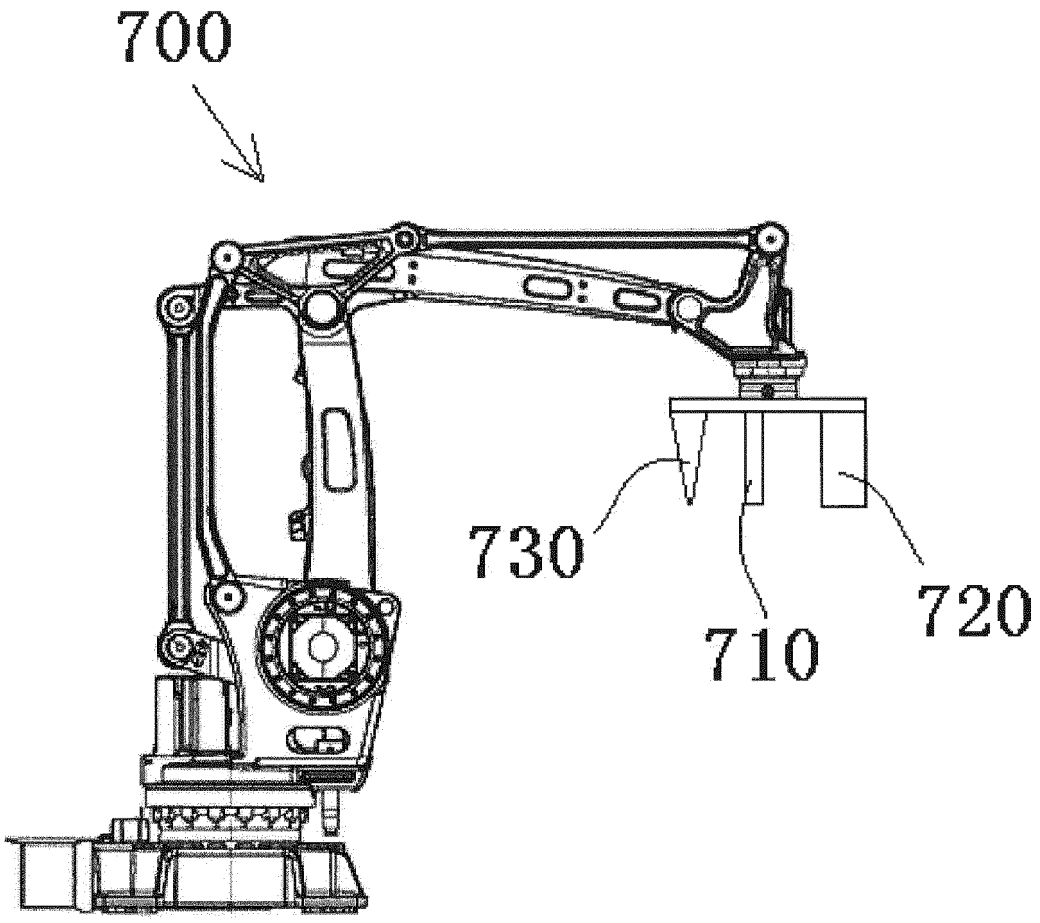

Fig.2

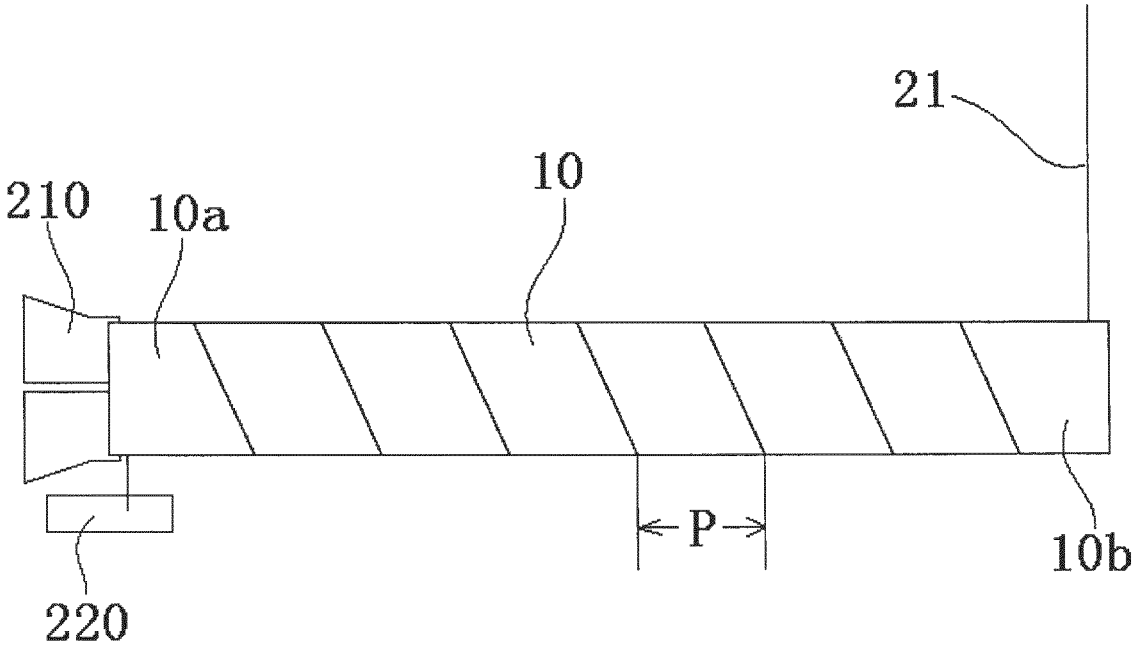

Fig.3

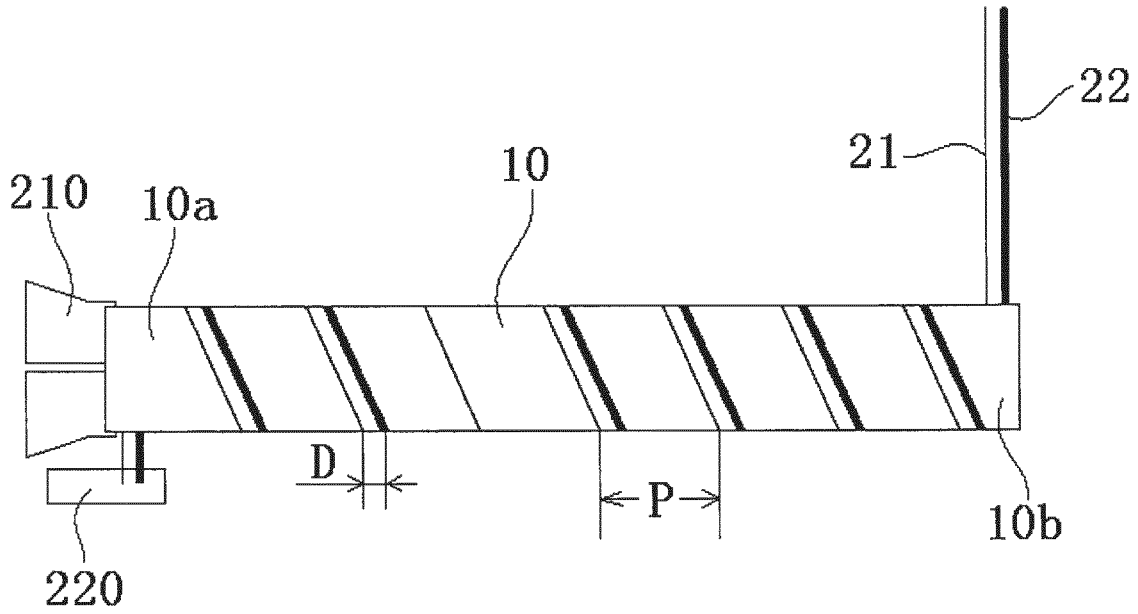

Fig.4

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 19 16 5369

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 2003 086091 A (HARISON TOSHIBA LIGHTING CORP) 20 March 2003 (2003-03-20)	1-15	INV.
Y	* figures 1-5 *	1-15	H01F41/073
	* paragraphs [0034] - [0054] *		H01F41/082
	-----		B21F1/00
			B65H1/00
Y	CN 204 679 202 U (UNIV BEIJING JIAOTONG) 30 September 2015 (2015-09-30)	1-15	G01F1/00
	* figure 1 *		G01N1/00
	* corresponding description *		

TECHNICAL FIELDS SEARCHED (IPC)

H01F
G01N
G01F
B21L
B65H
B21F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 September 2019	Weisser, Wolfgang

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 16 5369

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

09-09-2019

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2003086091 A	20-03-2003	NONE	
CN 204679202 U	30-09-2015	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- CN 201810288708X **[0001]**