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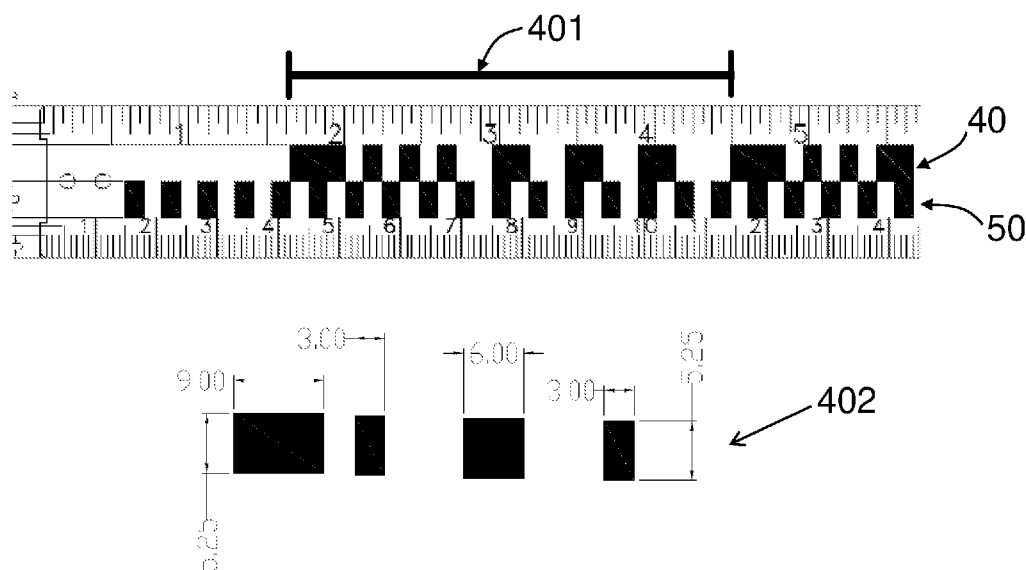


Figure 5B

(57) Abstract: An electronic measurement device and method thereof is provided. The electronic measurement device includes a casing assembly (10), a reel (34), and a tape blade (36) wound on the reel (34). The electronic measurement device further includes incremental encoder barcodes (50), absolute encoder barcodes (40), an optical reader module (603), and a processor (702). The incremental encoder barcodes (50) are readable for generating incremental measuring data indicating a linear extension of the tape blade (36). The absolute encoder barcodes (40) are readable for generating absolute measuring data indicating absolute position on the tape blade (36). The processor (702) is operable to correct the incremental measuring data on the basis of the absolute measuring data to output a measured value. The electronic measurement device and method thereof has advantage in various aspects such as high accuracy, synchronization, technical simplicity, ease of manufacturing, assembling, operation, maintenance and carrying around.

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ELECTRONIC MEASURING DEVICE AND METHOD THEREOF

FIELD OF INVENTION

[0001] The present invention generally relates to electronic measurement, and more particularly, to electronic measuring device and method thereof.

BACKGROUND

[0002] Electronic tape measuring apparatus take measurement by combining electronic means to process information. Conventional electronic measuring apparatus, for example, count mechanical contacts or links, such as punching holes, and then convert the counting numbers into electronic pulses for further processing so as to generate digital values. These conventional apparatus and methods are problematic in various aspects, such as being inaccurate, vulnerable to mechanical damage and external contamination, technically complex, difficult to manufacture, and expensive, etc.

SUMMARY

[0003] The present invention provides an electronic measuring device and method thereof to overcome one or more existing technical problems as stated above.

[0004] According to one aspect of example embodiments, there is provided an electronic measuring device. The electronic measuring device includes a casing assembly having an opening, a reel arranged within the casing assembly, and a tape blade wound on the reel and operable to extend through the opening as the reel is rotated. The electronic measuring device further includes incremental encoder barcodes, absolute encoder barcodes, an optical reader module, and a processor. The incremental encoder barcodes are imprinted on a surface of the tape blade along a length of the tape blade, and are readable for generating incremental measuring data indicating a linear extension of the tape blade. The absolute encoder barcodes are imprinted on the surface of the tape blade along the length of the tape blade, and are readable for generating absolute measuring data indicating absolute position on the tape blade. The processor is

electrically connected to the optical module and is operable to analyze electronic signals from the optical reader module for correcting the incremental measuring data on basis of the absolute measuring data to output a measured value.

[0005] According to a further aspect of example embodiments, there is provided an electronic measuring device. The electronic measuring device includes a casing assembly having an opening, a reel arranged within the casing assembly, and a tape blade wound on the reel and operable to extend through the opening as the reel is rotated. The casing assembly includes a front casing, a back casing, and a middle casing arranged between the front casing and the back casing. The electronic measuring device further includes an optical reader module and a floating holder. The floating holder is arranged within the casing assembly. The optical reader module is fixed to the floating holder such that the floating holder carries the optical reader module.

[0006] According to yet a further aspect of example embodiments there is provided a method for measuring length for an object. The method includes generating incremental measuring data by reading, by a first set of optical readers, incremental encoder barcodes imprinted on a surface of a tape blade, the generating incremental measuring data indicating a linear extension of the tape blade; generating absolute measuring data by reading, by a second set of optical readers, absolute encoder barcodes imprinted on the surface of the tape blade, the absolute measuring data indicating absolute position on the tape blade; and correcting, by a processor, the incremental measuring data on basis of the absolute measuring data.

[0007] Other example embodiments are discussed hereinafter.

[0008] The electronic measuring device and method thereof are advantages in various aspects. Advantages of both incremental encoder barcodes and absolute encoder barcodes are utilized. The incremental encoder barcodes have high resolution to measure linear extension of a tape blade by obtaining incremental measuring data. The absolute encoder barcodes encode information of absolute or exact position for certain point or interval on the tape blade. The absolute encoder barcodes are read to obtain absolute measuring data that serve as a basis in making correction once an error occurs for the measurement of the incremental encoder barcodes, thereby ensuring high accuracy. The incremental encoder barcodes and the absolute encoder barcodes are all printed on the tape blade and thus they always synchronize with the tape blade.

Synchronization issues and miscounts by the counter that exist in many conventional measuring apparatus to cause inaccurate measurement are thus avoided by electronic measuring in accordance with present example embodiments. Further, incremental encoder barcodes and absolute encoder barcodes are read by one or more optical readers to extract related position or measurement information without necessity of physical or mechanical contacts or links. High resolution and accuracy can thus be achieved without the necessity of overcoming technical obstacles that are generally unavoidable and sometimes impossible to overcome when using mechanical contacts or links. Electronic measuring devices in accordance with one or more example embodiments possess technical simplicity and can be easily manufactured, assembled, operated, and maintained, and are also convenient to be carried around.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Embodiments of the present invention will now be described, with reference to the accompanying drawings in which:

[0010] Figure 1 is an illustration of an electronic measuring device in accordance with an example embodiment.

[0011] Figure 2 is an illustration of the electronic measuring device of Figure 1 viewed from another perspective.

[0012] Figure 3A is a top view of the electronic measuring device of Figure 1.

[0013] Figure 3B is an illustration of a printed circuit board (PCB) of a display and main PCB of the electronic measuring device of Figure 1.

[0014] Figure 4A is an illustration illustrating part of an internal structure of the electronic measuring device of Figure 1.

[0015] Figure 4B is an illustration illustrating part of an internal structure of the electronic measuring device of Figure 1.

[0016] Figure 5A is an illustration illustrating a tape blade of an electronic measuring device in a wound state in accordance with an example embodiment.

[0017] Figure 5B is an illustration illustrating a tape blade with barcodes printed in accordance with an example embodiment.

[0018] Figure 6A is an illustration illustrating a tape blade with barcodes printed and two sets of optical readers in accordance with an example embodiment.

[0019] Figure 6B is an illustration illustrating the two sets of optical readers of Figure 6A.

[0020] Figure 6C illustrates the first set of optical readers of Figure 6A.

[0021] Figure 6D illustrates output signal curves of the first set of optical readers of Figure 6C.

[0022] Figure 7 is a block diagram for an electronic measuring device in accordance with an example embodiment.

[0023] Figure 8 is a block diagram for an electronic measuring device in accordance with another example embodiment.

[0024] Figure 9A illustrates a floating holder in accordance with an example embodiment.

[0025] Figure 9B illustrates a floating holder of Figure 9A with two carriers removed.

[0026] Figure 9C illustrates a first carrier of Figure 9A.

[0027] Figure 9D illustrates a second carrier of Figure 9A.

[0028] Figure 9E illustrates a bottom view of the floating holder of Figure 9A.

[0029] Figure 10 is a flow chart illustrating a method for measuring length in accordance with an example embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS

[0030] Example embodiments relate to electronic measuring device and method thereof with unconventional design and operation to take measurement with various advantages.

[0031] As illustrated in Figures 1-5B, the electronic measuring device, such as an electronic tape, includes a casing assembly or enclosure 10. The casing assembly 10 can be formed of suitable materials, such as metal, or plastic with light weight, or combination thereof. The casing assembly 10 includes a front casing 101, a back casing 102, and a middle casing 103 arranged between the front casing 101 and the back casing 102. The casing assembly 10 defines a cavity or internal space housing components such as an internal frame or frame 30, a reel 34, and a tape blade 36. The front casing 101, the back casing 102, and the middle casing 103 are detachable or removable, which renders it easy and convenient to maintain or replace one or more components arranged within the casing assembly 10.

[0032] An opening 12 (e.g., exit slot) is provided on at an end of the casing assembly 10, such as at a side near the bottom of the casing assembly 10, such that the tape blade 36 is extendable through the opening 12 when taking measurement. At one end of the tape blade 36, a hook or clip 13 is provided to prevent the end of the tape blade 36 from entering the casing assembly 10 and to serve as a finger grasp for pulling the tape blade 36 from the casing assembly 10. A locker or lock button 14 is provided on the middle casing 103 such that the tape blade 36 can be locked into a fixed state, for example, by pressing the lock button 14. In this manner, during an idle state (e.g., not taking measurement), the hook 13 is avoided being applied a tensile force by the tape blade 36.

[0033] A display or screen 16, such as a liquid crystal display (LCD), is provided to visually show the measured length. The display 16 may be coupled to the frame 30 without physically connecting to the casing assembly 10. As such, the display 16 is not affected when detaching the casing assembly 10. As an example, the surface of the display 16 is lower than the adjacent surface of the casing assembly 10 such that the display 16 appears to be falling within the casing assembly 10 from certain perspective. A display cover may be provided to protect (e.g., by covering) the display 16 from dust or contamination. The display 16 electrically couples to a printed circuit board (PCB), such as a LCD PCB 162, so that the display 16 is electrically operable to display a measured value for reviewing.

[0034] In some embodiments, control buttons are provided to serve various control functions. Control buttons 104 and 106 are arranged on the front casing 101 and the back casing 102 respectively. For example, button 104 and button 106 are defined to activate saving functions to

save the current reading of the electronic measuring device into a first memory storage and a second memory storage (both not shown) respectively. The control buttons can be arranged differently according to practical requirement, such as depending upon the specific design of particular products. A function button 18 is further provided on one side or surface of the back casing 102. The function button 18 may be a membrane keypad which contains four dome switches (not shown). The function button 18 is provided to serve various control functions. Examples of the functions performed by the four dome switches on the function button 18 include Midpoint / Reset Zero, Selection of Inside / Outside Measurement, Selection / Conversion of Measurement Units, and Holding the Last Value.

[0035] On one side of the back casing 102, as illustrated in Figure 2, there is provided a holding mechanism 20 that makes it easier for users in carrying the electronic measuring device around. The holding mechanism 20 includes a plate, fixing means, and hooking means. The plate, such as a press plate 201, couples to the back casing 102 and serves as a supporting base for the fixing means and the hooking means. The fixing means, such as one or more screws (not shown), fix or secure the press plate 201 onto the back casing 102. The hooking means, such as a belt hook 203 (e.g., a string or rope made of proper materials, such as metal, fiber, etc.), couples to the press plate 201 to be holdable by a user, thereby facilitating the carrying of the electronic measuring device by the user. The plate may be an integral part of the back casing 102. For example, the plate may be integrated with the back casing 102 with proper mechanical treatment such as soldering, welding, etc.

[0036] The frame 30 is arranged inside the casing assembly 10 and supports a main PCB 32. The main PCB 32 includes various electronic means or circuitry, such as processing circuitry, operable to process signal or data regarding the measurement such that measurement results can be visually displayed for users' view. Inside the casing assembly 10 there is provided with a reel 34 that is supported by a shaft 38. The shaft 38 may be positioned in the center of the casing assembly 10. The reel 34 may be a spring recoilable take-up reel. The tape blade 36 is wound onto the reel 34 with one end extending through the opening 12 and connecting to the hook 13. The tape blade 36 can be made of plastic, steel, or combination thereof, or any other suitable non-metallic materials as long as it has sufficient strength and flexibility for use.

[0037] Pluralities of visual indicia are imprinted or printed onto one surface of the tape blade 36. As illustrated in Figure 5B for example, the visual indicia are barcodes having bars or marks, and spaces. The tape blade 36 is provided with two types or sets of barcodes: absolute encoder barcodes 40 and incremental encoder barcodes 50. All these barcodes are printed on same side or surface of the tape blade 36 and along the extension length of the tape blade 36. As such, position information encoded in the barcodes always synchronizes with or corresponds to the movement of the tape blade 36. Synchronization issue existing in conventional measurement devices is avoided. Additionally and alternatively, one or more sets of human-readable markings or scales are printed on same surface of the tape blade 36. Further alternatively, the absolute encoder barcodes 40 and incremental encoder barcodes 50 may be printed on different side or surface of the tape blade 36 and along the extension length of the tape blade 36.

[0038] The incremental encoder barcodes 50 include a series of intervals or units with a predefined width. The incremental encoder barcodes 50 can be read or decoded by optical readers or sensors such that measurement information (such as direction of displacement and number of counter) can be obtained for generating incremental measuring data during the tape blade 36 being pulled from or from or withdrawn into the casing assembly 10.

[0039] The incremental encoder barcodes 50 include periodically repeated units with each unit including a mark and a space. The width along the direction of the tape blade for each of the periodically repeated units is X millimeter (mm), where X is a positive integer. As an example, X=6.

[0040] The absolute encoder barcodes 40 are unique barcodes for a defined barcode interval or interval or unit and contains absolute or exact position data for such defined interval on the tape blade 36. By reading out the absolute encoder barcode, the tape blade position for corresponding interval is obtained. As an example, the absolute encoder barcodes 40 include a series of intervals or units. Each interval 401 includes information that indicates absolute or exact position for the interval 401. As such, each interval 401 is configured to identify an absolute position for an interval in the tape blade. Each interval 401 may have a predefined length, such as 72mm. Figure 5B further illustratively shows a pattern 402 (such as shape and dimension) of a representative interval of the absolute encoder barcodes 40. The unit in the pattern 402 is mm. For each interval, the absolute encoder barcodes 40 have a unique barcode which contains “start

bit + 12 bit (data) + stop bit". The absolute encoder barcodes 40 thus provide absolute position for each barcode interval. To encode marks and spaces of the absolute encoder barcodes 40, width is reference to the resolution of the incremental encoder barcodes 50, where the resolution, as an example, is 1mm.

[0041] As an example, when taking measurement, during the period when the tape blade 36 is pulled from or withdrawn into the casing assembly 10, the incremental encoder barcodes 50 are read by optical readers. By counting the number of electronic signals (such as electronic pulses) with a counter (such as a UP/DOWN counter, which can be hardware implemented and/or software implemented), and comparing the phases between these signals, displacement and moving direction of the tape blade 36 can be obtained by a processing unit and a measured value corresponding to linear extension of the tape blade 36 is generated and then displayed on the display 16.

[0042] At each predefined interval (e.g., the interval 401 of the absolute encoder barcodes 40), the absolute encoder barcodes 40 are read to generate absolute measuring data. To achieve this, the optical readers for the absolute encoder barcodes 40 always emit light to read the absolute encoder barcodes 40. Whether the measurement of the incremental encoder barcodes 50 is correct is determined, by a processor, by comparing the read out (i.e., incremental measuring data) of the incremental encoder barcodes 50 with the absolute measuring data. Where there is an inconsistency between the incremental measuring data and the absolute measuring data, an error is deemed present. When such error occurs, the processor corrects the incremental measuring data on basis of the absolute measuring data to output a measured value. For example, the processor can replace or update the incremental measuring data with the absolute measuring data. Alternatively, the processor directly outputs or transmits the absolute measuring data as a measured value to a display for displaying.

[0043] The incremental encoder barcodes 50 may have high resolution such that minor or fine displacement of the tape blade 36 is measurable. The absolute encoder barcodes 40 may have lower resolution as long as measurement errors for the incremental encoder barcodes 50 are correctable every predefined interval. In an example embodiment, resolutions for the incremental encoder barcodes 50 and the absolute encoder barcodes 40 are 1mm and 72mm respectively. The

measurement results based on the incremental encoder barcodes 50 are monitored and corrected every 72mm.

[0044] Optical readers or switches or sensors or scanners are provided within the casing assembly 10 to decode or read barcodes. For example, the optical readers are placed close to the output side of the casing assembly 10 (e.g., within the casing assembly 10 and near or proximate to the opening 12). The optical readers can be arranged differently as long as they can read barcodes for generating incremental measuring data and absolute measuring data. Each of the optical readers or sensors converts light rays into electronic signals. Each optical reader includes a light source operable to emitting light onto the tape blade, and a light detecting means operable to detect the light reflected from the tape blade and generate electronic signals. As an example, the optical readers are reflective type optical switches including light emitter (such as an infrared emitting diode and detector (such as an NPN phototransistor or photo Darlington) to sense the amplitude of signal reflected from the tape blade to identify existence of a barcode for example.

[0045] The electronic measuring device is provided with two sets of optical readers, with each set including one or more optical readers. The first set of optical readers is associated with the incremental encoder barcodes 50 and is used to read the incremental encoder barcodes 50. For example, the first set of optical readers is arranged in a way as being located near the opening 12 above the incremental encoder barcodes 50 when the tape blade 36 is pulled out or pushed in the casing assembly 10. The second set of optical readers is associated with the absolute encoder barcodes 40 and is used to read the absolute encoder barcodes 40. For example, the second set is arranged in a way such that the second set is located above the absolute encoder barcodes 40 when the tape blade 36 is pulled out or pushed into the casing assembly 10.

[0046] The first set of optical readers may include two or more optical readers. The distance between adjacent optical readers of the first set of optical readers is $X\text{mm}/2 \times N + Y\text{mm}$, where X is the length for one periodical unit of the incremental encoder barcodes, N is a positive integer, and Y is the resolution of the electronic measuring device. As illustrated in Figure 6A, the first set of optical readers 52 includes three optical readers 53, 54, and 55. The distance between two adjacent optical readers is $(3\text{mm} \times N + Y\text{mm})$ as indicated by 521, where N is a positive integer, such as 1, 2, 3... As an example, $Y=1$. As further illustrated in Figure 6A, the second set of optical readers 42 includes one optical reader.

[0047] Figures 6C and 6D illustrate configuration of the first set of optical readers and their corresponding output signal curves. The periodically repeated unit of the incremental encoder barcodes 50 is 3mm, the phase angle difference of electronic signals output by two adjacent optical readers is multiple of 60 degree (see the signal curves 523, 524, and 525 corresponding to electronic signals output by the optical readers 53, 54, and 55 respectively), which can identify a displacement of 1mm for the tape blade 36. If the tape blade 36 slides out from the reel 34, signal from the optical reader 53 will lead the change and signals from the optical readers 53 and 54 will repeat the signal in a period of time. If the tape blade 36 slides into the reel 34, signal from the optical reader 53 will lead the change and signals from the optical readers 55 and 54 will repeat the signal in a period of time. In another embodiment, the first set of optical readers includes only two optical readers, and the phase angle difference for electronic signals output by adjacent optical readers is a multiple of 90 degrees. In yet a further embodiment, the first set of optical readers includes only four optical readers, and the phase angle difference for electronic signals output by adjacent optical readers is a multiple of 45 degrees.

[0048] Figure 7 illustrates a block diagram 700 for an electronic measuring device in accordance with an example embodiment. The diagram 700 includes a processing unit or processor 702, a memory 703, a displaying means or display 16, an optical reader module 703 having a first set of optical reader or sensors 704 and a second set of optical readers or sensors 705, a tape blade 36, various buttons or keys 706, and a battery pack or battery 708 that supplies power to the electronic measuring device.

[0049] The first set of optical readers 704 reads incremental encoder barcodes on the tape blade 36 and generates electronic signals processed by the processor 702 to obtain incremental measuring data corresponding to linear extension of the tape blade 36. In each predefined interval, such as 72mm, the second set of optical readers 705 reads absolute encoder barcodes on the tape blade 36 and generates electronic signals processed by the processor 702 to obtain absolute measuring data (e.g., exact or absolute position corresponding to the interval).

[0050] As an example, the processor 702 includes counting means or counter operable to count the number of incremental encoder barcodes read such that displacement of the tape blade 36 is calculated. The processor 702 includes analyzing means or analyzer operable to analyze the phase of electronic signals output from the first set of optical readers 704 such that direction of

the movement of the tape blade 36 is determined. On basis of the displacement and the direction information, the processor 702 calculates a linear extension value of the tape blade 36 corresponding to a measured value or length for an object. The measured value is further displayed on the display 16 for viewing. As a further example, the processor 702 includes comparator means or comparator operable to compare the incremental measuring data with the absolute measuring data. When an inconsistency is determined, the incremental measuring data is determined as incorrect, and a correction is made for the incremental measuring data in accordance with the absolute measuring data, and a correct measure value or length is output and displayed on the display 16. Additionally and alternatively, the processor 702 includes driving means or driver operable to drive the optical readers 704 and 706. In some example embodiments, means such as the counter, the analyzer, the comparator, the driver, etc. are programmed and software implemented. In some other example embodiment, these means are hardware implemented as circuitry separately arranged on the main PCB 32 or integrated with other units or components such as the processors 702.

[0051] The data as collected or processed, such as the current reading of the optical reader module 603, may be stored in the memory 703. The memory 703 may represent more than one memory that are disposed separately and configured to store different kinds of data according to practical needs.

[0052] Various keys 706 are operable to actuate various functions, such as switching between ON and OFF states, locking or unlocking the tape blade, adjusting displaying parameters, etc.

[0053] Additionally and alternatively, the diagram 700 further includes a Bluetooth module 710 and/or a radio frequency (RF) module 712 to enable wireless communication with a computer device, such as a smartphone (e.g., sending signals to a portal device or a personal computer). As such, operation of the electronic measuring device can be manipulated by a user on a separate computer device, and measure results can be processed, such as being reviewed and stored, on such computer device.

[0054] Figure 8 illustrates a block diagram 800 for an electronic measuring device in accordance with an example embodiment. The diagram 800 includes a main PCB 32

communicating with a sensor Flexible Printed Circuit (FPC) 806, an ON/OFF switch 810 operable to turn on or off the electronic measuring device, and a battery 814 operable to supply power.

[0055] The main PCB 32 includes a select/convert unit button 802, an inside/outside button 804, a rezero/midpoint button 808, a Bluetooth button 812 operable to actuate Bluetooth function, and a Bluetooth low energy (BLE) module 816.

[0056] As the tape blade is pulled from or pushed into of the casing assembly, the tape angle from the reel to the opening changes. This generally incurs variation of light signals incident onto and reflected from the tape blade, and accordingly negatively affects the accuracy in measurement. A floating folder 90, as illustrated in Figures 9A-9E, minimizes this negative effect. The floating holder 90 can be made of suitable materials, such as plastic, metal, or combination thereof.

[0057] The floating holder 90 is located at the opening 12 within the case assembly 10 and carries an optical reader module including one or more optical readers. The floating holder 90 is floating so as to minimize the change of distance between the optical readers and the tape blade. In particular, the floating holder 90 has two points fixed on the housing 104 and 106. The tape blade 36 is assembled into the holder 90 of which the sensor's position is under control. When the tape blade 36 is pull in/out form the reel 34, the tape angle is changing. The holder 90 will match the angle so that the position from sensor to barcode is under control.

[0058] As illustrated, the floating holder 90 includes a base 91, and fix points or rods 92 engageable with the base 91 and capable of being coupled or locked to the casing assembly 10. The base 91 includes a first groove 93 supportable to a first carrier 920 and a second groove 94 supportable to a second carrier 940. The first groove 93 is confined by a bottom wall 922 and two side walls 924 and 942. Two pillars or posts 926 are provided onto the bottom wall 922 and can mate with two openings or apertures of the first carrier 920 such that the first carrier 920 is secured to the first groove 93. The second groove 94 is confined by side walls 942 and 944. Two T-shape members 946 are secured to and between the side walls 942 and 944, with one end of each member mating with corresponding opening or aperture of the second carrier 940. The first and the second carriers 920 and 940 are operable to carry the optical reader module including

optical readers, either the first set or the second set of optical readers such that the optical readers are in a floating state with the holder 90 to minimize distance variation due to tape blade movement. The first and the second carriers 920 and 940 can be configured in parallel.

[0059] Figure 10 is a flow chart illustrating a method for measuring length in accordance with an example embodiment. The method, for example, can be executed by an electronic measuring device as stated above. The method measures length of an object with improved accuracy by reading barcodes imprinted on a tape blade. The method employs two sets of barcodes to obtain two sets of measuring data: incremental measuring data and absolute measuring data. The incremental measuring data can reflect fine or minor extension of the tape blade. The absolute measuring data, which indicates absolute or exact position on the tape blade, are used to monitor the incremental measuring data every predefined interval, and make correction when an error is determined. The non-contact measuring method in accordance with example can achieve, among other advantages, improved accuracy, for example, by overcoming synchronization issues that widely exist in conventional systems.

[0060] Block 1002 states generating incremental measuring data. For example, a first set of optical readers read incremental encoder barcodes imprinted on a surface of a tape blade for generating incremental measuring data. The incremental measuring data indicate a linear extension of the tape blade.

[0061] Block 1004 states generating absolute measuring data. For example, a second set of optical readers read absolute encoder barcodes imprinted on the surface of the tape blade. The absolute measuring data indicate absolute position on the tape blade.

[0062] Block 1006 states correcting, by a processor, the incremental measuring data on basis of the absolute measuring data. The processor compares the incremental measuring data with the absolute measuring data. For example, when there is an inconsistency between the incremental measuring data and the absolute measuring data, an error is deemed present for the incremental measuring data. As an example, this can be due to a missing of number counting for an electronic pulse generated by the first set of optical readers. The processor replaces or updates the incremental measuring data with the absolute measuring data and generates a correct measured value indicating the measuring length. In some example embodiment, the correct measured value

is transmitted to a display such that the measured value can be presented in a digital form for users' viewing visually.

[0063] As used herein, the terms “barcode” refers to an optical, machine-readable, representation of data or information. The “barcode” includes one-dimensional barcodes, matrix barcodes, and other codes with patterns carrying optical, machine-readable representation of data or information.

[0064] As used herein, the terms “absolute position” means exact position of a point on a tape blade. As an example, an “absolute position” can be a value corresponding to a value represented by a human-readable marking on the tape blade as on a conventional tape.

[0065] It would be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to example embodiments as set forth above without departing from the spirit of the example embodiments as broadly constructed. The example embodiments are, therefore, to be considered in all respects as illustrative and nonrestrictive.

CLAIMS

What is claimed is:

1. An electronic measuring device comprising:

a casing assembly having an opening;

a reel arranged within the casing assembly;

a tape blade wound on the reel and operable to extend through the opening as the reel is rotated;

incremental encoder barcodes imprinted on a surface of the tape blade along a length of the tape blade, the incremental encoder barcodes being readable for generating incremental measuring data indicating a linear extension of the tape blade;

absolute encoder barcodes imprinted on the surface of the tape blade along the length of the tape blade, the absolute encoder barcodes being readable for generating absolute measuring data indicating absolute position on the tape blade;

an optical reader module; and

a processor electrically connected to the optical reader module and operable to analyze electronic signals from the optical reader module for correcting the incremental measuring data on basis of the absolute measuring data to output a measured value.

2. The electronic measuring device of claim 1, wherein the incremental encoder barcodes includes periodically repeated units with each unit including a mark and a space.

3. The electronic measuring device of claim 2, wherein the width along the direction of the tape blade for each of the periodically repeated units is Xmm, wherein X is a positive integer.

4. The electronic measuring device of any of claims 1-3, wherein the absolute encoder barcodes include a series of barcode intervals, each barcode interval containing absolute position information for the barcode interval on the tape blade.

5. The electronic measuring device of claim 4, wherein each of the series of barcode intervals is configured to identify an absolute position for an interval in the tape blade.

6. The electronic measuring device of any of claims 1-3, further comprising a display operable to display the measured value in a digital form.
7. The electronic measuring device of any of claims 1-3, further comprising a Bluetooth module enabling wireless communication of the electronic measuring device with a computer device.
8. The electronic measuring device of claim 1, wherein the optical reader module includes
 - a first set of optical readers arranged within the casing assembly and proximate to the opening for reading the incremental encoder barcodes; and
 - a second set of optical readers arranged within the casing assembly and proximate to the opening for reading the absolute encoder barcodes.
9. The electronic measuring device of claim 8, wherein the first set of optical readers includes two or more optical readers.
10. The electronic measuring device of claim 9, wherein the distance between adjacent optical readers of the first set of optical readers is $X\text{mm}/2 \times N + Y\text{mm}$, wherein X is the length for one periodical unit of the incremental encoder barcodes, N is a positive integer, and Y is the resolution of the electronic measuring device.
11. The electronic measuring device of claim 9, wherein the phase angle difference for electronic signals output by adjacent optical readers of the first set of optical readers is:
 - a multiple of 60 degrees if the first set of optical readers includes three optical readers;
 - a multiple of 90 degrees if the first set of optical readers includes two optical readers; and
 - a multiple of 45 degrees if the first set of optical readers includes four optical readers.
12. The electronic measuring device of any of claims 8-11, wherein the first set of optical readers and the second set of optical readers are reflective type optical switches.
13. The electronic measuring device of any of claims 8-11, further comprising a floating holder

supportable to the first set of optical readers and the second set of optical readers.

14. The electronic measuring device of claim 13, wherein the floating holder has a fix point operable to couple to the casing assembly.

15. The electronic measuring device of any of claims 1-3, further comprising a radio frequency (RF) module operable to send signals to a portable device or a personal computer.

16. An electronic measuring device comprising:

- a casing assembly having an opening, the casing assembly including a front casing, a back casing, and a middle casing arranged between the front casing and the back casing;

- a reel arranged within the casing assembly;

- a tape blade wound on the reel and operable to extend through the opening as the reel is rotated;

- a floating holder arranged within the casing assembly; and

- an optical reader module fixed to the floating holder such that the the floating holder carries the optical reader module.

17. The electronic measuring device of claim 16, wherein the floating holder includes a fix point coupled to the casing assembly such that the first set of optical readers and the second set of optical readers are in a floating state.

18. The electronic measuring device of claim 16, wherein the floating holder includes a base and two fix rods engageable with the base, and wherein the two fix rods are engageable to the casing assembly such that distance variation between the first set of optical readers and the second set of optical readers and the tape blade is minimized.

19. The electronic measuring device of claim 18, wherein the base includes a first groove supportable to a first carrier and a second groove supportable to a second carrier, and wherein the first carrier is operable to carry the first set of optical readers, and the second carrier is operable to carry the second set of optical readers.

20. The electronic measuring device of claim 19, wherein the first carrier and the second carrier are configured in parallel along a direction transverse to the length of a portion of the tape blade that is being read.

21. The electronic measuring device of any of claims 16-20, wherein the floating holder is located at the opening within the casing assembly.

22. The electronic measuring device of any of claims 16-20, further comprising a holding mechanism provided on the back casing, wherein the holding mechanism includes a plate, fixing means for securing the plate onto the back casing, and hooking means coupled to the plate for facilitating the carrying of the electronic measuring device by a user.

23. A method for measuring length of an object, comprising:

generating incremental measuring data by reading, by a first set of optical readers, incremental encoder barcodes imprinted on a surface of a tape blade, the generating incremental measuring data indicating a linear extension of the tape blade;

generating absolute measuring data by reading, by a second set of optical readers, absolute encoder barcodes imprinted on the surface of the tape blade, the absolute measuring data indicating absolute position on the tape blade; and

correcting, by a processor, the incremental measuring data on basis of the absolute measuring data.

24. The method of claim 23, wherein the step of correcting further includes:

comparing the incremental measuring data with the absolute measuring data; and

replacing, when there is an inconsistency between the incremental measuring data and the absolute measuring data, the incremental measuring data with the absolute measuring data for generating a measured value indicating the length of the object.

25. The method of claim 24, further comprising: displaying, by a display, the measured value in a digital form.

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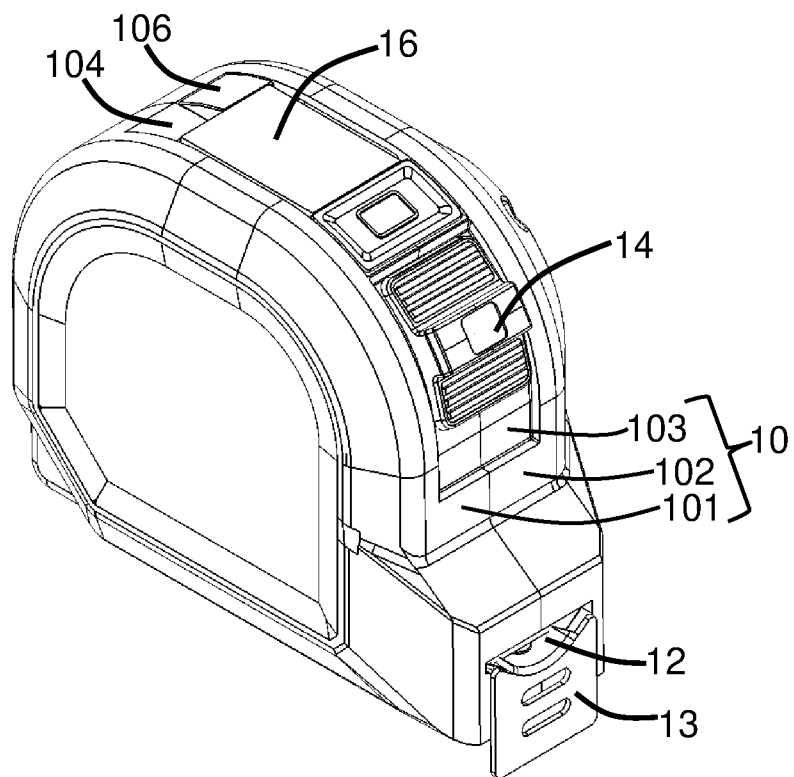


Figure 1

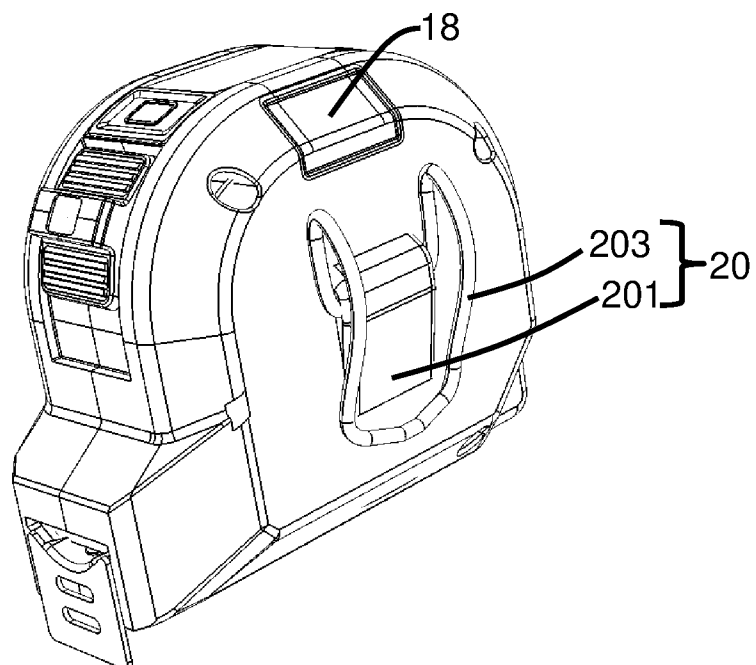


Figure 2

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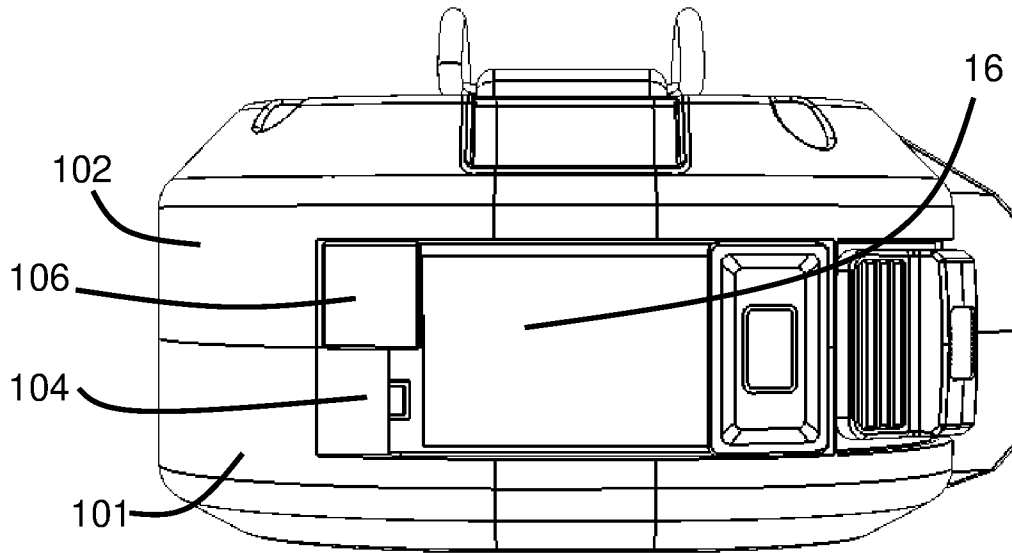


Figure 3A

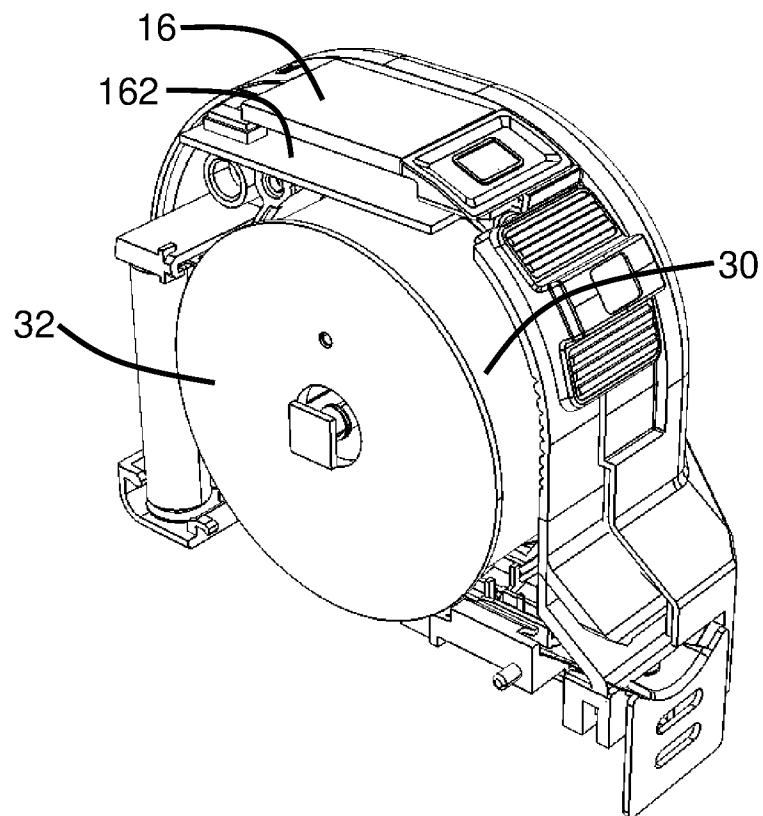


Figure 3B

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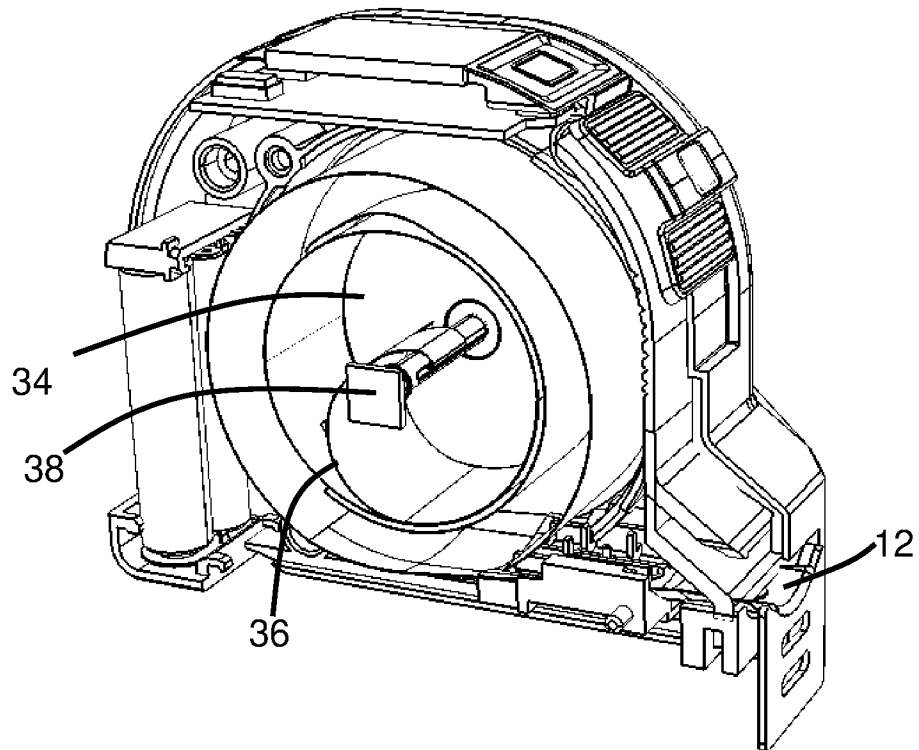


Figure 4A

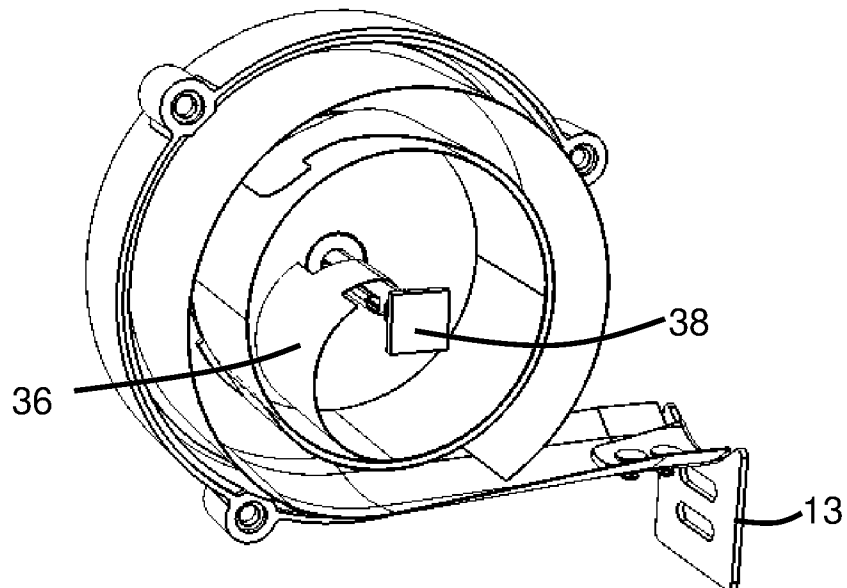


Figure 4B

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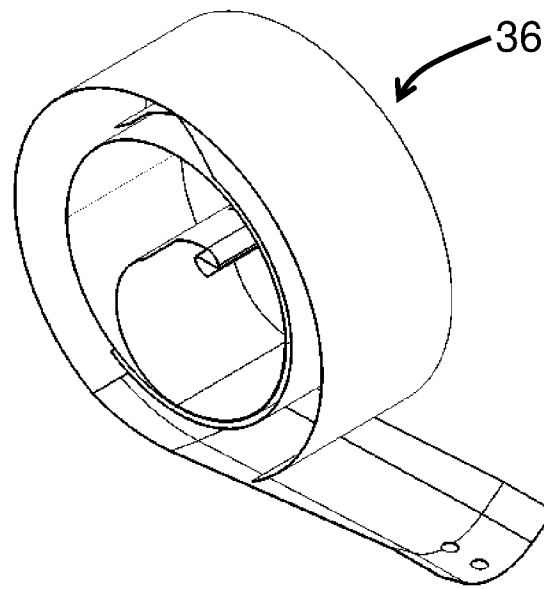


Figure 5A

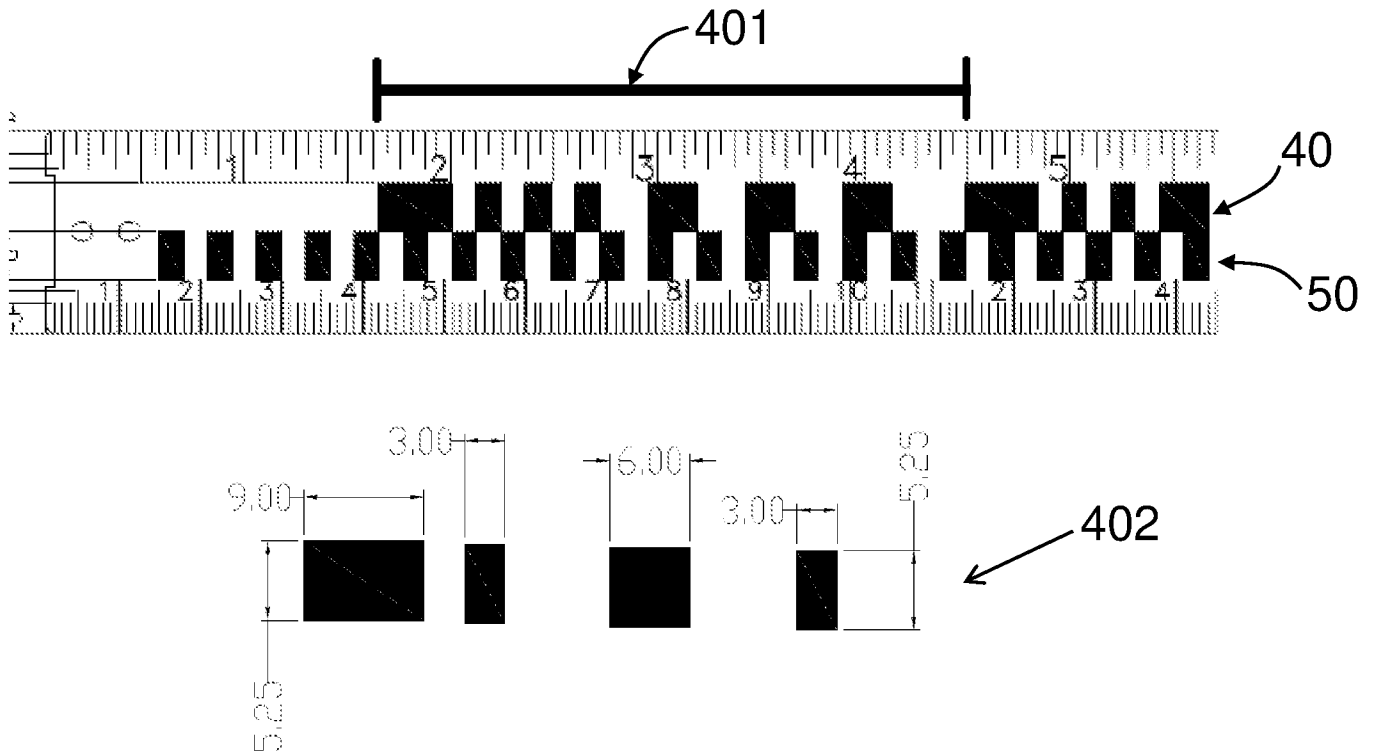


Figure 5B

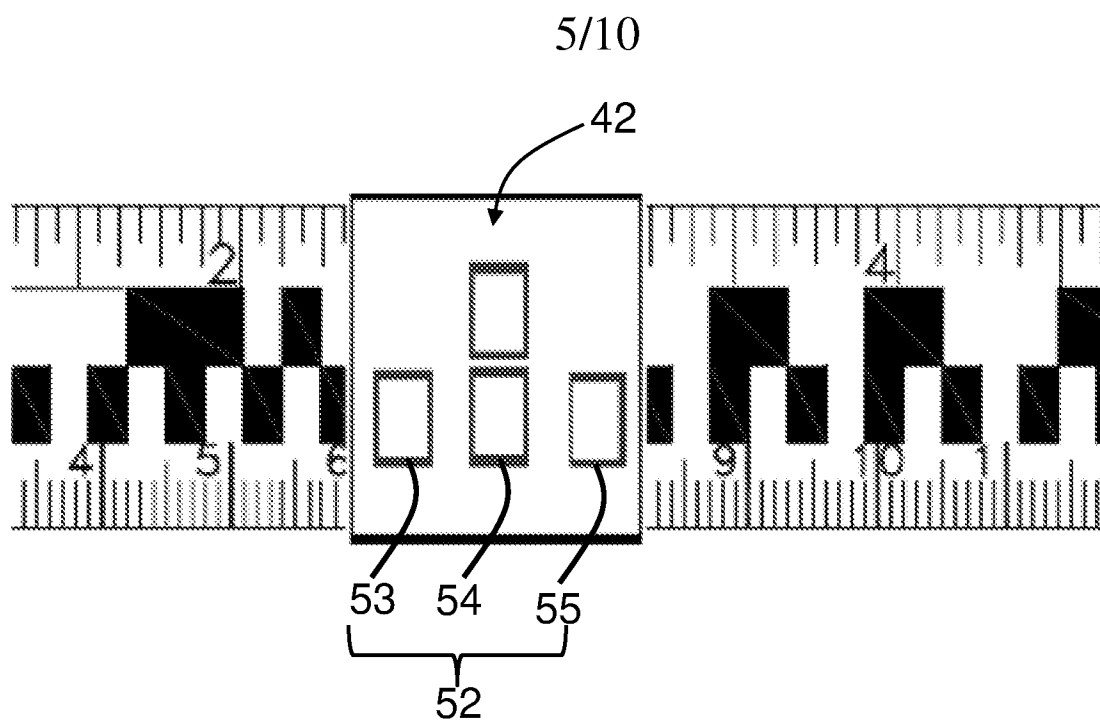


Figure 6A

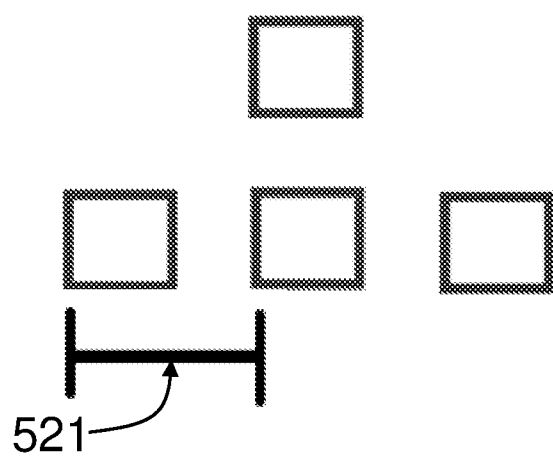


Figure 6B

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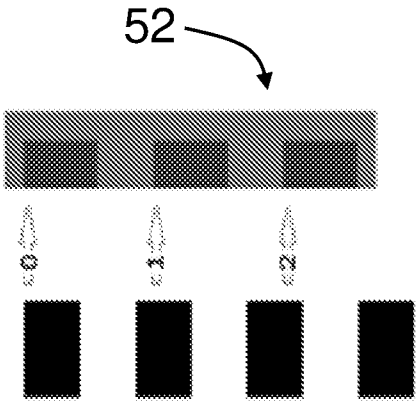


Figure 6C

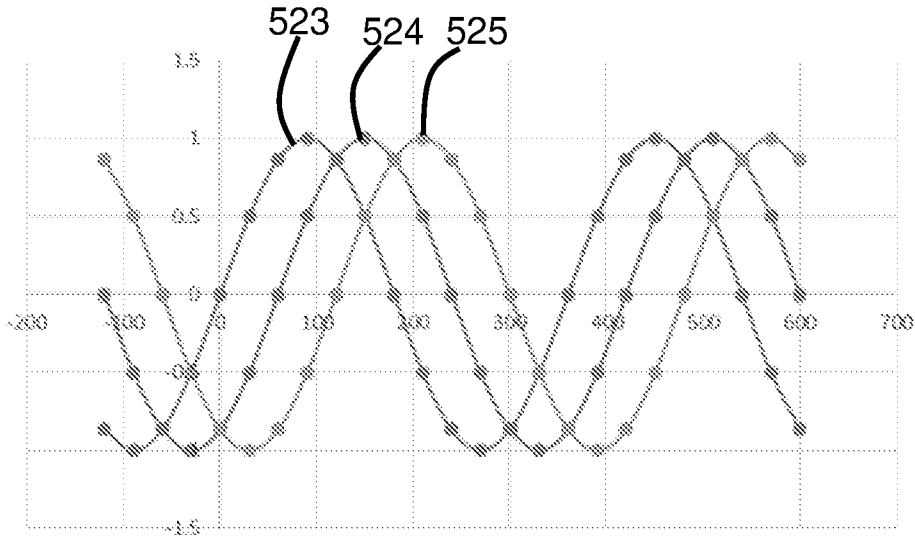


Figure 6D

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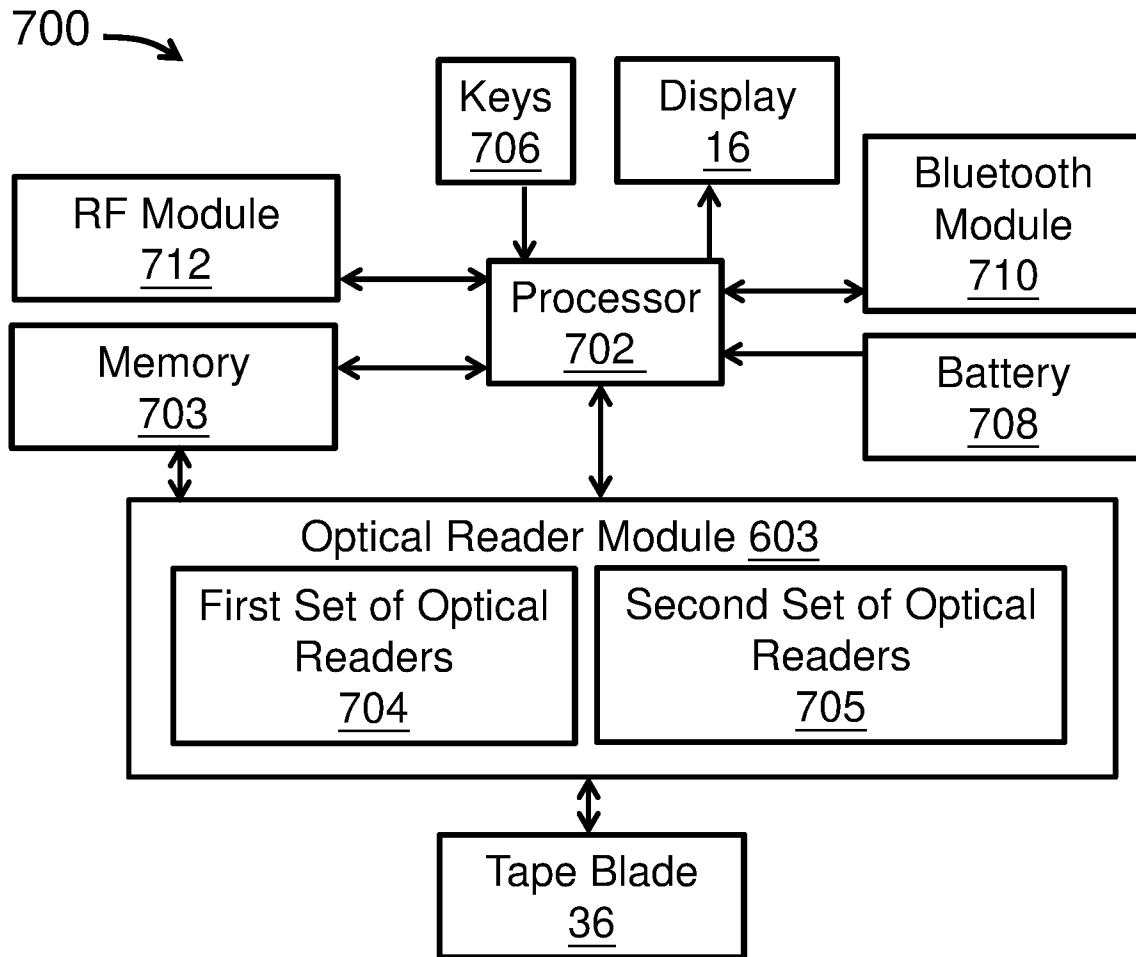


Figure 7

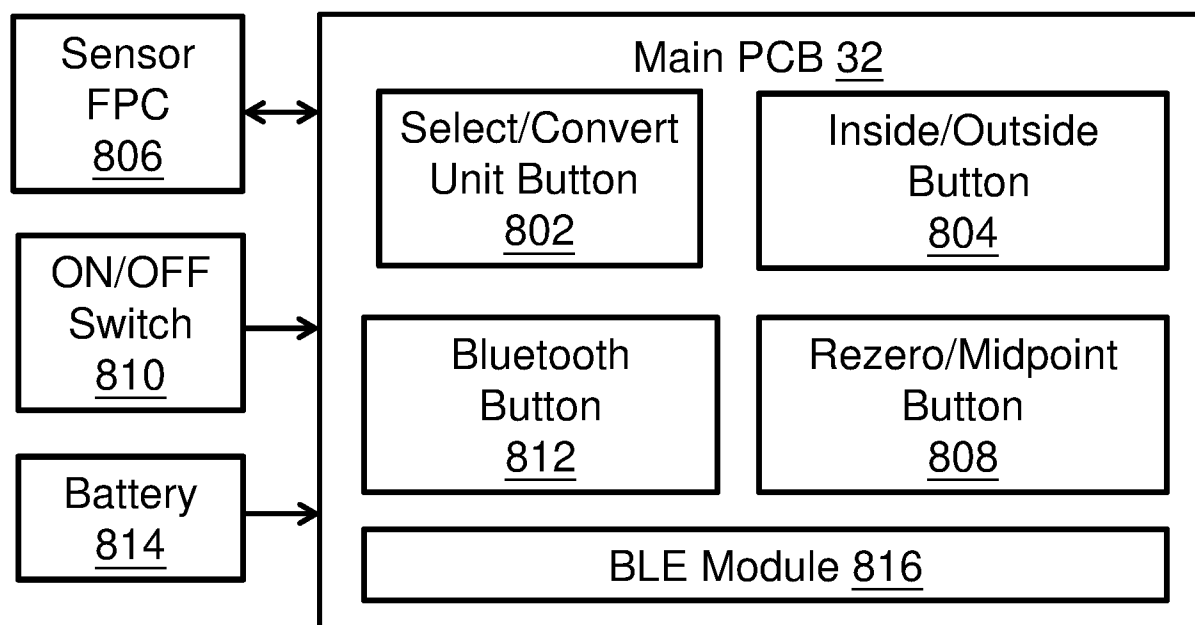


Figure 8

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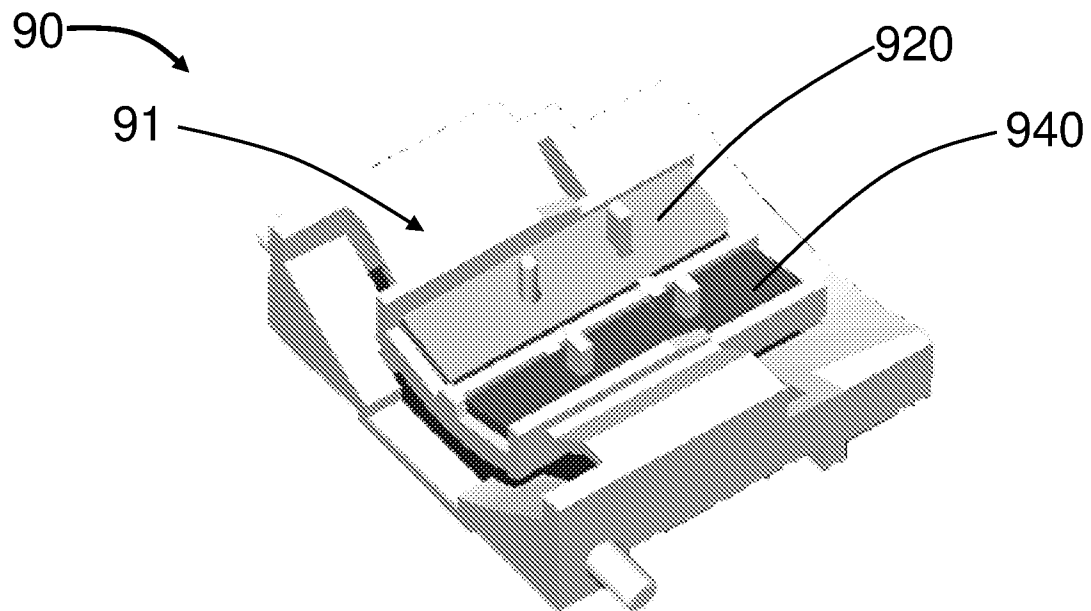


Figure 9A

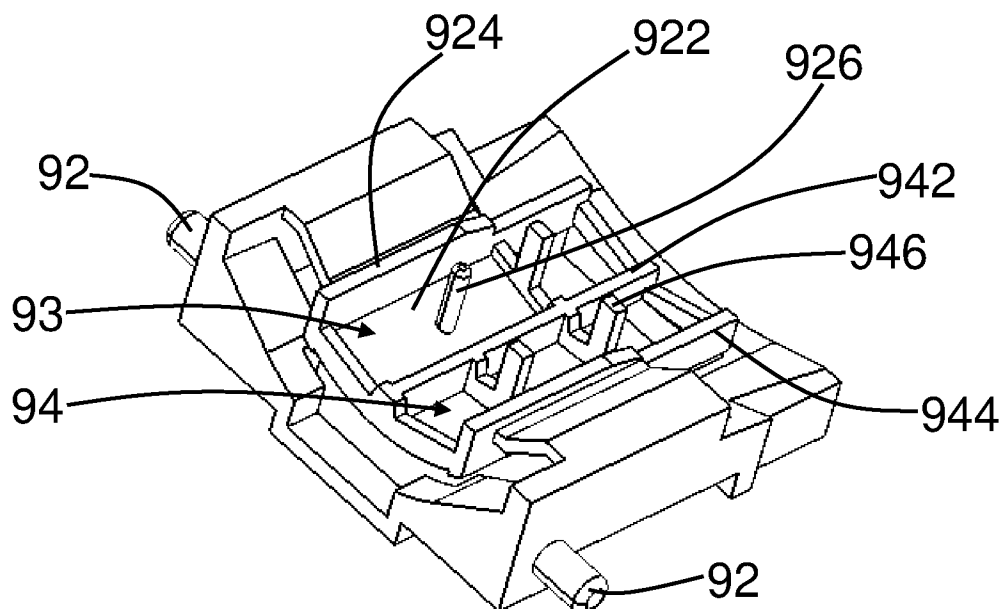


Figure 9B

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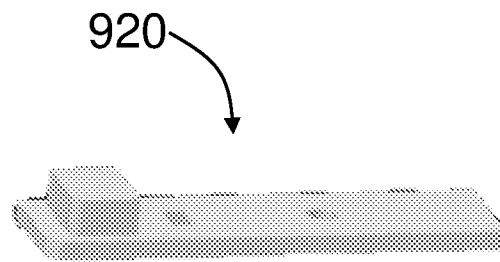


Figure 9C

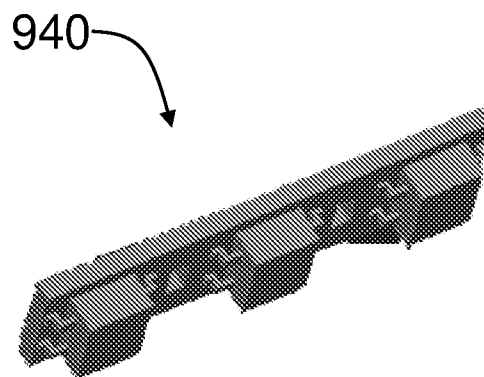


Figure 9D

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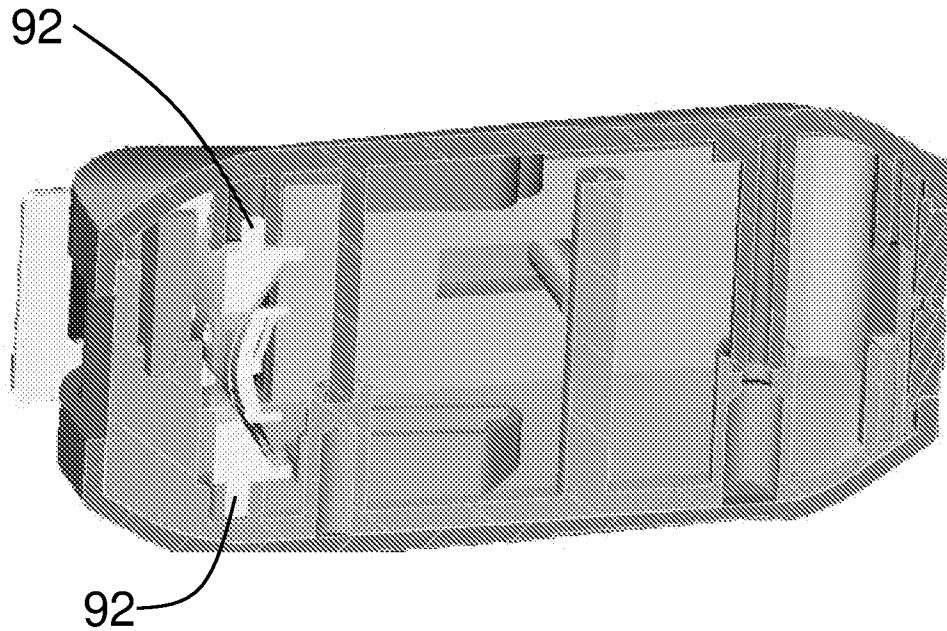


Figure 9E

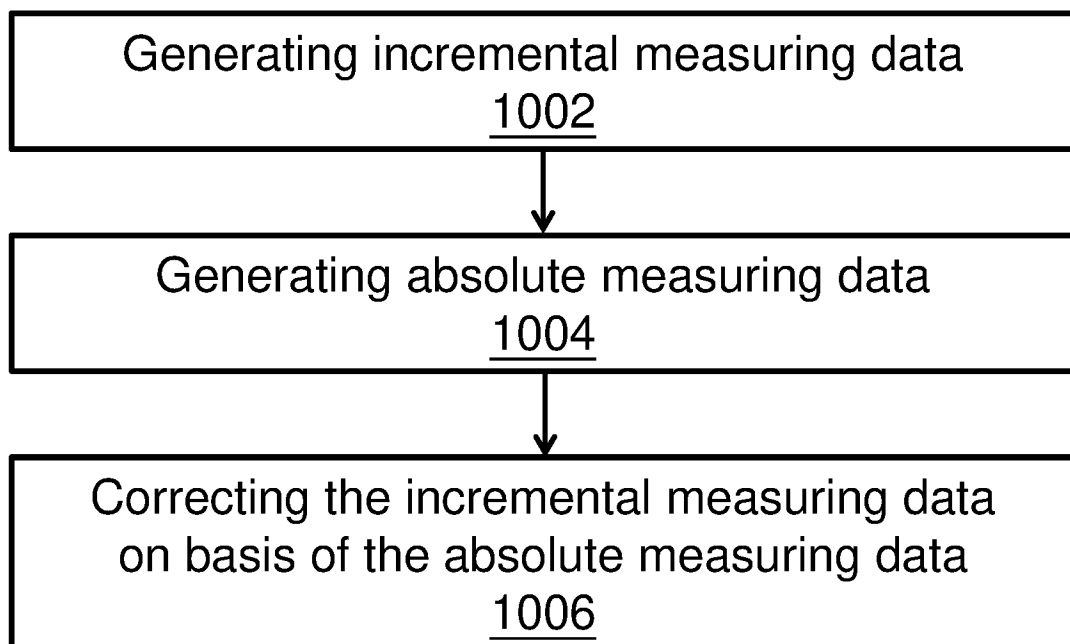


Figure 10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2018/107845

A. CLASSIFICATION OF SUBJECT MATTER

G01B 3/10(2006.01)i; G01B 7/02(2006.01)i; G01B 7/26(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)

G01B

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)

EPTXT;USTXT;VEN;WOTXT;CNABS;CNTXT;CNKI:BARCODE, correct, CODE, tape blade

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5027526 A (CRANE R STEPHEN) 02 July 1991 (1991-07-02) description, column 4 line 29 - column 8 line 6, and figures 1-9	1-15, 23-25
Y	US 5027526 A (CRANE R STEPHEN) 02 July 1991 (1991-07-02) description, column 4 line 29 - column 8 line 6, and figures 1-9	16-22
Y	US 2014250708 A1 (BAUER ANTHONY JOHN) 11 September 2014 (2014-09-11) paragraphs 0183-188 and figure 3	16-22
A	CN 201628523 U (DAI, HAIZHOU) 10 November 2010 (2010-11-10) the whole document	1-25
A	CN 205537520 U (SINOPEC CORP ET AL.) 31 August 2016 (2016-08-31) the whole document	1-25
A	JP 5288720 B2 (CHUGOKU DENRYOKU KK) 11 September 2013 (2013-09-11) the whole document	1-25
A	EP 1661515 A2 (WEIHERMUELLER & VOIGTMANN) 31 May 2006 (2006-05-31) the whole document	1-25



Further documents are listed in the continuation of Box C.



See patent family annex.

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“E” earlier application or patent but published on or after the international filing date

“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“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

“&” document member of the same patent family

Date of the actual completion of the international search

19 June 2019

Date of mailing of the international search report

03 July 2019

Name and mailing address of the ISA/CN

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Facsimile No. (86-10)62019451

Telephone No. 62085713

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2018/107845**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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A	CN 108489406 A (SHANGHAI BEIGAO MEDICAL TECHNOLOGY CO., LTD.) 04 September 2018 (2018-09-04) the whole document	1-25
A	CN 106556304 A (CHITWING TECHNOLOGY GROUP CO., LTD.) 05 April 2017 (2017-04-05) the whole document	1-25
A	CN 107305115 A (ZENG, QINGCHENG) 31 October 2017 (2017-10-31) the whole document	1-25

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2018/107845

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