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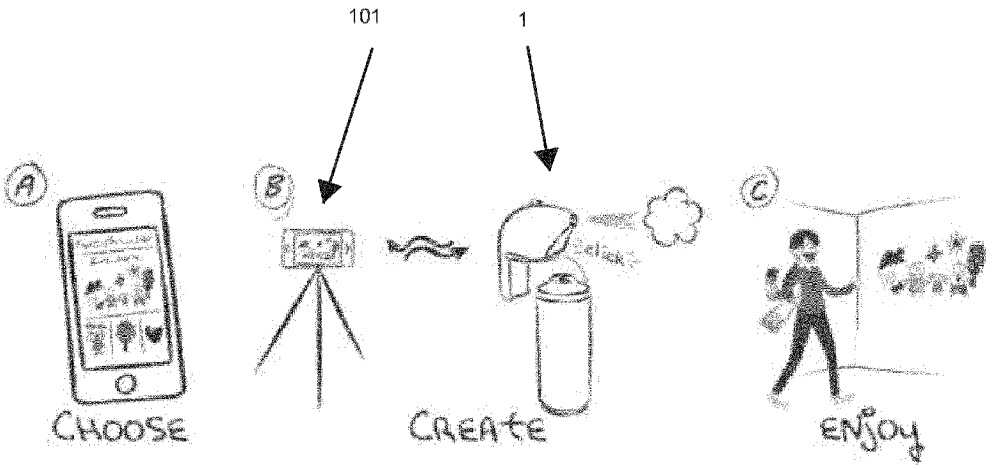

FIG 1

(57) Abstract: The present invention provides a wireless printing device attached to a pressurized paint container used to cover surfaces with a painted picture, photographs, patterns, logos, etc. Further the present invention relates to a method for controlling the wireless spray printing device where said method comprises a use of sensors for controlling and identification orientation or determining the position of a wireless spray printing device in the space or room by using positioning system (for example indoor positioning system) and transmission image files and commands to the printer for controlling the printing process.

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A wireless spray-printing device for surface painting or decoration

Reference is made to US provisional patent applications Nos US 62/331,299 filed on 05/03/2016 and US 62/471,973 filed on 06/16/2017.

Technical field

The present invention relates to a field of printing techniques, in particular, in the field of printers for a pressurized paint container or can used to cover surfaces with a painted picture, photographs, patterns, logos, etc., where for printing are used pressurized paint in an pressurized paint can. Said pressurized paint can is attached to a wireless spray printing device comprising a printer housing integrated with a spray printing device printer head. The present invention relates in addition to a method for controlling the wireless spray printing device where said method comprises a use of sensors for controlling and identification orientation or determining the position of a wireless spray printing device in the space or room by using positioning system (for example indoor positioning system) and transmission image files and commands to the printer for controlling the printing process.

It should be noted that spray printing means in the present invention not only spraying the paint through the air onto a surface to form a colour pixel where are used nozzles for full cone, hollow cone and flat stream but also spraying paint dropwise to the surface, i.e. one paint drop is one pixel.

Technical background

From the art is known spray painters who may cover large surfaces with the spray paint from spray can. All paintings are done by hand and therefore creating the wall paintings depends from the skills of the artist. For large scale painting the orientation of the spray can is challenging and the artist must have very good focus to the concept of the picture.

From the document EP12160353.4, Hexagon Technology Center GmbH, 25.09.2013 is known a graphical application system with a surface spattering system comprising a nozzle means, a nozzle control mechanism and a spattering material supply further comprises a spatial referencing unit to reference the device in space relative to the target surface, a computation means for controlling the expelling by the nozzle control

mechanism according to predefined spattering data, a communication means for establishing a communication link from the reference unit to the computation means. In prescribed solution the spatial referencing unit is located remote from the spattering device and comprises a 3D imaging unit with at least two optical 2D cameras arranged with a stereobasis inbetween the cameras. The 3D imaging unit determines the position and orientation of the spattering device by digital image processing of images taken by the cameras where in addition the spattering device comprises a set of visual features which is built in such a way, that the position and orientation of the spattering device is determined by the spatial referencing unit. The 3D unit comprises an identification means for identifying the visual features of the set of visual features in the image, a measuring means for determining picture coordinates of the visual features and a 3D modelling means for determining position and orientation according to picture coordinates and geometrical constraints given by stereobasis. The aim of the above described surface spattering system is to have painting system which enables paint 3D object with different colour in same time or to repair paint in already painted areas, therefore said solution uses at least two cameras and a set virtual features. However, it does not provide a simple printing device for pressurized paint reservoir or can which can be operated by non-professional user who wants for example just decorate his/her apartment wall with picture.

Disclosure of the invention

The overall objective of the wireless spray printing device hereinafter spray printing device is to improve and commercialize a new do-it-yourself wall art solution which enables to transfer or paint pictures and designs directly from a computer or smartphone to any surface. For this, the applicant of present application has developed a wireless spray printing device for pressurized paint container or pressurized paint can where said spray printing device communicates in preferred embodiments with smartphone's sensors (camera) through an app that controls the painting process. However invention is not limited to be implemented as an app on a smartphone. The pressurized paint container hereinafter pressurized paint can means in the present invention an aerosol spray paint can where a can or container contains a paint and propellant under pressure whereas the paint and propellant are mixed and some of the propellant, active ingredients and solvents are dissolved/mixed in the paint. The mixture of the paint and propellant is released when valve button is depressed.

In addition it means a pressurized paint can where can or container is filled with liquid propellant which does not dissolve in the paint (or paint does not dissolve in propellant), i.e. propellant is not dissolved in paint, but pressure of the propellant drops when container is emptied. During the use of pressurized paint can the propellant pushes the paint out through the valve when it is depressed.

It means further the pressurised paint cans where inside the can is bag (so-called bag on valve system) which is filled during the product (can) filling with paint whereas the can itself is filled with propellant so that the paint and propellant are not exposed (see for example document US 4,117,951, 3.10.1978, Cebal). In said can the liquefied propellant can be used which keeps pressure in container constant during emptying of the container.

To the spray printing device itself is attached to a pressurized paint can in order to complete the desired wall design using spray paint. With said spray printing device, the whole process of planning and completing a personalized wall design can thus be done by everyone without any additional cameras or location markers (the virtual features).

As such, the spray printing device converts digital designs such as photos, pictures, ornaments etc. into surface design such a wall design where photos, pictures, ornaments etc. are transmitter wirelessly from the camera to spray printing device and all the user needs to do is to download the app, choose the suitable image from a large gallery made up of custom art and images for example by an international community of artists and designers, attach a spray paint can to the spray printing device and print the picture on the desired surface such as wall, ceiling, canvas etc. Basically with said developed spray printing device any surface can be painted, even in a large scale the pictures can be painted to the exterior wall of the buildings.

As a tool that any home decorator or interior designer can easily use without intermediaries, the spray printing device according to present invention has remarkable potential in the decorative arts market. The main competitive solutions are either very expensive (custom wall paintings), not easy to use (stencils) or cannot be customized (stickers, posters), whereas the spray printing device will offer superior functionality, personalization, ease-of-use and competitive pricing. What is more, the current Do-It-Yourself trends and the emerging maker culture will further support the fast market uptake of the printer device.

The above described device is described by applicant of present invention in the US provisional patent application No. 62/331,299 filed on 05/03/2016 and incorporated herewith by reference and in the US provisional patent application No. US 62/471,973 filed on 06/16/2017 and incorporated herewith by reference.

In the first embodiment the spray printing device comprises a one fixed nozzle where one paint pixel is printed from paint nozzle at once so that the all picture or decoration will be completed in line by line moving the spray printing device horizontally or vertically in the front of painted or decorated surface. In further embodiment of the present invention for painting or decorating bigger surfaces (like the walls of houses or buildings) the nozzle of the spray printing device is movable or rotating around its mounting axis. This will solve the problem how to paint a wider area with spray printing device with one move or with one movement for example from left to right or from right to left, and how to print a number of paint pixels (paint dots) in one row (in vertical row, from down to up, in one column etc.).

According the first embodiments of the present invention spray printer device for surface painting comprises a housing having a gripping means for attaching and fixing the pressurized paint can into housing and a spray activation device attached to the upper portion of the housing for releasing the spray paint from the spray can and directing pressurized paint into a spray printing device printing head comprising a printing valve, a spray channel attached to the printing valve and followed by a spray nozzle for forming a printed pixel to the painted surface. The printing process is controlled by electronics comprising radio transceiver for receiving and transmitting signals from camera module to printing module and from printing module to camera module. Into the housing is integrated a power supply compartment (a battery compartment), on/off and control switches. In addition into the housing is provided with rollers or wheels so that the spray printing device can be moved in the front of surface (or in the surface) within the predetermined distance to help user and to guarantee that the paint pixel sprayed from printing nozzle has a controlled size. This will help to paint the image more evenly.

According to the second embodiment of the present invention there is provided a technical solution of the spray printing device printing head and paint nozzle where said paint spray nozzle is turned by rotary positioner assembly up and down or down and up in the range of up to 90 degrees, i.e. the turning angle of the paint nozzle around

its mounting axis is up to 90 degrees, preferably in the range of 60 to 90 degrees. Thus the paint nozzle is moved in vertical position down and up or vice versa.

In general the spray printing solution is made up of two basic modules: a spray-printing device and a camera module. The spray paint can or pressurised paint can is attached to the spray-printing device. The user moves spray printing device manually or mechanically in front of the painted surface or wall in order to spray paint onto said surface. The camera module which can be for example a smartphone, is tracking the position of the spray-printing device in an x-y plane on the surface to be painted.

The paint nozzle is formed in the one end of a rotating nozzle shaft which is rotatable fixed via bearings to printing head, and a rotary positioner assembly is placed to the other end of the rotating nozzle shaft for rotating the shaft with paint nozzle to print approximately up to 100 paint pixels in one vertical row correspondingly to the picture pixels to be printed in the surface.

When the camera module and the spray-printing device is switched on the picture data from camera module is sent to printing module. Then the tracking led on the spray-printing device will be switched on by user when the trigger lever is pressed. In the same time the spray-printing device sends the time stamp package to the camera module. The time stamp is received by camera module and the camera module detects the first frame with the illuminated tracking led and send time stamp of said frame back to the printing module. The printing module calculates based on these two time stamps the time delay in the system. The results of calculations are used by the system to compensate the tracking delay. The camera module continuously detects coordinates of the tracking LED and send the coordinate data to the printing module. The printing module compensates the delay and uses the calculated coordinates to decide the opening the printing valve. The closing time of the printing valve is constant and predetermined before the printing by user.

The mobile application in the camera module tracks the position of the spray-printing device and sends the information back to the spray-printing device where the data is processed and according the location of the spray-printing device the printer to produce a coloured area on the surface (herein referred to as a pixel). The camera module transmits data about 1-500 pixels that are in vertical line from tracking position.

In alternative embodiment the camera module finds tracking sensor and sends sensor position on image, based on position data from camera module and sensor data from

the inertial measurement unit (IMU) the control unit calculates current estimated position of the spray printing device and decides if the current pixels needs to be printed or not. The inertial measurement unit is used as described in document Francois Caron, et al "GPS/IMU data fusion using multisensory Kalman filtering: introducing of contextual aspects" Volume 7, Issue 2, June 2006, pages 221-230. If yes then open valve command is sent from camera module to the printing module, if not nothing is sent. For transmitting data between the camera module and the spray-printing device is used Bluetooth connection in the camera module and spray-printing device. Alternatively an external radio transmitter is used which is connected to the camera module's USB port (micro USB, mini USB etc.). The separate radio transmitter enables faster communication than Bluetooth and therefore better accuracy because the transmitter uses the custom protocol (developed by authors of the present invention) which enables low and constant latency delay communication between modules. Compared to Bluetooth protocol the developed custom protocol enables to send data in the moment when needed as the Bluetooth sends data packages periodically for example after every 7,5 ms. In this way the all image processing and decision making weather to release the pixel or not is done in the camera module instead of the printer. Only data that is sent to the printer is command to open printing valve.

The dynamics of operation is that the user moves the spray-printing device sideways holding it vertically while the rotary positioner assembly for example a servomotor angles paint nozzle up and down to print a vertical line in about every 0.01- 1 seconds. The spray-printing device receives pixel data in real time in form of lines located vertically from the tracking beacon. To print a line, the spray-printing device first needs to receive data about this line from camera module.

The spray printing device operation can be viewed as cycles, with each cycle one vertical line is printed. One cycle starts by receiving data from the camera module, or it can be received during the previous cycle. Moving the paint nozzle starts from one side (top or bottom) and is moved and stopped in as many individual vertical positions as set by user (1-500 positions). In each position the spray-printing device reads the line data and decides whether to shoot a pixel or not. Positioning the paint nozzle is very fast, taking much less than a millisecond to reach position next to previous and stop. Shooting paint takes about 2 milliseconds. If the user has set the spray-printing device on 500 positions, then one cycle should take about 1 second. With higher

position setting the hand movement is therefore slower and lower position setting the hand movement can be faster. When the other side (opposite from starting point) is reached, the nozzle moves back to starting point in a single movement. This is the end of single cycle.

Further development of spray printing device according to present invention enables printing of lines in any angle. The user can work with the printer more freely and do not need to hold the printer vertically.

The spray printing device is equipped with electronic lever that reads data about spray printing device position referenced from horizon (or from an angle that it was calibrated at before starting work) in the wall plane. This data is transmitted periodically to the camera module. Camera module uses this angle to read the pixel data from image file. Camera module, after calculating tracking position, reads pixels in a line from that position at the angle received. Now the data about these pixels are transmitted to the spray-printing device.

The result is an image that is printed on the surface several pixels in vertical row at a time. The application saves the pixels already printed on the wall, avoiding repeated layers and identifying any missing pixels. The user can use their smartphone to either upload their own picture or purchase one from an existing gallery that is created in collaboration with artists and designers and then simply spray print it onto a wall. The camera module tracks the spray printing device position and software developed for present solution determines the place or point where to release the colour pixel.

The gallery of artwork itself may be created in collaboration with artists and designers – upon uploading their design, a standard licensing agreement will be concluded between parties and if the author so wishes, a countdown tool will also be employed to limit the times the artwork can be bought and/or sold.

Brief description of drawings

The present invention is explained more in detail with references to figures added, where

Figure fig 1 illustrates the general concept of the printing system according to the present invention, shown is a camera module and printing module;
Figures fig 2A, 2B and 2C illustrate a perspective views of a printing module according to the first embodiments of the present invention;

Figure fig 3A illustrates the side view of the printing module;

Figure fig 3B illustrates the cross-section view of the printing module along the line AA in the fig 3A;

Figure fig 3C illustrates in more detail the sectional view of the printing head of the printing module;

Figures fig 4A, 4B, 4C and 4D illustrate accordingly the perspective view of the printing module with pressurized paint can, a side view, a rear view and a top view of the printing module;

Figure fig 4E illustrates a sectional view of the printing module with pressurized paint can along the line B-B in the fig 4C;

Figure fig 5 is a schematic overview of an electronics arranged in the printing module to control printing and position of the printing module during the spray painting.

Figure fig 6 illustrates the general concept of the second embodiment of a wireless spray-printing device according to the present invention, shown is schematically different positions of the painted paint pixels;

Figures fig 7 to fig 9 illustrates different view of the spray-printing device according to present invention;

Figure fig 10 illustrates side view of a spray-printing device with a cut lines A-A and B-B;

Figure fig 11 illustrates the cross-section view of the spray-printing device along the cut line A-A in the fig 10;

Figure fig 12 illustrates the cross-section view of the spray-printing device along the line B-B in the fig 10;

Figure fig 13 illustrates side view of a spray-printing device with a cut line D-D and J-J;

Figure fig 14 illustrates the cross-section view of the spray printing device along the line D-D in the fig 13 and separate view of section G;

Figure fig 15 illustrates the cross-section view of the spray printing device along the line J-J in the fig 13 and separate view of section K;

Figure fig 16 illustrates a cross-section view G in more detail;

Figure fig 17 illustrates a cross-section view K in more detail;

Figure fig 18 illustrates and front view of the spray-printing device;

Figure fig 19 illustrates in more detail a section C view in fig 18;

Figures 20 to fig 23 illustrate different views of the spray-printing device according to present invention.

Detailed description of invention

The present invention comprises of two modules: a spray printing device and camera module 101. The camera module 101 comprises a camera 102, sensors, a transceiver (receiver and transmitter – a communication module, not shown in the drawings), a processor and software for identification position and orientation of the spray printing device 100 in real time near to the painted surface. The software tracks the location of the spray-printing device in two-dimension when the spray-printing device is moved before the painted surface for in an x-y plane.

According to the first embodiment of the present invention the printing module 1 (fig 3A-3C) comprises a housing 2 with gripping means 3 to connect and fix an pressurized paint can 201 to said housing 2, a printing head 4 comprising a flow channels 5 for spray paint, valves 6, sprayer 7, an electronics 8 (fig 7) comprising a control processor unit 801, processors, valve control means 806, memory means 802, connectors, inertial measurement unit (IMU) 803, Bluetooth low energy (BLE) unit 804, a transmitter, a tracking sensor (for example tracking LED) 805; a battery compartment 9 in the housing and power supply 10 (battery means), on/off and control switches 11. The control unit 801 is connected with power supply (battery means) 10. The inertial measurement unit (IMU) 803 used in present invention is an electronic device that measures and reports a printing module specific force and angular rate by using a combination of accelerometers and gyroscopes. In alternative embodiment of the invention the IMU has GPS devices. The Bluetooth low energy unit is used to provide reduced power consumption communication between the printing module 1 and the camera module 101.

In addition the housing 2 may be provided with rollers or wheels 12 placed to the housing so that the printing module 1 can be moved in the front of surface within predetermined distance to help user and guarantee that the colour pixel sprayed from printing head has controlled size. The transmitter 13 fixed in the printing head is for example LED diode, ultrasonic transmitter, laser beam from laser diode or radio transmitter. The housing is printed with 3D printing technology or injection moulded comprising the gripping means 3 for gripping and fixing the spray can to upper part of the housing 2.

To the upper part of the housing 2 is attached a spray activation device 14 (for example needle assembly) comprising an extension or a needle 15, a filter 16, a seal 17 (O-ring) and a fastener, for example a nut) 18 for fixing said spray activation device to the housing 2. The needle 15 is a tube with outer diameter corresponding to the diameter of the opening in the pressurized paint can 201 valve (not shown in the drawings). When the spray paint reservoir is connected to the spray activation device the needle 15 is pressed to the opening in the spray paint reservoir valve. Same time the needle pushes down and opens spray paint reservoir valve to direct pressurised paint from the pressurized paint can to the needle tube and through flow channel 5 and filter 16 to printing head valve 6. The spray paint under the pressure can flow to the printing head valve 6 which is in closed state when the printing device is not working. The leak proof fastening is created between the external wall of the spray paint reservoir nozzle and said needle 15. In addition the sealing (O-ring) 17 is placed between the spray activation device 14 and printing head valve 6 to prevent paint leakages.

The printing head valve 6 comprises electromagnets (not shown in the drawings) for opening said valve and a closing means (not shown in the drawings) such as a spring for closing said printing valve. The printing valve 6 is followed by a spray channel 23 and a spray nozzle 7 or sprayer for forming shape of the printed pixel. The printing valve 6 is controlled by the electronics 8 placed into housing 2. The electronics 8 comprises control processor unit 801 which controls an opening and closing of the printer head valve 6. The software in the control processor unit 801 controls and communicates with the camera module 101 through transmitter 802 and sensors in the printing head 4. To the control processor unit is connected the inertial measurement unit 803 for controlling location of the printing head where said unit comprises for example a movement sensors, accelerometers and gyroscopes. The electronics comprises also receiver or Bluetooth low energy unit 804 (BLE) for receiving signal from the camera module (for example from the smartphone) and directing the picture characteristics or pixels to SprayPrinter device. When the printing valve is opened by the electromagnets the spray paint under the pressure flows through the spray channel 22 to the sprayer 7. The printing valve 6 is controlled by the electromagnets and electronics and when the signal is received from the camera module the printing valve opens accordingly to the picture to be printed to the surface. To control more effectively the work of the printer module to the upper part of the housing is attached the trigger lever 19 which activates a spring switch 20 when said trigger lever is pressed down by

user. The spring switch controls the power circuit which provides the power to the electromagnets of the printing valve.

The lower part of the housing provided with a compartment 9 for a battery means which are intended to supply the printer module and electronics with power. In the bottom of the housing is placed on-off switch 21 to turn the power on or off. The battery means are connected to the electronics 8 placed in the printer module. For charging the battery means the printer module is provided with a USB input (micro-B, mini-B, type-A, type-B etc.) 23.

Into the lower part of the housing are arranged a rollers or wheels 12 which will support the printing module when said module is placed to the surface to be painted. This will help user to maintain the right distance of the printing module from the painted surface.

In the top of the printer module housing above the spray nozzle is arranged the sensor or tracking LED 13 for tracking the position of the printing module 1.

The camera module 101, that is positioned toward the surface to be painted, transmits video feed to the processor inside the camera module. Software thresholds each frame, so that only well illuminated areas are light, everything else is dark. Within this the time that the printing module waited before lighting the tracking LED, the info about trigger pressing reaches the camera module so the software can anticipate the event of LED lighting up and take notice of it. Now, as the software has info about which light area is made by the tracking LED, it traces the edges of this particular area. Then the software calculates the centroid of this area and transmits the pixel coordinates of the centre to the printing module. This is done with each frame. Based on position data from camera module and sensor data from the inertial measurement unit (IMU) the control unit calculates current estimated position of the printing module and decides if the current pixel needs to be printed or not and then opens the printing valve 6 for n ms if needed.

Alternatively when the LED beacon position coordinates are sent to the printing module the calculation of the coordinates does not only rely on the information of the camera module but also on the data from the inertial measurement unit (IMU), the printing module control unit calculates next current estimated position of the printing module and decides if the next current pixel needs to be printed or not and then opens the printing valve for x ms if needed. Said process is done repeatedly until the user releases the printing module trigger lever 19. Each time when the trigger lever in the

printing module is pressed again the position of the printing module is determined according to the process described above.

Alternatively by pressing trigger lever by user the printing module will wait commands to open/close printing valve from camera module. Whereas the camera module finds a tracking LED in the camera frame and a tracking software in the camera module calculates pixel coordinates of the LED light centroid and based on the pixel value of said coordinates decides whether to send or not the command to printing module to open the printing valve. Said step is continuously repeated until the image is spray printed into surface and user releases the printing module trigger lever.

According to the second embodiment of the present invention to wide a painting are a wireless spray printing device illustrated in accompanying drawings (fig 6 – fig 23) for surface painting or decoration comprises a printing head 110 attached to a housing 202 having a gripping means 203 for gripping and attaching an pressurized paint can to said housing, a spray activation device attached to the upper portion of the housing and having an extension 204 for pushing down an pressurized paint can valve and for directing aerosol spray paint into a printing head 110 when pressurized paint can is attached to the spray printing device, a top of the housing 202 is designed as a printing head 110 comprising a printing valve 6 having a means for opening said printing valve and a valve closing means, a paint channels attached to the printing valve 6 and followed by a paint nozzle 213 for forming an aerosol paint printed pixels to the painted or decorated surface, an electronics comprising radio transceiver for receiving and transmitting signals from camera module and to camera module and means for controlling printing valve 6.

In addition the housing may be provided with rollers or wheels 12 placed to the housing so that the spray printing device can be moved in the front of surface within predetermined distance to help user and guarantee that the colour pixels sprayed from printing head has controlled size. The tracking sensor 805 fixed in the printing head is for example LED diode, ultrasonic transmitter, laser beam from laser diode or radio transmitter. The housing 202 and the printing head cover may be printed with 3D printing technology or preferably by injection moulding. The housing comprises a gripping means 203 for gripping and fixing the spray can or an pressurized paint can to upper part of the housing 202.

The spray printing device comprises a printing head comprising a flow channels for spray paint, valves, electronics 8 comprising a control processor unit, processors,

valve control means, memory means, connectors, inertial measurement unit (IMU), Bluetooth low energy (BLE) unit, a transmitter, a tracking sensor (for example tracking LED); a battery compartment in the housing and power supply 9 (battery means), on/off and control switches. The control unit is connected with power supply (battery means). The inertial measurement unit (IMU) used in present invention is an electronic device that measures and reports a printing module specific force and angular rate by using a combination of accelerometers and gyroscopes. In alternative embodiment of the invention the IMU has GPS devices. The Bluetooth low energy unit is used to provide reduced power consumption communication between the spray-printing device and the camera module.

To the upper part of the housing is attached a spray activation device (for example needle assembly) comprising an extension or a needle, a filter, a seal (O-ring) and a fastener, for example a nut for fixing said spray activation device to the housing. The needle for example is a tube with outer diameter corresponding to the diameter of the opening in the pressurized paint can valve (not shown in the drawings). When the spray paint reservoir is connected to the spray activation device the needle is pressed to the opening in the spray paint reservoir valve. Same time the needle pushes down and opens spray paint reservoir valve to direct pressurised aerosol spray paint from the spray paint reservoir to the needle tube and through flow channel and filter to printing head valve. The spray paint under the pressure can flow to the printing head valve 6 which is in closed state when the printing device is not working. The leak proof fastening is created between the external wall of the spray paint reservoir nozzle and said needle. In addition the sealing (O-ring) can be placed between the spray activation device and printing head valve 6 to prevent paint leakages.

The printing head valve 6 comprises electromagnets (not shown in the drawings) for opening said valve and a closing means (not shown in the drawings) such as a spring for closing said printing valve. The printing valve is followed by a paint channels and a paint nozzle 213 or sprayer for forming shape of the printed pixel.

Alternatively the pressurised paint is sprayed out by valve-less micro-pump which comprises an inlet channel, an outlet channel, a chamber, a membrane and electromagnetic or piezoelectric actuator (i.e. for example in the form of piezo disc attached to the pump membrane). The valve-less micro-pump prevents to reduce the

printing head valve malfunction when printing device is not used for a long time so that the paint can be dried out. It will be easier to clean the micro-pump with paint solvent.

The printing valve 6 is controlled by the electronics placed into housing 202. The electronics comprises control processor unit which controls an opening and closing of the printer head valve. The software in the control processor unit controls and communicates with the camera module through transmitter and sensors in the printing head. To the control processor unit is connected the inertial measurement unit for controlling location of the printing head where said unit comprises for example a movement sensors, accelerometers and gyroscopes. The electronics comprises also receiver or Bluetooth low energy unit (BLE) for receiving signal from the camera module (for example from the smartphone) and directing the picture characteristics or pixels to spray printing device. When the printing valve is opened by the electromagnets the spray paint under the pressure flows through the paint channels to the paint nozzle 213.

The paint channels comprise a first rigid paint cannel tube 212 attached to printing valve 6, an elastic paint cannel tube 223 attached in one end to first channel tube 212 and in other end to second rigid paint channel tube 233 connected to a input channel of the paint nozzle 213. The elastic paint channel allows rotation of the paint shaft 207 with paint nozzle 213 thus the paint pixels are painted to the surface in one line or column.

The printing valve 6 is controlled by the electromagnets and electronics and when the signal is received from the camera module the printing valve opens or closes accordingly to the picture to be printed to the wall. To control more effectively the work of the spray printing device to the upper part of the housing is attached the trigger lever which activates a spring switch when said trigger lever is pressed down by user. The spring switch controls the power circuit which provides the power to the electromagnets of the printing valve.

The lower part of the housing provided with a compartment for a battery means 9 which are intended to supply the spray-printing device and electronics with power. In the bottom of the housing is placed on-off switch to turn the power on or off. The battery means are connected to the electronics placed in the spray-printing device. For charging the battery means the spray-printing device is provided with a USB input (micro-B, mini-B, type-A, type-B etc.).

Into the lower part of the housing are arranged a rollers or wheels 12 which will support the printing module when said module is placed to the surface to be painted. This will help user to maintain the right distance of the printing module from the painted surface.

In the top of the spray printing device housing above the spray nozzle is arranged the sensor or tracking LED 805 for tracking the position of the spray printing device.

The paint nozzle 213 is formed to one end of a rotating nozzle shaft 207 which is rotatable fixed via bearings 205 to printing head whereby axle of the paint nozzle is perpendicular with axle of the shaft 207. A rotary positioner assembly is placed to the other end of the rotating nozzle shaft 207 for rotating the shaft with paint nozzle to print approximately up to 100 paint pixels in one vertical row correspondingly to the picture pixels to be printed in the surface.

In one embodiment the rotary positioner assembly is placed into a case 216 integral with printing head 110 and housing 202 and having a cover 214 which is closed after assembly said rotary positioner assembly. The rotary positioner assembly comprises magnets 210 placed into bottom of said case, a rotational actuator solenoid 206 fixed to the rotating nozzle shaft 207 and rotating with said shaft, an encoder 222 connected to a printed circuit board 211 comprising an electronic means for controlling the rotary positioner assembly and fixed into the case 216.

The movement of the rotational actuator solenoid 206 fixed to the rotating nozzle shaft 207 is controlled by encoder 222 in cooperation with magnets 210 and by software running in spray printing device.

In yet another embodiment the rotary positioner assembly controlled by electronic means is a servo motor which movement is controlled by said electronic means and by software running in the wireless wideband spray printing device and said servo motor is turning the paint nozzle up and down in the range of up to 90 degrees, preferably in the range of 60 to 90 degrees.

When the spring switch is pressed by the trigger lever by the user on the spray-printing device, two things will happen in the spray-printing device simultaneously. First, the spray-printing device waits about 100ms and then lights up the tracking sensor (tracking LED), at the same time the control unit sends info via Bluetooth low energy unit that the trigger was pressed to the camera module. In this way the implemented software in the camera module can be sure of this being the light from the tracking LED. The camera module 101, that is positioned toward the wall, transmits video feed

to the processor inside the camera module. Software thresholds each frame heavily, so that only well illuminated areas are light, everything else is dark. Within this 100ms time that the spray printing device waited before lighting the tracking LED, the info about trigger pressing reaches the camera module so the software can anticipate the event of LED lighting up and take notice of it. Now, as the software has info about which light area is made by the tracking LED, it traces the edges of this particular area. Then the software calculates the centre of this area and transmits the coordinates of the centre to the printer. This is done with each frame. Based on position data from camera module and sensor data from the inertial measurement unit (IMU) the control unit calculates current estimated position of the spray printing device and decides if the current pixel needs to be printed or not and then opens the printing valve 6 for x ms if needed. Then the LED beacon position is sent on image and the LED beacon location is relayed on image and based on position data from camera module and sensor data from the inertial measurement unit (IMU) the control unit calculates next current estimated position of the spray printing device and decides if the next current pixel needs to be printed or not and then opens the printing valve for x ms if needed. Said process is done repeatedly until the user releases the spray printing device trigger lever 19. Each time when the trigger lever in the spray-printing device is pressed again the position of the printing module is determined according to the process described above.

Alternatively by pressing trigger lever by user the printing module will wait commands to open/close printing valve from camera module. Whereas the camera module finds a tracking LED in the camera frame and a tracking software in the camera module calculates pixel coordinates of the LED light centroid and based on the pixel value of said coordinates decides whether to send or not the command to printing module to open the printing valve. Sais step is continuously repeated until the image is spray printed into surface and user releases the spray printing device trigger lever.

The spray-printing device according to the present invention uses a special paint that can be shot from a distance 10-20cm from the wall and still creating a fairly small dot 1-4mm. The same time the paint nozzle 213 can be angled up and down (60-90 degrees) via servomotor and positioned fast and accurately to aim each shot within this freedom of movement. The camera module transmits data about 1-500 pixels that are in vertical line from tracking position. All these properties give to a wideband spray-printing device the ability to print about 5-20cm wide band of image in a single pull.

The wireless application based spray printer device for surface painting (as named SprayPrinter device) is unique in its capabilities and is unrivalled on the marketplace today. The main innovation lies in:

- the novel use of Bluetooth, sensors and LED lights in connecting and controlling the smartphone, the mobile app and the printer head, resulting in wireless printing capabilities;
- the use of accelerometers and gyroscopes for improving the accuracy of the device and thus achieving better-quality prints. The accelerometer provides an acceleration as function of time which when integrated over the time the signal is measured provides a velocity and then integrating velocity over time will give position. The gyroscope provides an orientation and based on the distance calculated and the orientation, the new position of the print head can be estimated by adding this distance with it orientation to the last known position to provide the instant position of the print head.
- the use of state-of-the-art electromagnetic valves that can open and close up to 200 times per second, giving users the freedom to move their hands freely just as with a regular paintbrush;
- the use of spray paint in the creation process, whereas the number of layers (i.e. colours) is defined by the user.

These aspects combined makes the printing process unique, hassle-free and easy, eliminates the need for any other devices and/or wires and gives the user complete freedom in choosing and installing their art.

Compared to other surface art products such as wall stickers, prints, paintings, designer wallpaper etc., the SprayPrinter offers a solution that is highly customizable without any extra cost and easy to obtain and install. SprayPrinter feeds into the current maker culture that is gaining global traction as people are increasingly turning to customized, non-mass-produced and do-it-yourself solutions (see for more information on the DIY and maker movement).

Using SprayPrinter does not require any artistic talent compared to having to produce the artwork yourself and then having it printed) and there is no extra cost inherent in the chosen level of customization or the size of the piece. The user is allowed complete freedom and is not restricted by the size, style, content or any other aspect of the

desired artwork – they are involved in the decorating process, which makes the process intimate and adds personal value to the user's living/working/etc. environment.

The main improvements of the present invention are:

	V1	**V2**
Max image size	320x320 px	1920x1080px (full HD)
How many printers can be tracked by single camera module	1	5
Max hand movement speed	5cm/s	20cm/s
Worktime for 1m² of layer	20min	5min
Tracking LED	Visible light	Infrared/visible light (visible for iPhones)
Communication between printer and phone	Bluetooth	Bluetooth and separate radio transmitter for greater printing speed and accuracy
Image treatment	None in the app	Breaking into layers can be done in the app
Perspective correction (Keystoning)	no	Yes
Pixel size	10 mm	3-10 mm
Speed	10pxl/s	200pxl/s
Accuracy	+/- 20mm	+/- 2mm

The hardware and software of the device enables to achieve greater printing accuracy (from 15 to 2 millimeters), printing speed (from 15 to 200 pixels/second) and reduced time delay (up to 2-3 milliseconds).

List of structural elements:

1- Printing module

101- Camera module

102- Camera

2- Housing

201- Aerosol spray paint reservoir

3- Gripping means

4- Printing head

5- Flow channel

6- Printing head valve

7- Spray nozzle or Sprayer

8- Electronics

801- Control processor unit

802- Memory means

803- IMU

804- BLE

805- Tracking sensor

9- Battery compartment

10- Power supply (battery means)

11- Off/on and control switches

12- Rollers

13- Transmitter

14- Spray activation device

15- Extension (needle)

16- Filter

17- Seal (O-ring)

18- Fastener (Nut)

19- Trigger lever

20- Spring switch

21- On-off switch

22- Spray channel

23- USB input

110- printing head

202- housing

203- gripping means

204- extension

205- bearings

206- solenoid

207- paint shaft

210- magnets

211- printed circuit board

212- first rigid paint channel

213- paint nozzle

214- cover

216- case

222- encoder

223- elastic paint channel tube

233- second rigid paint channel tube

Claims

1. A wireless spray printer device for a pressurized paint can used for surface painting or decoration comprising a printing head (4) attached to a top of a housing (2), a spray paint activation device (14) attached to the upper portion of the housing and having an extension for pushing down an pressurized paint can valve and for directing spray paint into a printing head, whereas

the printing head comprises a printing valve, a spray channel (22) attached to the printing valve (6) and followed by a spray nozzle (7) for forming a printed pixel to the painted surface, an electronics (8) comprising radio transceiver for receiving and transmitting signals from camera module and to camera module and means for controlling printing valve (6), whereas

the housing comprises in a upper part a gripping means (3) for gripping and attaching an pressurized paint can (201) to housing, and an extension (15) for pushing down an pressurized paint can valve and for directing aerosol spray paint into a printing head (4) when pressurized paint can is attached to the spray printer device.

2. The wireless spray printer device according to claim 1, whereas the electronics (8) comprise a control processor unit (801) with memory means (802) for software to control printing and to determining a position of the spray printing device and a wireless transceiver unit (804) to transfer data between the printer device module and the camera module.

3. The wireless spray printer device according to claim 1 and 2, whereas the printing valve comprises a means for opening printing valve and means for closing printing valve, whereas the means for opening the printing valve (6) are electromagnets controlled by a valve control means (806) connected to the control unit (801) and the means for closing printing valve are a spring.

4. The wireless spray printer device according to claim 1 and 2 whereas the printing valve (6) is valve-less micro pump connected to the control unit (801).

5. The wireless spray printer device according to claim 1 whereas said electronics (8) in the printing head (4) comprises an inertial measurement unit (803) comprising sensors such as movement sensors, accelerometers and gyroscopes.

6. A wireless spray printing system for surface painting comprising a wireless spray printer device according to claims 1-6 as a printing module, a camera module and a

software program for controlling said camera module and a position of a spray printer device printing module.

7. The wireless spray printing system according to claim 6 whereas a spray printer device converts digital designs into surface art wirelessly when user uses a software app after choosing the suitable image from a gallery made up of custom art and images, attaching the printing device to a spray can and printing the picture on the desired surface.

8. The wireless spray printing system according to claim 6 where the location of the spray printer device is controlled by camera module whereas the printing valve of the spray printer device is actuated when said device location corresponds to the place in the painted picture where the colour pixel is intended to be painted.

9. The wireless spray printing system according to claim 6 where after switching on the printer module by user the system software boots and initializes the printing module, sends from camera module printing parameters to the printing module and after confirmation from the microcontroller unit (MCU) the printing parameters, the camera module starts sending image data packages to the printing module, after having received last image data package the control unit in printing module confirms transmission.

10. The wireless spray printing system according to claim 9 where by pressing trigger lever by user the printing module waits until the camera module has detected the pressing of the trigger lever in said printing module and then the control unit of the printing module lights up the tracking beacon (tracking LED), at the same time the control unit sends info that the trigger lever was pressed to the camera module thereafter

a) the printing module sends a time stamp package to the camera module

b) the time stamp is received by camera module and the camera module image sensor detects the first frame with the illuminated tracking led and sends time stamp of said frame back to the printing module,

c) the printing module calculates based on these two time stamps the time delay in the system whereas the results of calculations are used by the system to compensate the tracking delay, thereafter

d) the printing module uses the calculated coordinates to decide the opening the printing valve whereas the closing time of the printing valve is constant and predetermined before the printing by user.

11. The wireless spray printing system according to claim 10 where the camera module continuously calculates coordinates of the tracking LED in the step b) and send calculated coordinate data to the printing module.

12. The wireless spray printing system according to claim 10 where in addition to camera based tracking in a step c) is used a inertial measurement unit (IMU) for calculating position of the printing module on the surface.

13. The wireless spray printing system according to claim 9 where by pressing trigger lever by user the printing module will wait commands to open/close printing valve from camera module whereas

- the camera module finds a tracking LED in the camera frame and a tracking software in the camera module calculates pixel coordinates of the LED light centroid and based on the pixel value of said coordinates the camera module decides whether to send or not the command to printing module to open the printing valve,

the calculation of the position data of the printing module is continuously repeated by the tracking software in camera module until the image is spray printed into surface and user releases the printer module trigger lever.

14. A wireless spray printing device for surface painting or decoration comprising a printing head (110) attached to a housing (202) having a gripping means (203) for gripping and attaching an pressurized paint can to said housing, a spray activation device attached to the upper portion of the housing and having an extension (204) for pushing down an pressurized paint can valve and for directing aerosol spray paint into a printing head (110) when spray paint reservoir is attached to the spray-printing device, a top of the housing (202) is designed as a printing head (110) comprising a printing valve (6) having a means for opening said printing valve and a valve closing means, a paint channels attached to the printing valve (6) and followed by a paint nozzle (213) for forming an aerosol paint printed pixels to the painted or decorated surface, an electronics comprising radio transceiver for receiving and transmitting signals from camera module and to camera module and means for controlling printing valve (6), whereas

for widening the painted area the paint nozzle (213) is formed to one end of a rotating nozzle paint shaft (207) which is rotatable fixed via bearings (205) to printing head whereby axle of the paint nozzle is perpendicular with axle of the shaft (207), and

a rotary positioner assembly is placed to the other end of the rotating nozzle shaft (207) for rotating the shaft with paint nozzle to print approximately up to 100 paint pixels in one vertical row correspondingly to the picture pixels to be printed in the surface.

15. The wireless spray printing device according to claim 14 where the rotary positioner assembly is placed into a case (216) integral with printing head (110) and housing (202) and having a cover (214), and comprising magnets (210) placed into bottom of said case, a rotational actuator solenoid (206) fixed to the rotating nozzle shaft (207) and rotating with said shaft, an encoder (222) connected to a printed circuit board (211) comprising an electronic means for controlling the rotary positioner assembly and fixed into the case (216).

16. The wireless spray-printing device according to claim 15 where the movement of the rotational actuator solenoid (206) fixed to the rotating nozzle shaft (207) is controlled by encoder (222) in cooperation with magnets (210) and by software running in spray-printing device.

17. The wireless spray-printing device according to claim 16 where the rotary positioner assembly controlled by electronic means is a servo motor which movement is controlled by said electronic means and by software running in the wireless wideband spray-printing device and said servo motor is turning the paint nozzle up and down in the range of up to 90 degrees, preferably in the range of 60 to 90 degrees.

18. The wireless spray-printing device according to claim 14 where paint channels comprise a first rigid paint cannel tube (212) attached to printing valve (6), an elastic paint cannel tube (223) attached in one end to first channel tube (212) and in other end to second rigid paint channel tube (233) connected to a input channel of the paint nozzle (213).

19. The wireless spray-printing device according to claim 14 where the electronics in the printing head comprise a tracking sensor (tracking LED) attached to the printing head (110), a control processor unit with memory means for software to control printing and to determining a position of the spray-printing device and a wireless transceiver unit to transfer data between the printer device module and the camera module.

20. The wireless spray printing device according to claim 14 where the means for opening the printing valve (6) are electromagnets controlled by a valve control means connected to the control unit.

21. The wireless spray printing device according to claim 14 where said electronics in the printing head comprises an inertial measurement unit comprising sensors such as movement sensors, accelerometers and gyroscopes.

22. A wireless wideband spray-printing system for surface painting or decoration comprising a wireless spray-printing device module according to the claims 14 to 21, camera module and software for controlling said camera module and a position of a spray-printing device.

23. The wireless wideband spray-printing system according to claim 22 where a spray-printing device converts digital designs into wall art wirelessly when user uses a software app after choosing the suitable image from a gallery made up of custom art and images, attaching the printing device to a spray can and printing the picture on the desired wall surface.

24. The wireless wideband spray-printing system according to claim 22 where the location of the spray-printing device is controlled by camera module whereas the printing valve of the spray-printing device is actuated when said device location corresponds to the place in the painted picture where the colour pixel is intended to be painted.

25. The wireless wideband spray-printing system according to claim 22 where after switching on the printer module by user the system software boots and initializes the printing module, sends from camera module printing parameters to the printing module and after confirmation from the micro controller unit (MCU) the printing parameters, the camera module starts sending image data packages to the printing module, after having received last image data package the control unit in printing module confirms transmission.

26. The wireless wideband spray-printing system according to claim 21 where by pressing trigger lever by user the printing module waits until the camera module has detected the pressing of the trigger lever in said printing module and then the control unit of the printing module lights up the tracking sensor (tracking LED), at the same time the control unit sends info that the trigger lever was pressed to the camera module thereafter

a) the printing module send the time stamp package to the camera module and the time stamp is received by camera module and the camera module detects the first frame with the illuminated tracking led and send time stamp of said frame back to the printing module,

b) the printing module calculates based on these two time stamps the time delay in the system whereas the results of calculations are used by the system to compensate the tracking delay, thereafter

c) the printing module uses the calculated coordinates to decide the opening the printing valve whereas the closing time of the printing valve is constant and predetermined before the printing by user;

d) the printing nozzle is rotated by rotary positioner assembly from down to up or from up to down and the vertical row of paint pixels is painted to the surface.

27. The wireless wideband spray-printing system according to claim 22 where in addition to camera based tracking in a step c) is used an inertial measurement unit (IMU) for calculating position of the printer module on the surface.

28. The wireless wideband spray-printing system according to claim 23 where by pressing trigger lever by user the printing module will wait commands to open/close printing valve from camera module, when the camera module finds a tracking LED in the camera frame and a tracking software in the camera module calculates pixel coordinates of the LED light centroid and based on the pixel value of said coordinates decides whether to send or not the command to printing module to open the printing valve, the step a) is continuously repeated until the image is spray printed into surface and user releases the printer module trigger lever.

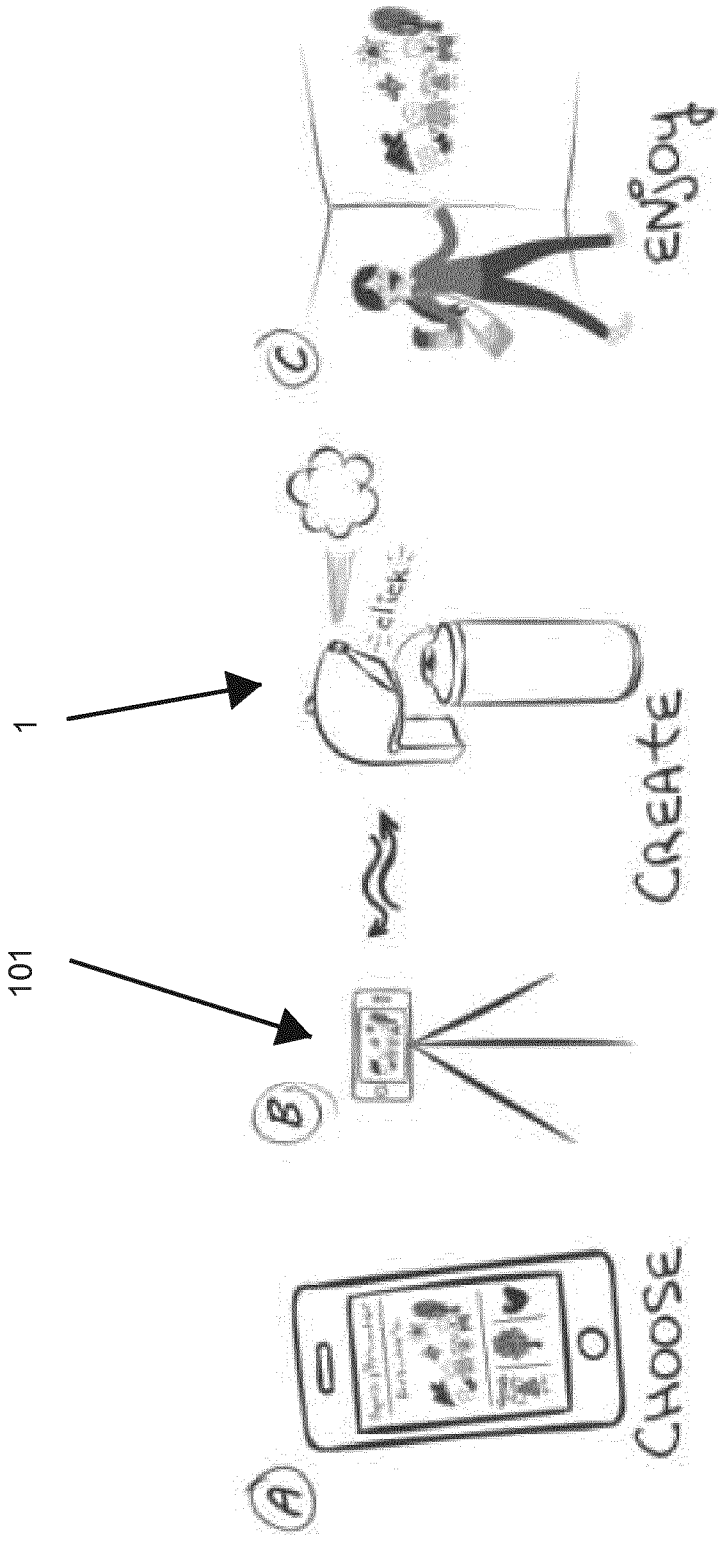


FIG 1

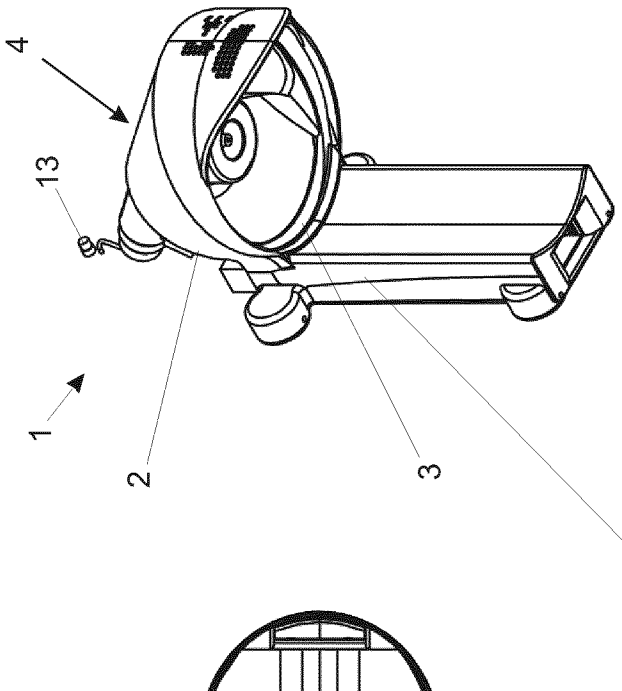


FIG 2C

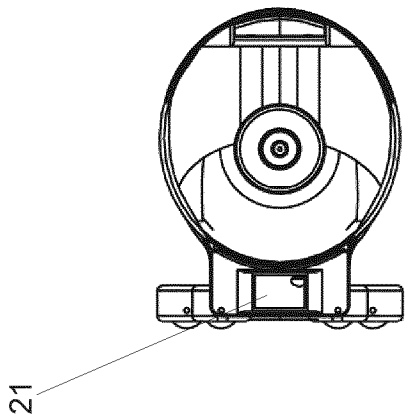


FIG 2B

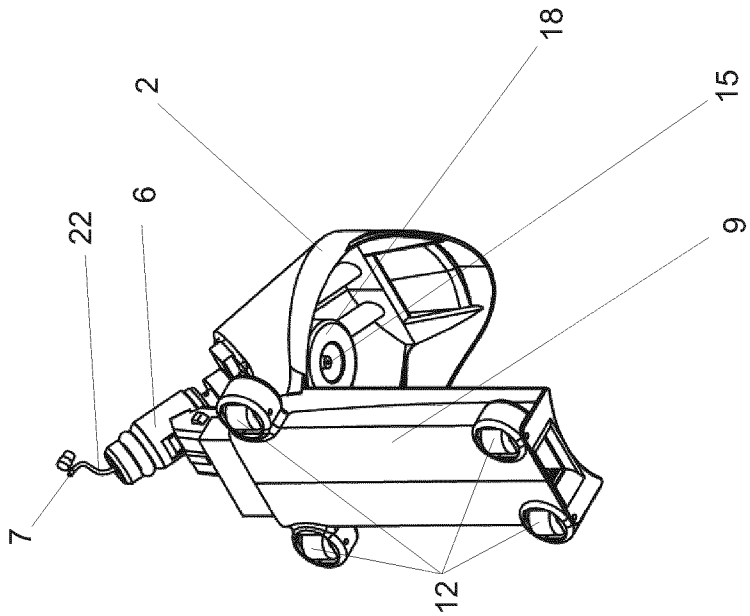


FIG 2A

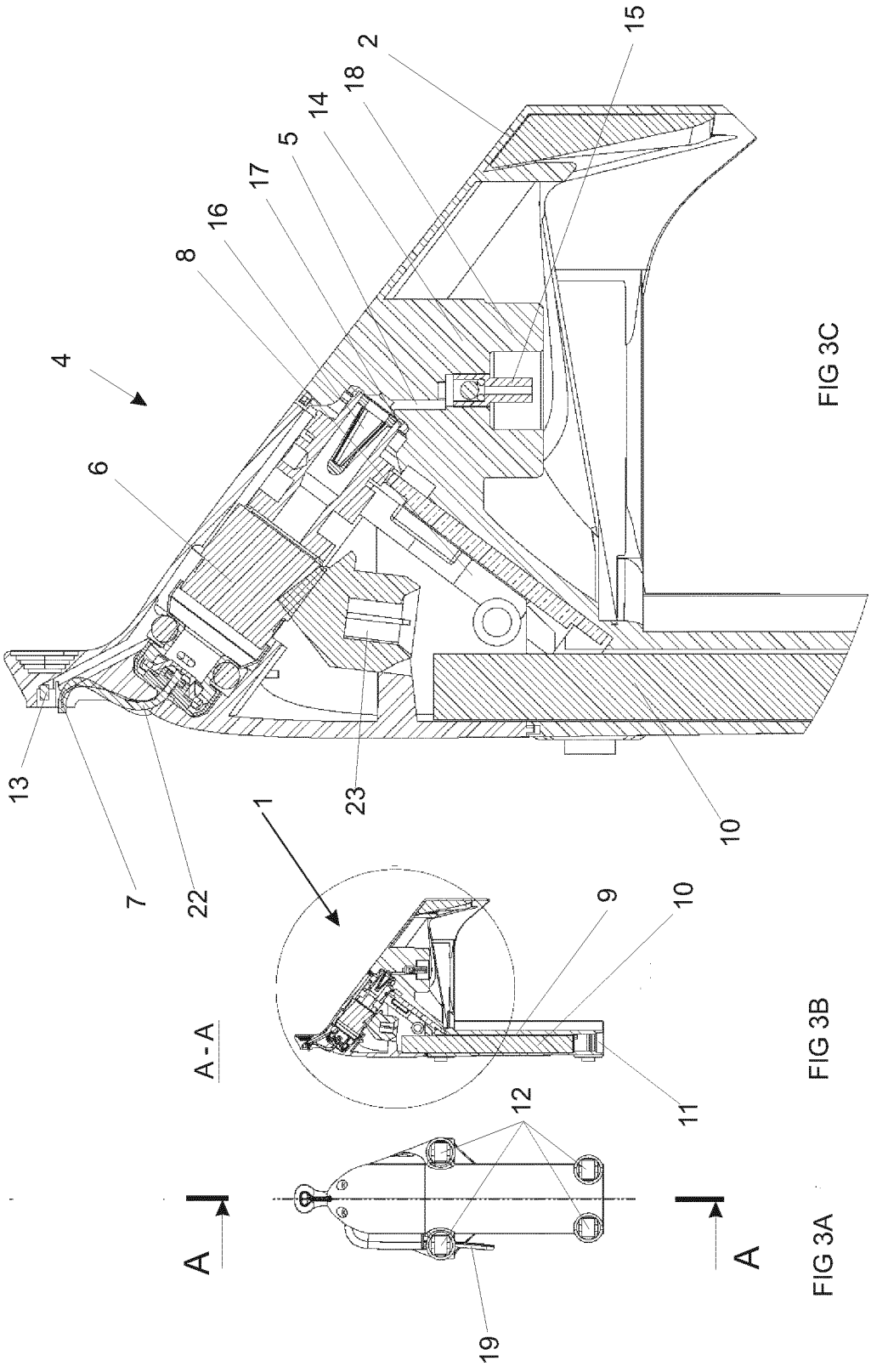


FIG 3C

FIG 3B

FIG 3A

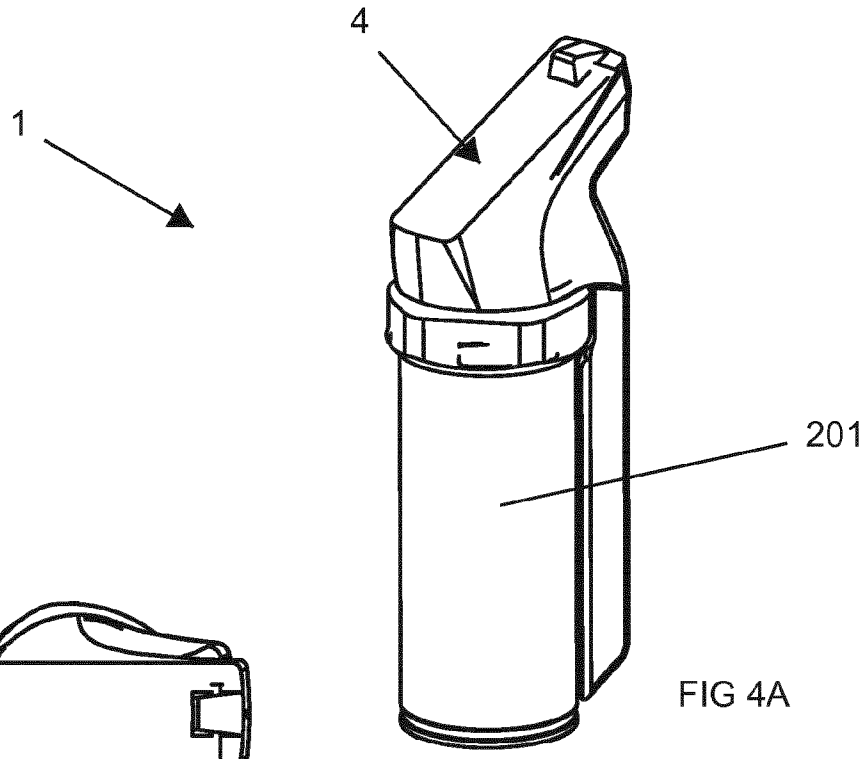
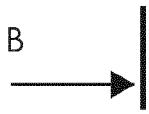


FIG 4A

FIG 4D



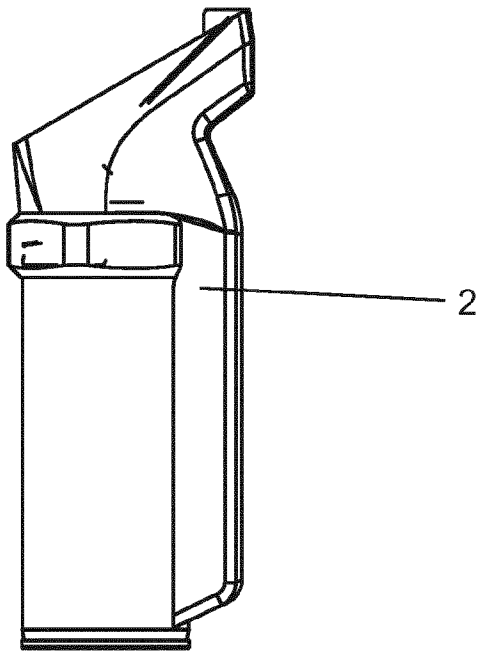
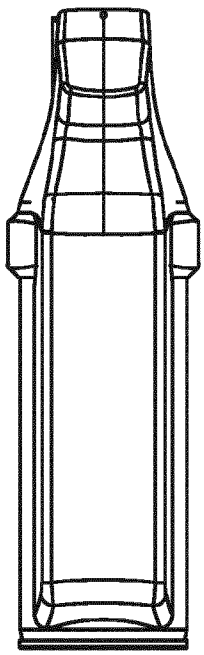


FIG 4B



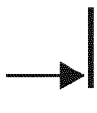


FIG 4C

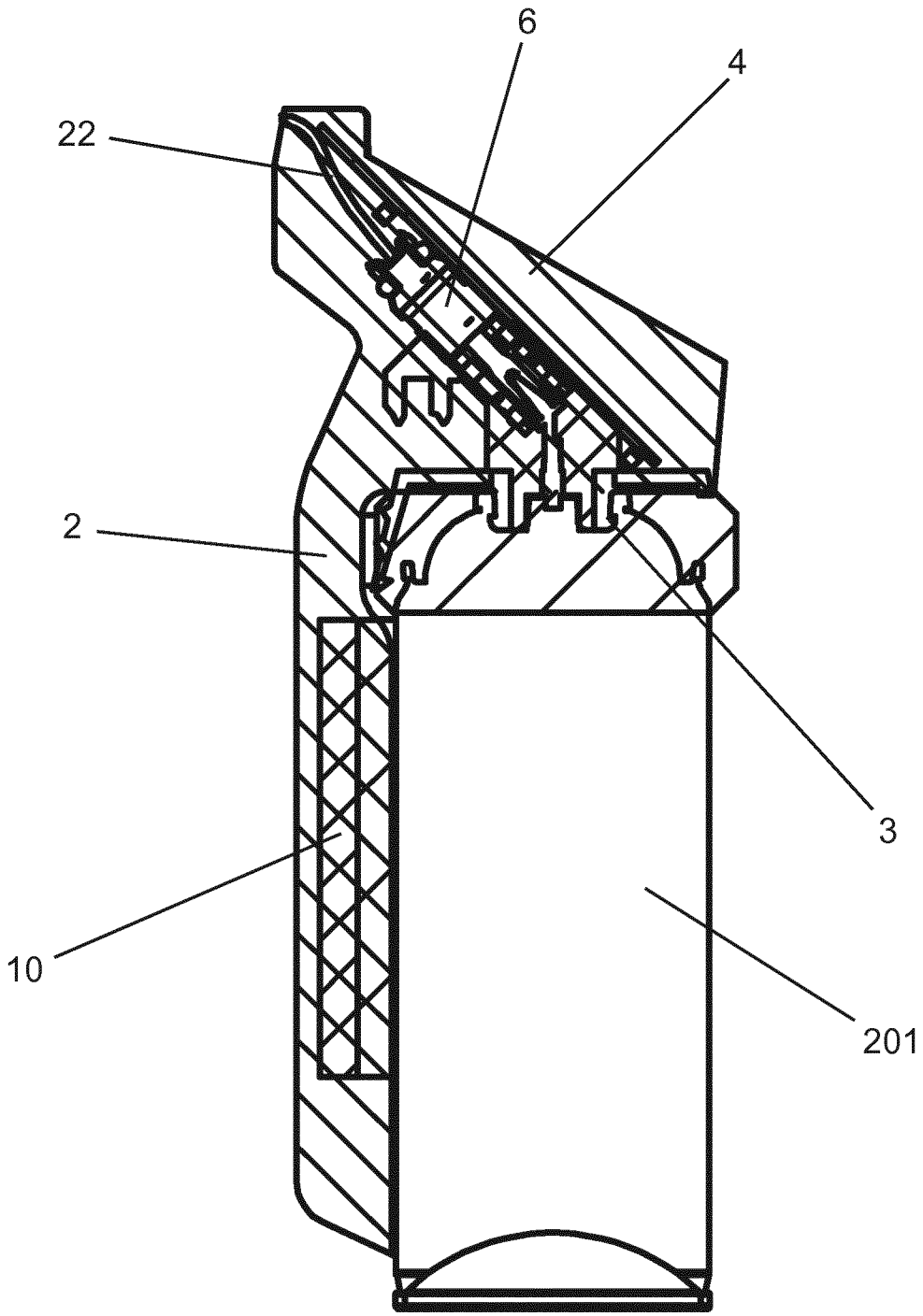


FIG 4E

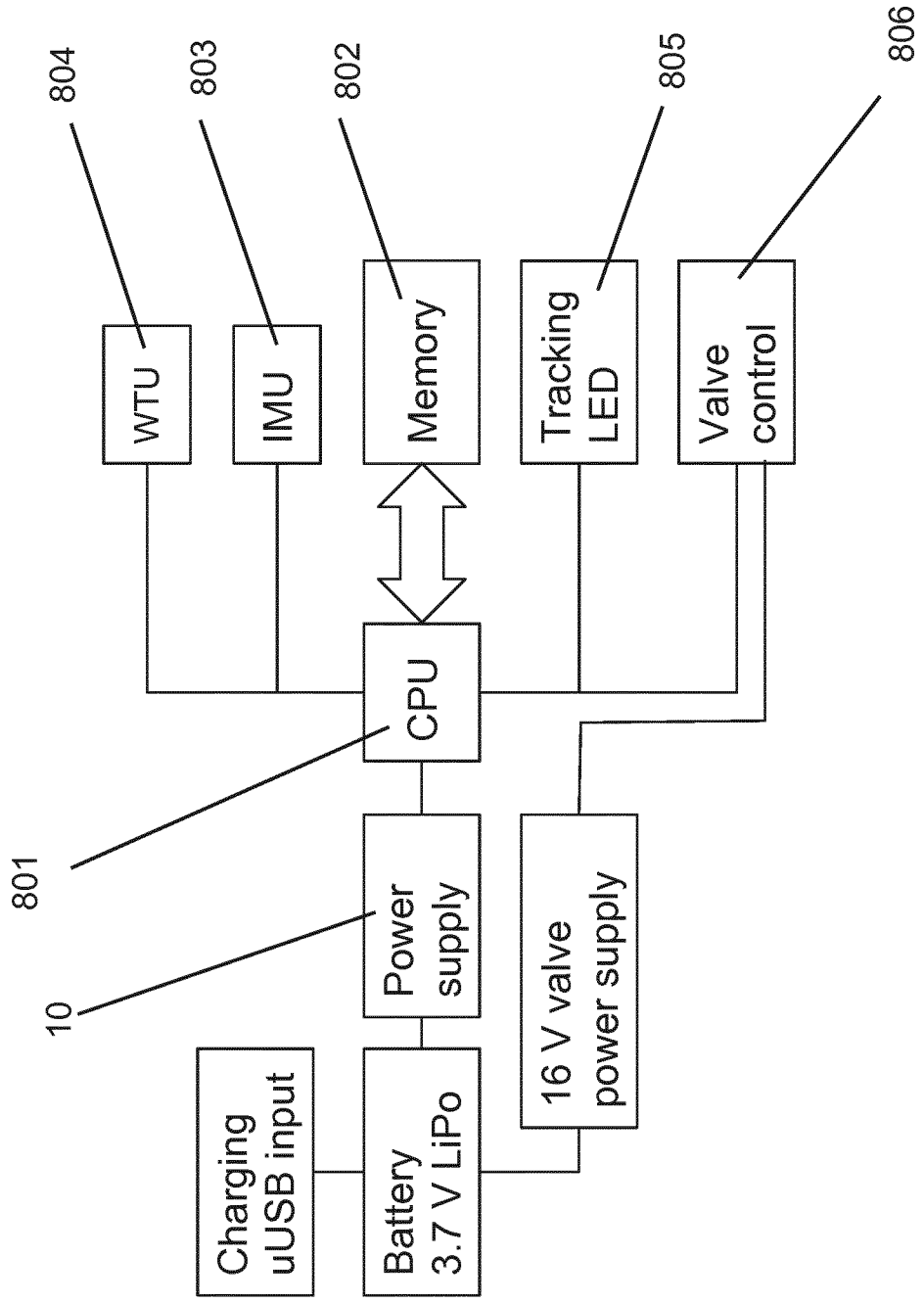

804
803
802
805
806
WTU
IMU
Memory
Tracking LED
Valve control
CPU
801
10
Power supply
16 V valve power supply
Charging uUSB input
Battery 3.7 V LiPo

FIG 5

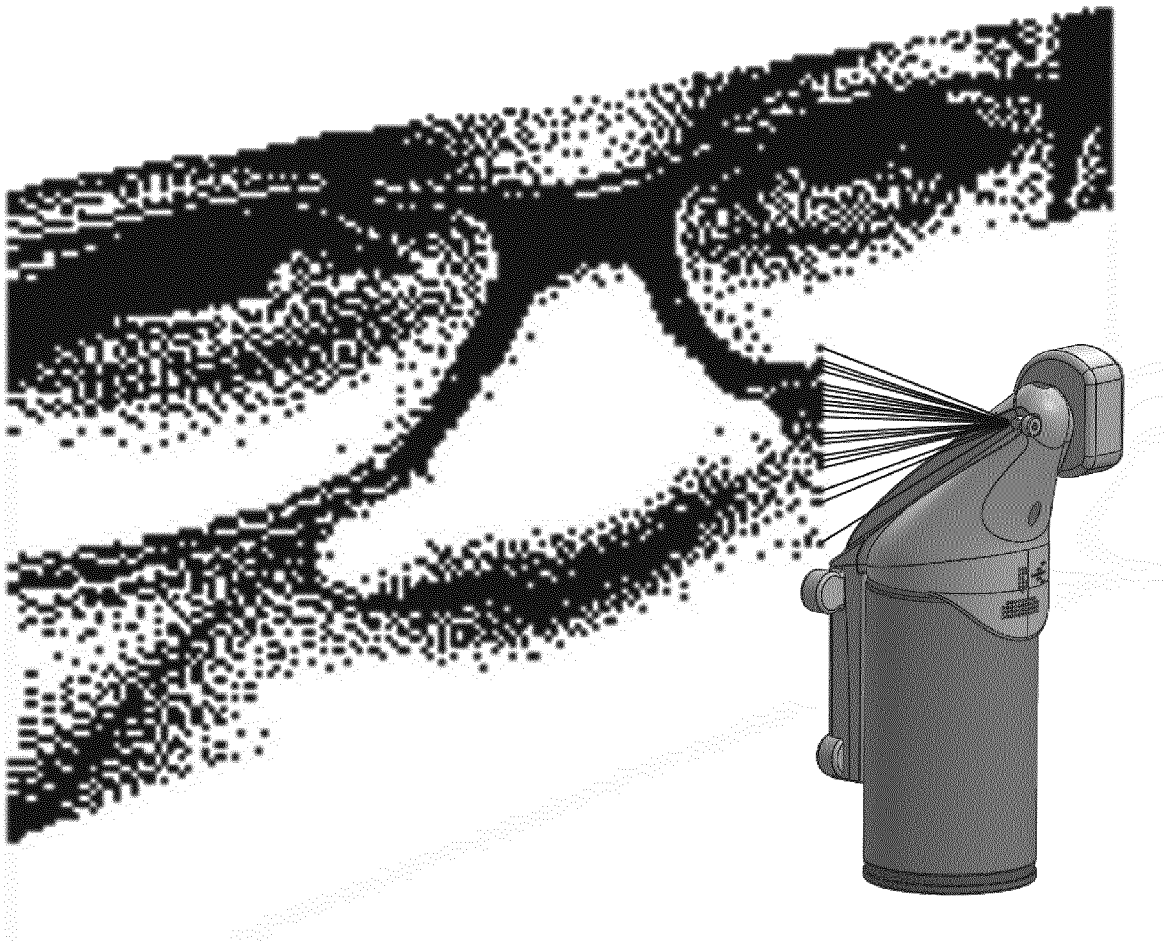


FIG 6

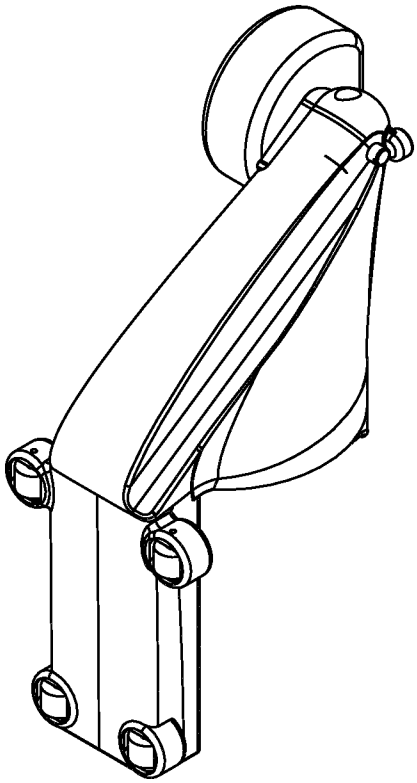


FIG 7

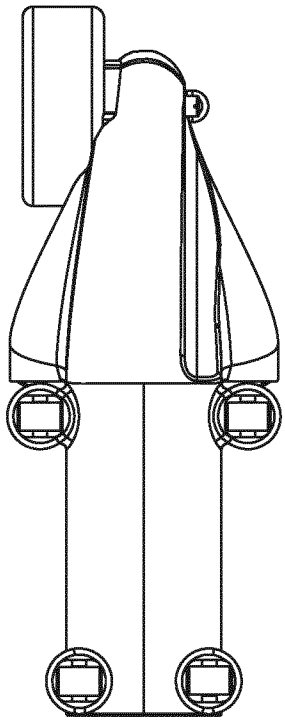


FIG 8

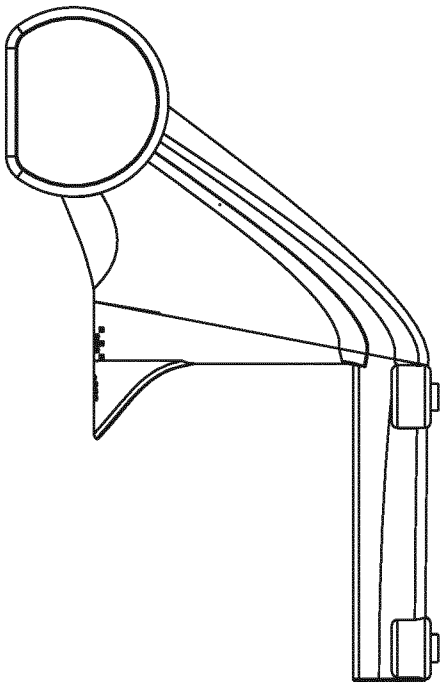


FIG 9

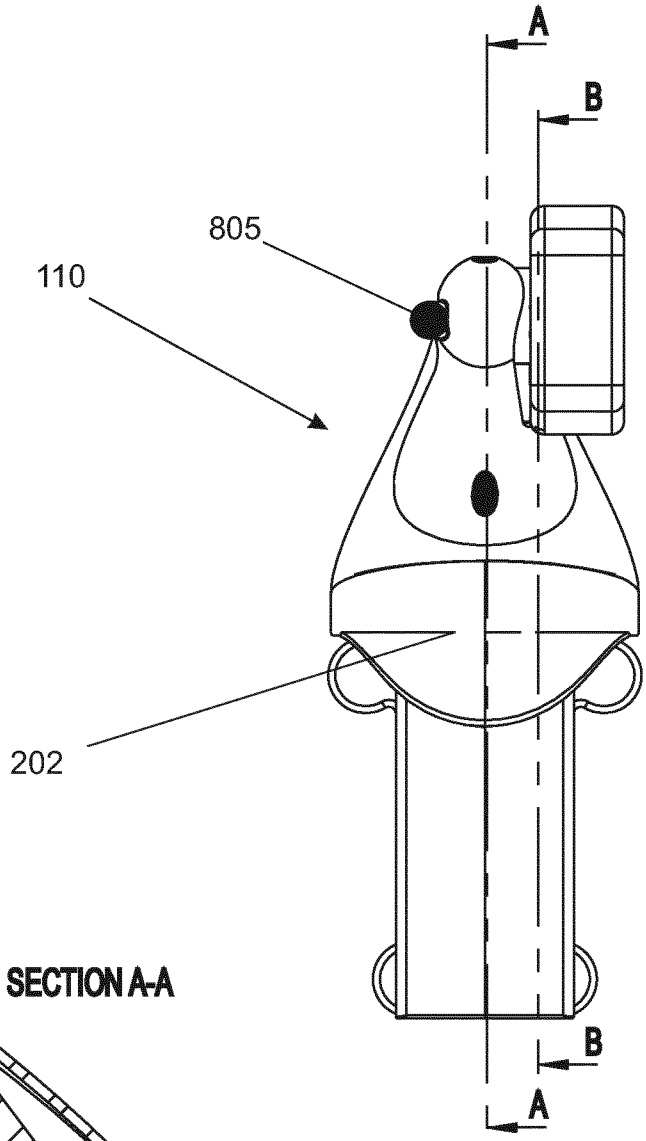


FIG 10

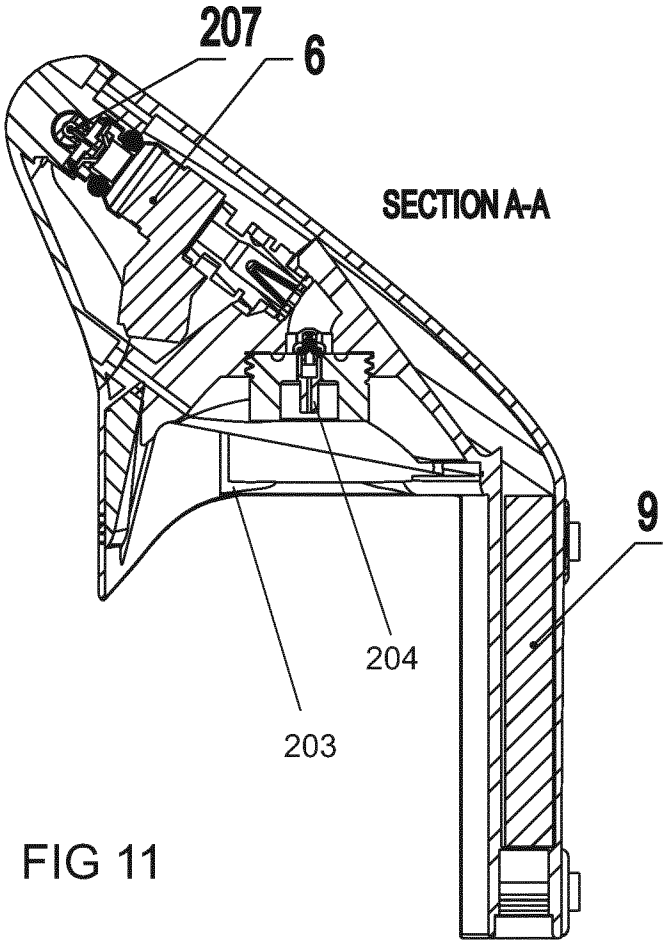


FIG 11

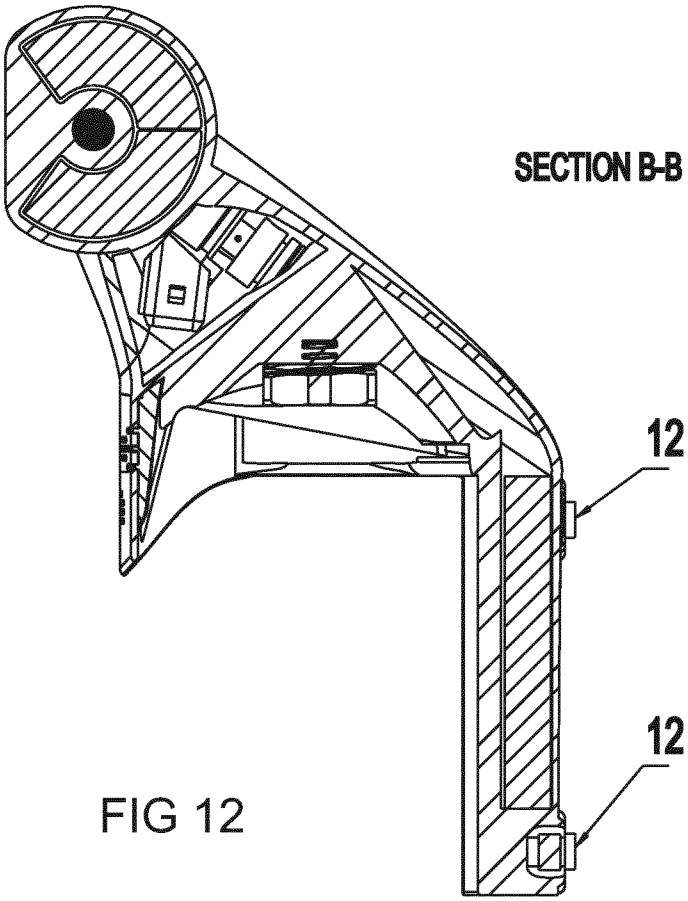


FIG 12

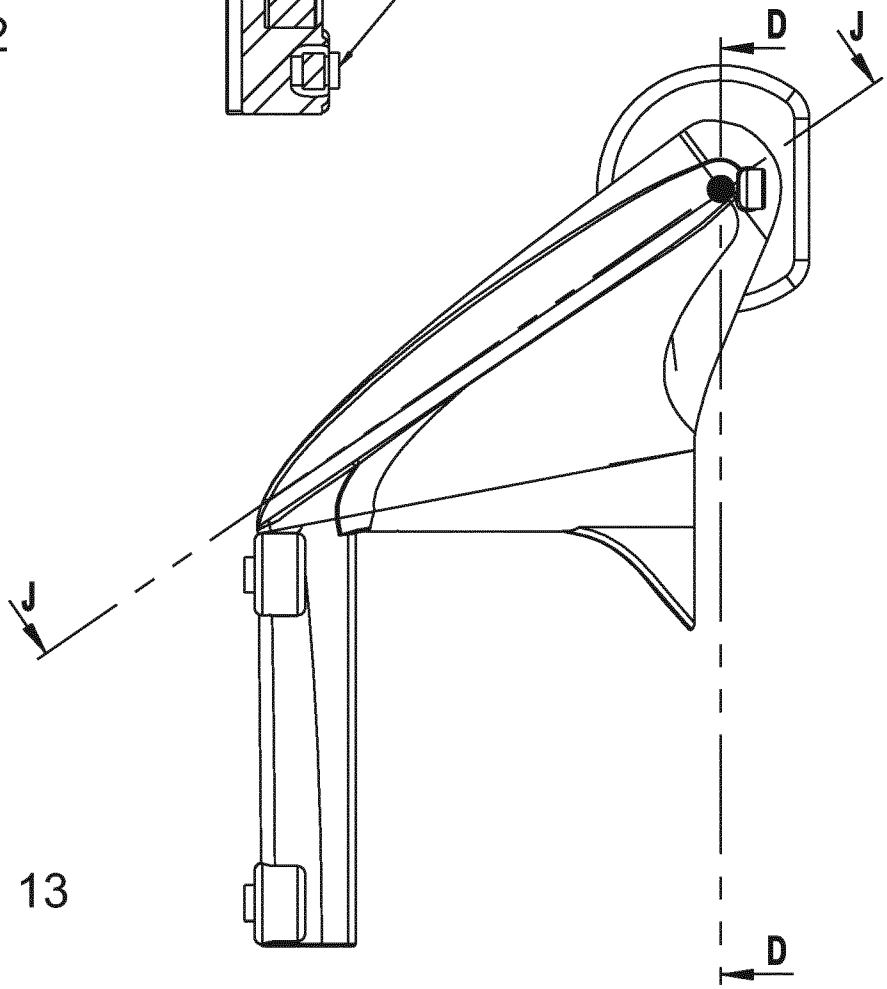


FIG 13

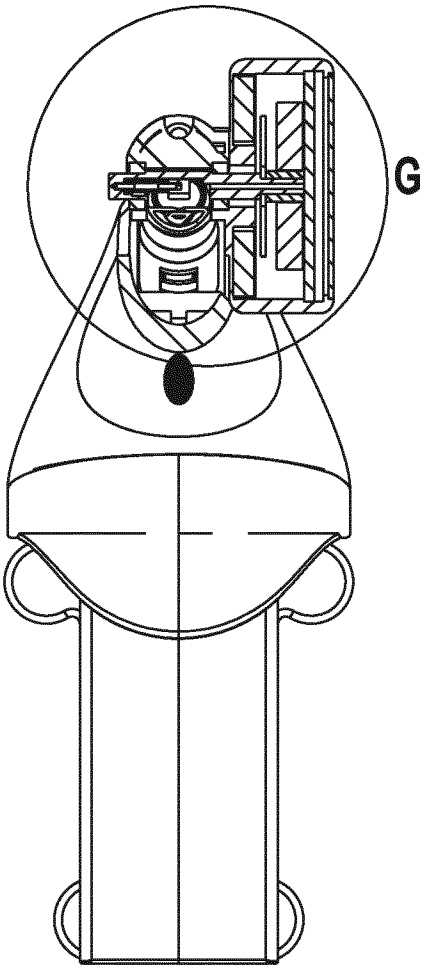


FIG 14

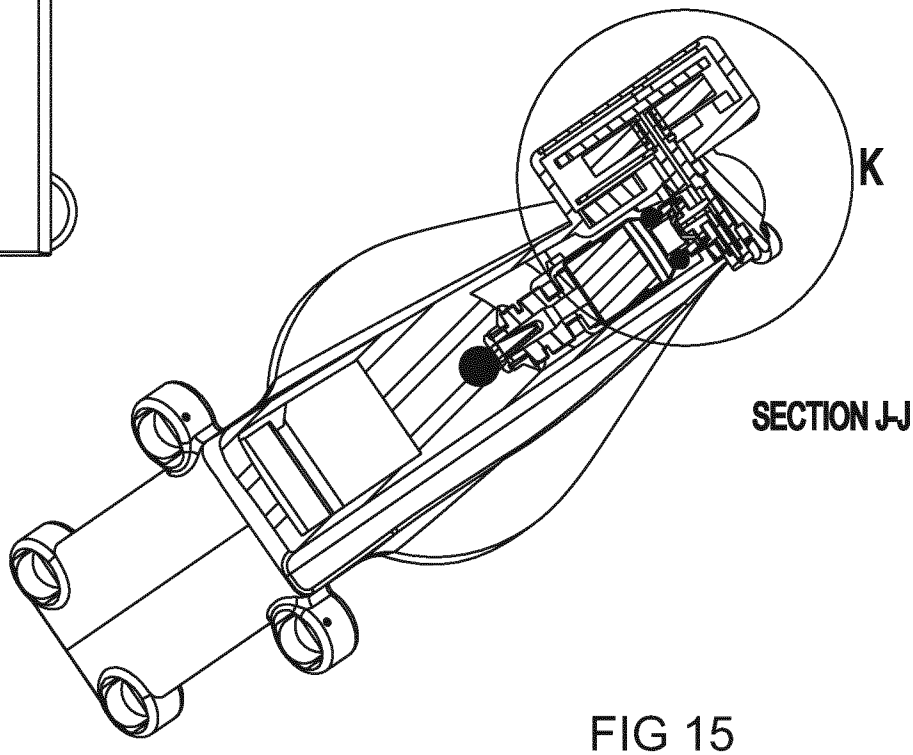
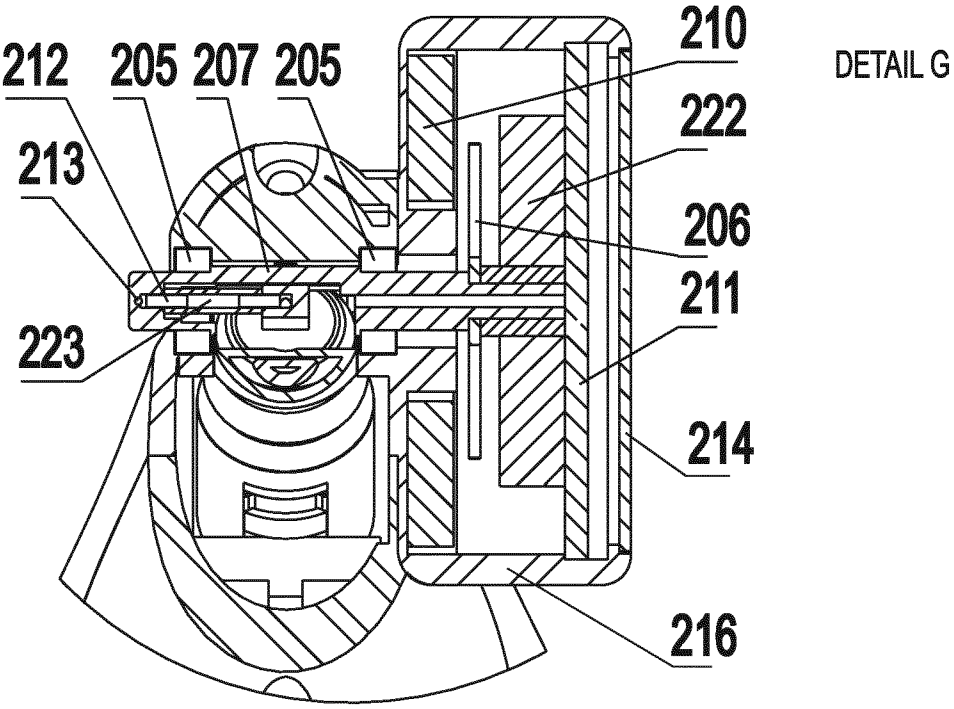


FIG 15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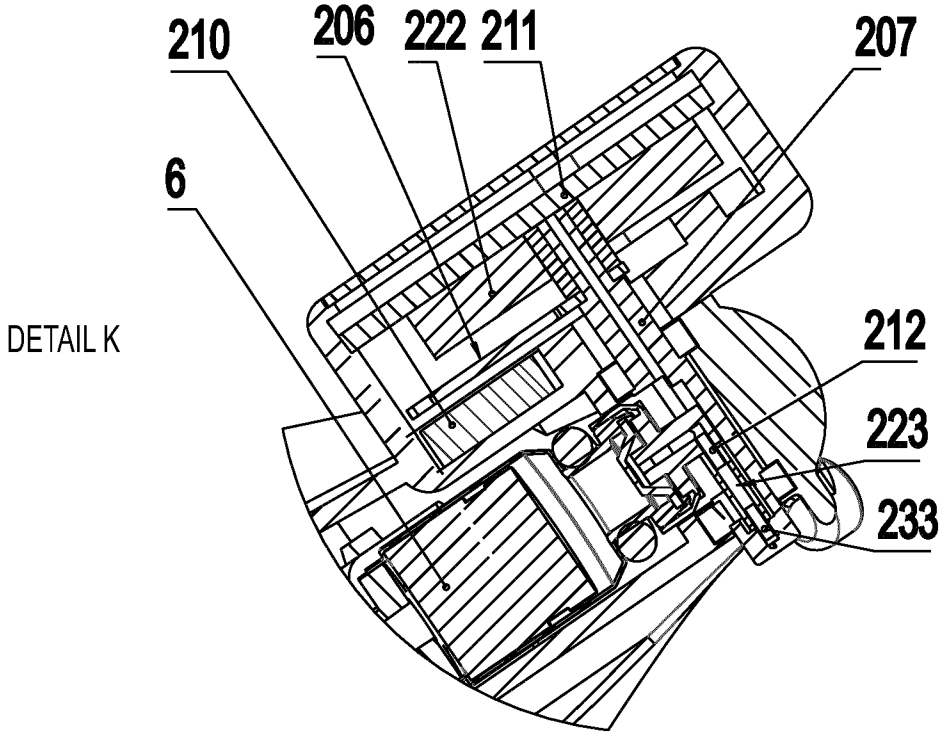
223
214
216
DETAIL G

FIG 16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212
223
233
DETAIL K

FIG 17

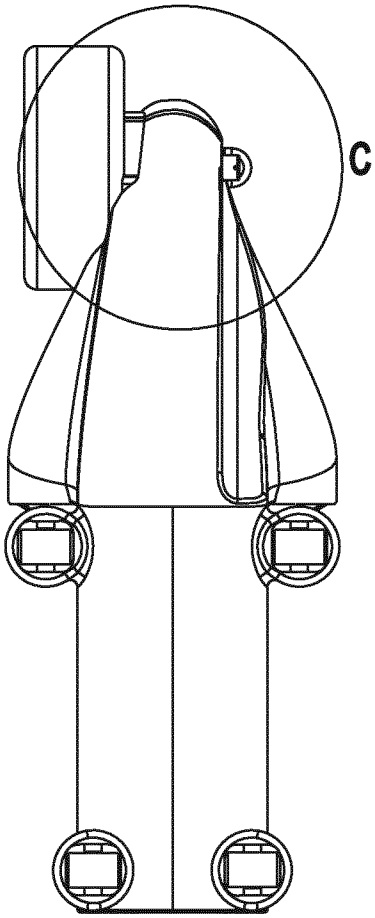

FIG 18

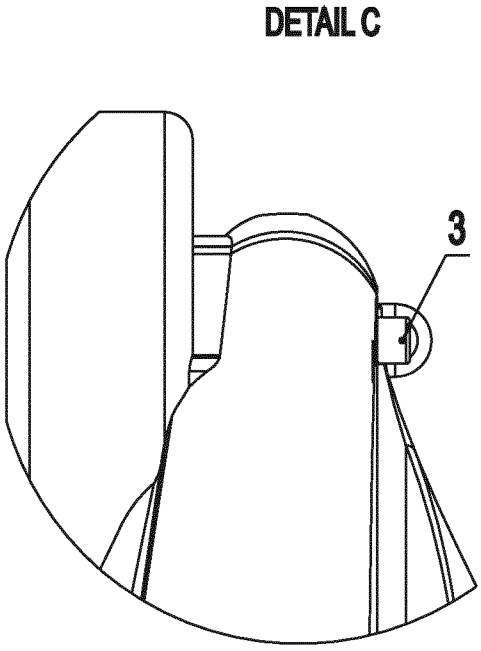

FIG 19

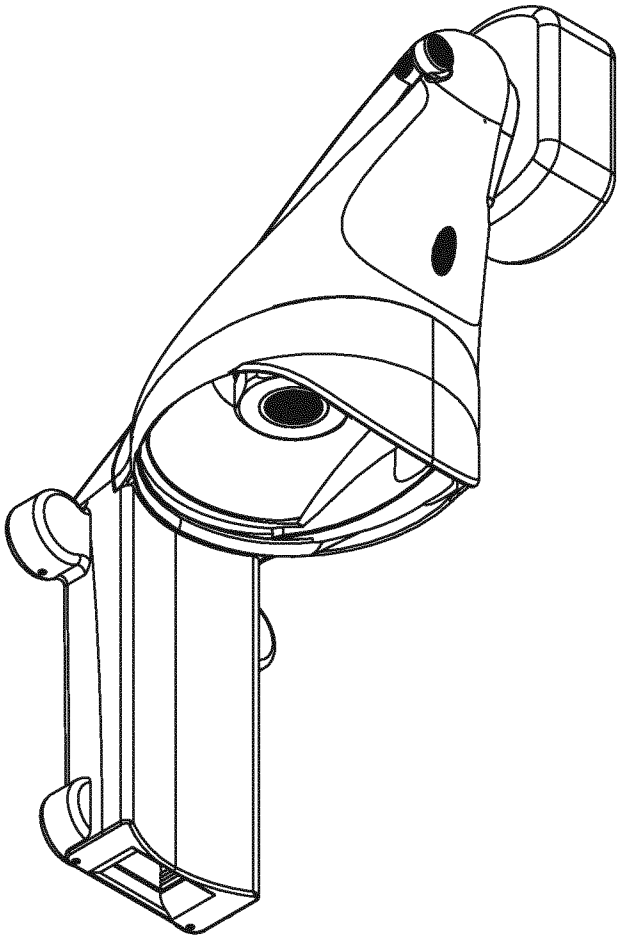

FIG 20

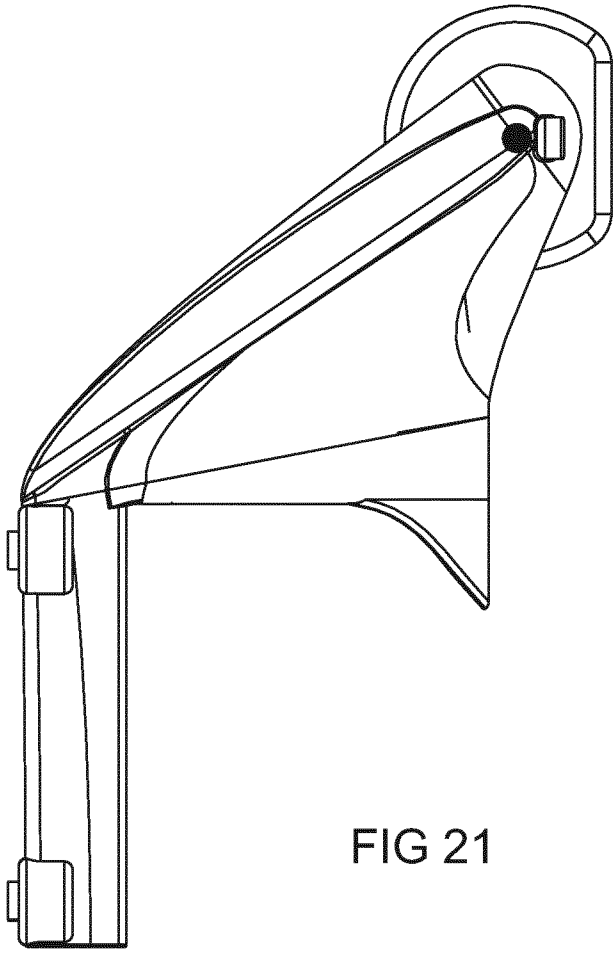

FIG 21

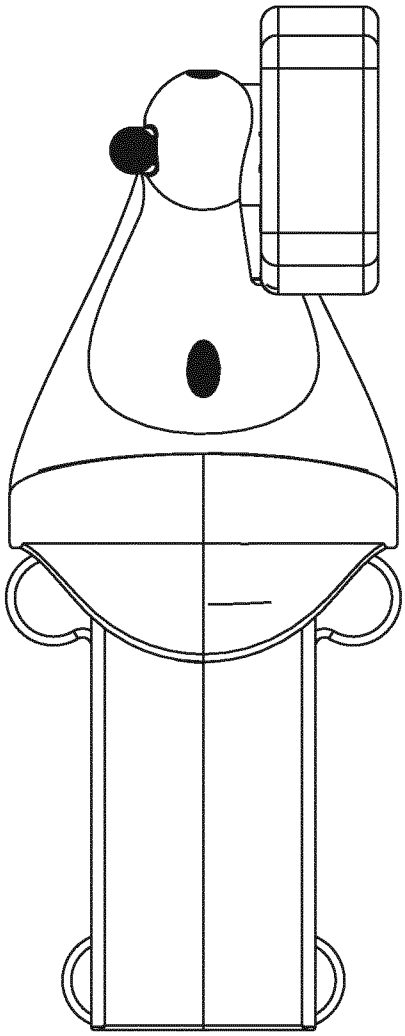

FIG 22

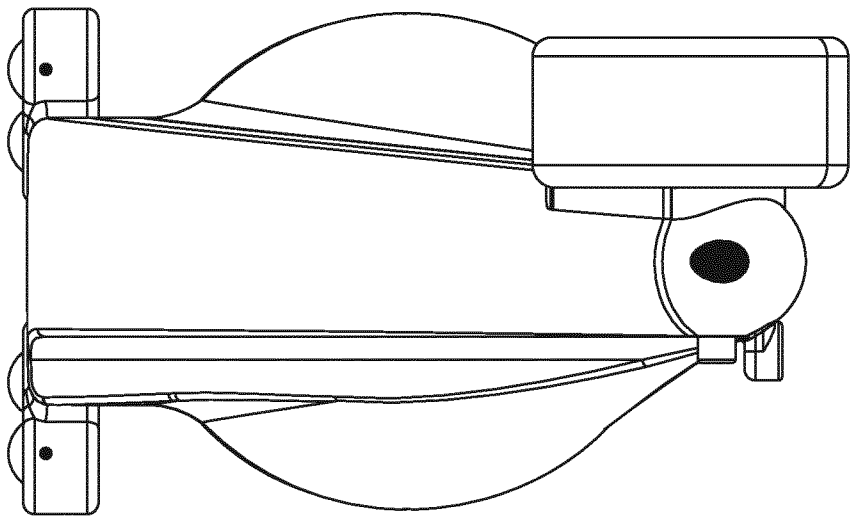

FIG 23

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/060589

A. CLASSIFICATION OF SUBJECT MATTER
INV. B05B12/00 B05B1/14 B05B12/12 B65D83/20
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)
B05B B65D

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	EP 2 641 661 A1 (HEXAGON TECHNOLOGY CT GMBH [CH]) 25 September 2013 (2013-09-25) abstract; figures 1,6-8 paragraph [0171] - paragraph [0184]	1-13
A	US 5 868 840 A (KLEIN II RICHARD J [US] ET AL) 9 February 1999 (1999-02-09) the whole document	1-29

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

☒ See patent family annex.

* Special categories of cited documents :

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"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

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"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
23 June 2017	12/07/2017

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	Moroncini, Alessio

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2017/060589

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2641661 A1	25-09-2013	BR 102013005874 A2	04-08-2015
		CA 2809876 A1	20-09-2013
		CN 103317846 A	25-09-2013
		EP 2641661 A1	25-09-2013
		KR 20130106785 A	30-09-2013
		KR 20150086219 A	27-07-2015
US 5868840 A	09-02-1999	NONE	