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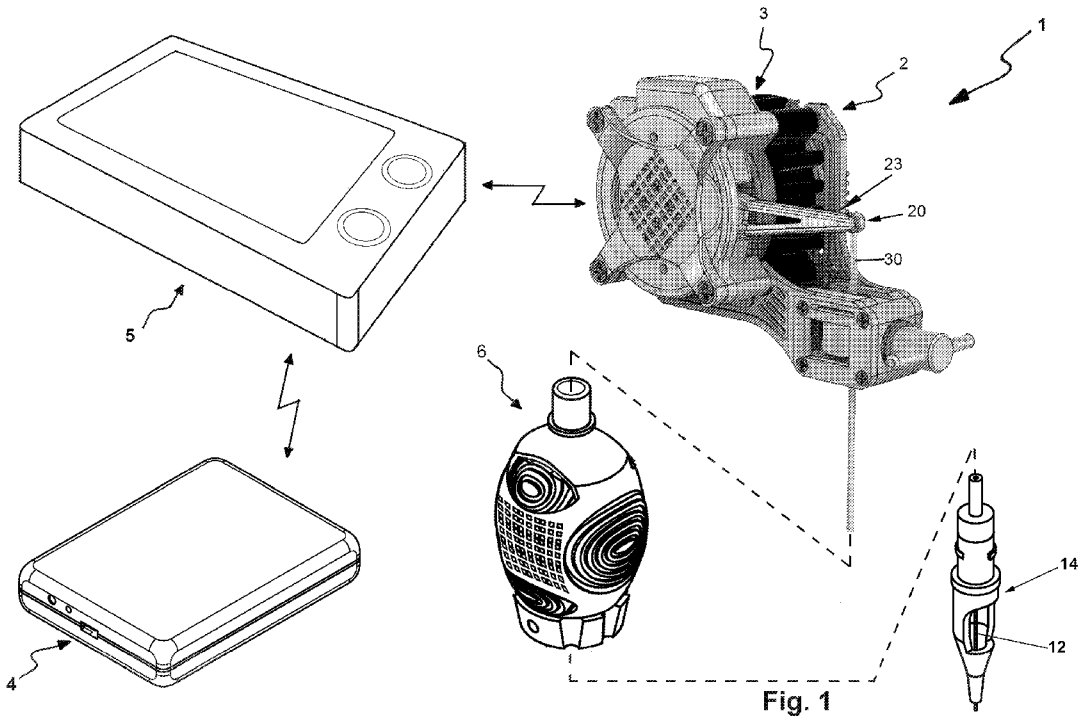

Fig. 1

(57) Abstract: System (1) for tattooing a skin surface comprising a tattoo machine (2) with an electric actuating means (3) for moving a needle (12) of a cartridge (14), and a control unit (5) comprising a microcontroller adapted to generate pilot signals for commanding the electric actuating means (3) in order to move the needle (12) by an oscillatory motion having a period (T), the control unit (5) being configured to receive control signals and values of setting parameters adapted to initialize said the machine (2), the control signals comprising electric consumption signals of the electric actuating means (3) and signals regarding the position of the needle (12) with respect to the cartridge (14), the microcontroller processing the control signals and values for generating pilot signals in order to control the period (T) of the oscillatory motion of the needle (12). A method of tattooing a skin surface is also provided.

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TITLE: "SYSTEM FOR TATTOOING A SKIN SURFACE, AND CORRESPONDING METHOD"

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FIELD OF THE INVENTION

The present invention refers to a system for tattooing a skin surface, provided with at least one tattoo machine.

The present invention refers also to a method of tattooing a skin surface of a person or animal.

PRIOR ART

It is known that a tattoo is obtained by three common types of stroke: "line", "shading", and "filling" which are made by a needle or a group of needles dipped into suitable inks. Nowadays, tattoos are obtained by machines, known also as "guns", which enable to automatically move the needle. Substantially, the machines are of two types and are mainly distinguished according to the employed mechanics: "coil" machine or "rotary" machine.

The "coil" machines comprise one or more electromagnetic coils fixed to a frame and actuated for controlling the displacement of a hammer, known also as bar, to which a sliding element is hooked which transfers the motion to a needle or a needle group. The hammer manages the needle motion with respect to a ferrule of a cartridge, particularly the length of the travel and the frequency, which are the features enabling to adjust the "softness" by which the needle or the needle group are inserted under the skin. The travel of the hammer is adjusted by a contact screw and by the supply voltage or by a value of the supply voltage.

The contact screw and the value of the supply voltage are manually adjusted, and the settings depend on the skillfulness and

experience of the tattooer. Moreover, the tattooers must provide two or more suitably calibrated machines, in order to sequentially inscribes different types of strokes.

The rotary machines use an electric motor and commutation means for moving the needle or the group of needles. The frequency of the needle or needles is controlled by varying the value of the supply voltage, while the travel of the needle or needles is adjusted by adjustment screws or by substituting part of the commutation means.

With reference to the types of strokes and the respective frequencies, a possible adjustment calibrates the operative frequency in a range comprised between 100 and 140 Hz.

The travel of the needle depends on factors such as:

-hardness, resiliency, and thickness of the skin which vary according to the zone to be tattooed and/or subject to be tattooed;

-the type of the drawing to be tattooed with reference to the ink amount and how the ink is released,

Some known approaches are described in the U.S. patents US2011/0288575 A1 (Colton et al.) regarding a wireless system for applying tattoos, and N° US2016/0121093A1 (Fan-Mei-Chi-Na Hsinyen Co., Ltd.) regarding a wireless tattoo apparatus.

Adjusting the prior art machines is not easy and quick and is subjected to the sensibility of a tattooer. Coarse settings, approximate adjustments and calibrations in relation to the skin of a subject to be tattooed, compromise the quality of the obtained tattoo.

Due to the above mentioned reasons, the machines and systems

of the prior art are substantially a tradeoff solution and as such are not completely satisfying with reference to the quality of the obtained tattoo and the pain inflicted to the tattooed subject during a tattooing session.

The technical problem underlying the present patent application consists of devising and making available a system for tattooing a skin surface having structural and operative characteristics such to meet the required needs, overcoming the inconveniences cited with reference to the prior art.

A further object of the present invention consists of piloting in a controlled way the motion of the needle for increasing the efficiency of the machine and for making easy and efficient the adjustment without requiring a particular technical knowledge.

Another object consists of reducing the tears in the tattooed skin and consequently the pain feeling.

BRIEF SUMMARY OF THE INVENTION

The solution idea forming the basis of the present invention is that of actuating and precisely controlling the motion of the needle when a tattoo is inscribed, and of improving the sharpness of the obtained stroke without impairing the characteristic of a simple adjustment of the machine.

Based upon such a solution idea, the technical problem is solved by a system comprising at least one tattoo machine provided with electric actuating means for moving at least one needle of a cartridge, and comprising a control unit provided with a microcontroller, the microcontroller being adapted to generate pilot signals for commanding the electric actuating means in order

to move said at least one needle by an oscillatory motion having substantially a period (T), the control unit being configured to receive control signals and values of setting parameters adapted to initialize said at least one machine, the control signals comprising electric consumption signals of said electric actuating means, and signals regarding the position of said at least one needle with respect to the cartridge, the microcontroller processing the control signals and the values of the setting parameters for generating said pilot signals in order to control said period (T) of said oscillatory motion of said at least one needle.

Advantageously, the electric actuating means is a controlled-motion type motor and the microcontroller comprises a timed counter adapted to generate said at least one pilot signal for clockwise and counterclockwise piloting the motor with respect to an initial position.

In an embodiment, the system comprises a voltage regulator interposed between a power supply and a PWM modulator having a pulse width modulation, the PWM modulator being configured to pilot a rotary machine by a first command signal and/or to pilot a coil machine by a second command signal, the microcontroller being configured to generate a first pilot signal adapted to pilot said voltage regulator, and a second pilot signal adapted to pilot the PWM modulator.

Advantageously, a sensing unit is associated to the microcontroller and is configured to sense the second command signal and to generate a corresponding sensing signal, the

microcontroller processing the sensing signal for obtaining operative parameters of the coil machine and for generating, based on said operative parameters, the first pilot signal and second pilot signal.

Preferably, a sensing module provided with at least one capacitive touch sensor, is configured to receive at least one grip signal output from a machine associated to the microcontroller, the sensing module being configured to generate a first enabling signal for enabling the microcontroller to output the pilot signals.

Advantageously, an actuating pedal is provided with at least one load cell and is configured to generate at least one activating/deactivating signal corresponding to a pressure received on the outer surface of the actuating pedal in order to activate/deactivate the machine based on said activating/deactivating signal.

The technical problem is also solved by a method of tattooing a skin surface comprising: using at least one tattoo machine provided with an electric actuating means for moving at least one needle of a cartridge; and comprising commanding the electric actuating means by a control unit provided with a microcontroller, said microcontroller generating pilot signals for commanding said electric actuating means in order to move said at least one needle by an oscillatory motion having substantially a period (T); receiving values of setting parameters and control signals adapted to initialize said at least one machine, said control signals comprising electric consumption signals of said electric actuating

means, and signals regarding the position of said at least one needle with respect to said cartridge, and processing the setting parameters and control signals for generating the pilot signals in order to control said period (T) of said oscillatory motion of said at least one needle (12).

Advantageously, the method provides to electromechanically reset the machine, initialize a timed counter associated to said microcontroller based on said initial values of said setting parameters, and process said values of said setting parameters by a first operative mode (Mode1) or a second operative mode (Mode2), wherein:

- the first operative mode (Mode1) uses initial frequency and Duty-Cycle values for determining a downward speed and an upward speed of said needle during a period (T) of said oscillatory motion,

- the second operative mode (Mode2) uses said initial frequency (f) and Duty-Cycle values for determining an upper idle time and a lower idle time of said at least one needle during said period (T) by providing a downward speed and an upward speed of said at least one needle substantially equal to a predetermined constant value;

- generating said pilot signals based on the first operative mode (Mode1) or on said second operative mode (Mode2).

Suitably, it is provided to command the machine by piloting a driver adapted to command the electric motor and/or to command at least one rotary machine and/or at least one coil machine by piloting a PWM modulator having a pulse width modulation and a

voltage regulator by respectively a third pilot signal and fourth pilot signal generated by the microcontroller.

Moreover, the method provides to sense a second command signal adapted to command the coil machine and to generate a sensing signal based on the second sensed command signal and to generate the third pilot signal and fourth pilot signal by using a self-adjusting algorithm of the voltage as a function of the sensing signal.

The characteristics of the system for tattooing a skin surface and of the method according to the present invention, will appear from the following description of an embodiment example given in an indicative non-limiting purposes with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In such drawings:

- Figure 1 illustrates a perspective schematic view of a system implemented according to the present invention in an embodiment;

- Figure 2 schematically illustrates a block diagram of the system of Figure 1;

- Figure 3 illustrates a block schematic view of some operative modes of a machine commanded by a control unit implemented according to the present invention;

- Figure 4 schematically illustrates a block diagram of an actuating pedal associable to a system made according to the present invention;

- Figure 5 schematically illustrates a block diagram of a

system implemented according to the present invention in a further embodiment.

DETAILED DESCRIPTION

With reference to such figures, 1 illustrates a portable system for tattooing a skin surface, according to the present invention in a first embodiment.

The system 1 comprises at least one tattoo machine 2 provided with an electric actuating means 3 mechanically associated to a support or supporting frame 10. A transmission member 20 is associated to said electric actuating means 3 for moving, by an oscillatory motion, at least one needle 12 of a cartridge 14. The cartridge 14 is substantially provided with a tubular-shaped container, comprising the tattoo needle 12 or a group of tattoo needles 12, associated to an elastic return or spring element inside the cartridge 14. A handle or grip 6 is interposed between the support 10 and cartridge 14. In an embodiment, the handle 6 is removably associable to the machine 2 for being gripped by the hand of the tattooer.

The control unit 5, provided with a microcontroller 50, is configured to receive control signals and values of setting parameters 60 regarding the machine 2, for processing the received control signals and the values of the setting parameters 60 with reference to a required operative mode of the machine 2 and to output at least one pilot signal, Dr and Com, for commanding the electric actuating means 3.

In an embodiment, the electric activation means 3 is an electric motor preferably a controlled-motion motor of the type:

a stepper motor, for example a linear induction motor, a piezoelectric motor or a voice coil motor. Such types of motors are controlled by a driver 54 piloted by first pilot signals Dr generated by the microcontroller 50.

In the present embodiment, the stepper motor 3 does not perform complete rotations, but is commanded by means of the microcontroller 50 to perform an oscillatory motion with respect to an initial position adapted to generate the oscillatory motion of the needle 12.

In the following description, a controlled-motion machine 2 comprises a controlled-motion motor. In the described example, the electric actuating means is a stepper motor 3.

In the embodiment illustrated in Figure 1, the commutation means 20 comprises a commutator arm 23 which is keyed to a rotation shaft of the stepper motor 3 and is coupled, at an opposite end, to an idle rod 30 associated to the needle 12. The idle rod 30 is rotatively idly pivoted to the commutator arm 23. At the opposite end, the idle rod 30 is axially associated to the cartridge 14 and is coupled to the needle 12.

The stepper motor 3 commands a clockwise and anticlockwise rotation of the shaft with respect to the initial position, for a predetermined number of positions, generating an alternating rotary motion. Due to the commutation means 20, the needle 12 is moved by a controlled oscillatory motion substantially of period T. Particularly, the needle 12 is moved by a substantially rectilinear oscillatory motion.

As illustrated in Figure 2, the microcontroller 50 outputs first

pilot signals Dr to the driver 54, and the driver 54 is configured to command the stepper motor 3 by second pilot signals Com.

The setting parameters 60 of the controlled-motion machine 2 comprise:

- an initial point Pin [mm] of the needle 12, travel initial position, a position directly set by the tattooer;

- travel [mm] of the needle 12, in other words the distance from the initial point Pin to the final point Pfin reached during the oscillation of the needle 12. The travel value is directly set by the tattooer;

- Duty-Cycle [%] of the motion of the needle 12 during the oscillation period T, which defines the residence time of the needle 12 above or below the skin, or the downward speed or upward speed of the same;

- oscillation frequency f [Hz] of the needle 12.

The indicated setting parameters 60 vary as a function of the used tattooing technique and/or of the stroke to be inscribed. Such setting parameters 60 depend also on: skin density of the zone to be tattooed, conformity of the part of the body to be tattooed, environment temperature, number and size of the used needles 12.

In the present embodiment, the microcontroller 50 is configured to process the received data and initial values of the setting parameters 60 by a first operative mode Mode1 or a second operative mode Mode2, as schematically illustrated in Figure 3.

In an embodiment, the operation of the microcontroller 51 provides to:

- assign 61 initial values to said setting parameters 60 according to the values set by the tattooer;

- select 62 the first operative mode Mode1 or the second operative mode Mode2 and process said values of the setting parameters 60 for generating and outputting corresponding first pilot signals Dr to the driver 54 for commanding the stepper motor 3. Particularly, by the two operative modes Mode1 or Mode2, the tattooer can vary the speed and the idle time of the needle 12 with respect to the Duty-Cycle and oscillation frequency f set by a first processing 63 or second processing 64. The operative modes Mode1 and Mode2 will be more specifically described in the sub-paragraph: "Operative Modes Mode1 And Mode2".

In an embodiment, the microcontroller 50 is associated to one or more data and/or setting parameters storage means 60, such means are schematically indicated by number 52.

Moreover, the microcontroller 50 comprises a counter implemented in the firmware using a timer for precisely timing the advancement of the steps of the stepper motor 3 both clockwise and anticlockwise with respect to an initial position.

A digital pulse of a square wave period timed by a known "timer interrupt", enables to advance the stepper motor 3 by a step in the direction indicated by the Boolean variable and at the attainment of a predefined final step, inverts the motion direction and the state of the variable itself.

A displaying device 8, which in an embodiment provides an LCD display and a touch screen provided with a graphic interface, is coupled to the control unit 5 and particularly to the

microcontroller 50. The displaying device 8 is configured to receive the values of the setting parameters 60 set by the tattooer. Moreover, the displaying device 8 enables to activate/deactivate the machine 2, to insert or display the data processed by the microcontroller 50 and the values of the setting parameters 60 input and/or stored in said storage means 52 and/or in further external storage means 59.

Additional modules can be associated to the microcontroller 50 e.g. for example Bluetooth 57', Wi-Fi modules 58, and modules 59 for an USB connection or to be connected to an external memory of the micro SD-card type for filing data. Further, one or more auxiliary connecting channels 58', for further control peripherals, can be provided and connected to an input of the microcontroller 50.

The system 1 is supplied by a DC main electric network 53 by interposing an electric commutator module 56. Further modules can be provided and coupled to the electric commutator module 56 for a voltage modulation and/or a pulse width modulation (PWM) of the supply signal.

The electric commutator module 56 is activated by the microcontroller 50 by an activation signal for suitably supplying the driver 54 through an output OUT. Preferably, by a bus associated to an output BUS-U, the microcontroller 50 outputs the first pilot signals Dr to the driver 54.

In an embodiment, a lighting device 9, preferably a LED, provided with a driver, is associated to the controlled-motion machine 2 and is activable and the intensity is automatically

adjustable by the microcontroller 50 for suitably lighting the part to be tattooed.

By activating the system 1, the microcontroller 50 and machine 2, and particularly the motor 3 and commutation means 20 are electromechanically reset. In an embodiment, the commutation means 20 are positioned in a stop position, the counter is initialized and the functions controlling the motion of the motor and needle 12 of the machine 2 are selected and set.

Then, the microcontroller 50 outputs the pilot signal Com for commanding the stepper motor 3 to position the needle 12 at the initial point Pin. When the tattooer turns on the system 1, by for example interacting with the display of the displaying device 8, by an activation screen, the system 1 is supplied and the stepper motor 3 is commanded by the microprocessor 50 by the driver 54 and according to the operative modes Mode1 and Mode2 set by the tattooer. The oscillatory motion of the stepper motor 3 is transmitted to the needle 12 by the commutation means 20 for generating an oscillatory controlled-motion having substantially a period T. The oscillatory motion of the needle 12 being substantially an oscillatory rectilinear motion.

When the tattooer uses the machine 2, the microcontroller 50 receives control signals from the machine 2 and processes such control signals for generating in a controlled way at least the first pilot signal Dr. In an embodiment, the control signals comprise, for example, a signal regarding the position of the needle 12, the electric consumption and the position of the stepper motor 3, for example by using a suitable encoder not illustrated

in the figures, and other analogous signals.

According to an embodiment, the system 1 further comprises an actuating pedal 4 provided with at least one load cell 42 and a further microcontroller 43 which are interfaced by an analog-digital converter A/D 44. Preferably, the A/D converter is of the 24-bit type. The load cell 42 and the further microcontroller 43 enable to translate the pressure exerted by the tattooer on the external surface of the actuating pedal 4 in respective pressure signals B1 enabling to define activation/deactivation signals directed to the microcontroller 50 for activating/deactivating the machine 2.

The actuating pedal 4 comprises a battery element 47, preferably a lithium battery and a charge regulator module 46 adapted to supply a microcontroller 43. The battery element 47 is associable to an electric supply network 53 to be recharged by means of the charge regulator 46.

A voltage regulator 48, connected to the battery element 47, adjusts the value of the supply voltage by adapting it for correctly supplying both the microcontroller 43 and all the active connected modules. An on/off button 49 and a state indicator 45, and also further auxiliary modules, can be provided. In an embodiment, the actuating pedal 4 wirelessly communicates with the processing unit 5 by a Bluetooth module 57 suitably interfaced with a further Bluetooth module 57' associated to the microcontroller 50.

The actuating pedal 4 provided with at least one load cell 42 is precise, reliable and more user-friendly for the tattooer which

can also adjust the level of the sensibility to the pressure on the pedal 4 for activating the machine 2.

In a further embodiment illustrated in Figure 5, the control unit 5 and particularly the microcontroller 50 are configured to command one or more controlled-motion machines 2 and/or at least one machine made according to the prior art, in other words a rotary machine 90 and/or a coil machine 91, of the standard type or corresponding to them. The control unit 5 comprises the electric commutator module 56 provided with a further output OUT1 activable by further activation signals output by the microcontroller 50.

A PWM modulator 95 with a pulse width modulation and a variable voltage regulator 96 are arranged in cascade to each other and are piloted respectively by a third pilot signal S1 and by a fourth pilot signal S2 output by the microcontroller 50. The PWM modulator 95 outputs a first command signal C1 which, through a first output 01, is delivered to the rotary machine 90. A second command signal C2 is suitably output and, through a second output 02, is delivered to the coil machine 91.

The first command signal C1 and second command signal C2 are voltage-adjusted by the regulator 96 preferably in a voltage range. In an embodiment, the voltage range is from 2V to 18V. In addition, the first command signal C1 is modulated by a pulse width modulation (PWM) by the PWM modulator 95.

Moreover, the second command signal C2 can be frequency-modulated by adjusting the excitation timing of the coils. Consequently, the control unit 5, according to the present invention, enables to also command the coil machines 91 of the

"contactless custom" type. In an embodiment, the third pilot signal S1 and fourth pilot signal S2 can be manually modified by the tattooer, through the displaying device 8.

The pulse width modulation (PWM) of the first command signal C1 enables to more precisely and efficiently adjust the rotary power of the rotary machine 90, for obtaining a substantial increase of the motive force at a low number of rounds, and consequently a reduction of the wear of the mechanical parts, an improvement of the reactivity of the rotary machine 90, and a proper start for any condition of use.

An analysis system is for determining the parameters used by the tattooer both for performing a correct "tuning" of the machine itself, and for checking the correct selection among the machines suitable for the type of the stroke to be tattooed.

Suitably, a sensing unit provided with at least one current sensor 97 is interposed between the second output 02 of the PWM modulator 95 and the coil machine 91 and is associated to the microcontroller 50 by an amplifier 98 for sensing the instantaneous consumption. In an embodiment, the current sensor 97 generates a sensing signal Ds, the microcontroller 50 samples, preferably at regular intervals, the received sensing signal Ds for determining the trend of the current instantaneous consumption in a respective electric period T', in other words the time lapsing between a contact and a successive contact between two poles, defined by the tab and by the pin of the coil machine 91. The microcontroller 50 analyzes the data, in other words the samples sensed by the sampling step, and obtains operative parameters of said coil

machine 91, e.g. the period T' of the pulses and a Duty-Cycle value tied to the period T'.

Moreover, an offset parameter ST, expressed as a percentage, is obtained by analyzing the samples in the period T' of the sensing signal Ds. The offset parameter ST represents the offset of the voltage between the command signal C2, the sensed voltage V_R with respect to an effective value V_E of the voltage required for an optimal operation of the employed coil machine 91.

A voltage self-adjusting algorithm is used for voltage adjusting the command signal C2 by adjusting the third pilot signal S1. Specifically, the command signal C2 can be subjected to a voltage variation from a minimum value proximate to 2V to a maximum value set by the user, for example 18V. A continuous sampling in a time range Δt of the parameters ST for one or more periods T of the needle 12 travel and a processing of such sampled values, enables to determine the voltage effective value V_E. This processing enables to determine a minimum value of the offset parameter ST and to obtain an ideal tuning or an automatic adjustment of the coil machine 91. In comparison with a manual setting of the supply voltage value of the machine 2, which is usually not very precise and subjected to the sensibility of the tattooer, it is possible to automatically obtain a more constant and precise oscillation frequency of the needle 12, by improving the execution of a stroke. This enables to increase the efficiency and reduces the energy consumption.

A diagram of the trend of the instantaneous current consumption is also shown on the graphic interface, as an analysis

instrument, for visually obtaining the trend of the electric consumption and a possible offset of the offset parameter ST in order to make easier a possible manual adjustment.

In an embodiment, the control unit 5 comprises a sensing module 7 provided with a capacitive touch sensor 7a configured to receive touch signals or grip signals of a capacitive dynamic type from at least one button and/or ground planes of each machine 2, 90 and 91 associated to and commanded by the control unit 5. The sensed module 7 can also receive further signals for common and auxiliary functions.

The grip signals are processed by the sensing module 7 for automatically sensing when a machine is gripped by a tattooer, by outputting corresponding signals A1, A1', A1" to the microcontroller 50.

According to an embodiment, the microcontroller 50, based on the received signal A1, A1', A1", shows on the display of the displaying device 8 a control screen corresponding to the gripped machine among machines 2, 90 and 91.

In an embodiment, a commutator 99 is associated to the electric actuating means 3 of each controlled-motion machine 2 or rotary machine 90 or coil machine 91. Each commutator 99 is uniquely activated by a corresponding signal selecting the outputs ID, received from a bus 123 connected to an output OUT-bus of the microcontroller 50 for a selective enabling. The selection signal of the outputs ID is generated by processing the signals A1, A1', A1" from the sensing module 7 or from a manual selection on the interface of the displaying device 8.

In an embodiment, the firmware of the control unit 5 enables to create, modify, cancel, and save the so-called "quick presets" categorized according to the type of use, e.g. "line", "shading", "filling", and "custom". Each quick preset contains all the operative parameters directly tied to the execution of a tattoo, categorized according to the type of the useable machines, e.g.: operative mode in other words the operative mode MODE1 or MODE2, the oscillation frequency f, "initial point Pin", travel of the needle 12 and Duty_cycle for the controlled-motion machines 2; "voltage" and "beating frequency (excitation timing)" for the coil machines 91; "voltage" and the pulse width modulation or PWM modulation for the rotary machines 90.

Moreover, the firmware manages the operation of the external memory, specifically an external memory 58 of the micro SD-Card type enables to store indexable files by user name, containing the group of the quick presets for each user; these banks of parameters could be afterwards recalled for following sessions of the same customers. The presets can be downloaded in a computer for modifying the parameters, adding observations, make statistics and create a file of the customer sheets.

The firmware is adapted to support Wi-Fi connections for receiving informative messages, for gaining access to files contained in the external memory 58 of the micro SD-Card type and is adapted for possible additional future functions. It is also provided a connection by Bluetooth modules 57' enabling to associated Bluetooth devices BLE, as the actuating pedal 4 or the "BlackOverLab Rotary wireless", to the control unit 5.

In an embodiment, a local device 200, which is in communication with the control unit 5 and is connected to a remote server 250, can start a wired or wireless transmission for the first guided activation or for updating the firmware of the control unit 5. Particularly, the device 200 comprises a software developed also to be shared by several platforms adapted to interface the control unit 5 to the remote server 250. Specifically, the remote server 250 verifies the user ID and the respective serial numbers, present in the control unit 5, and in an affirmative way, delivers an activation/updating signal to the control unit 5.

The activation signal defines a writing of new operative firmware labeled with the user ID, which enables to activate the control unit 5 by substantially implementing a first safety system.

In a further embodiment, a second safety system can be activated every time the control unit 5 is turned on. Particularly, every time the control unit 5 is turned on, it is verified if the unique serial codes, identified also as a hardware key, associated to the control unit 5 itself, match the respective serial codes stored in the memory 52. If they match, the control unit 5 is made accessible, otherwise is blocked.

In an embodiment, before the first activation, by means of the sensing module 7, the control unit 5 starts by enabling the use of the controlled-motion machine 2 and/or rotary machine 90 and/or coil machine 91 gripped by the tattooer. In this case, the displaying device 8 shows a screen loading a predefined menu by which the values of said setting parameters 60 can be modified, recalled or input.

At each turnoff sensed by the sensing module 7, the microcontroller 50 will save, in an EEPROM memory, all the setting parameters corresponding to: the controlled-motion machine 2 (setting parameters 60), coil machine 91 and rotary machine 90.

Under an operative mode, the values of the setting parameters 60 are changed also during the operation of the corresponding machines.

The firmware and hardware can be suitably modified according to specific needs.

OPERATIVE MODES MODE1 AND MODE2

According to an embodiment, the first operative mode Mode1 provides to calculate the following values [µs]:

- a first time among successive downward steps, calculated by:

*{[(100-Duty-Cycle)/100]*range/total number of steps} + Minimum time required to perform 1 step}*

- a second time among successive upward steps, calculated by:

*{[(Duty-Cycle)/100]*range/number of steps} + Minimum time required to perform 1 step}*

- a first upper idle time range (change of direction) calculated by:

[idle minimum time for the change of direction/2]

- a second lower idle time range (change of direction) calculated by:

[idle minimum time for the change of direction/2].

In an embodiment, the second operative mode Mode2 provides to determine the following values [µs]:

- a third time among successive downward steps, equal to:

[Minimum time required to perform 1 step]

- a fourth time between two successive upward steps, equal to:

[minimum time required to perform 1 step]

- a third lower idle time range (change of direction) having formula:

*{[(100-Duty-Cycle)/100]*range} + [(Duty-Cycle)/100)* minimum idle time for the change of direction)}.*

- a fourth upper idle time range (change of direction) having formula:

*{[(Duty-Cycle)/100]*range} + [(Duty-Cycle)/100)*minimum idle time for the change of direction)}.*

By selecting the first operative mode Mode1, the first processing 63 substantially uses the set value of the parameter Duty-Cycle with reference to the set value of the parameter of the oscillation frequency f for defining a downward speed and an upward speed of the needle 12 during the oscillation period T, which is maintained constant. The first processing 63 calculates the time required to perform a single step both in the upward phase and in the downward phase. If the value of "Duty-Cycle" is less than 50%, in order to maintain constant the value during the oscillation period T of the needle 12, it is obtained an increase of the speed value during the downward semi-period Td of the period T and a decrease of the value of the upward speed during the semi-period Ts. The downward speed decreases until it attains the limit case of 0% wherein the downward speed will be equal to the technically possible maximum speed (Vc).

If the value of Duty-Cycle is greater than 50%, the downward Td and upward semi-periods Ts are inversely proportional to the case when the value of Duty-Cycle is less than 50%, as for the speed of the needle 12.

By selecting the second operative mode Mode2, there is a second processing 64 using the set value of the parameter Duty-Cycle with reference to the set value of the parameter of the oscillation frequency f, for defining a lower or under-skin idle time ΔTin, and an upper or over-skin idle time ΔTsup for the needle 12, by considering a downward speed and an upward speed equal to a predetermined constant value Vc. Particularly, it is considered an upward speed equal to the downward speed of the needle 12 and equal to a predetermined constant value Vc. In an embodiment, the predetermined constant value Vc is substantially equal to a technically attainable maximum speed.

If the value of Duty-Cycle is less than 50%, it is obtained a lower idle time ΔTin of the under-skin needle 12 with respect to the idle time ΔTsup of the over-skin needle 12. When the limit case of 0% is attained, the under-skin idle time of the needle 12 will be equal to the minimum time for performing a change of direction of the needle 12.

If the value of the Duty-Cycle is greater than 50%, the idle times will be inversely proportional to the case when "Duty-Cycle" is less than 50%.

Moreover, when the operative mode Mode1 has a Duty-Cycle value equal to 50%, the operation of the controlled-motion machine 2 corresponds substantially to the operation of the conventional

rotary machines 90. When the value of Duty-Cycle is greater or lower than 50%, the emulation approaches the operation of the coil machines 91.

Substantially, the used materials and also the dimensions could be anyone according to the needs.

It is noted that the system and method devised in this way have obtained the task and the prefixed objects by enabling to selectively control the motion of the needle by the processing unit, for an efficient control of the electric actuating means. The speed, frequency, depth and Duty-Cycle of the oscillatory motion of the needle of the controlled-motion machines are controlled for enabling to increase the efficiency of the obtained strokes, lines and shadings, which will be more accurate and sharper. Specifically, processing the values of the setting parameters by the first and second operative modes, enables to optimally adjust the oscillatory motion of the needle, reducing the skin tears for the benefit of the sharpness of the line, point or shading of a tattoo to be made.

Moreover, using the hereinbefore described control unit enables also to have an optimal operation of all the types of the existing conventional machines by manually adjusting the PWM modulator and also by automatically adjusting the supply voltage and/or current.

The invention, so devised, can be subjected to several modifications and variants all falling into the scope of the invention.

CLAIMS

1. System (1) for tattooing a skin surface comprising at least one tattoo machine (2, 90, 91) provided with an electric actuating means (3, 3', 3") for moving at least one needle (12) of a cartridge (14), characterized by comprising a control unit (5) provided with a microcontroller (50), said microcontroller (50) being adapted to generate pilot signals (Dr, Com, S1, S2) for commanding said electric actuating means (3, 3', 3") in order to move said at least one needle (12) by an oscillating motion having substantially a period (T), said control unit (5) being configured to receive control signals and values of setting parameters (60) adapted to initialize said at least one machine (2, 90, 91), said control signals comprising electric consumption signals of said electric actuating means (3, 3', 3") and signals regarding the position of said at least one needle (12) with respect to the cartridge (14), said microcontroller (50) processing said control signals and said values of setting parameters (60) for generating pilot signals (Dr, Com, S1, S2) in order to control said period (T) of said oscillating motion of said at least one needle (12).

2. System according to claim 1, characterized in that said electric actuating means is a motor (3) of a controlled-movement type, and said microcontroller (50) comprises a timed counter adapted to generate said at least one pilot signal (Dr, Com) for clockwise and counterclockwise piloting said motor (3) with respect to an initializing position.

3. System according to claim 1, characterized by comprising a voltage regulator (96) interposed between a power supply (53,

56) and a PWM modulator (95), said PWM modulator (95) being configured to pilot a rotating machine (90) by a first command signal (C1) and/or to pilot a coil machine (91) by a second command signal (C2), said microcontroller (50) being configured to generate a first pilot signal (S1) configured to pilot said voltage regulator (96) and a second pilot signal (S2) configured to pilot said PWM modulator (95).

4. System according to claim 3, characterized by comprising a sensing unit (97, 98) associated to said microcontroller (50) and configured to sense said second command signal (C2) and to generate a corresponding sensing signal (Ds), said microcontroller (50) processing said sensing signal (Ds) for obtaining operative parameters of said coil machine (91) and for generating, based on said operative parameters, said first pilot signal (S1) and said second pilot signal (S2).

5. System according to claim 3, characterized by comprising a sensing module (7) provided with at least one capacitive touch sensor (7a) which is configured to receive at least one gripping signal generated by a machine (2, 90, 91) associated to said microcontroller (50), said sensing module (7) being configured to generate a first enabling signal (A1, A1', A1") for enabling said microcontroller (50) to generate said pilot signals (Dr, Com, S1, S2).

6. System according to claim 1, characterized by comprising an actuating pedal (4) provided with at least one load cell (42) and configured to generate at least one activation/deactivation signal (B1) corresponding to a pressure received on the outer

surface of said actuating pedal (4) in order to activate/deactivate said machine (2, 90, 91) based on said activation/deactivation signal (B1).

7. Method of tattooing a skin surface that provides to:

- use at least one tattoo machine (2, 90, 91) provided with an electric actuating means (3, 3', 3") for moving at least one needle (12) of a cartridge (14);

characterized by:

- commanding said electric actuating means (3, 3', 3") by a control unit (5) provided with a microcontroller (50), said microcontroller (50) generating pilot signals (Dr, Com, S1, S2) for commanding said electric actuating means (3, 3', 3") in order to move said at least one needle (12) by an oscillating motion having substantially a period (T);

- receiving values of setting parameters (60) and control signals for initializing said at least one machine (2, 90, 91), said control signals comprising electric consumption signals of said electric actuating means (3, 3', 3"), and signals regarding the position of said at least one needle (12) with respect to the cartridge (14);

- processing said values of setting parameters (60) and said control signals for generating pilot signals (Dr, Com, S1, S2) in order to control said period (T) of said oscillating motion of said at least one needle (12).

8. Method according to claim 7, characterized by:

- electromechanically resetting said machine (2);

- initializing a timed counter associated to said

microcontroller (50) based on said initial values of said setting parameters (60);

- processing (70) said values of said setting parameters (60) by means of a first operative mode (Mode1) or a second operative mode (Mode2), wherein:

- said first operative mode (Mode1) uses a frequency value (f) and an initial Duty-Cycle value for determining a downward speed and an upward speed of said needle (12) during a period (T) of said oscillatory motion,

- said second operative mode (Mode2) uses said frequency value (f) and said initial Duty-Cycle value for determining an upper idle time (ΔT_{sup}) and a lower idle time (ΔT_{inf}) of said at least one needle (12) during said period (T) by providing a downward speed and an upward speed of said at least one needle (12) substantially equal to a predetermined constant value (Vc);

- generating said pilot signals (Dr, Com) based on said first operative mode (Mode1) or on said second operative mode (Mode2).

9. Method according to claim 7, characterized by commanding said machine (2) to pilot a driver (54) configured to command said electric motor (3) and/or command at least one rotating machine (90) and/or at least one coil machine (91) by piloting a PWM modulator (95) and a voltage regulator (96) that are piloted respectively by a third pilot signal (S1) and a fourth pilot signal (S2) generated by said microcontroller (50).

10. Method according to claim 9, characterized by:

- sensing a second command signal (C2) configured to command said coil machine (91) and generating a sensing signal (Ds) based

on said second command signal (C2);

- generating said third pilot signal (S1) and said fourth pilot signal (S2) by using a voltage self-adjusting algorithm as a function of said sensing signal (Ds).

AMENDED CLAIMS
received by the International Bureau on 17.05.2019

CLAIMS

1. System (1) for tattooing a skin surface comprising at least one tattoo machine (2, 90, 91) provided with an electric actuating means (3, 3', 3") comprising commutation means (20) for moving at least one needle (12) of a cartridge (14), **characterized by** comprising a control unit (5) provided with a microcontroller (50), said microcontroller (50) being adapted to generate pilot signals (Dr, Com, S1, S2) for commanding said electric actuating means (3, 3', 3") in order to move said at least one needle (12) coupled to said commutation means (20) by an oscillating motion having substantially a period (T), said control unit (5) being configured to receive control signals and values of setting parameters (60) adapted to initialize said at least one machine (2, 90, 91), said control signals comprising electric consumption signals of said electric actuating means (3, 3', 3") and said setting parameters (60) comprising values regarding the position of said at least one needle (12) with respect to the cartridge (14), said microcontroller (50) processing said control signals and said values of setting parameters (60) for generating pilot signals (Dr, Com, S1, S2) in order to control said period (T) of said oscillating motion of said at least one needle (12).

2. System according to claim 1, **characterized in that** said electric actuating means is a motor (3) of a controlled-movement type, and said microcontroller (50) comprises a timed counter adapted to generate said at least one pilot signal (Dr, Com) for clockwise and counterclockwise piloting said motor (3) with respect to an initializing position.

3. System according to claim 1, **characterized by** comprising a voltage regulator (96) interposed between a power supply (53, 56) and a PWM modulator (95), said PWM modulator (95) being configured to pilot a rotating machine (90) by a first command signal (C1) and/or to pilot a coil machine (91) by a second command signal (C2), said microcontroller (50) being configured to generate a first pilot signal (S1) configured to pilot said voltage regulator (96) and a second pilot signal (S2) configured to pilot said PWM modulator (95).

4. System according to claim 3, **characterized by** comprising a sensing unit (97, 98) associated to said microcontroller (50) and configured to sense said second command signal (C2) and to generate a corresponding sensing signal (Ds), said microcontroller (50) processing said sensing signal (Ds) for obtaining operative parameters of said coil machine (91) and for generating, based on said operative parameters, said first pilot signal (S1) and said second pilot signal (S2).

5. System according to claim 3, **characterized by** comprising a sensing module (7) provided with at least one capacitive touch sensor (7a) which is configured to receive at least one gripping signal generated by a machine (2, 90, 91) associated to said microcontroller (50), said sensing module (7) being configured to generate a first enabling signal (A1, A1', A1") for enabling said microcontroller (50) to generate said pilot signals (Dr, Com, S1, S2).

6. System according to claim 1, **characterized by** comprising an actuating pedal (4) provided with at least one load cell (42)

and configured to generate at least one activation/deactivation signal (B1) corresponding to a pressure received on the outer surface of said actuating pedal (4) in order to activate/deactivate said machine (2, 90, 91) based on said activation/deactivation signal (B1).

7. Method of tattooing a skin surface that provides to:

- use at least one tattoo machine (2, 90, 91) provided with an electric actuating means (3, 3', 3") comprising commutation means (20) for moving at least one needle (12) of a cartridge (14);

characterized by:

- commanding said electric actuating means (3, 3', 3") by a control unit (5) provided with a microcontroller (50), said microcontroller (50) generating pilot signals (Dr, Com, S1, S2) for commanding said electric actuating means (3, 3', 3") in order to move said at least one needle (12) coupled to said commutation means (20) by an oscillating motion having substantially a period (T);

- receiving values of setting parameters (60) and control signals for initializing said at least one machine (2, 90, 91), said control signals comprising electric consumption signals of said electric actuating means (3, 3', 3") and said setting parameters (60) comprising values regarding the position of said at least one needle (12) with respect to the cartridge (14);

- processing said values of setting parameters (60) and said control signals for generating pilot signals (Dr, Com, S1, S2) in order to control said period (T) of said oscillating motion of said at least one needle (12).

8. Method according to claim 7, **characterized by:**

- electromechanically resetting said machine (2);

- initializing a timed counter associated to said microcontroller (50) based on said initial values of said setting parameters (60);

- processing (70) said values of said setting parameters (60) by means of a first operative mode (Mode1) or a second operative mode (Mode2), wherein:

- said first operative mode (Mode1) uses a frequency value (f) and an initial Duty-Cycle value for determining a downward speed and an upward speed of said needle (12) during a period (T) of said oscillatory motion,

- said second operative mode (Mode2) uses said frequency value (f) and said initial Duty-Cycle value for determining an upper idle time (ΔT_{sup}) and a lower idle time (ΔT_{inf}) of said at least one needle (12) during said period (T) by providing a downward speed and an upward speed of said at least one needle (12) substantially equal to a predetermined constant value (Vc);

- generating said pilot signals (Dr, Com) based on said first operative mode (Mode1) or on said second operative mode (Mode2).

9. Method according to claim 7, **characterized by** commanding said machine (2) to pilot a driver (54) configured to command said electric motor (3) and/or command at least one rotating machine (90) and/or at least one coil machine (91) by piloting a PWM modulator (95) and a voltage regulator (96) that are piloted respectively by a third pilot signal (S1) and a fourth pilot signal (S2) generated by said microcontroller (50).

10. Method according to claim 9, **characterized by:**

- sensing a second command signal (C2) configured to command said coil machine (91) and generating a sensing signal (Ds) based on said second command signal (C2);

- generating said third pilot signal (S1) and said fourth pilot signal (S2) by using a voltage self-adjusting algorithm as a function of said sensing signal (Ds).

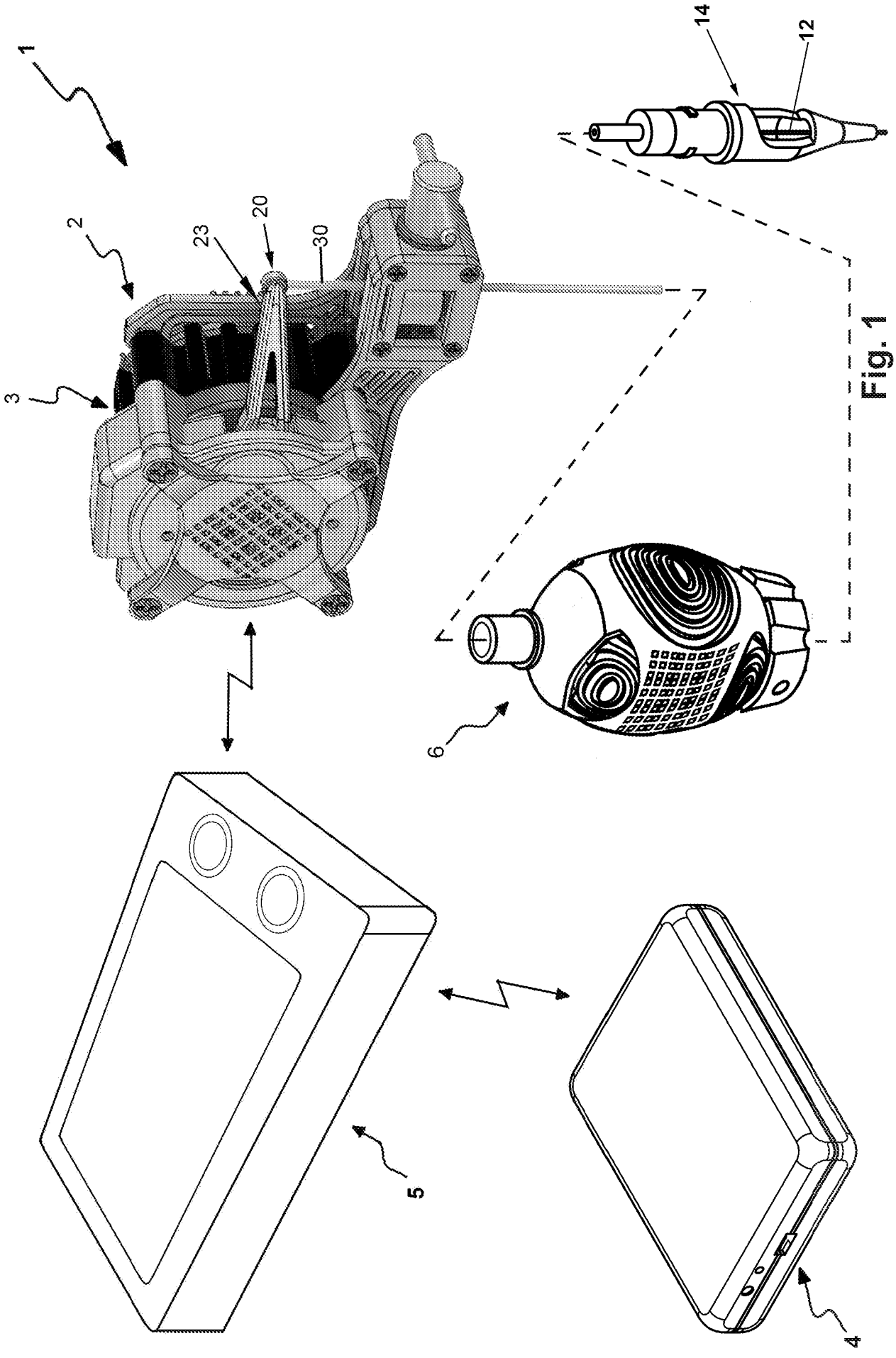
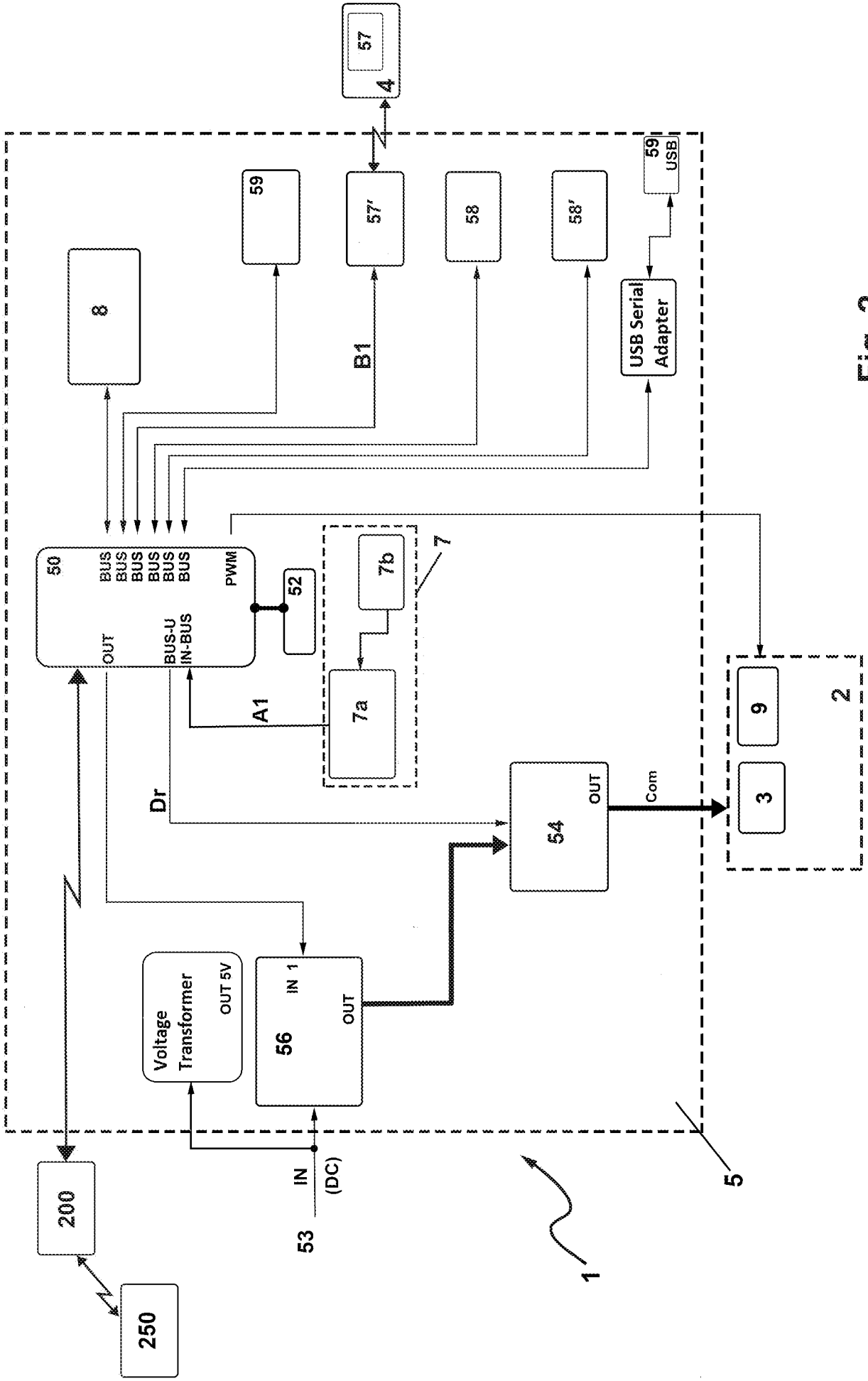


Fig. 1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59
57'
58
58'
59
USB
8
B1
USB Serial Adapter
50
BUS
BUS
BUS
BUS
BUS
BUS
PWM
52
OUT
BUS-U
IN-BUS
7b
7
7a
A1
Dr
54
OUT
Com
9
3
2
Voltage Transformer
OUT 5V
56
IN 1
OUT
200
250
IN
(DC)
53
1
5

Fig. 2

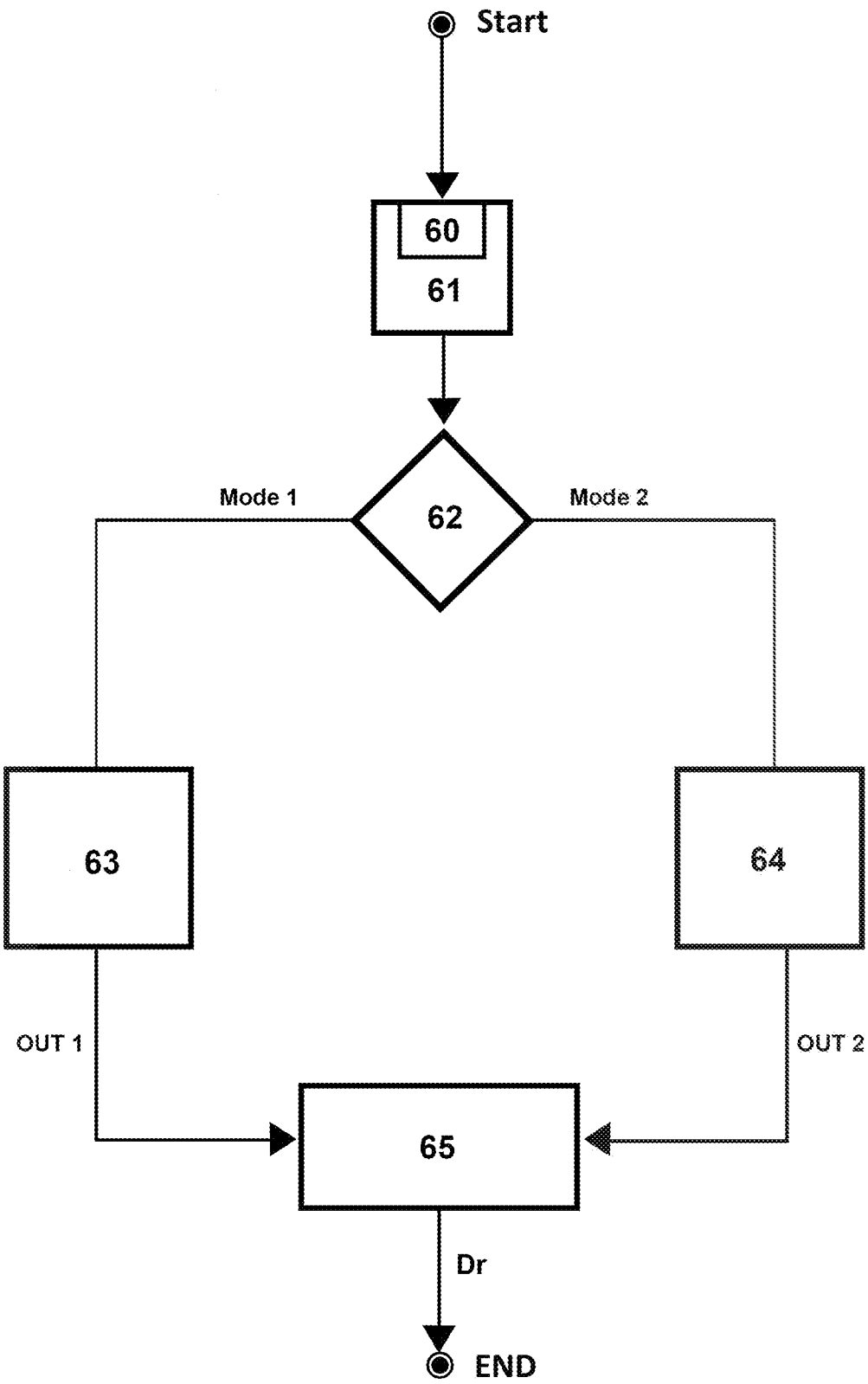


Fig. 3

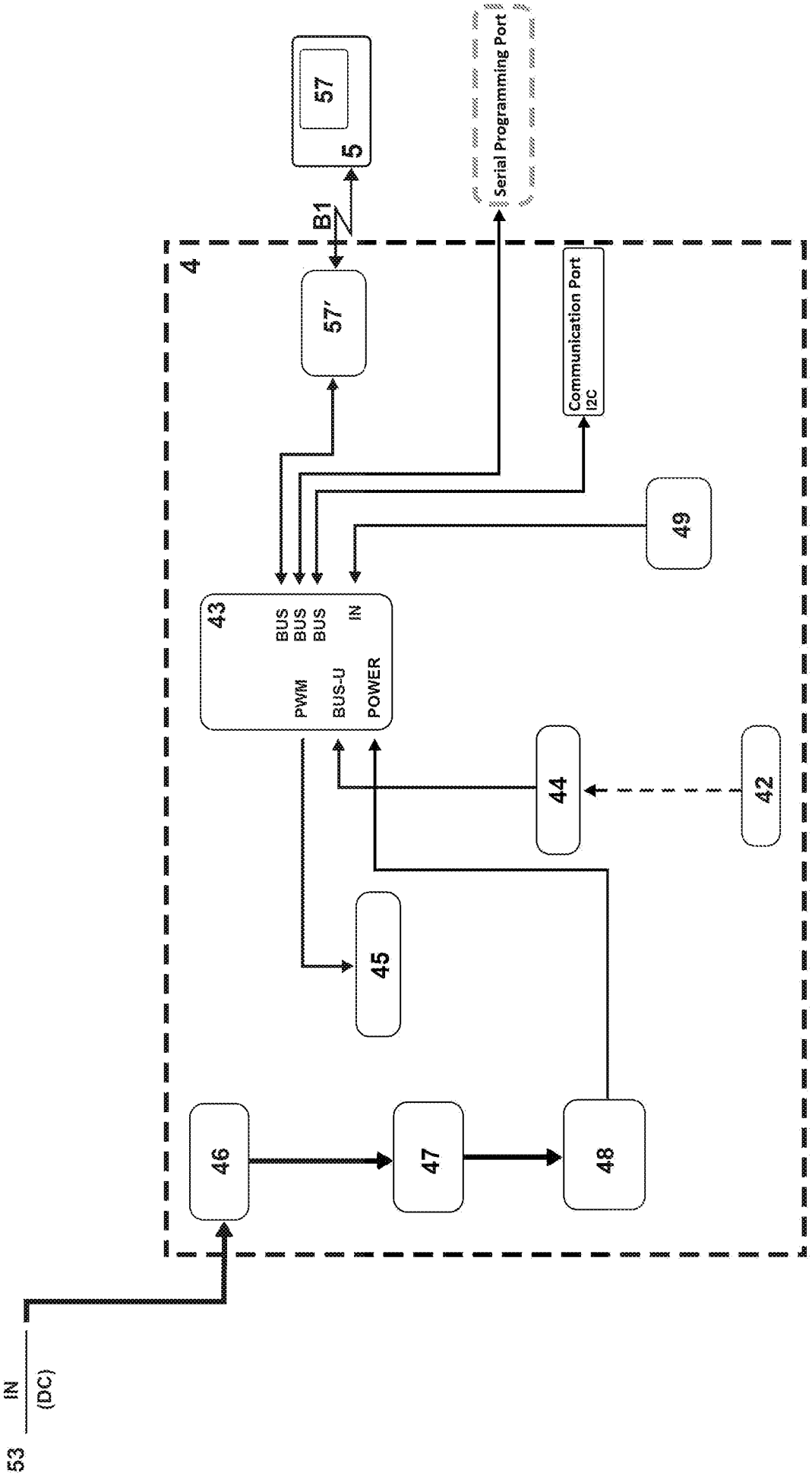
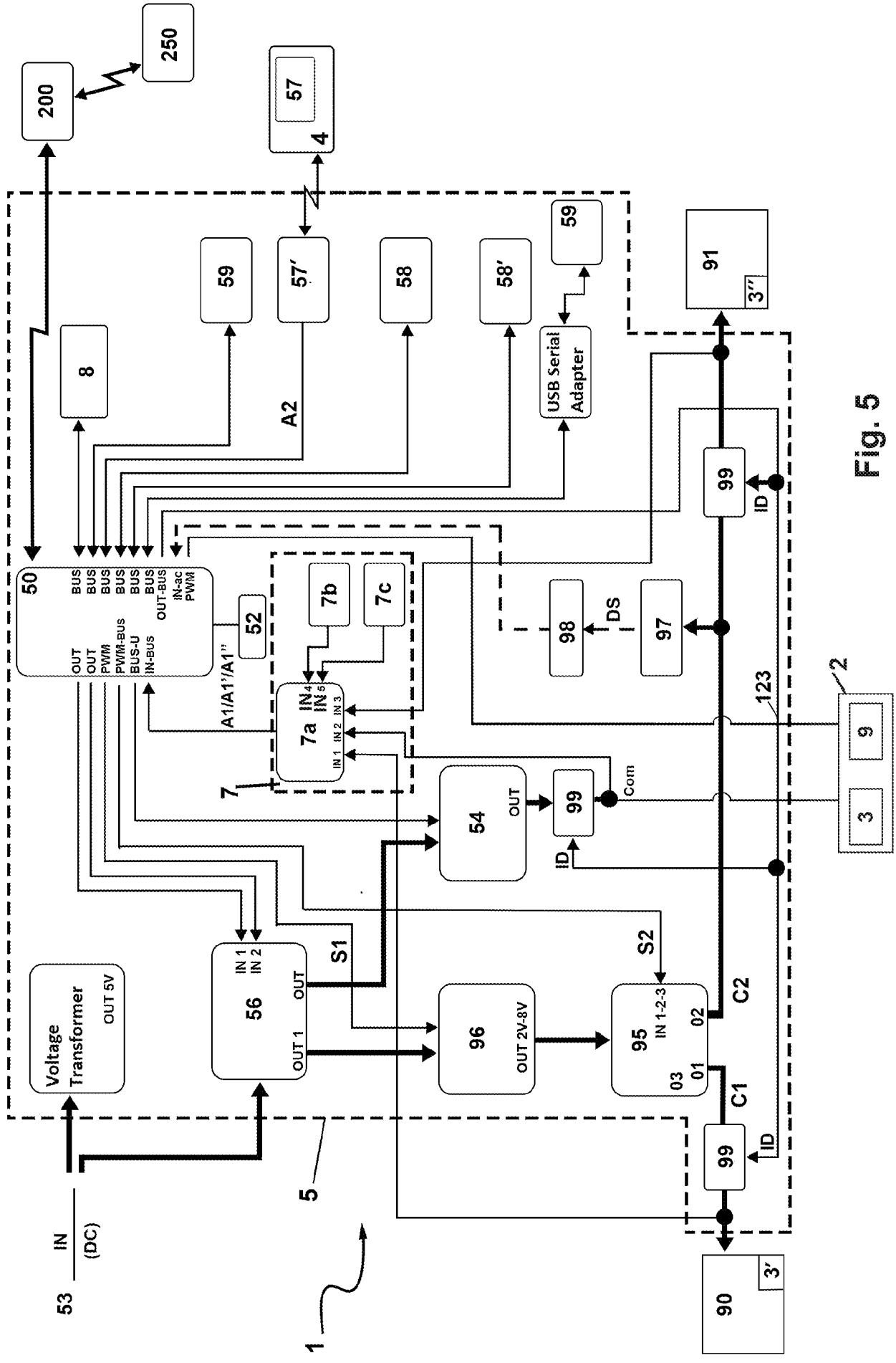

53
IN
(DC)
4
46
47
48
45
43
BUS
BUS
BUS
IN
PWM
BUS-U
POWER
44
42
49
57'
B1
5
57
Communication Port
I2C
Serial Programming Port

Fig. 4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250
57
4
59
57'
58
58'
59
91
3''
8
A2
USB Serial Adapter
99
ID
50
BUS
BUS
BUS
BUS
BUS
OUT-BUS
iN-ac PWM
OUT
OUT
PWM
PWM-BUS
BUS-U
iN-BUS
52
A1/A1'/A1''
7b
7c
98
DS
97
123
2
9
3
7a
IN4
IN5
IN3
IN 1
IN 2
7
54
OUT
99
Com
ID
S1
S2
Voltage Transformer
OUT 5V
56
IN 1
IN 2
OUT
OUT 1
96
OUT 2V-8V
95
IN 1-2-3
02
03
01
C2
C1
99
ID
5
53
IN
(DC)
1
90
3'

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/059385

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61M37/00 A01K11/00
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)
A61M A01K

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	US 2011/288575 A1 (COLTON BRETT [US] ET AL) 24 November 2011 (2011-11-24)	1,2,6,7
A	paragraphs [0002], [0008], [0010], [0001], [0013] - [0015], [0017], [0018], [0020], [0022], [0023], [0026], [0030], [0031], [0058], [0061], [0065], [0066] paragraphs [0054], [0063] paragraphs [0068], [0073], [0074], [0083] - [0089], [0092], [0092], [0107], [0108], [0111] - [0115], [0117] figures 1,6,10,11	3-5,8-10

A	US 2016/121093 A1 (FAN CING-RONG [TW]) 5 May 2016 (2016-05-05) paragraphs [0018] - [0021], [0024], [0025] figures	1,6,7

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

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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

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

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

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

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 March 2019	29/03/2019

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	Jankowska, M

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2018/059385

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011288575 A1	24-11-2011	NONE	
US 2016121093 A1	05-05-2016	TW M499122 U	21-04-2015
		US 2016121093 A1	05-05-2016