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(54) PAINT COAT APPLICATION DEVICE AND PAINT COAT APPLICATION METHOD

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Description

TECHNICAL FIELD

[0001] The subject of the invention is a paint coat application device for applying a paint coat and a paint coat application method, in particular applied onto small objects for mass-scale production and made entirely or partially of metal.

BACKGROUND ART

[0002] In known solutions, the process of paint coat application onto objects to be painted is in most cases carried out in stages, by alternate spraying of successive paint coats and heating objects being painted in heated chambers with stabilised temperature, then cooling and applying another layer, and placing them again in the heated chamber. In most cases, a process of paint coat application onto small metal elements comprises consecutive spraying of successive paint layers in a drum system, sometimes partially automated, and moving objects being painted into an oven with a stabilised temperature, then cooling and moving back into the drum. In order to ensure optimal mechanical coat properties, there can be as many as 20 such cycles. This need of multiple transport of objects being painted onto special screens, mixing and cooling requires constant quality control. The economy of such a process is not favourable, due to cyclical use of ovens, which, because of the typically significant capacities, leads in practice to continuous operation. Considering energy consumption, oven heating is the main cause of loss due to the need of ventilation as the drying process involves evaporation of thinners, where heat energy is emitted together with thinner fumes straight into the atmosphere.

[0003] Of course, an improvement of such a process is heating of objects directly in the drum. There are currently several companies offering such devices made in Germany, China, USA. This kind of equipment is expensive, owing to the high level of technical complication related to the necessity of compliance with safety standards concerned with the flammability of condensed thinner vapour present in a mass of objects being painted. The need for a construction with explosion-proof properties, in combination with the commonly used transfer of heat into the drum, for example a high-temperature heater heats the air inside the drum's chamber or shell, is the reason that all manufacturers give warranties only for using their own paints. Such a practice results in the price of the process being influenced to a great extent by painting equipment suppliers and, of course, it is not a financially advantageous solution for a paint shop owner.

[0004] Documents DE 10 2008 037 553 and US 2001 000 9692 disclose a device and a method for coating and drying elements in a drum.

[0005] With most of currently used paints, the heating process is one of the three painting processes, whereas

the remaining two are surface preparation and paint layer application. Its course is of crucial significance for mechanical and indirectly visual properties of paint coats. The heating process constitutes a fundamental problem limiting the output of paint shops. As it turns out, despite the relatively short duration of paint coat application onto a mass of 2 - 3 kg of elements which takes 15 - 20 minutes, the entire process of painting such an amount, for example in 6 - 12 cycles, lasts, depending on the paint, 4 - 8 hours.

[0006] In current stages of drying elements in painting processes, the paint coat temperature gradient is of key importance in the drying and hardening process. Typical oven drying of paint coats leads to gradient stabilisation from the outermost coat layer towards the surface of the object's material. This direction of heat transfer causes irregularities in the process of drying and hardening of the coat and deleterious effects related to stresses occurring in the coat crystallisation process. The external layer, as one which reaches the bonding temperature the fastest, shrinks, enveloping deeper layers which are still in a liquid state. This phenomenon leads to surface damage and a detrimental effect called the 'orange peel'. Although theoretically this effect always occurs with conventional heating, it is eliminated in practice by slowly heating of very thin layers. However, this solution has three fundamental drawbacks, namely the necessity to spray thin layers, which is connected with the resulting matt fractures called "velvet", "satin", etc. effects, the process is very time-consuming, the process generates significant power losses.

[0007] The temperature gradient problem with contact heating is so serious, that in order to minimise it, in car paint shops, infrared radiators are used for paint heating, in order to improve the depth of heat penetration into the paint layer. It is however worth pointing out that the use of infrared radiators changes instantaneous values of the lateral temperature gradient, but never its direction.

[0008] Other limitations are introduced by paint layer application technologies. There are used standard paint layer application spraying with HLVP, AIRLESS, etc. nozzle systems, whereas ultrasonic cavitation and rotatory dispersion technologies are still in experimental phases.

[0009] A lot of painting devices is known from patent specifications. One of them is the patent specification JP 6039327 A titled *Method and device for coating*, from which a paint coat application process is known according to which items to be painted are placed in a basket which is dipped in coating paint. After removing from the basket and preliminary draining of the coating paint, the items are put into rotary motion, in order to remove any excess paint. Afterwards, the painted items are heated with hot air.

[0010] From the patent specification US 6,302,961 B1, titled *Apparatus for applying a liquid coating to electrical components*, there is known a device for applying a liquid coat onto such elements as electric motor rotors. The device has multiple brackets which travel in relation to

induction heating elements. After applying a liquid coat, the electric motor rotors are moved near the induction heating elements, where the rotors are heated.

[0011] In addition, from the patent specification DE 19626209 A1, titled *Vorrichtung und Verfahren zum Beschichten eines Werkstücks*, there is known a device with an induction-heated element, which is heated in a chamber and gives back heat into a chamber with an element covered with a coating medium.

[0012] In yet another case, from the patent specification JP 2004243218 (A) is known a device in which an element to be painted is moved to position A, where it is covered with paint, then to position B, where the painted element is heated with a low-frequency induction heated element.

[0013] A shortcoming of the known solutions is that elements to be painted have to be moved one by one with an additional device from one position to another, where they are heated.

AIM OF THE INVENTION

[0014] The purpose of the invention is to create an integrated device for applying a paint coat onto small metal objects for mass-scale production, free of the disadvantages and inconveniences described above, characterising currently known solutions in this technological field.

DISCLOSURE OF THE INVENTION

[0015] The general idea of the invention is that in a device for applying paint coats in a drum system, in which heating of objects takes place directly inside a drum, an induction heating technique is used for heating of a mass of objects being painted, whereby a mass of objects is coated with paint cyclically in a single drum, then heated with heat induced directly inside of the objects being painted, and the device contains an induction heater, a PLC-based central control system which executes the paint coating cycle and communicates with the other components via discrete and analogue inputs and outputs, the induction heater, a valves set which is an assembly with solenoid valves, connected to a pneumatic pressure outlet, and the PLC-controlled valves effect desired motions of pneumatic actuators and the activation of a paint gun.

[0016] Especially, in a paint coat application device for coating paint medium onto metal elements, which comprises a container with the metal elements, an appliance feeding painting medium to be applied onto the metal elements and the device generating an alternating magnetic field causing the metal elements to be heated, the container is a non-metallic drum with a chamber and an opening enabling access into the chamber for the metal elements, which is closable by a movable lid fixed non-permanently relative to the non-metallic drum and a housing of the non-metallic drum, in relation to which the non-metallic drum is fixed rotatable about its axis, where-

as the device generating the alternating magnetic field causing the heating of the metal elements is a heating inductor of an induction heater which inductively heats the metal elements by the alternating magnetic field and which is located outside of the chamber of the non-metallic drum, and whereas the painting medium is fed into the chamber of the non-metallic drum using the appliance feeding the painting medium in order to be applied onto the metal elements, and inside of the chamber of the non-metallic drum a paint coat is applied onto the metal elements and the metal elements are heated, and inside of the chamber of the non-metallic drum, if necessary, the metal elements are cooled.

[0017] Preferably, the housing of the non-metallic drum is displaceably hingedly mounted to be swung on rigid supports, to at least one of which is fixed a tilting system which allows to tilt the non-metallic drum by any angle from a position in which the non-metallic drum's opening faces upwards to a position in which the non-metallic drum's opening faces downwards.

[0018] Preferably, the appliance feeding the painting medium is at least one paint gun with a nozzle placed inside the chamber of the non-metallic drum, which is mounted in the movable lid of the non-metallic drum.

[0019] The appliance feeding the painting medium can be at least one paint hose with a valve whose mouth is placed in the chamber of the non-metallic drum.

[0020] The heating inductor of the induction heater can be a device generating the alternating magnetic field having a frequency ranging from 30 kHz to 100 kHz, reaching an instantaneous magnetic induction value of a field generated between 0.2 T and 0.4 T, and magnetic flux values in a range of 0.1 Wb to 1.0 Wb.

[0021] Preferably, in a wall of the non-metallic drum are holes for draining excess painting medium.

[0022] Preferably, in the chamber of the non-metallic drum is the opening, situated coaxially with a drum rotation axis, through which painting medium fumes and/or a mix of painting medium fumes and air is extracted with a negative pressure system having a filter for capturing any painting medium residue and contaminants.

[0023] A servomotor can be attached by one end to the lid of the non-metallic drum, and the other end is fixed to the housing of the non-metallic drum, for opening and closing the lid of the non-metallic drum.

[0024] Preferably, the device has a system regulating rotation speed of the drum, a system regulating tilt of the drum and amount of the painting medium being fed, temperature and time of heating of the metal elements.

[0025] A further idea of the invention is that in a paint coat application method for applying a painting medium onto metal elements heated in a non-metallic drum's chamber, after placing the metal elements in the non-metallic drum's chamber, the painting medium is fed into the chamber, the metal elements are coated by the painting medium and heated using a heating inductor of an induction heater creating eddy currents in the metal elements, which results in raising their temperature to pre-

set values depending on a paint type and a paint coat thickness, after which the temperature of the metal elements is maintained in a pre-set temperature range, until a paint coat on the metal elements hardens.

[0026] Preferably, after hardening of the paint coat applied earlier, the temperature of the metal elements is reduced to a pre-set value depending on the paint type and the paint coat thickness, after which another paint coat application cycle begins, involving the feeding of the painting medium into the non-metallic drum's chamber, the heating of the metal elements, maintaining the pre-set temperature range of the metal elements until the hardening of another paint coat and cooling of the metal elements, while the paint coat application cycle repeats until a pre-set paint coat thickness is obtained.

[0027] A change of heating temperature of the metal elements can be effected by changing value of current flowing in an induction coil.

[0028] Preferably, the painting medium is fed into the non-metallic drum's chamber with at least one paint gun and the metal elements are mixed during the feeding of the painting medium, by putting the non-metallic drum into a rotary motion during which linear speed of the metal elements is not greater than the square root of the product of the distance between the metal elements and the drum rotation axis, and gravitational acceleration g .

[0029] The painting medium can be fed into the non-metallic drum's chamber through holes in the drum wall, and the metal elements are mixed during the feeding of the painting medium, during which the linear speed of the metal elements is not greater than the square root of the product of the distance between the metal elements and the drum rotation axis, and gravitational acceleration g , after which the drum rotation speed is increased to a value at which excess painting medium is drained through the holes in the drum wall, as a result of a centrifugal force acting on the painting medium.

[0030] Preferably, painting medium fumes and/or a mix of painting medium fumes and air is extracted from the non-metallic drum's chamber through an opening located coaxially with the drum rotation axis, with a negative pressure system having a filter for capturing any painting medium residue and contaminants.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] The invention will now be described by way of example and with reference to the accompanying drawings in which:

Fig. 1 shows a block diagram presenting connections between elements of a paint coat application device;
Fig. 2A and 2B show a general operation diagram of the paint coat application device;
Fig. 3 shows a front axonometric view of the paint coat application device;
Fig. 4 shows a back axonometric view of the paint coat application device;

Fig. 5 shows a cross-section of a non-metallic drum with its housing in the background;

Fig. 6 shows a diagram of a power supply and control system of the paint coat application device;

Fig. 7 shows a diagram of a pneumatic system of the paint coat application device; and

Figs. 8A, 8B and 8C show a block diagram of an operation algorithm of the paint coat application.

10 MODE(S) FOR CARRYING OUT THE INVENTION

[0032] A coat application device for applying a paint coat onto elements, as provided by the invention, comprises in general a container for the elements to be painted, in short a charge, an appliance for feeding a painting medium to be applied onto the elements, and a device generating an alternating magnetic field causing the metal elements to be heated, the PLC-based central control system 11, shown in Fig.1, which executes paint coating cycles and communicates with other elements of the device via discrete and analogue inputs and outputs. The device generating an alternating magnetic field is an induction heater 19 powered by an inductor with a high frequency current, which creates a rapidly alternating magnetic field, and, after placing the charge at a sufficient distance inside the field, induces eddy currents in the charge, which causes its heating. The induction heater 19 is fitted with an induction heater cooling system 18. The device also contains a valve set 15 which is an assembly with solenoid valves, connected to a pneumatic pressure outlet, and the PLC-controlled valves effect desired motions of pneumatic actuators and activation of a paint gun 14. The device also has an actuator 16 for tilting the drum of the device allowing the charge to pour out. Furthermore, the programmable logic controller (PLC) 11 controls a ventilation system 17. In addition, the device contains an actuator 13 opening and closing the drum lid which is controlled by the valves set, and signals from the actuator tilting the drum and the actuator opening and closing the drum lid are transmitted to the PLC 11. The PLC 11 also controls a drum drive 12, which can be a programmable inverter connected with an asynchronous motor, which enables drum rotation with full regulation of rotation speed.

[0033] Device's operation, shown in Figs. 2A and 2B, is carried out in general in several operating phases: initialisation 20, first mixing 30 of charge, relaxation 40, second mixing 50 of charge, next relaxation 60, verification 70 of a cycle number, opening 80 of the drum lid and tilting 90 of the drum.

[0034] In the initialisation phase 20, the control system is initialised in step 21, the drum is brought to its basic position in step 22, charge is placed inside of the drum in step 23, the drum lid is closed in step 24 and sensors checked in step 25. During the first mixing charge phase, in step 31 a paint coat is applied with a paint gun onto the elements placed inside the drum. After the relaxation phase, the second mixing charge phase follows, during

which the charge placed inside of the drum is induction-heated in step 51. After another relaxation phase and verifying the number of cycles executed, the drum lid is opened and the drum is tilted to pour out the charge.

[0035] The paint coat application device 100 presented in detail in Figs. 3, 4 and 5 is generally used for coating many small elements, henceforth referred to as a charge, which are made entirely or at least partially of metal. Elements to be painted, after cleaning and degreasing are poured into drum 110, which is a main element of the paint coat application device 100, lacquering or painting for short, and in which the whole painting process is carried out, comprising the application of at least one paint coat, hardening it and, if necessary, cooling. The drum 110 is made of a non-metallic material transparent to magnetic fields and resistant to high temperatures. In one of the embodiments, the drum 110 is made, for example, from fibreglassbased composites. The drum 110, most often in a shape of a cylinder closed at the bottom and narrowing into a truncated cone with an opening at the top, or in the shape of a flattened sphere with the opening at the top, is mounted with a set of bearings to the base 121 of a housing 120, in relation to which the drum can rotate about its axis, shown in Fig. 3 as axis z. The drum 110, which at the top has the opening enabling access to the chamber created inside the drum, can be closed with a movable lid 122, mounted so that it can be moved in relation to the drum 110 and the housing 120 of the drum 110. In the lid 122 of the drum, at least one paint gun 125 with the nozzle is mounted inside the drum's chamber. In order to enable the application of multi-coloured coats, there are mounted more than one pistol in the lid, one of which can be used for feeding cleaning agents into the chamber of the drum 110. In one of the build examples, the drum 110 has ribs, for instance, longitudinal and/or oblique, which assist in the mixing of metal elements in the chamber of the drum 110. The drum 110 is put into a rotary motion about its axis with a first drive system 150, which has an electric motor fixed to the base of the housing, on whose shaft of a pulley is mounted, from which force is transmitted through a belt transmission onto the pulley 126 of the drum 110, which is mounted on a shaft of the drum 110 concentrically to the rotation axis 115 of the drum 110, which is axis z. The drive systems are controlled with a control system whose transmitting cables are grouped in the form of an electric bundle 155.

[0036] In one of the solutions presented in detail in Fig. 5, the shaft of the drum 110 is made from a pipe 111, whose an opening or an inlet hole is inside the chamber of the drum 110. The pipe 111 of the shaft of the drum 110 runs to an intermediate pipe 114 which communicates with a filtration system 127 through a connection 156, to which a flexible pipe 165, shown in Fig. 4, is connected to a system for venting air cleaned from paint and hazardous compounds fumes. The shaft of the drum 110 is supported by a bearing set 113. Thanks to the location of the pipe 111 for venting paint fumes in the drum rotation

axis 115, a simple solution can be applied to solve the problem of removing chemicals hazardous to the environment which are produced in the chamber of the drum 110 during painting and hardening of paint. Whereas by placing the pulley 126 of the drum 110 near the bearing set 113, high bending stresses are avoided, which allows the use of the pipe as a shaft for the drum 110.

[0037] The base 121 of the housing 120 is displaceably hinged by a mounting assembly 130 to a left support 131 and a right support 132 so that it can be swung. The left support 131 and the right support 132 are coupled with bracing elements 124, which allow the creation of a rigid structure for supporting the drum 110. In one of the embodiments, to the base 121 of the housing, a top guard of the drum 110 can be attached. The mounting assembly 130 includes a shaft supported by a set of tilting bearings which connect the shaft, and thus the mounting assembly 130 to the left support 131 and the right support 132, which enables the drum 110 to tilt in a vertical plane about its horizontal axis marked in Fig. 3 as axis x. Tilting of the drum 110 in a plane which is perpendicular to the base 121 of the housing 120 is made possible by a tilting system 160 which contains a motoreducer transmitting torque onto the shaft of the mounting assembly 130. The motoreducer is controlled by a controller of the control system located in an electrical systems housing 140, which transmits control signals regulating the direction of tilting the drum 110, for example, with the opening of the drum 110 facing downwards or upwards. In addition, the controller transmits start/stop signals when the desired position has been reached, for instance, the position in which the drum 110 is tilted with the opening facing downwards, which makes it easier to remove painted charge. In another embodiment, two pivots attached by means of bearings to rigid supports are mounted to the base 121, forming the mounting assembly 130 which enables tilting of the drum 110 with the opening facing both downwards and upwards. In one of the solutions, the drum can be tilted with actuators with articulated arms.

[0038] In the supports 131 and 132 are mounted systems presented in greater detail in Figs. 6 and 7.

[0039] Furthermore, the paint coat application device 100 contains a power supply and control system 200 presented in Fig. 6, which controls the paint coat application process, or painting for short. In one of the embodiments, the power supply and control system 200 contains the power supply system 210, the control system 220 with an operator's panel 221, a fume extraction control system 230 with an inverter 232 of a motor 231 of a fume extraction fan 233 with a paint fume extraction collector 234, a valve control system 240 with pneumatic system valve controllers 241 and painting valve and painting pressure controllers 242, a cooling system 250, a drum rotation system 260 with an inverter 261 of rotation frequency of a shaft of a motor 262 of the drum and with a proximity sensor 263, a drum tilt system 270 with a controller 271 of a drum tilt motoreducer 272 regulating the drum tilt

angle and the drum tilt speed, and with the proximity sensor 273, and the heater 280 with the inductor 281, a transformer 282, the electronics and control module 284 regulating the power of the heater 280, and with an optical temperature sensor 283 for metallic elements onto which the paint coat is applied.

[0040] Fig. 7 shows a diagram of a pneumatic system 300 of the paint coat application device 100, which contains a compressed air generation system 310, a cooling system 320 with a cooling valve 321 and a cooling nozzle 322, an atomiser system 330 and a painting system 340 containing a main painting pressure valve 341, a painting pressure valve 342, a pressure tank with paint 343, a manometer 344 and a painting nozzle 345. The compressed air generation system 310 has at least one compressor 311 driven with a motor 312, a filter 313, a pressure regulation valve 314, a manometer 315 and a main valve 316. The atomizer system 330 has a forced air pressure regulation valve 331, a manometer 332, a forced air nozzle 333, an atomizer pressure regulation valve 334, a manometer 335 and an atomiser nozzle 336.

[0041] The paint coat application process consistent with a method provided by the invention, presented in a block diagram in Figs. 8A, 8B and 8C, divided in consecutive cycles, is initiated after start-up in step 401, from an operator's panel level, after defining process parameters for each painting cycle, after selecting the control type in step 402. Individual process steps can be saved and loaded whenever required to the memory for the duration of the entire process.

[0042] Both in a manual mode, as well as in an automatic mode, during feeding of a painting medium, metal elements are mixed during the feeding of the painting medium with paint guns, putting a non-metallic drum into a rotary motion, during which linear speed of the metal elements is not higher than the square root of the product of the distance between the metal elements and the drum rotation axis, and gravitational acceleration g . At the speed as defined above, a force of friction of individual metal elements against a drum wall and/or one to another, resulting from a force of pressure caused by a centrifugal force, is less than the gravitational force of individual elements.

[0043] In another embodiment, the painting medium is fed into the drum's chamber through holes in a drum wall, and the metal elements are mixed during the feeding of the painting medium, putting the drum into the rotary motion, during which the linear speed of the metal elements is not higher than the square root of the product of the distance between the metal elements and the drum rotation axis, and gravitational acceleration g after which the drum rotation speed is increased to the value at which excess painting medium is drained through the holes in the drum wall as a result of the centrifugal force acting on the painting medium.

[0044] After selecting manual control, the paint coat application process is executed in the manual mode, in which in step 403 a main pressure valve is turned on or

off, in step 404 ventilation is turned on or off, in step 405 drum tilt and drum rotations are turned on or off, and in step 406 a heater is turned on or off. In addition, in the manual mode, in step 407 cooling is turned on or off, in step 408 painting pressure is turned on or off and in step 409 pre-set painting is turned on or off.

[0045] After selecting the automatic control mode, the coat application process is executed in the automatic mode, where in step 410 a check is run, whether there are painting procedures available, and if there are, in step 411 procedures are loaded for each cycle, after which in step 412 the painting process is started. If there are no procedures available, and after checking in step 413 whether procedures need to be specified, in step 414 the procedures screen is enabled and procedures are entered, or in step 415 painting cycle parameters are entered manually. The painting procedure is continued in step 416, where another painting cycle is started, with retaining its parameters, and in step 417 the check is run, whether a pre-set temperature has been reached and, if necessary, the heater is regulated in step 418. When the pre-set temperature has been reached, in step 419 a cycle time count is initiated with the start of painting, and after the cycle has completed, which is verified in step 420 and confirming in step 421 that a cycle was the last one, the painting process is completed in step 422. Data pertaining the pre-set values depending on a paint type and a paint coat thickness, after which the temperature of the metal elements is maintained in a pre-set temperature range and until a paint coat on the metal elements hardens are given by manufactures of paint and lacquers.

[0046] In the automatic mode, participation of the device's operators is minimised and all of the procedures specified above are executed according to specific algorithms, and when there are available ready procedures defining each cycle, the activation and supervision of the process is limited to a few basic switching operations.

[0047] In reference to the above figure descriptions, in particular to Figs. 3, 4, 5 and 6, it must be emphasised that the charge, which usually is a large number of small parts counted even in hundreds or thousands of pieces, is induction-heated with an element generating an alternating magnetic field causing the heating of metal elements, which is an induction coil 281 of an induction heater 280, heating by induction metal elements by the alternating magnetic field creating eddy currents in the metal elements. Induction heating of charge is possible, because a non-metallic drum has been used, and the heater 280 is inside the drum 110, and is most often affixed to a housing 120. In one of the build examples, the heating inductor, through which flows a current ranging between values of 200 A and 1000 A, is a device, generating the alternating magnetic field with a frequency ranging from 30 kHz to 100 kHz, reaching a magnetic induction value of the field generated between values of 0.2 T and 0.4 T and magnetic flux values in the range of 0.1 Wb to 1.0 Wb. In one of the solutions, a winding of an inductor 281 of the heater 280 is made from a tube, a material with

high electrical conductance, for example, copper, through which a cooling fluid can, flow. The winding of the inductor 281 and a transformer 282 can have in this solution an individual cooling system 250. The induction coil 281 is located near the place where the most metal elements accumulate during pouring and mixing when the drum 110 is rotating. During rotary motion of the drum 110, the metal elements to be painted initially move with the drum 110, then sink after reaching a position in which the force of friction of individual metal elements relative to the drum wall and/or between one another, caused by the force of pressure resulting from the centrifugal force is less than a force of weight of a single element. Thus, the induction coil 281 is affixed to the housing 120 near a fixing point of the drum 110, which is shifted by several degrees in the direction of the drum's rotation, in relation to the lowest point of the drum 110.

[0048] The paint coat application device, in one of the embodiments, is controlled by the PLC compliant with PLC standards and requirements. Control of the device, as has been mentioned, is carried out via an operator's HMI touch panel. Basic information received by the control system 220 is charge temperature, measured with the temperature optical sensor 283, and other data are discrete signals supplied by drum position induction proximity sensors and emergency drum position proximity shift sensors, a closure sensor for the lid of the drum 110, and a signal transmitted when the machine's emergency shut-off switch has been pressed. With the operator's panel, various quantities and signals determining drum tilt, drum rotation speed and its direction can be regulated. In one of the embodiments, these quantities are transmitted by a frequency converter controlling the electric motors, turning the ventilation system on and off and setting flow speed of a medium's stream, turning on the heater, activating the main process air pressure valve, activating the painting pressure valve and a paint tank, turning on the cooling function and activating the painting function valve.

[0049] In particular, the charge heating process is regulated with a proportional-integral-derivative controller (PID controller) incorporated into a controller connected to the feedback loop with the temperature sensor 283 which regulates in real time the temperature of the heater 280. After the pre-set temperature has been reached, depending on cycle settings, the painting process may begin, which is carried out with a paint gun to which the painting medium is fed under pressure from the paint tank, through tubes and/or flexible tubes fitted with electromagnetic valves. In one of the embodiments, it is possible to conduct the painting process with two or more paint guns connected to different paint tanks. This allows to carry out painting in different manners or obtain varying painting results, for instance, painting with an undercoat, special gloss layers, two-colour elements. The pressure of process air in the drum is regulated with the valves mentioned earlier in the description of the control system. Painting or lacquering is conducted during cyclical spray-

ings whose duration is set in the controller, which provides for effective use of the painting medium. In one of the build examples, painting fumes are extracted directly from the drum through an opening situated in the drum axis and fed first through a pipe which is at the same time the drum shaft, and then through a flexible tube connected to a fan 233, whose motor 231 is connected to an inverter 232. The motor's speed and its activation can be regulated from the level of an operator's panel 221. During painting, charge is mixed when the drum is put into rotary motion. The drum can also be put into oscillating motion by cyclically decreasing and increasing the tilt angle.

[0050] In one of the embodiments, painting is carried out with a device's centrifugal operation system for applying paint coats. In such a case, there are specially made microholes in the device's drum and painting is conducted by pouring a certain amount of paint with the charge by a paint hose and putting the drum into a quick rotary motion. The painting medium in this solution is fed into a chamber through microholes in the drum wall and metal elements are mixed during the feeding of the painting medium, putting the drum into such rotary motion during which the force of friction of individual metal elements relative to the drum wall and/or to one to another, caused by the force of pressure caused in turn by the centrifugal force is less than the force of weight of the single element. The painting medium settles on the charge and the unused content, after increasing the drum's rotation speed to a certain value, flows out of the drum through microholes in the drum wall, as a result of the centrifugal force where it is collected into a special tank and can be used again. This provides for more effective use of the painting medium, as compared to painting where paint fumes are sucked out by the fume extraction fan 233.

[0051] The distinguishing feature of the presented paint coat application device, as compared to other painting machines, is a new way of heating the charge, which makes it possible to save significant amounts of energy and obtain paint coats of a very high quality, in particular when compared to solutions where charge is heated by blowing hot air. The advantage of the presented solutions is that metal elements are not moved one by one with an additional device, and paint coat application, heating of the metal elements being painted and inter-stage cooling of the metal elements being painted is carried out inside the chamber of a single device.

[0052] The solution based on the invention as defined in the appended claims is presented in selected build examples. However, the invention is not confined to these examples. It is obvious that modifications can be introduced without changing the essence of the solution. The presented build examples do not exhaust the full extent of possibilities of the application of the solution based on the invention, as defined in the appended claims.

Claims

1. A paint coat application device for coating paint medium onto metal elements, which comprises a container with the metal elements, an appliance feeding painting medium to be applied onto the metal elements and a device generating an alternating magnetic field causing the metal elements to be heated, **characterised in that** the container is a non-metallic drum (110) with a chamber and an opening enabling access into the chamber for the metal elements, which is closable by a movable lid fixed non-permanently relative to the non-metallic drum (110) and a housing of the non-metallic drum (110), in relation to which the non-metallic drum (110) is fixed rotatable about its axis, whereas the device generating the alternating magnetic field causing the heating of the metal elements is a heating inductor (281) of an induction heater (280) which inductively heats the metal elements by the alternating magnetic field and which is located outside of the chamber of the non-metallic drum (110), and whereas the painting medium is fed into the chamber of the non-metallic drum (110) using the appliance feeding the painting medium in order to be applied onto the metal elements, and inside of the chamber of the non-metallic drum (110) a paint coat is applied onto the metal elements and the metal elements are heated, and inside of the chamber of the non-metallic drum (110), if necessary, the metal elements are cooled.
2. The paint coat application device according to claim 1, **characterised in that** the housing of the non-metallic drum (110) is displaceably hingedly mounted to be swung on rigid supports (131, 132), to at least one of which is fixed a tilting system which allows to tilt the non-metallic drum (110) by any angle from a position in which the opening of non-metallic drum (110) faces upwards to a position in which the non-metallic drum's opening faces downwards.
3. The paint coat application device according to claim 1 or 2, **characterised in that** the appliance feeding the painting medium is at least one paint gun with a nozzle placed inside the chamber of the non-metallic drum (110), which is mounted in the movable lid of the non-metallic drum (110).
4. The paint coat application device according to claim 1 or 2, **characterised in that** the appliance feeding the painting medium is at least one paint hose with a valve whose mouth is placed in the chamber of the non-metallic drum (110).
5. The paint coat application device according to claim 1 or 2, or 3, or 4, **characterised in that** the heating inductor (281) of the induction heater (280) is a device generating the alternating magnetic field having a frequency ranging from 30 kHz to 100 kHz, reaching an instantaneous magnetic induction value of a field generated between 0.2 T and 0.4 T, and magnetic flux values in a range of 0.1 Wb to 1.0 Wb.
6. The paint coat application device according to claim 1 or 2, or 3, or 4, or 5, **characterised in that** in a wall of the non-metallic drum (110) are holes for draining excess painting medium.
7. The paint coat application device according to claim 1 or 2, or 3, or 4, or 5, or 6, **characterised in that** in the non-metallic drum chamber is an opening, situated coaxially with the drum rotation axis (115), through which painting medium fumes and/or a mix of painting medium fumes and air is extracted with a negative pressure system (230) having a filter (233) for capturing any painting medium residue and contaminants.
8. The paint coat application device according to claim 1 or 2, or 3, or 4, or 5, or 6, or 7, **characterised in that** a servomotor is attached by one end to the lid of the non-metallic drum (110), and the other end is fixed to the housing of the non-metallic drum (110), for opening and closing the lid of the non-metallic drum (110).
9. The paint coat application device according to claim 1 or 2, or 3, or 4, or 5, or 6, or 7, or 8, **characterised in that** it has a system (260) regulating rotation speed of the non-metallic drum (110), a system (270) regulating tilt of the non-metallic drum (110) and amount of the painting medium being fed, temperature and time of heating of the metal elements.
10. A paint coat application method for applying a painting medium onto metal elements heated in a non-metallic drum's chamber, **characterised in that** after placing the metal elements in the non-metallic drum's chamber, the painting medium is fed into the chamber, the metal elements are coated by the painting medium and heated using a heating inductor of an induction heater creating eddy currents in the metal elements, which results in raising their temperature to pre-set values depending on a paint type and a paint coat thickness given by manufactures of paint and lacquers, after which the temperature of the metal elements is maintained in a pre-set temperature range given by manufactures of paint and lacquers, until a paint coat on the metal elements hardens.
11. The paint coat application method according to claim 10, **characterised in that** after hardening of the paint coat applied earlier, the temperature of the metal elements is reduced to a pre-set value depending on the paint type and the paint coat thickness, after

which another paint coat application cycle begins, involving the feeding of the painting medium into the non-metallic drum's chamber, the heating of the metal elements, maintaining the pre-set temperature range of the metal elements until the hardening of another paint coat and cooling of the metal elements, while the paint coat application cycle repeats until a pre-set paint coat thickness is obtained.

12. The paint coat application method according to claim 10 or 11, **characterised in that** a change of heating temperature of the metal elements is effected by changing value of current flowing in an induction coil.
13. The paint coat application method according to claim 10 or 11, or 12, **characterised in that** the painting medium is fed into the non-metallic drum's chamber with at least one paint gun and the metal elements are mixed during the feeding of the painting medium, by putting the non-metallic drum into a rotary motion during which linear speed of the metal elements is not greater than the square root of the product of the distance between the metal elements and the drum rotation axis, and gravitational acceleration g.
14. The paint coat application method according to claim 10 or 11, or 12, **characterised in that** the painting medium is fed into the non-metallic drum's chamber through holes in a drum wall, and the metal elements are mixed during the feeding of the painting medium, during which the linear speed of the metal elements is not greater than the square root of the product of the distance between the metal elements and the drum rotation axis, and gravitational acceleration g, after which the drum rotation speed is increased to a value at which excess painting medium is drained through the holes in the drum wall, as a result of a centrifugal force acting on the painting medium.
15. The paint coat application method according to claim 10 or 11, or 12, or 13, or 14, **characterised in that** painting medium fumes and/or a mix of painting medium fumes and air is extracted from the non-metallic drum's chamber through an opening located coaxially with the drum rotation axis, with a negative pressure system having a filter for capturing any painting medium residue and contaminants.

Patentansprüche

1. Eine Lackschicht Anwendungs Vorrichtung zum Beschichten Lackmedium auf Metallelementen, die einen Behälter mit den Metallelementen umfasst, ein Gerät Fütterung Malmittel, um auf die Metallelemente und angewendet werden, eine Vorrichtung, die ein magnetisches Wechselfeld bewirkt, dass die Metallelemente erwärmt werden, **dadurch gekenn-**

zeichnet, daß der Behälter eine nicht-metallische Walze (110) mit einer Kammer und einer Öffnung, die den Zugang in die Kammer für die Metallelemente, die verschließbar durch einen beweglichen Deckel nicht dauerhaft relativ zu der nichtmetallische Trommel fixiert (110) und ein Gehäuse des nichtmetallischen Trommel (110) im Verhältnis zu dem der nichtmetallische Walze (110) um seine Achse drehbar befestigt ist, wohingegen die Vorrichtung, die das magnetische Wechselfeld verursacht die Erwärmung des Metallelemente ist Heizinduktor (281) einer Induktionsheizung (280), die induktiv erwärmt die Metallelemente durch das magnetische Wechselfeld und die Außenseite der Kammer der nichtmetallische Trommel (110) befindet, und dass das Gemälde Medium in das eingespeist Kammer des nichtmetallischen Trommel (110) mit dem Gerät Zuführen des Malmedium um auf den Metallelementen angewendet werden, und im Inneren der Kammer des nichtmetallischen Trommel (110) eine Lackschicht auf den Metallelementen angewendet und die Metallelemente werden erhitzt, und das Innere der Kammer des nicht-metallischen Trommel (110), falls notwendig, die Metallelemente gekühlt werden.

2. Der Farbüberzug-Auftragvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** das Gehäuse des nicht-metallischen Trommel (110) verschiebbar gelenkig gelagert an starren Stützen (131, 132) geschwenkt werden kann, um von dem zumindest einen fest ist eine Kippvorrichtung, die an die nichtmetallische Walze (110) um einen beliebigen Winkel aus einer Position, in der die Öffnung nichtmetallischen Trommel (110) nach oben in eine Position, in der Öffnung der nichtmetallischen Trommel nach unten gerichtet ist zu kippen erlaubt.
3. Die Lackschicht-Auftragvorrichtung nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** das Gerät Zuführen des Malmedium wenigstens eine Farbspritzpistole mit einer Düse in der Kammer des nichtmetallischen Trommel (110), die im montierten platziert der bewegbare Deckel des nicht-metallischen Trommel (110).
4. Die Lackschicht-Auftragvorrichtung nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** das Gerät Zuführen des Malmedium mindestens ein Farbschlauch mit einem Ventil, dessen Mündung in der Kammer des nicht-metallischen Trommel (110) angeordnet ist.
5. Die Farbschicht-Auftragvorrichtung nach Anspruch 1 oder 2 oder 3 oder 4, **dadurch gekennzeichnet, daß** die Erwärmung Induktor (281) der Induktionsheizer (280) ist eine Vorrichtung, die das magnetische Wechselfeld mit einer Frequenz im Bereich von 30 kHz bis 100 kHz und erreichte eine momentane

magnetische Induktion Wert eines Feldes erzeugt zwischen 0,2 T und 0,4 T, und die magnetische Flusswerte in einem Bereich von 0,1 bis 1, 0 Wb Wb.

6. Die Farbschicht-Auftragvorrichtung nach Anspruch 1 oder 2 oder 3 oder 4 oder 5, **dadurch gekennzeichnet, dass** in einer Wand des nicht-metallischen Trommel (110) gekennzeichnet sind, Löcher zum Ablassen überschüssigen Malmmedium. 5
7. Der Farbüberzug Anwendungsvorrichtung nach Anspruch 1 oder 2 oder 3 oder 4 oder 5 oder 6, **dadurch gekennzeichnet, daß** das nichtmetallische Trommelkammer gekennzeichnet ist eine Öffnung koaxial zu der Trommeldrehachse befindet (115), durch die Malmittel Dämpfe und / oder eine Mischung aus Malmittel Dämpfe und Luft wird mit einem Unterdrucksystem (230) mit einem Filter (233) zum Erfassen jeder Malmittel Rückstände und Verunreinigungen extrahiert. 10
8. Die Lackschicht-Auftragvorrichtung nach Anspruch 1 oder 2 oder 3 oder 4 oder 5 oder 6 oder 7, **dadurch gekennzeichnet, dass** ein Servomotor ist mit einem Ende an dem Deckel des nicht-metallischen Trommel (110 angebracht) und das andere Ende ist mit dem Gehäuse des nicht-metallischen Trommel (110) zum Öffnen und Schließen des Deckels des nicht-metallischen Trommel (110) befestigt ist. 15
9. Der Farbanstrich Anwendungsvorrichtung nach Anspruch 1 oder 2 oder 3 oder 4 oder 5 oder 6 oder 7 oder 8, **dadurch gekennzeichnet, dass** sie ein System (260) zur Regelung der Drehgeschwindigkeit des nichtmetallischen hat Trommel (110), ein System (270) zur Regelung der Neigung der nichtmetallische Walze (110) und die Höhe des Bildes Medium zugeführt, die Temperatur und Dauer des Erhitzens der Metallelemente. 20
10. Eine Lackschicht Anwendungs Verfahren zum Aufbringen einer Malmittel auf Metallelemente in einem nicht-metallischen Trommelkammer, **dadurch gekennzeichnet, erhitzt** nach dem Platzieren der Metallelemente in der nicht-metallischen Trommel Kammer wird die Malmittel in die Kammer zugeführt wird, die Metallelemente werden durch die Malmittel beschichtet und erhitzt mit einer Wärme Induktivität einer Induktionsheizung Schaffung Wirbelströme in der Metallelemente, die bei der Erziehung ihrer Temperatur auf Ergebnisse voreingestellten Werte in Abhängigkeit von einer Lacktyp und einer Lackschichtdicke gegeben durch produziert Farbe und Lacke, woraufhin die Temperatur der Metallelemente in einem voreingestellten Temperaturbereich gegeben durch beibehalten Hersteller von Farben und Lacken, bis eine Farbschicht auf den Metallelementen aushärtet. 25

11. Die Lackschicht Anwendungsverfahren nach Anspruch 10, **dadurch gekennzeichnet, daß** nach dem Aushärten der Lackschicht bereits aufgebracht, wird die Temperatur der Metallelemente zu einem voreingestellten Wert in Abhängigkeit von der Farbtyp und dem Lackschichtstärke reduziert, wonach ein anderes Farbanstrich Anwendungszyklus beginnt mit der Zuführung des Gemäldes Medium in die nichtmetallische Trommelkammer, das Erwärmen der Metallelemente, die Aufrechterhaltung der voreingestellten Temperaturbereich der Metallelemente, bis die Aushärtung des weiteren Lackschicht und Abkühlen des Metall-Elemente, während die Lackschicht Anwendungs Zyklus wiederholt, bis eine voreingestellte Lackschichtdicke erreicht ist. 30
12. Der Farbüberzug Anwendungsverfahren nach Anspruch 10 oder 11, **dadurch gekennzeichnet, dass** eine Änderung der Heiztemperatur der Metallelemente durch Ändern Wert fließenden Strom in einer Induktionsspule durchgeführt wird. 35
13. Der Farbüberzug Anwendungsverfahren nach Anspruch 10 oder 11, oder 12, **dadurch gekennzeichnet, dass** das Bild Medium mit mindestens einer Spritzpistole, in die nichtmetallische Trommelkammer zugeführt wird und die Metallelemente während der Zuführung des Bildes gemischt Medium, indem man die nicht-metallische Trommel in eine Drehbewegung, während der Lineargeschwindigkeit der Metallelemente nicht größer ist als die Quadratwurzel des Produkts aus dem Abstand zwischen den Metallelementen und der Trommeldrehachse und der Erdbeschleunigung g. 40
14. Der Farbüberzug Anwendungsverfahren nach Anspruch 10 oder 11, oder 12, **dadurch gekennzeichnet, dass** das Bild Medium wird durch Löcher in einer Trommelwand in die nichtmetallische Trommelkammer zugeführt wird, und die Metallelemente während der Zuführung des gemischten malt Medium, bei dem die lineare Geschwindigkeit der Metallelemente nicht größer ist als die Quadratwurzel des Produkts aus dem Abstand zwischen den Metallelementen und der Trommeldrehachse und der Erdbeschleunigung g, wonach die Trommeldrehgeschwindigkeit auf eine erhöhte Wert, bei dem überschüssige Malmittel wird durch die Löcher in der Trommelwand abgelassen, als Ergebnis einer auf der Malmittel wirkende Fliehkraft. 45
15. Die Lackschicht Anwendungsverfahren nach Anspruch 10 oder 11 oder 12 oder 13 oder 14, **dadurch** Malmittel Dämpfe und / oder einer Mischung aus Malmittel Dämpfe und Luft gekennzeichnet ist aus der nicht-metallischen Trommel Kammer durch extrahiert eine Öffnung koaxial zu der Trommeldrehachse befindet, mit einem Unterdrucksystem mit ei- 50

nem Filter zum Einfangen von jeder Malmedium Rückstände und Verunreinigungen.

Revendications

1. Un dispositif de peinture d'application de revêtement pour le revêtement de support de la peinture sur des éléments métalliques, qui comprend un récipient avec des éléments métalliques, un appareil d'alimentation milieu de peinture devant être appliquée sur les éléments métalliques et un dispositif générant un champ magnétique alternatif amenant les éléments métalliques à chauffer, **caractérisé en ce que** le récipient est un tambour non métallique (110) avec une chambre et une ouverture permettant l'accès dans la chambre pour les éléments métalliques, qui peut être fermée par un couvercle mobile fixé de manière non permanente par rapport au tambour non métallique (110) et un boîtier de tambour non métallique (110), par rapport à laquelle le tambour non métallique (110) est fixé en rotation autour de son axe, tandis que le dispositif de génération du champ magnétique alternatif provoquant le chauffage des éléments métalliques est un chauffage inducteur (281) d'un dispositif de chauffage à induction (280) qui chauffe par induction des éléments métalliques par le champ magnétique alternatif et qui est situé à l'extérieur de la chambre de tambour non métallique (110), et tandis que le milieu de peinture est introduit dans la chambre de tambour non métallique (110) en utilisant l'appareil d'alimentation du milieu de peinture afin d'être appliqué sur des éléments métalliques, et à l'intérieur de la chambre de tambour non métallique (110) une couche de peinture est appliquée sur les éléments métalliques et les éléments métalliques sont chauffés, et à l'intérieur de la chambre de tambour non métallique (110), le cas échéant, les éléments métalliques sont refroidis.
2. Le dispositif de la peinture d'application de revêtement selon la revendication 1, **caractérisé en ce que** le boîtier du tambour non métallique (110) est déplaçable monté de manière articulée pour pivoter sur des supports rigides (131, 132), au moins l'un est fixe un système de basculement qui permet d'incliner le tambour non métallique (110) par un angle à partir d'une position dans laquelle l'ouverture de tambour non métallique (110) tournée vers le haut à une position dans laquelle l'ouverture du tambour non métallique tournée vers le bas.
3. Le dispositif de la peinture d'application de revêtement selon la revendication 1 ou 2, **caractérisé en ce que** l'appareil d'alimentation du milieu de peinture est au moins un pistolet à peinture avec une buse placée à l'intérieur de la chambre de tambour non

métallique (110), qui est monté dans le couvercle mobile du tambour non métallique (110).

4. Le dispositif de la peinture d'application de revêtement selon la revendication 1 ou 2, **caractérisé en ce que** l'appareil d'alimentation du milieu de peinture est au moins un tuyau de peinture avec une valve dont l'embouchure est placée dans la chambre du tambour non métallique (110).
5. Le dispositif de la peinture d'application de revêtement selon la revendication 1 ou 2, ou 3, ou 4, **caractérisé en ce que** l'inducteur de chauffage (281) du dispositif de chauffage à induction (280) est un dispositif de génération du champ magnétique alternatif ayant une fréquence allant de 30 kHz à 100 kHz, pour atteindre une valeur instantanée de l'induction magnétique d'un champ généré entre 0,2 T et 0,4 T, et les valeurs de flux magnétique dans une plage de 0,1 à 1 0,0 Wb Wb.
6. Le dispositif d'application de peinture de revêtement selon la revendication 1 ou 2, ou 3, ou 4, ou 5, **caractérisé en ce que** dans une paroi du tambour non métallique (110) sont des trous pour drainer l'excès de milieu de peinture.
7. Le dispositif de la peinture d'application de revêtement selon la revendication 1 ou 2, ou 3, ou 4, ou 5, ou 6, **caractérisé en ce que** dans la chambre de tambour non métallique est une ouverture, située coaxialement à l'axe de rotation du tambour (115), à travers laquelle la peinture moyen des fumées et / ou un mélange de peinture et des vapeurs moyennes air est extrait d'un système de pression négative (230) comportant un filtre (233) pour capturer les contaminants et les résidus moyen peinture.
8. Le dispositif de la peinture d'application de revêtement selon la revendication 1 ou 2, ou 3, ou 4, ou 5, ou 6, ou 7, **caractérisé en ce qu'un** servomoteur est fixé par une extrémité au couvercle du tambour non métallique (110), et dont l'autre extrémité est fixée au boîtier du tambour non métallique (110), pour ouvrir et fermer le couvercle du tambour non métallique (110).
9. Le dispositif de la peinture d'application de revêtement selon la revendication 1 ou 2, ou 3, ou 4, ou 5, ou 6, ou 7, ou 8, **caractérisé en ce qu'il** comporte un système (260) de régulation de vitesse de rotation de la non métallique tambour (110), un système (270) de régulation de l'inclinaison du tambour non métallique (110) et la quantité du milieu de peinture étant alimenté, de la température et du temps de chauffage des éléments métalliques.
10. Un procédé d'application de revêtement de peinture

pour appliquer un matériau de peinture sur des éléments métalliques chauffés dans la chambre un tambour non métallique, **caractérisé en ce qu'**après mise en place des éléments métalliques dans la chambre du tambour non métallique, le milieu de peinture est introduit dans la chambre, la éléments métalliques sont revêtues par le moyen de la peinture et chauffé au moyen d'un inducteur de chauffage d'un appareil de chauffage par induction créant des courants de Foucault dans les éléments métalliques, ce qui conduit à élever leur température de pré-réglage des valeurs en fonction d'un type de peinture et une épaisseur de couche de peinture donnée par manufacturés de la peinture et des vernis, après quoi la température des éléments métalliques est maintenue dans un intervalle de température pré-ensemble donné de fabrique de la peinture et des laques, jusqu'à ce qu'une couche de peinture sur les éléments métalliques durcit.

11. Procédé de peinture d'application de revêtement selon la revendication 10, **caractérisé en ce qu'**après le durcissement de la couche de peinture appliquée à l'heure, la température des éléments métalliques est réduite à une valeur prédéfinie en fonction du type de peinture et l'épaisseur de la couche de peinture, après quoi un autre cycle de peinture d'application de revêtement commence, impliquant l'alimentation du milieu de peinture dans la chambre de tambour non métallique, le chauffage des éléments métalliques, de maintenir la gamme pré-régler la température des éléments métalliques jusqu'à ce que le durcissement d'une autre couche de peinture et le refroidissement de la éléments métalliques, tandis que le cycle de peinture application de la couche se répète jusqu'à une épaisseur de couche de peinture pré-ensemble est obtenue.
12. Le procédé d'application de revêtement de peinture selon la revendication 10 ou 11, **caractérisé en ce qu'**un changement de température de chauffage des éléments métalliques est effectué en changeant la valeur du courant circulant dans une bobine d'induction.
13. Procédé de peinture d'application de revêtement selon la revendication 10 ou 11, ou 12, **caractérisé en ce que** le moyen de peinture est introduit dans la chambre du tambour non métallique avec au moins un pistolet à peinture et les éléments métalliques sont mélangés pendant l'alimentation de la peinture moyen, en plaçant le tambour non métallique en un mouvement de rotation au cours de laquelle vitesse linéaire des éléments métalliques est inférieure ou égale à la racine carrée du produit de la distance entre les éléments en métal et l'axe de rotation du tambour, et accélération de la pesanteur g.

14. Procédé de peinture d'application de revêtement selon la revendication 10 ou 11, ou 12, **caractérisé en ce que** le moyen de peinture est introduit dans la chambre du tambour non métallique à travers des trous dans une paroi du tambour, et les éléments métalliques sont mélangés pendant l'alimentation de la peinture moyenne, au cours de laquelle la vitesse linéaire des éléments métalliques est inférieure ou égale à la racine carrée du produit de la distance entre les éléments en métal et l'axe de rotation du tambour, et accélération de la pesanteur g, après quoi la vitesse de rotation du tambour est porté à une valeur à laquelle milieu de peinture en excès est évacuée à travers les trous dans la paroi du tambour, à la suite d'une force centrifuge agissant sur le moyen de peinture.
15. Procédé de peinture d'application de revêtement selon la revendication 10 ou 11, ou 12, ou 13, ou 14, **caractérisé en ce que** la peinture fumées moyennes et / ou un mélange de peinture fumées moyennes et de l'air est extrait de la chambre de tambour non métallique par une ouverture située de manière coaxiale avec l'axe de rotation du tambour, avec un système de pression négative ayant un filtre pour capturer toute la peinture résidu milieu et les contaminants.

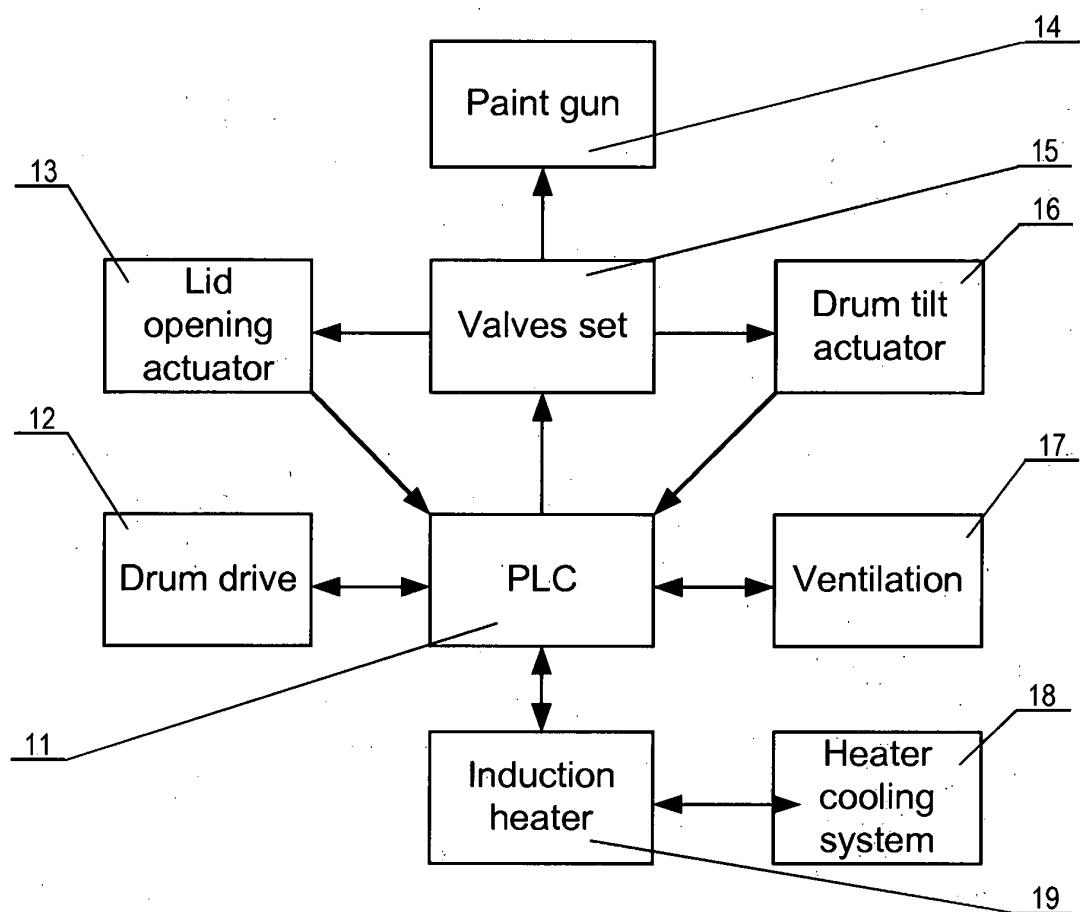


Fig. 1

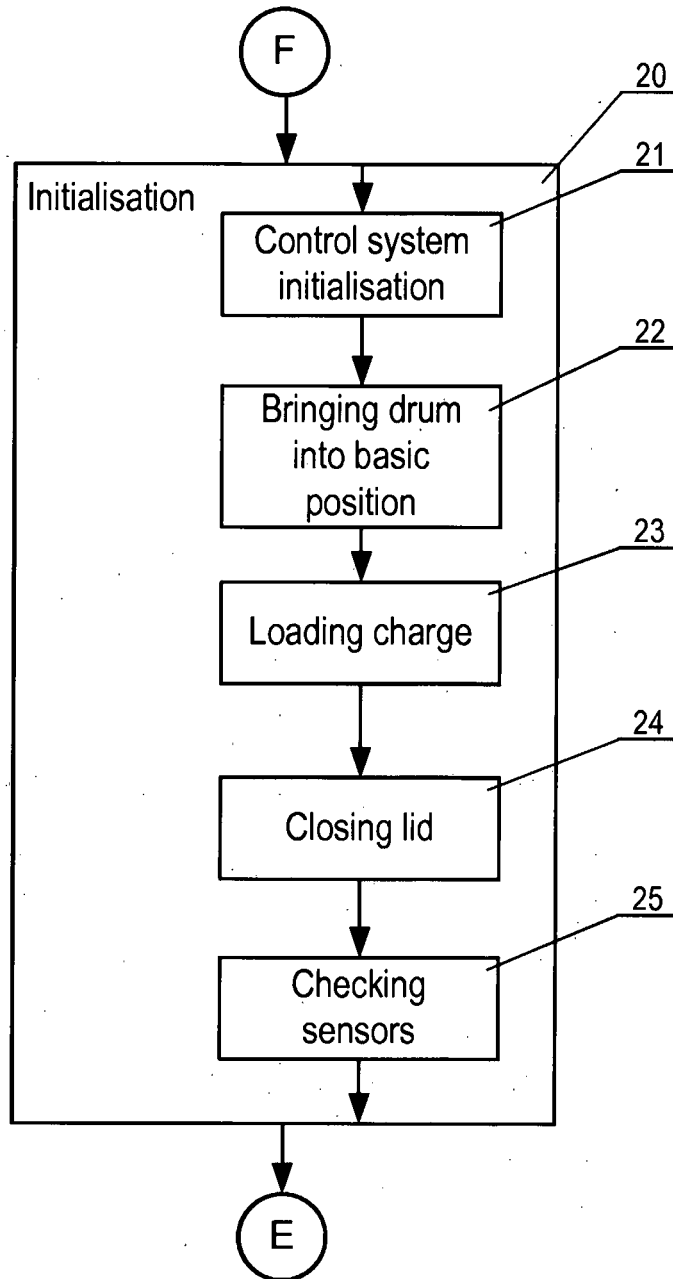


Fig. 2A

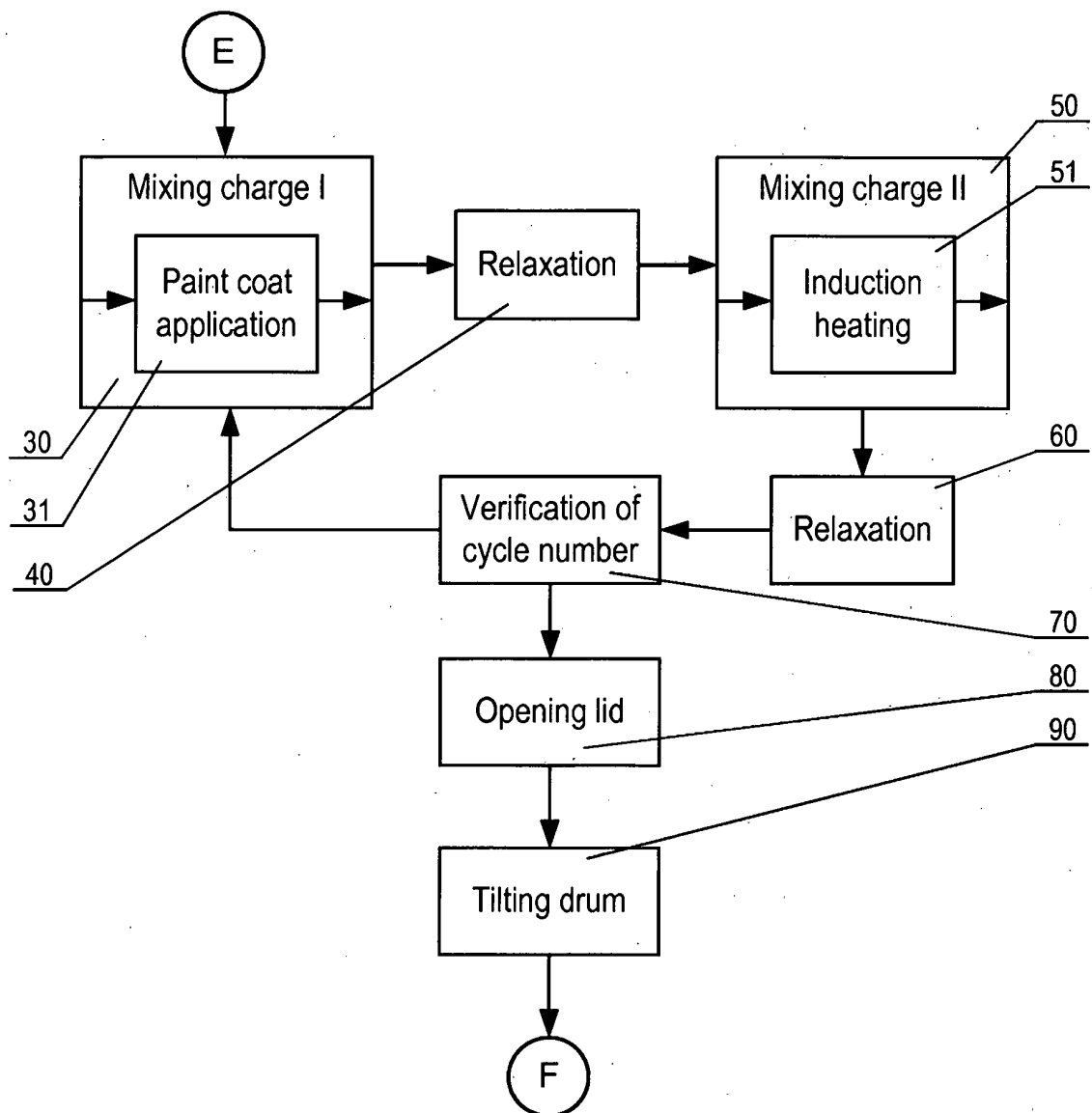


Fig. 2B

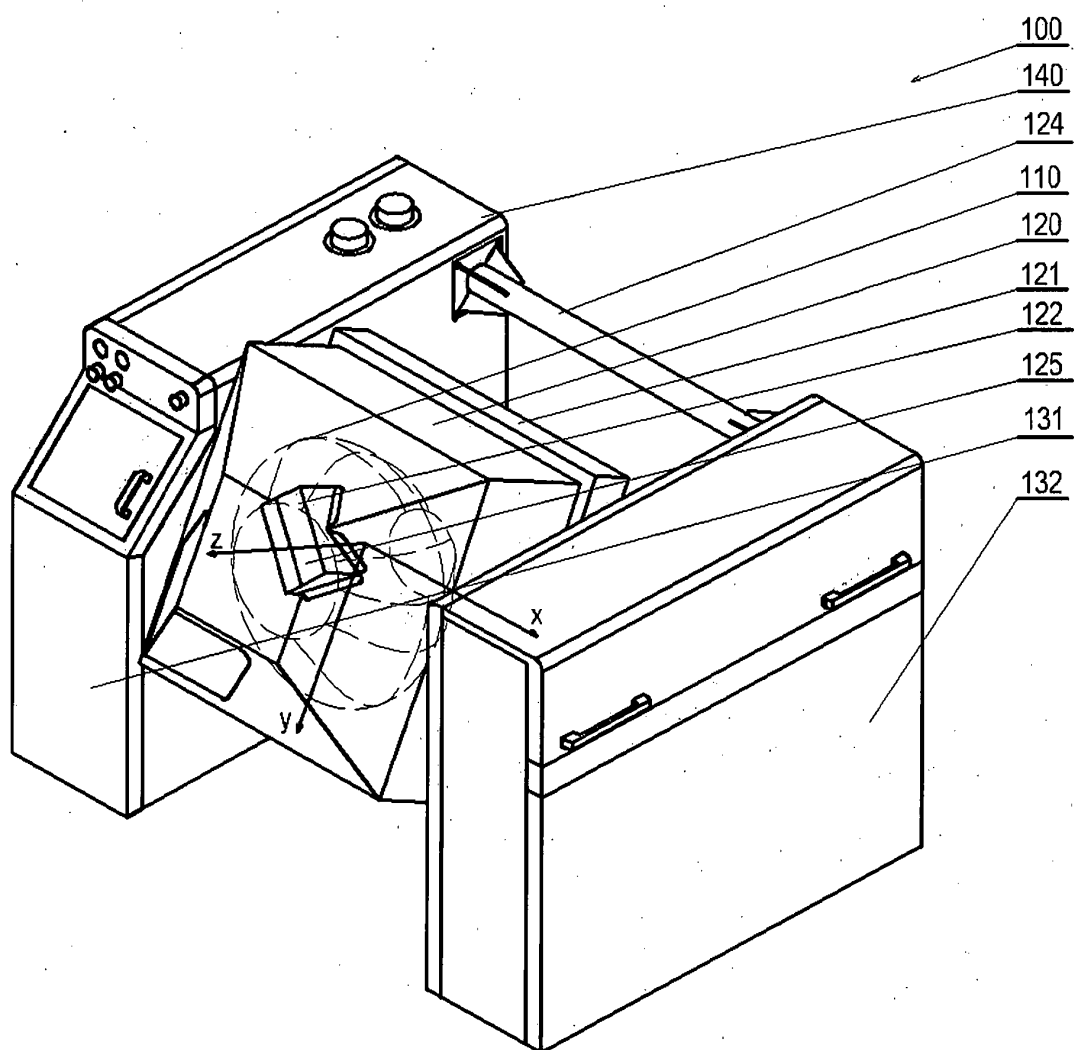


Fig. 3

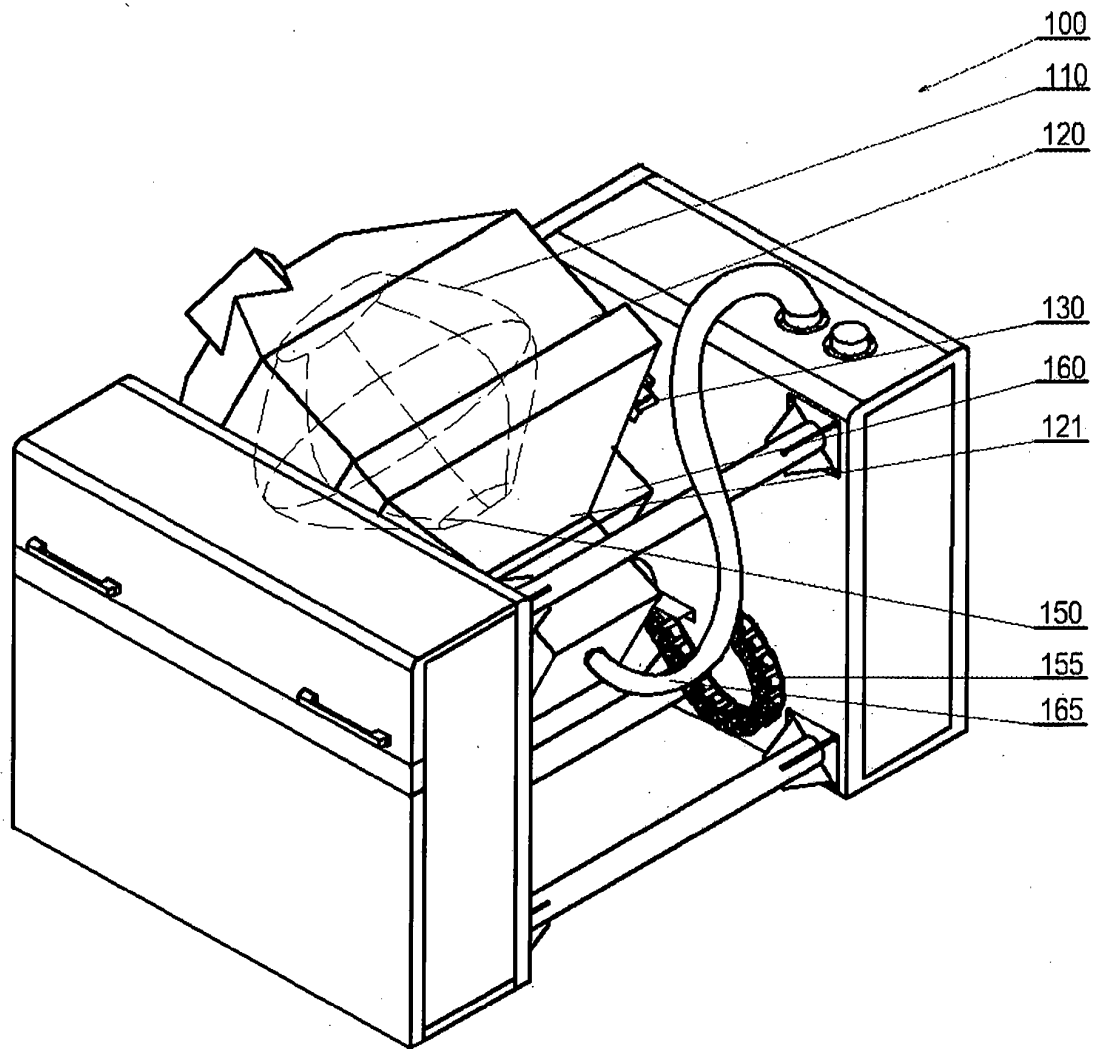


Fig. 4

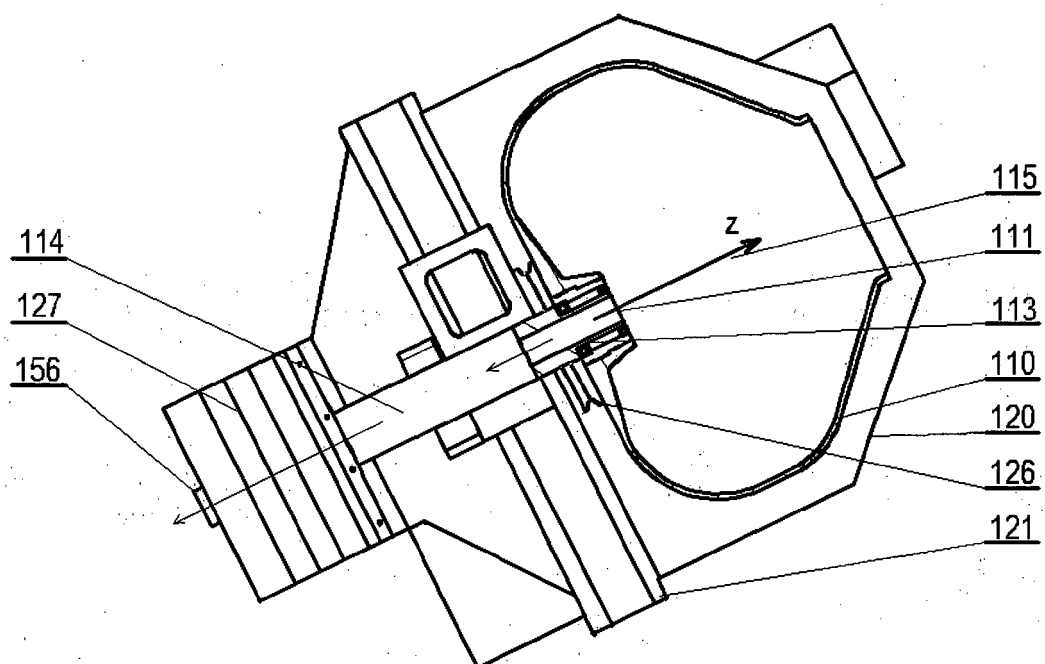


Fig. 5

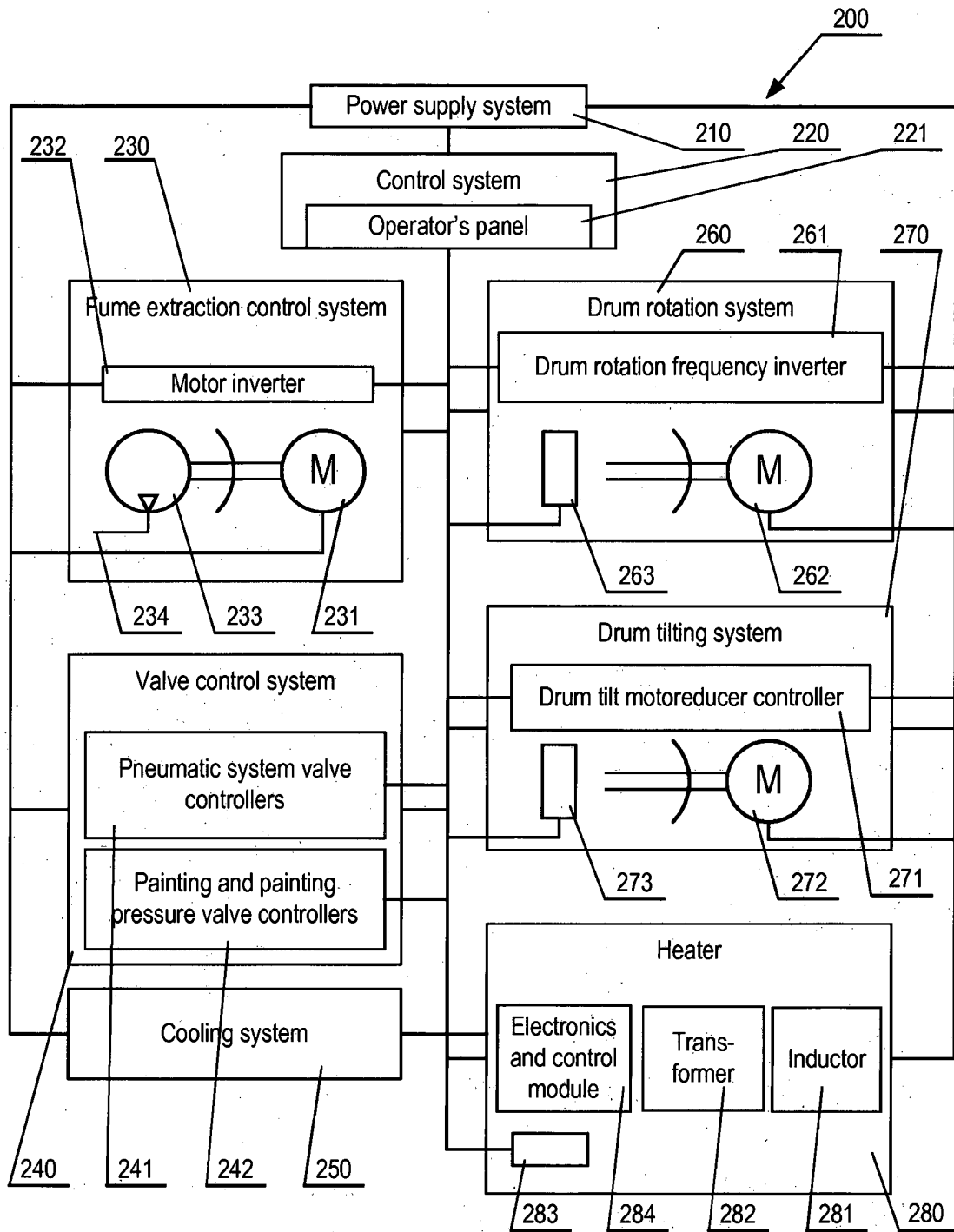


Fig. 6

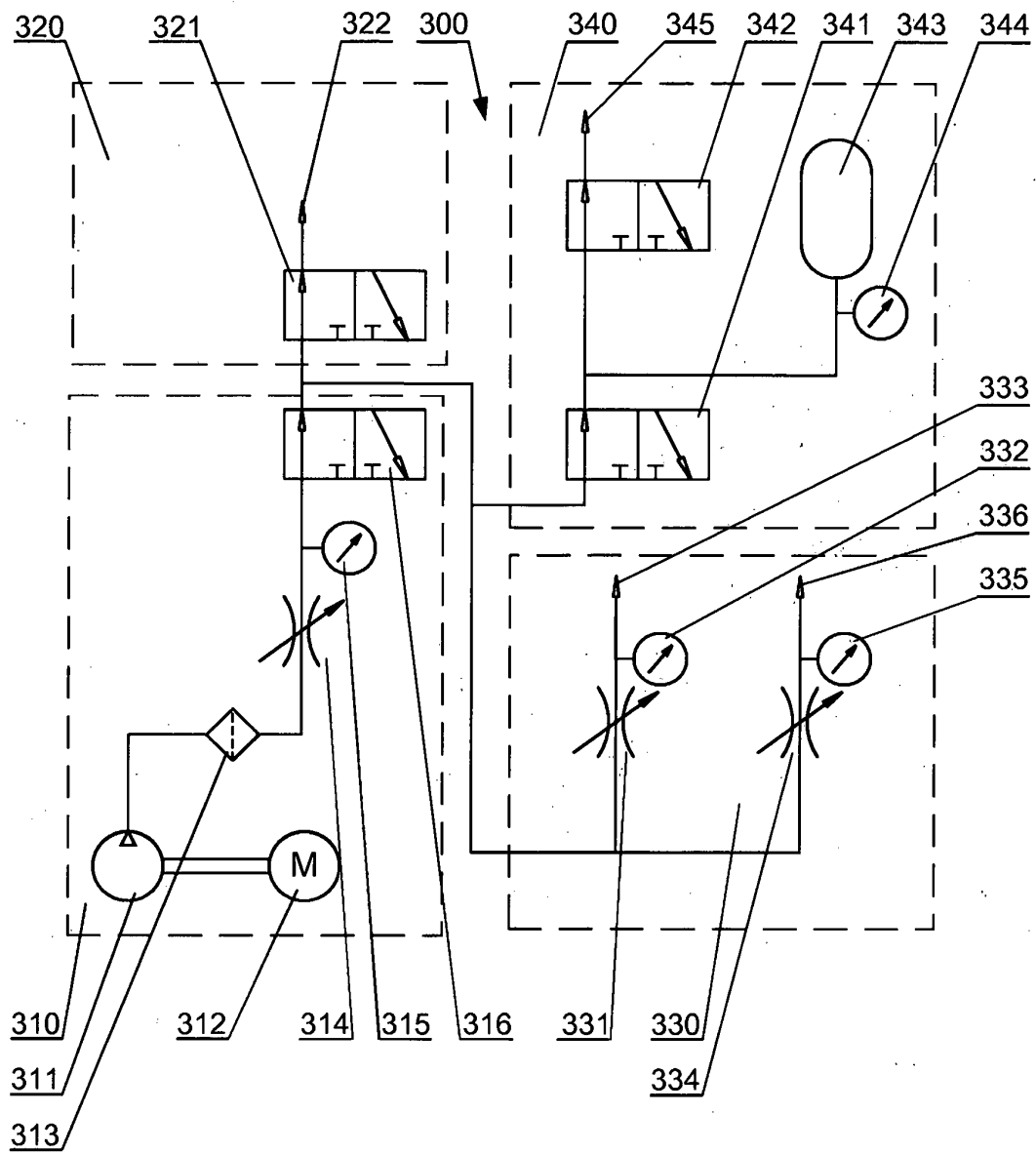


Fig. 7

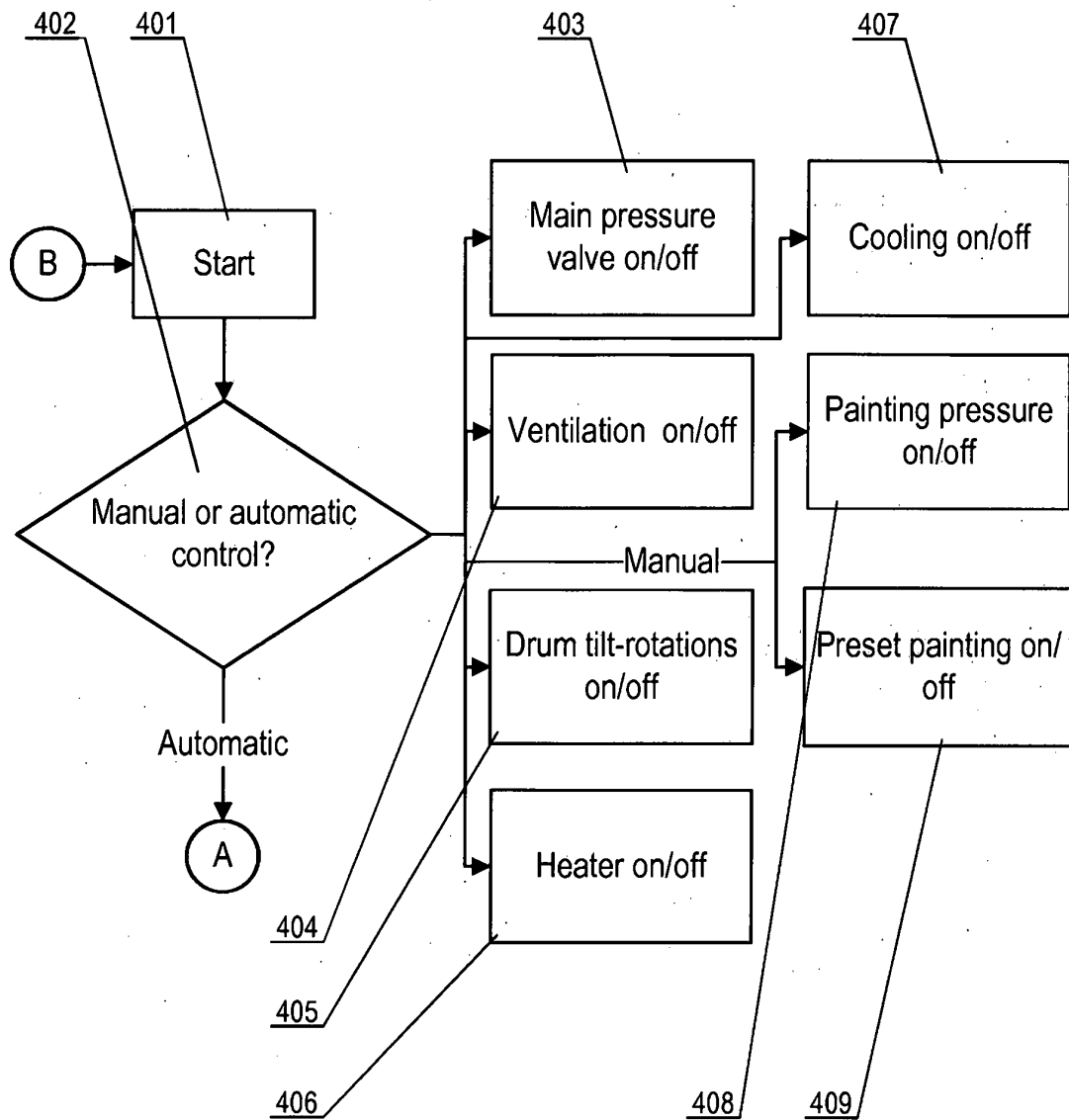


Fig. 8A

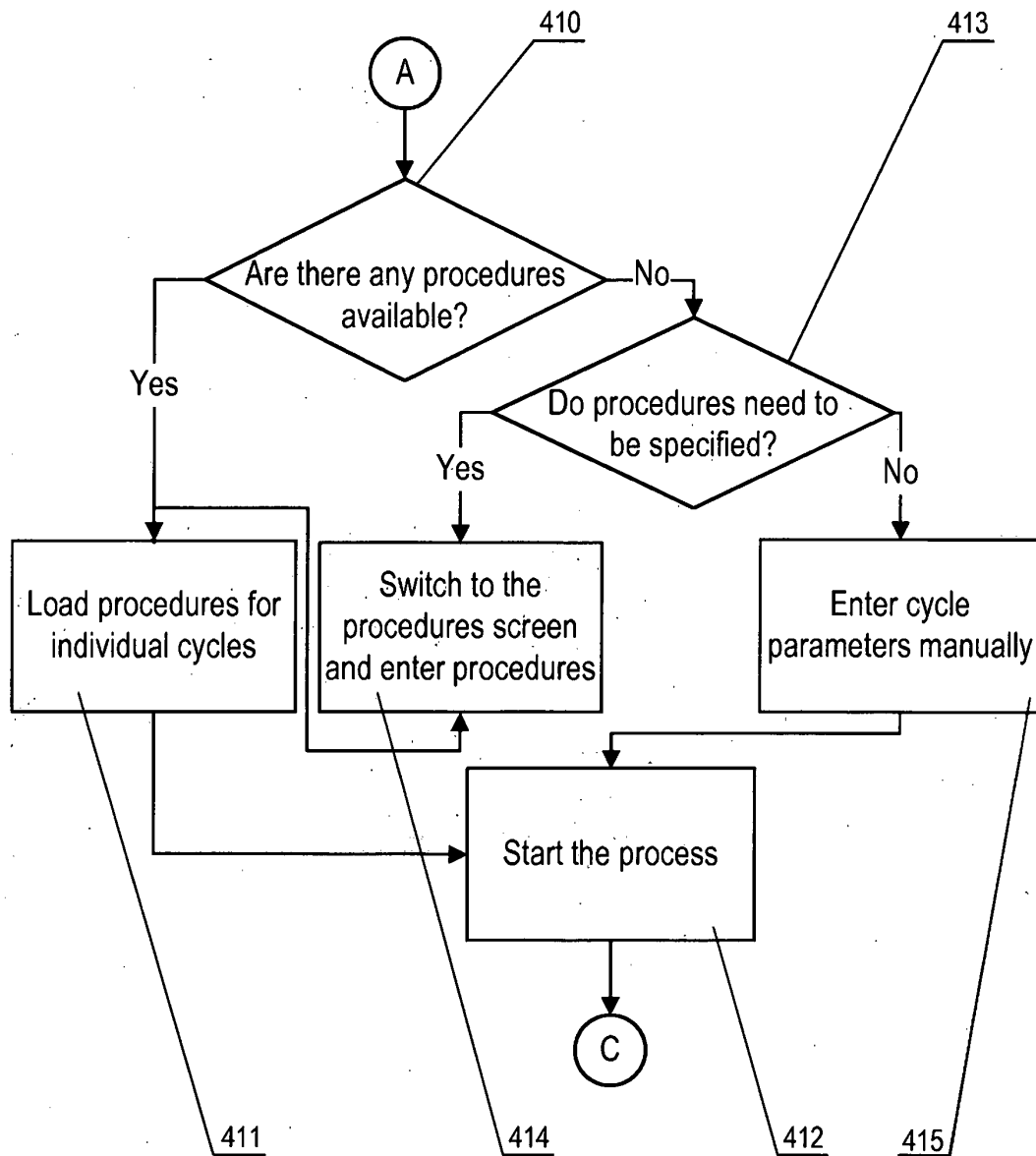


Fig. 8B

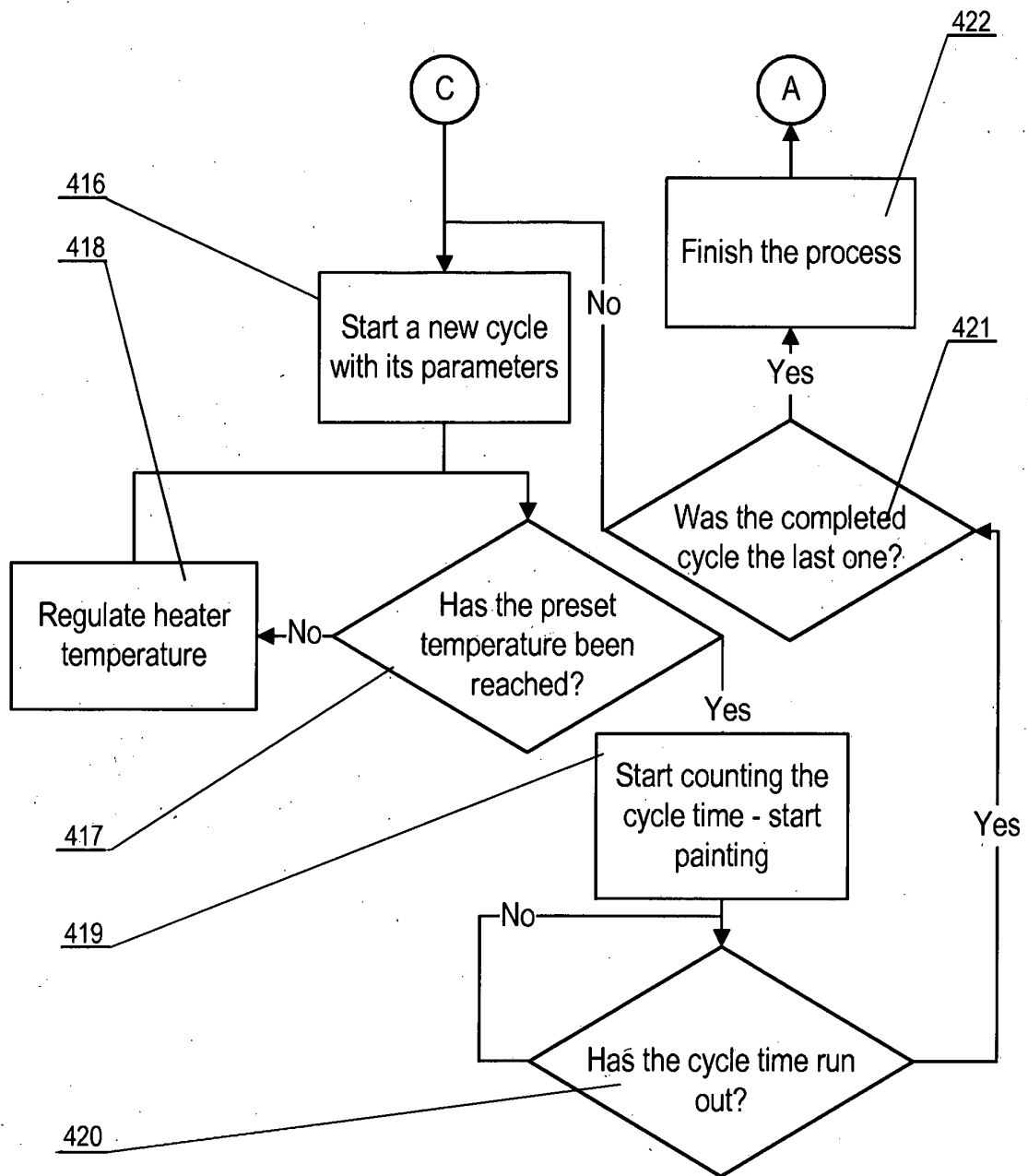


Fig. 8C

REFERENCES CITED IN THE DESCRIPTION

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