(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
24 August 2017 (24.08.2017)

WIPO | PCT

(10) International Publication Number
WO 2017/141053 A1

(51) International Patent Classification:
G01B 3/00 (2006.01) *G01B 3/04* (2006.01)

(21) International Application Number:
PCT/GB2017/050425

(22) International Filing Date:
17 February 2017 (17.02.2017)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
1602821.9 17 February 2016 (17.02.2016) GB

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

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

Published:

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

(54) Title: VARIABLE SCALE RULER

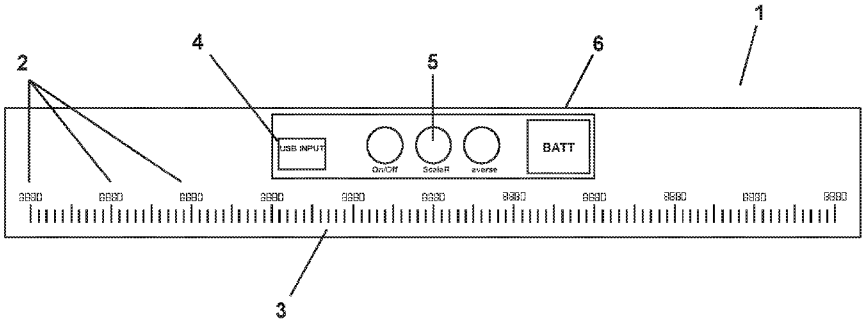


Figure 1

(57) Abstract: 1. A digital ruler with a variable display comprising: (i) a display component able to display alphanumeric characters and/or graticules digitally coupled to display drivers adapted to drive said display component, (ii) a micro controller constructed and programmable to drive the display component (i) through said drivers, to run software, to receive user input, to communicate with the user and/or externally, such as via the internet, to receive software changes, scales and graticules beyond any pre-programmes into said microcontroller (iii) a battery adapted to supply local power to the apparatus, (iv) an external power input adapted to re-charge the battery and/or provide an alternative power source to the apparatus, (v) at least one user interface coupled to the micro controller (ii), and (vi) coded software adapted to control said display driver(s), user interfaces and power management.

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DESCRIPTION

VARIABLE SCALE RULER

This invention is concerned with digital rulers. More specifically it is concerned with rulers incorporating variable digital displays such as multiple different digital scales and their corresponding graticules. In such rulers the display is adapted to show alphanumeric characters and/or scales which can be varied as required by a user.

There are many drawbacks in conventional rulers, not least their fixed scale and graticule and the consequent need for different rulers for different scales, graticules and/or countries and/or professions. So a user of rulers frequently has a need for and has to purchase, carry and switch use of multiple different scale rulers. The problem is exacerbated if working overseas or from country to country. To address this problem the inventor has devised a multiple variable scale digital ruler, which can access multiple different scales and their associated graticules and display them either from in-built software or where not stored in on-board memory by communicating over the internet wirelessly to access remotely accessible scales and corresponding graticules, which can be downloaded to the ruler, displayed and used for measurements.

It is desirable to achieve this with minimal power usage. It is also desirable to be able to achieve this within a single, self-contained and therefore unitary or integrated ruler in which external wires and other external components are absent except when there is a need to comment and communicate with an external source of scales and corresponding graicules.

According to this invention there is provided:-

A digital ruler with a variable display:

(i) a display component able to display alphanumeric characters and/or graticules digitally, coupled to display drivers adapted to drive said display component,

(ii) a micro controller constructed and programmable to drive the display component (i) through said drivers, to run software, to receive user input, to communicate with the user and/or externally, such as via the internet to receive software changes, scales and graticules beyond any pre-programmes into said microcontroller

(iii) a battery adapted to supply local power to the apparatus,

(iv) an external power input adapted to re-charge the battery and/or provide an alternative power source to the apparatus,

(v) at least one user interface coupled to the micro controller (ii), and

(vi) coded software adapted to control said display driver(s), user interface and power management.

The digital display component of the ruler can be practically any digital graphic display that is capable of displaying multiple different alphanumeric characters and graticules associated with scales of a ruler, or a segmented display such characters without a graticule. For example the graphic digital display component can be an LCD matrix screen or an e-ink paper type such screen. It is preferred to adopt e-ink paper type screens, as graphic screen or multiple such miniature screens in a segmented display.

Other preferred and optional features are to be found amongst the sub claims.

In order that the invention may be illustrated, more easily appreciated and readily carried into effect by those skilled in the art, embodiments of it will now be described purely by way of non-limiting example with reference to the accompanying drawings, wherein:

Figure 1 is a "top-down" plan view of a variable display digital ruler incorporating a variable digital scale,

Figure 2 is a cross sectional view through the mid part of the ruler display shown in Figure 1,

Figure 3 is a block diagram of the minimum electronic components required to construct a ruler depicted in figures 1 and 2,

Figure 4 is a more detailed view of essential and preferred electronic components for a digital ruler,

Figure 5 is a view of a 4 numbered digital display suitable for use as the variable scale digits associated with a pre-printed fixed graticule,

Figure 6 is a view of the ruler display in use with 3 blocks of the 4 numbered digital display,

Figure 7 is a suggested format for the displayed ruler scale,

Figure 8 is a plan view of a digital ruler embodiment incorporating a central display between the edges including graticules,

Figure 9 is a view of alternative geometric apparatus that can include the digital ruler components,

Figures 10 is a view of a T-square that can also include the digital ruler components,

Figure 11 is a plan view of a ruler with multiple transparent layers, each having an extension for LED illumination,

Figure 12 is a side elevation of the Figure 11 arrangement,

Figure 13 is an expanded sectional view of pat of the Figure 12 view, showing illumination of one of transparent layers, and

Figure 14 is an isometric view of an alternative unitary construction of digital ruler including the PCB and two user interface buttons

Referring to the drawings and initially to the variable scale ruler embodiments of Figures 1 to 7, the variable scale measurement ruler preferably includes the following features in its overall mechanical construction:-

(a) A printed millimetre graticule

(b) An electronic display of 4 digit figures providing the variable scale and integrated with the graticule

(c) Several user interface buttons to control the Ruler functions

(d) Electronics to drive the display, run the user interface, and communicate with a host PC

(e) Compartment to carry a suitable 1.5v battery to power the electronics

(f) USB client input to link to a PC and recharge battery.

The digital ruler can be manufactured by moulding the various components together into unitary construction and so robust for heavy and repeated manual use. The digital ruler can be moulded to become transparent in effect to the user where possible, to give an appearance and impression similarity to a clear plastic non-digital ruler.

As shown in the top down vertical view of Figure 1 this digital unitary construction ruler 1 comprises a moulded plastics body with variable scale digits 2, a pre-printed graticule 3, horizontal USB input 4, user interface buttons 5 and battery compartment 6.A cross sectional view through the middle of the product is similar to the illustration of Figure 2. The substrate of the illustrated ruler has an e-ink paper display 6 visible through a clear acetate plastics overmould 12, whilst the display drivers 8 are substrate – mounted and connected via a flat flexi cable 9 to a main electronics circuit board (PCB) 10. A micro controller 10a is affixed to the main board, but here covered by an opaque plastics material by way of an opaque acetate over mould 11. Embedded within an upper surface part of that opaque overmould 11 are the user input buttons 5 of the user interface, to change scale by recalling from built-in memory

and/or to access non built-in scales from an external source which can be downloaded for example from the internet.

In order to construct such a Variable Scale Electronic Ruler as has been illustrated and so far described, a set of electronic components are required. These are preferably:-

(i) An ePaper display that is either segmented or larger screen type

(ii) A microcontroller to drive the display, run the software, receive user input, communicate with the user and external devices, receive software changes and other ruler scales that are not built-in and retrievable from memory

(iii) A battery to supply local power

(iv) An external power input to re-charge the battery and/or provide an alternative power source

An example of a corresponding functional block diagram is depicted in Figure 3, where the display 6 is associated with micro controller 10a having user interface 5, power input 13, battery 14 and external interface 15.

One suitable and preferred enabling technology for the digital display of this embodiments is the ePaper (e-ink Paper) technology. This has major advantages since it only requires minimal power during the brief period that the digital display is changed. At all other times, power may be removed from the electronics, thus providing independent operation for many years. The monochrome nature of the display in such e-ink display digital ruler embodiments also provides a very high contrast ratio making the display viewable even in very dim light and in direct sunlight. The ePaper technology also provides the fine resolution needed to create a digitally created and displayed graticule supporting millimetre measurements.

An example of the required electronics in a little more detail are depicted in the generally self-explanatory block diagram of Figure 4.

The manufacturer (Digi-Key Corporation) of the ePaper display supplies standard and custom-built displays, as well as display drivers, as the technology involves creating a very high number of connections between the segments of the Scale Digits (680 lines) and the display drivers (around 300 lines per chip). It is important to note that selection of the specific micro controller to use will depend on the design of the display drivers provided with the ePaper display, the amount of volatile and flash memory the software requires and the power consumption during operation. However persons skilled in the art will be able to make a suitable selection to create a fully functioning digital ruler of the construction that has so far been illustrated and described.

Software Requirements

The coded software required can be readily customised precisely for the embodiments so far illustrated and described. For instance several functional blocks can be utilised, namely for:

1. Display Driver
2. User Interface
3. USB Client
4. Power Management

Each of these blocks is relatively simple to construct not requiring specialist knowledge beyond standard embedded processor routines, except the USB Client Software which is conveniently adapted from an off-the-shelf package to suit the selected microprocessor.

Achieving display of Variable Graduated Scales

This section of the specification describes the requirements for a preferred graphic display which displays both the required graticule and one or more numerical scales and has the ability to change the numbers and/or graticules to assist in the interpretation of drawings which have differing scales.

The specific display in this embodiment of digital ruler consists of a combination of graticule marks and numerical digits and/or graticules arranged to provide the user with a mechanism for physical distance measurement say of up to 300mm. In order to provide the user with the ability to view a variety of illustrations of different scales, the numbers are variable to suit the scale of the objects being measured. The electronic system adopted includes an electronic display, a microprocessor based controller, a power supply and wireless interface to allow remote control, software updates and re-configuration to occur.

The display itself consists of an array of 30 numbers arranged in a straight line 31cm long. Each number consists of a set of 4 digits, and each set may be placed 10mm apart along the 30cm length of the display. Each set of 4 digits can take the form shown in Figure 5.

In other words, each set contains three number characters and one which is always zero. It is preferable that the length of this set of 4 characters is no more than 6mm wide. The height of each character is dependent on the font chosen as shown in figure 6. Here, the top edge of the display is referenced 16, the bottom edge of the display is 17. There is an approximate width 18 of the character set that is about 6mm, whilst the approximate spacing 19 between character sets is about 10mm.

The height 20 of the display will be determined by the requirements of the size of the digits and character routing, but is not expected as shown in Figure 7 to be greater than about 10mm. There is an additional requirement for a scale designator (now shown) at both ends of the display which will show 2 alphanumeric characters. The overall format of such a preferred display is shown in Figure 7, with a length 21 of about 310mm, the top and sides of the display edges should be as narrow as possible, whilst the drivers should be placed along the bottom edge 22, providing access for the electronics along that edge.

Figure 8 shows an arrangement of ruler with digitally variable graticule 27 wherein the central panel 23 is itself in the form of a variable display.

The design of the display will be facilitated by the driver chips required for the number of characters supported. The resolution of the display technology is preferably about 0.1mm with information 24 such as scale 1:50 selected amongst possible scales, with a user interface button 25 protruding through that central display for a user to press select the scale or to select a different scale, and mode of operation displayed in a section 26 of the central display panel 23.

The overall length, width and thickness of the display will however be driven more by the display technology used.

Each number digit is 6mm in width and designed based on the resolution available from the technology and on the font required for best readability.

The alphanumeric characters are around 2mm in height, also dependent on the resolution available and the most suitable font for the display.

The electronics to drive the display includes a microprocessor based controller with software programming and user interface buttons for changing the graticule scale in use, and provides several external interfaces such as USB, Wi-Fi and Bluetooth for remote updates, additional scale downloads and other user control. Power will be provided by rechargeable battery.

The digital graphic screen ruler thereby allows users to adjust to a different scale and/or graticule as and when they require. Several scales are known which adopt the same graticule so it is possible to download other scales sharing the same graticule.

The ruler can be programmed to or otherwise be capable of downloading all different ruler scales and corresponding gratiucles. For example if a planner needed to use scale 1:50 in his or her plan they just need to adjust and select the scale graticule and units needed on the (shift) keyboard and it will appear on the digital graphic display, whilst retaining the ability to change to any other scales needed without the need to upon or use other fixed scaled manual

rulers. With simple touch operation, digital rulers according to the invention can be programmed to all known and used scales and graticules in modern life.

These digital ruler embodiments can therefore work in two different modes. There is a manual select mode, by simple push button selection of a scale/graticule already pre-set within the ruler's inbuilt software. In a secondary usage manner, which is fully digital, the user can again by simple push button download different scales/graticules that are not embedded or pre-set within the ruler memory. This facility enables users to download to the ruler via the internet any required different scale and/or graphic that is not embedded or pre-set into the ruler's memory.

The present ruler embodiments may or may not include a high definition digital touch or graphic screen. They can be made in different shapes and sizes as depicted in Figures 9 and 10, and all versions can operate in at least two different modes. Some embodiments of the present ruler incorporate a larger scanner (now shown). Other embodiments may incorporate an elastic strap at either or both ends, to which a writing implement may be releasably attached.

In one mode, the digital ruler can work by itself to display the selected scale and graticle without using the battery, but in another mode it can work by connecting wirelessly to the internet, or to any other suitable digital device such as a PC, smartphone, laptop and the like using any of the internet Wi-Fi communication protocols such as Bluetooth, Hotspot, Cloud. Once so connected with an external digital device, the user is able to download, save, select, change, edit, send, receive, scan, create any scale, graticule and data, images and the like without the need to change over to a manual ruler having a different fixed scale.

Any user of the digital ruler embodiments is able to download any required scale and/or graticule they may need from around the world. So a user such as a planner or architect or other technician could whilst working in USA say, download (to the one digital ruler) an American scale and use that in his work, whilst if in UK with the same one digital ruler he could download any required UK scale and/or graticule and use that, whilst if in Japan he could download to the one and same ruler device a Japanese scale and/or graticule. To this extent the present digital ruler can be regarded as a "universal" ruler that can dispense with the need for multiple different rulers each having their fixed scale or scales, since it can store or download any known scale in any language.

A basic and therefore more economic digital ruler can be constructed with a fixed millimetre gratricule and a segmented e-ink display that allows the numerical scale to be varied. This provides for up to 6 scales to be displayed which match with the millimetre graticule simply enumerated by the display. In other segmented display (as distinct from graphic display)

embodiments, to increase the number of scales, layers of transparent acrylic are added that are inscribed with additional graticules cut into the acrylic. These graticules are embedded into the digital ruler in a “latent” manner in that they remain unseen until illuminated on the edge of the layer by an LED light. This LED, once lit, will shine through the layer of acrylic and catch the graticule cut into that particular layer and reflect the LED light up to the user. By using different colours of LEDs for different layers of acrylic, the number of additional layers and therefore graticules available within segmented display versions would only be limited by the transparency of the acrylic layers. In one practical embodiment of such a modest economic segmented e-ink display digital ruler, three such different graticules are embedded by cutting into respective layers of acrylic and 3 LED lights of different colour are provided to illuminate them.

Embodiments are contemplated that provided a manual or fixed graticule and scale in addition to the variable digital display, for use in the event of failure of the digital such scale. For example three additional such scales may be provided and the ruler rotated to use them.

The illuminated graticules can be incorporated within the digital ruler embodiment by adjusting transparent layers above the display to include graticules which are lit on the edge of LED lights. A general overview of such an arrangement is shown in Figure 11. In that drawing, the transparent layer 28 is external at each end 29 to reach an LED placed on the PCB. Each graticule 30 is made by cutting into the under surface of the transparent layer, so the graticule is present but remains transparent.

In cross section, shown in Figure 12 several transparent layers can be stacked on top of each other so that a number of scales/graticules can be illuminated and so become visible to a user at different times. Reference 31 shows three different transparent layers in stacked array, reference 32 shows the scale display, references 33, 34 and show 3 separately illuminated LED lamps, each of a different colour, mounted on the PCB 36 the effect being illumination of the respective graticule/scale in use at any given time in a different colour.

As shown in Figure 13 by shaping the layer so that a roughly 45^{o} angle is maintained above each LED lamp, so the light from the LED is reflected into each layer. This light is not however visible to the user of the digital ruler until the light encounters an obstruction in the layer, which in this case is the graticule that has been embedded into the layer by cutting or etching. Reference 32 is the digital display, reference 37 is a graticule cut or etched into a transparent layer, reference 35 is one of the LED lamps shining vertically, and reference 38 shows that light reflecting internally within the respective layer so as to illuminate its corresponding graticule.

Figure 14 shows an enlarged isometric view of a digital ruler in unitary construction of which the main body 39 is provided with an embedded, recessed PCB 36, drivers 40 for the display 32, communicating with PCB, microprocessor 41 and user interface buttons 5 and 5a for varying the scale 42 selected and displayed on the digitally variable screen adapted to display alphanumeric characters 43 and if a non-segmented graphic screen is used, the selected graticule (not shown).

Communication between the digital ruler device with any other digital device, for the purpose of e.g., downloading different scales or for obtaining any other scale that is not pre-programmed into the memory of the device can be effected wirelessly via any suitable network communication protocol. In downloading any scale for internal memory of the ruler, such scale(s) can be saved and recalled for display as required by the user.

In yet further embodiments of the ruler which are not illustrated, the ruler can be modified so as also to include the functionality of a smart phone or tablet computer. For instance in the Figure 14 embodiment, the PCB and electronic components can be covered by a separate display screen, which has the conventional functionality of known smart phones and/or tablet computers.

CLAIMS

1. A digital ruler with a variable display comprising:
   (i) a display component able to display alphanumeric characters and/or graticules digitally coupled to display drivers adapted to drive said display component,
   (ii) a micro controller constructed and programmable to drive the display component (i) through said drivers, to run software, to receive user input, to communicate with the user and/or externally, such as via the internet, to receive software changes, scales and graticules beyond any pre-programmes into said microcontroller
   (iii) a battery adapted to supply local power to the apparatus,
   (iv) an external power input adapted to re-charge the battery and/or provide an alternative power source to the apparatus,
   (v) at least one user interface coupled to the micro controller (ii), and

   (vi) coded software adapted to control said display driver(s), user interfaces and power management.

2. A digital ruler as claimed in Claim 1 wherein the micro controller (ii) is also coupled to:
   (vii) power management means which in turn is coupled to the battery (iii) and the external power input (iv),
   (viii) a user interface which comprises user control buttons,
   (ix) random access memory,
   (x) flash memory, and
   (xi) a low power oscillator.

3. A digital ruler as claimed in either preceding claim, wherein the coded software for controlling the display drivers, user interface and power management operates on a conventional embedded process or routine.

4. A digital ruler as claimed in any preceding claim in which a physical client port is present as a user interface, coupled to the microcontroller, together with client port software adapted to suit the selected microprocessor.

5. A digital ruler as claimed in any preceding claim wherein the display component is capable of displaying a selection of multiple variable scales and/or graticules accessible from software that is a component part of the ruler or accessible externally from, for example, the internet, and preferably wirelessly via any suitable network communication protocol.

6. A digital ruler as claimed in Claim 5, which includes one or more of the following:

   (a) a printed graticule scale,
   (b) an electronic display of four figures providing for the variable scale and integrated with said graticule,
   (c) multiple user interface buttons adapted and programmed to control the functions of the ruler,
   (d) electronics adapted to drive the display, run the user interface and communicate externally with a host computer such as a PC,
   (e) a compartment able to house a suitable battery to power the electronics, a client input interface such as a USB client input port to link the ruler to such a host computer and re-charge the battery.

7. A digital ruler as claimed in Claim 5 or Claim 6, wherein the physical construction is of unitary apparatus wherein the components thereof are moulded together of such materials and in such manner as to present at least one transparent scale to a user.

8. A digital ruler as claimed in Claim 7, of which at least part is constructed in transparent plastics overmould, and at least part in opaque plastics overmould.

9. A digital ruler as claimed in any preceding claim wherein the display component (i) is one or more graphic or segmented LCD or e-ink paper screens.

10. A digital ruler as claimed in claim 9, in which the screen (i) is graphic with the capacity to display and vary both alphanumeric characters and graticule displayed.

11. A digital ruler as claimed in claim 9, in which the screen (i) is segmented in that it comprises a sequential array of individual screens making up the overall screen, and the ruler further comprises at least one fixed graticule that is pre-printed, pre-cut, pre-embedded or inscribed into a layer of the ruler.

12. A ruler as claimed in claim 11, wherein the said graticule is transparent and not visible to a user unless illuminated.

13. A ruler as claimed in claim 12 which is provided with one or more illuminating devices, such as lamps, for example LED lamps arranged to illuminate the graticule selected for the scale required by a user.

14. A ruler as claimed in any one of claims 11 to 13 comprising a stacked array of multiple transparent layers, in which each layer is provided with such a graticule.

15. A ruler as claimed in claim 14, provided with multiple illuminating devices corresponding to the number of transparent layers with graticules, and arranged to illuminate only the required graticule for the scale selected by a user.

16. A digital ruler as claimed in any preceding claim which further incorporates a generally centrally located additional screen for displaying information such as scale selected and/or scales available.

17. A digital ruler as claimed in any preceding claim in the shape of a geometric aid such as a protractor, T-bar, triangular drawing aid or set-square.

18. A digital ruler as claimed in any preceding claim, that further incorporates the functionality of a smart phone or tablet computer.

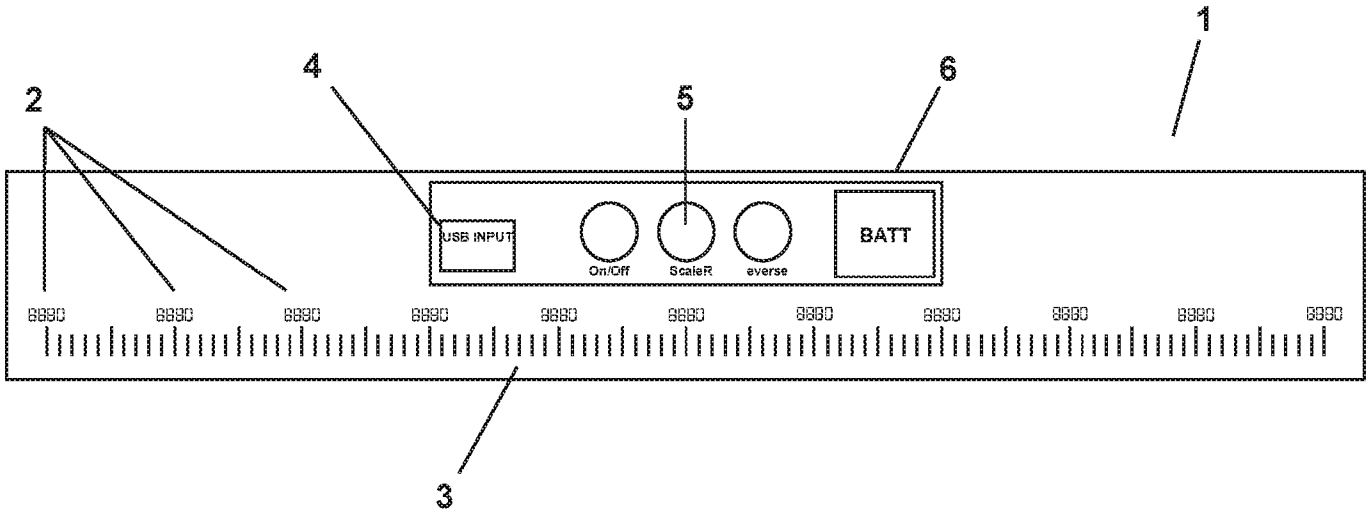


Figure 1

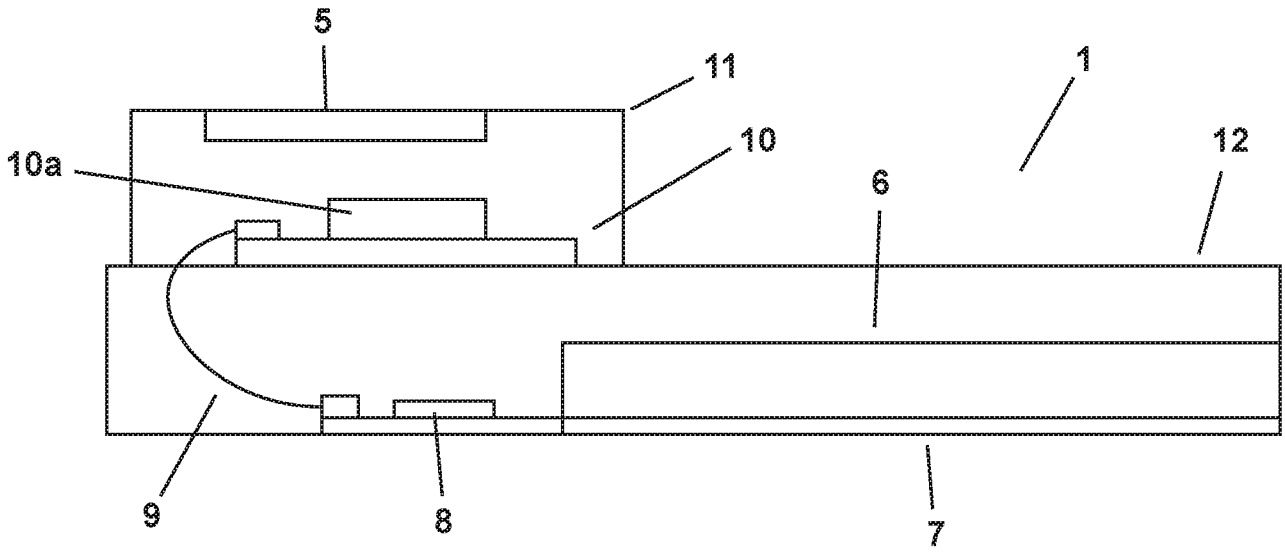


Figure 2

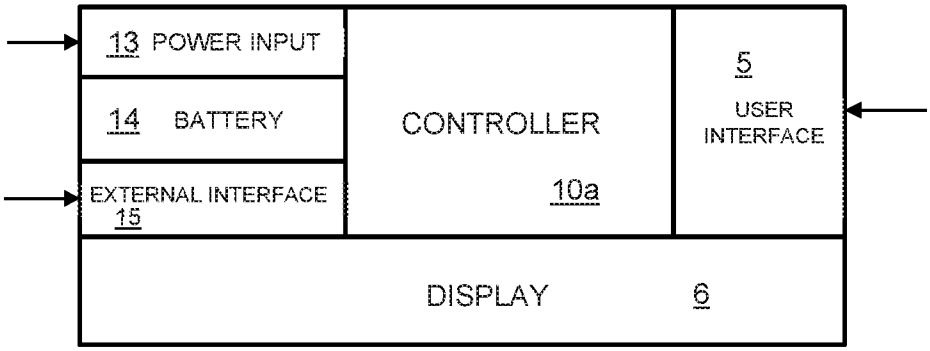


Figure 3

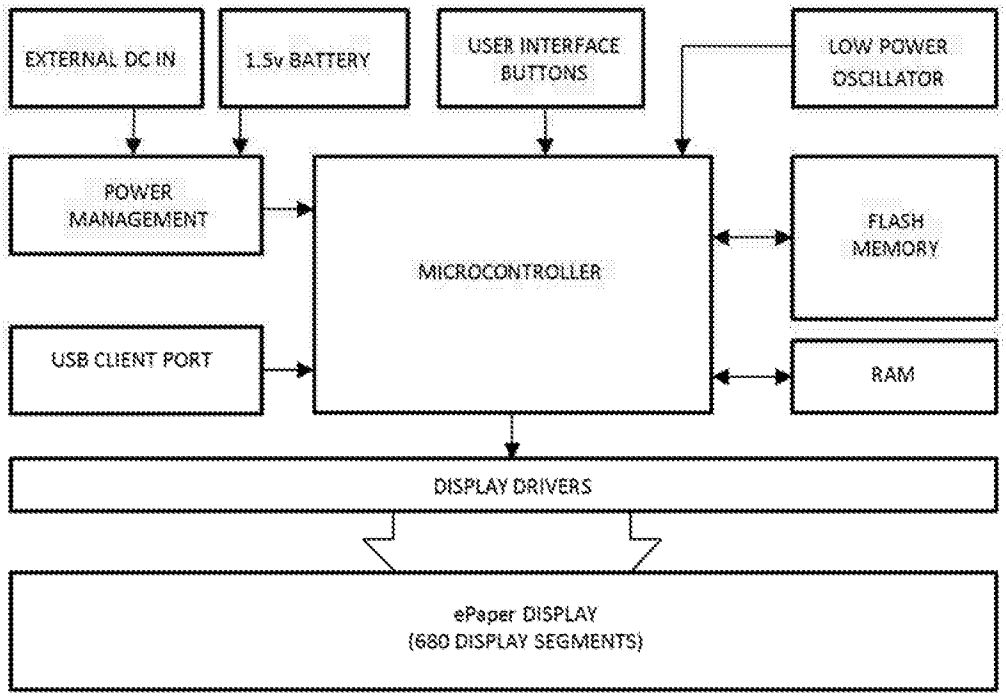


Figure 4



Figure 5

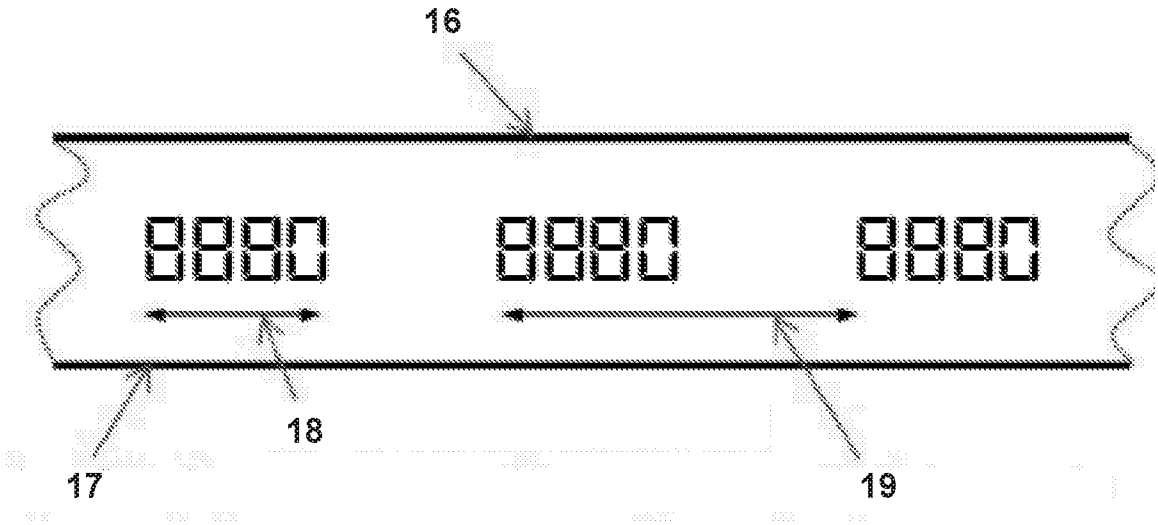


Figure 6

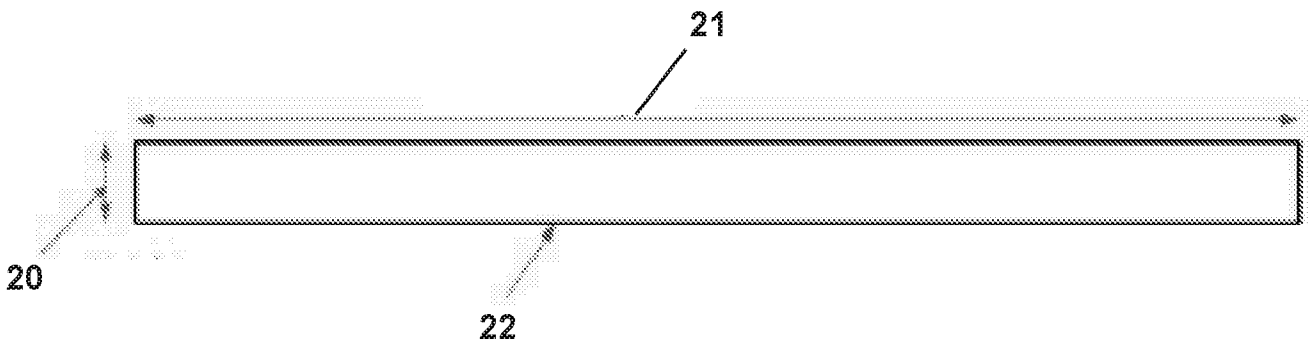


Figure 7

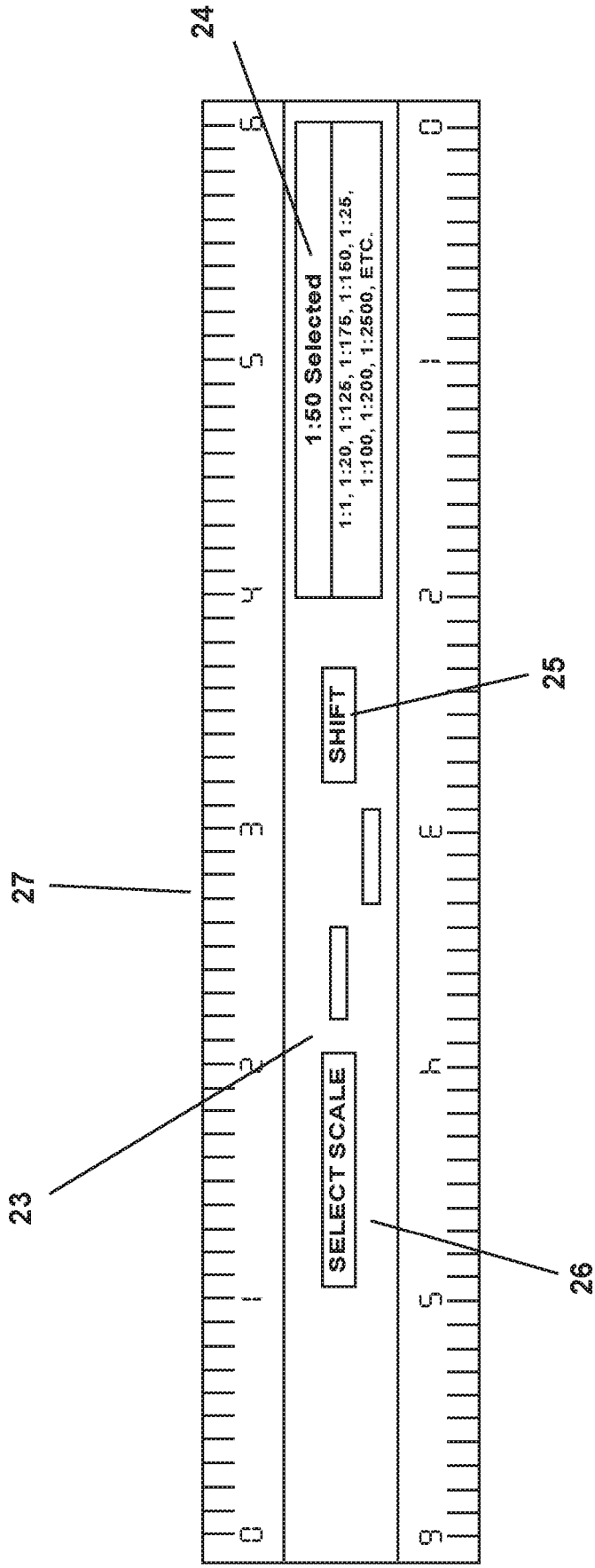

24
1:50 Selected
1:1, 1:20, 1:125, 1:175, 1:160, 1:25,
1:100, 1:200, 1:2500, ETC.
SHIFT
25
27
23
SELECT SCALE
26

Figure 8

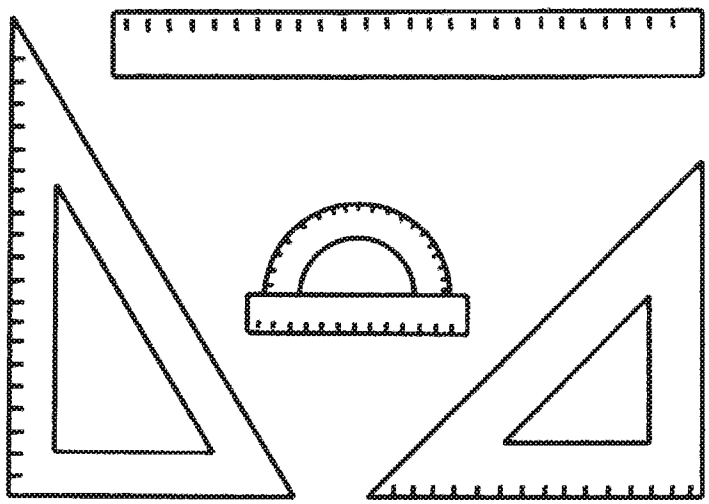


Figure 9

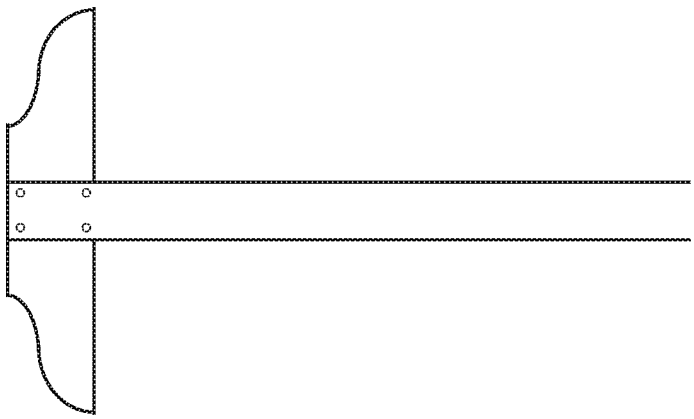


Figure 10

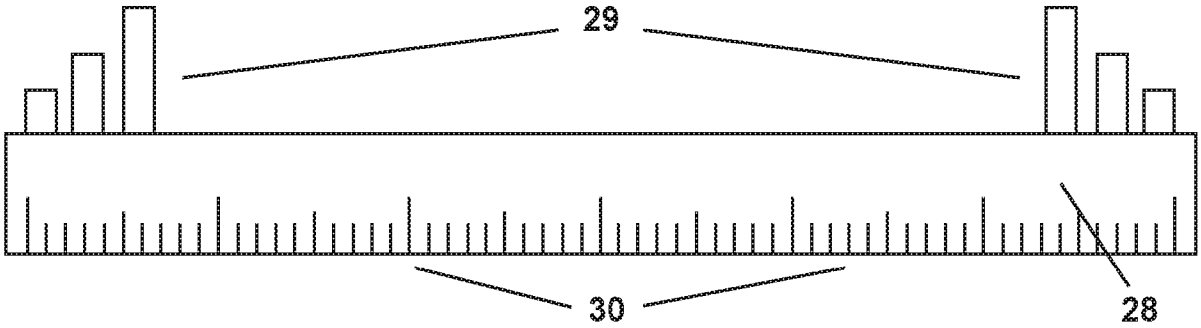


Figure 11

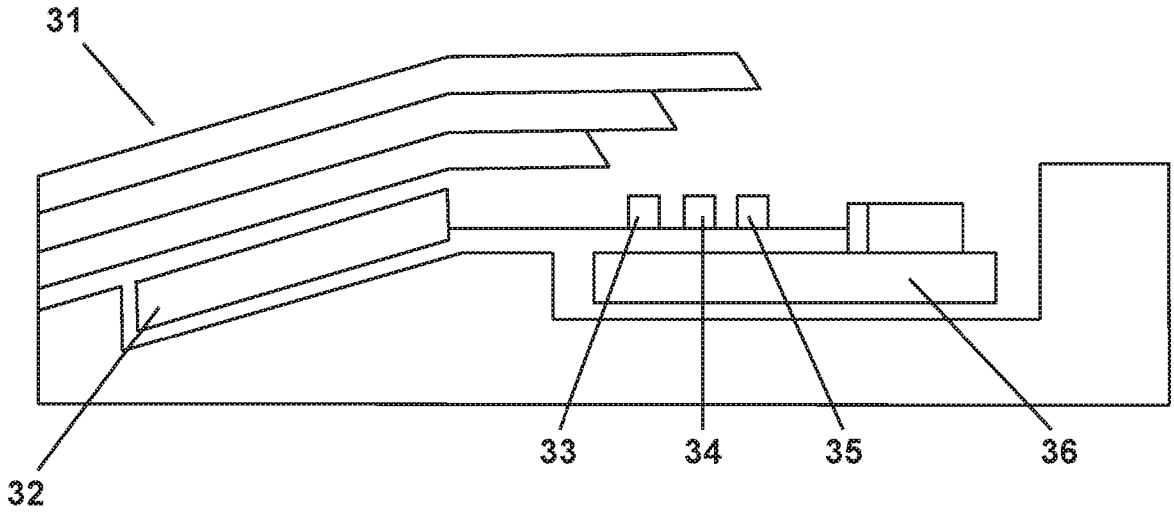


Figure 12

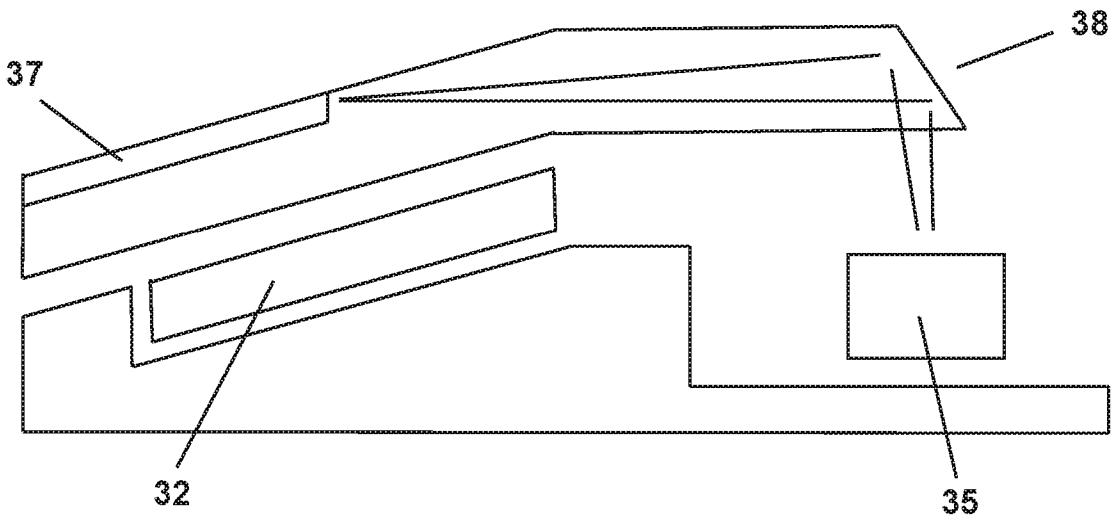


Figure 13

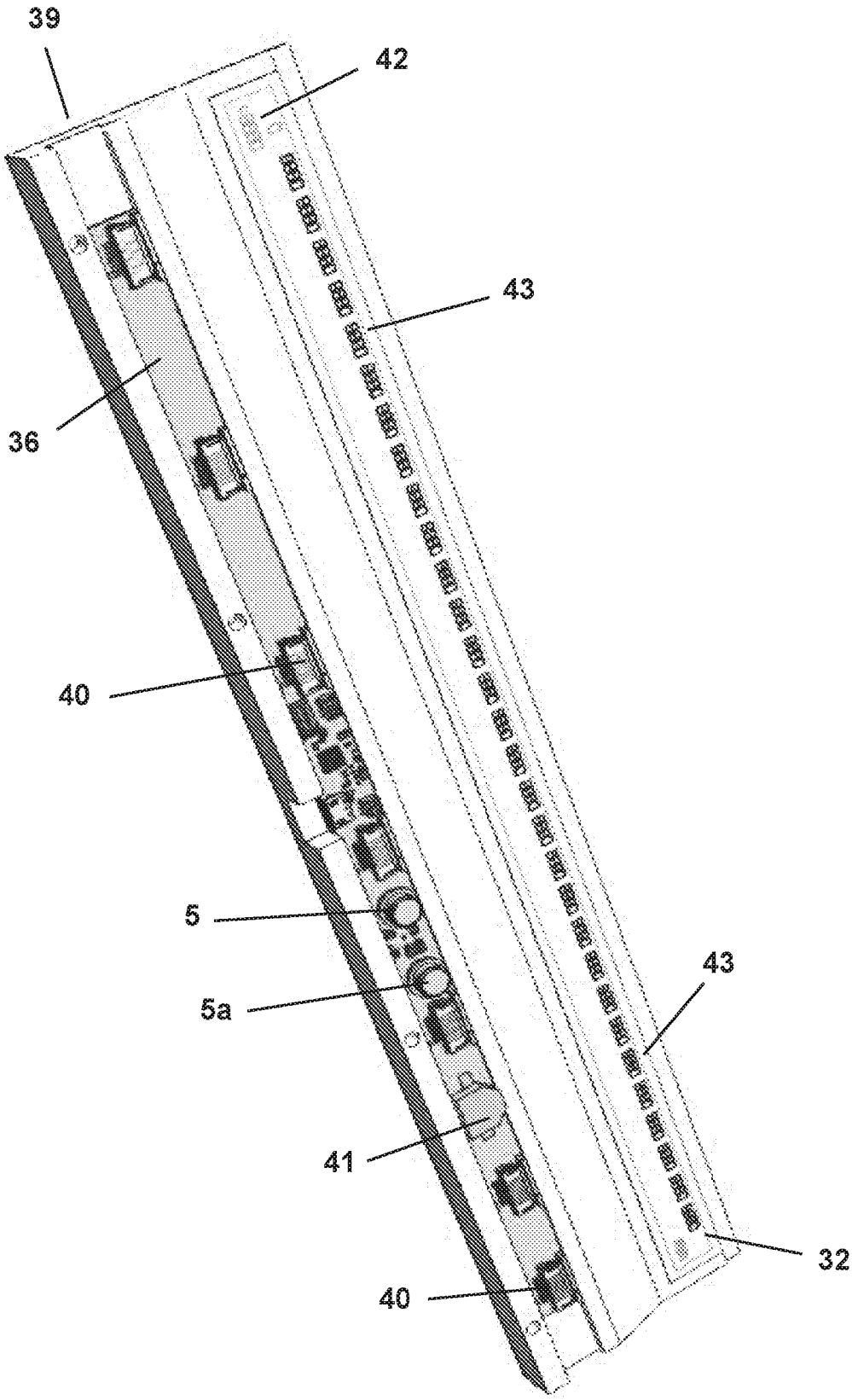


Figure 14

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2017/050425

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01B3/00 G01B3/04
ADD.

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Tyler Tschida: "Co-Creator Of Classics Releases Digital Ruler App For iPhone And iPad", , 4 June 2010 (2010-06-04), XP002770355, Retrieved from the Internet: URL:https://appadvice.com/appnn/2010/06/co creator-classics-releases-digital-ruler-ap p-iphone-ipad [retrieved on 2017-05-19] the whole document -----	1-18
X	EP 0 342 907 A2 (MCCANNON DOMINIC VIGNE) 23 November 1989 (1989-11-23) abstract; figures 3,5-7 column 5, line 52 - column 6, line 10 column 6, line 35 - column 8, line 19 -----	1-18

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

☒ See patent family annex.

* Special categories of cited documents :

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"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	Date of mailing of the international search report
19 May 2017	06/06/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Passier, Martinus

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2017/050425

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0342907 A2	23-11-1989	EP 0342907 A2	23-11-1989
		JP H0277601 A	16-03-1990
		US 5050312 A	24-09-1991