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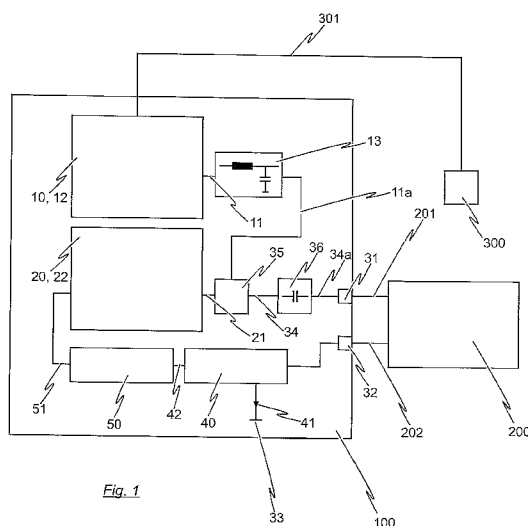


Fig. 1

(57) **Abstract:** An oscillator (100) for providing an oscillating voltage for a powder spray coating device (200) is specified. With the aim of improving the efficiency and the quality of the coating result of an article coated by means of the powder spray coating device (200), the solution according to the invention provides equipping the oscillator (100) with a first signal generator (10) for generating an intermediate circuit voltage (11) and a second signal generator (20) for generating a modulation signal (21), an oscillator voltage (34) being generated by means of a modulation unit (35). A current measuring device (40) measures the oscillator current (41) flowing through the powder spray coating device (200) and passes the measured oscillator current value (42) on to a regulating unit (50), which, by means of an actuating command (51), continually changes the frequency (23) of the modulation signal (21) generated in the second signal generator (20) in dependence on the measured oscillator current (41).

OSCILLATOR FOR AN ELECTROSTATIC POWDER SPRAY COATING DEVICE

The present invention relates to an oscillator for providing an oscillating voltage, the oscillating voltage being delivered to a powder spray coating device.

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It is known from the prior art to provide powder spraying devices, in particular spray guns and the like, for delivering a fluidized powder to an earthed surface to be coated with suitable high-voltage generators in order to impart high voltage to the coating powder that is leaving the powder spray coating device in the direction of the object to be coated.

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For this purpose, a transformer and a high-voltage cascade circuit connected thereto are provided, for example, within the powder spray coating device, the high-voltage transformer initially serving for the transformation to a moderately high voltage, and a voltage multiplication subsequently being performed in the sense of a cascade by the high-voltage cascade circuit supplied with the moderately high a.c. voltage, generally by combining diode paths and capacitors, for every half wave of the a.c. voltage.

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For this purpose, in the case of conventional oscillators an a.c. voltage is generated at their output, it being possible to set this a.c. voltage in its amplitude within certain limits. Different voltage amplitudes then result in different high-voltage amplitudes within the powder spray coating device, since the design of the high-voltage transformer and of the cascade circuit connected thereto is not adaptable. Consequently, an adaptability of the desired high voltage that is intended to be imparted to the coating powder is achieved by a variation of the amplitude of the oscillator voltage.

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An adaptation of the high voltage may be required in particular whenever the different coating parameters, such as for example the composition of the coating powder, the distance of the powder spray coating device from the object to be coated or else the nature of the object to be coated itself, are changed. For example, it may be provided that, to obtain the coating parameters for a specific coating result, the high voltage to be imparted to the powder spray coating material should be, for example, 100 kV. However, then there is the problem in the case of conventional oscillators for powder spray coating devices that relatively high losses occur as a result of the changing parameters of the electrical load at the oscillator output, on the one hand causing an undesired development of lost heat and on the other hand having the effect that, in the case of a known high-voltage

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transformer and known high-voltage cascade circuit within the powder spray coating device, the unknown parameter change means that it is no longer ensured that a high voltage with the desired values will actually be generated within the powder spray coating device when a specific amplitude of the oscillator a.c. voltage is prescribed. Both have adverse effects on the efficiency, and in particular on the quality of the coating result.

Proceeding from this problematic situation, the present invention was based on the object of developing an oscillator for providing an oscillating voltage for a powder spray coating device of the type mentioned at the beginning in such a way that the efficiency and the quality of the coating result are improved.

This object is achieved in the case of an oscillator for providing an oscillating voltage for a powder spray coating device of the type mentioned at the beginning by the features of patent claim 1. In particular, this object is achieved by the oscillator having a first signal generator for generating an intermediate circuit voltage and a second signal generator for generating a modulation signal as well as a modulation unit for generating an oscillator voltage, with a first terminal for outputting the generated oscillator voltage to a powder spray coating device and a second terminal for returning this used oscillator voltage to a reference potential being provided, and furthermore with a current measuring device for measuring an oscillator current and a regulating unit being provided. The modulation unit serves here for generating the oscillator voltage by modulation of the intermediate circuit voltage with the modulation signal. The measured value of the oscillator current determined by means of the current measuring device is transmitted here to the regulating unit, the regulating unit being designed for continually changing the modulation signal of the second signal generator on the basis of the transmitted measured value for the oscillator current.

By changing the frequency of the modulation signal of the second signal generator, the frequency of the resultant overall oscillator voltage is thereby likewise changed. Such a changing of the frequency of the oscillator voltage in dependence on the measured oscillator current has the effect that the high-voltage generation in the powder spray coating device supplied with the oscillator voltage takes place more efficiently, whereby the powder spray coating result improves significantly.

Furthermore, by such oscillator-current-dependent variation of the oscillator voltage frequency, unknown influences, such as for example the ambient temperature or the length of the feeding to the powder spray coating device, can be

controlled in such a way that they have a smaller influence on the high voltage that is actually generated within the powder spray coating device. Here it is of advantage in particular that the possibility of being able to deduce the high voltage generated within the powder spray coating device from the oscillator current that is
5 flowing allows an optimum coating result that is not dependent on unknown influences such as the ambient temperature and the length of the feedline to the powder spray coating device to be obtained by means of regulated variation of the oscillator frequency. Similarly, the advantage that the coating result becomes more independent of further influencing variables, such as the coating distance or
10 inadequate earthing of the object to be coated, can be achieved thereby.

Furthermore, the development of heat is reduced by the advantage of more efficient, i.e. lower-loss, high-voltage generation.

15 Advantageous developments of the invention are specified in the subclaims.

For example, it is envisaged in an advantageous way to design the regulating unit in such a way that it continually changes the frequency of the modulation signal of the second signal generator, and consequently also the resultant overall frequency
20 of the oscillator voltage, in such a way that the measured oscillator current becomes minimal.

In particular, it is also envisaged to obtain a minimum for this flowing oscillator current by corresponding regulation, that is to say a comparison of the measured
25 oscillator current with its predecessor value or its predecessor values, this minimum being obtained by means of the regulating unit by variation of the frequency of the modulation signal of the second signal generator. It is thereby ensured by the continual regulation, i.e. the continued regulation even after reaching such a minimum for the first time, that parameters changing in the course
30 of the time period of the coating operation, such as for example the ambient temperature or the distance from the object to be coated, do not have adverse effects on the coating result.

Furthermore, it is ensured in particular by the minimizing of the flowing oscillator
35 current thus achieved that the heat development is also optimally limited, and consequently that as little loss of heat as possible occurs.

It may be envisaged in this respect to arrange the current measuring device in the branch of the oscillator according to the invention that serves for returning the used

oscillator voltage from the second terminal to the reference potential. Here, the reference potential may be, in particular, the earth potential of the oscillator circuit. Arranging the current measuring device between the second terminal for returning the used oscillator voltage to the reference potential and the reference potential itself, i.e. in the returning branch, makes a flow measurement at a relatively low potential possible, since a large part of the voltage has already dropped in the powder spray coating device, and there in particular across the primary winding of the high-voltage transformer.

10 In a particularly advantageous way, however, it is envisaged to provide the current measuring device in the branch of the oscillator according to the invention that serves for supplying the oscillator voltage to be output to the powder spray coating device. The current measuring device is expediently arranged between the modulation unit and the first terminal for outputting the oscillator voltage. Such an arrangement has the effect in particular of effectively avoiding interference, which makes a more accurate measurement of the current in the measuring device possible.

20 Furthermore, it is envisaged to provide the first signal generator with a first pulse-width modulation unit and with at least one low-pass filter connected thereto. In the following, the term pulse-width modulation is intended to cover both the variation of a (square-wave) pulse duty factor at constant frequency of successive pulse packets, and the possibility of changing such a frequency of pulses to be delivered. Similarly, the term pulse-width modulation is intended to be understood as meaning the combination of these possibilities, i.e. a combination of pulse duty factor variation and changing the frequency of the signal pulses to be delivered.

30 By simple variation of the pulse duty factor and/or the frequency within the pulse-width modulation unit, a variation of the amplitude of the intermediate circuit voltage is consequently possible in a particularly simple way. The low-pass filter is in this case particularly dimensioned in such a way that a substantially smoothed d.c. voltage is output as the intermediate circuit voltage.

35 Furthermore, it is envisaged also to provide the second signal generator with a second pulse-width modulation unit, with the output modulation signal of which the intermediate circuit voltage is subsequently modulated by means of the modulation unit. In this way, the frequency of the modulation signal that is output by the second signal generator is changed by a simple changing of the pulse width (i.e. pulse duty factor and/or pulse packet frequency) of the second pulse-width

modulation unit, whereby the required option of setting the modulation frequency for the regulation performed by means of the regulating unit is possible in a particularly simple way.

- 5 To achieve a regulating range that is as wide as possible, it may also be envisaged to make the frequency of the modulation signal variable in a wide range, for example in the range between 10 and 30 kHz. Such a great range of frequencies that can be regulated makes it possible for the flowing oscillator current to be optimally adapted, for example to a minimum. Furthermore, the frequency range
10 between 10 and 30 kHz is well within the scope of pulse-width modulation, it being possible for particularly low-cost components to be used in this frequency range. It is at the same time also ensured by the frequency range between 10 and 30 kHz that the losses, particularly of the high-voltage transformer within the powder spray coating device, are low, while at the same time such a high-voltage
15 transformer is of a relatively small type of construction.

Furthermore, it may be envisaged to couple the oscillator voltage of the oscillator according to the invention capacitively to the first terminal for outputting the oscillator voltage. Coupling, for example by way of a coupling capacitor, thereby
20 eliminates d.c. components of the output oscillator voltage and smoothes the edges thereof to a certain degree, whereby in particular a high-voltage transformer within the powder spray coating device can be operated optimally and with little interference.

- 25 With regard to the intermediate circuit voltage, it may be envisaged to provide this in a range between 0 and 24 V. Such a voltage range ensures great operating and handling dependability with at the same time good accessibility of components providing short-circuit protection or interference suppression that are possibly to be provided, such as for example Zener diodes.

30 A preferred exemplary embodiment of the oscillator according to the invention for providing an oscillating voltage for a powder spray coating device is explained in more detail below on the basis of a drawing, in which:

- 35 Figure 1 shows a block diagram of an oscillator according to the invention for providing an oscillating voltage, with a current measuring device in the return branch, with a powder spray coating device connected to the oscillator;

Figure 1a shows a block diagram of the oscillator from Figure 1, with the difference that the current measuring device is arranged in the supply branch of the oscillator voltage;

5 Figure 2 shows a voltage-time diagram for an intermediate circuit voltage output by a first signal generator, after low-pass filtering has taken place;

10 Figure 3 shows a voltage-time diagram for an oscillator voltage, as obtained by modulation of an intermediate circuit voltage with a modulation signal in a modulation unit;

Figure 4 shows the oscillator voltage from Figure 3 after capacitive coupling has taken place to eliminate the d.c. component; and

15 Figure 5 shows a current-time diagram combined with a frequency-time diagram for the variation over time of the oscillator current compared with the variation over time of the frequency of the modulation signal.

20 Figure 1 shows a block diagram of an oscillator 100 according to the invention, which outputs at a first terminal 31 a capacitively coupled oscillator voltage 34a to a powder spray coating device 200, for example a powder spray gun. In the exemplary embodiment shown in Figure 1, the capacitive coupling of the oscillator voltage 34 takes place by means of a coupling capacitance 36 in order to obtain the capacitively coupled, largely d.c.-component-free oscillator voltage 34a. Such a capacitively coupled oscillator voltage 34a is of advantage if it is initially used to feed a high-voltage transformer within the powder spray coating device 200, in order to avoid high losses in the primary winding of said transformer.

25 Nevertheless, such a capacitive coupling of the oscillator voltage 34 is not absolutely necessary for the function of the oscillator 100, if - for example in the case of a different kind of structure of the powder spray coating device 200 - a d.c. component at the input of the powder spray coating device 200 does not lead to short-circuiting thereof.

35 In addition to the first terminal 31 for outputting the oscillator voltage 34 or 34a, a second terminal 32 is provided, for returning the oscillator voltage 34 used in the powder spray coating device to a reference potential 33. However, such a return to the reference potential 33 is only functionally specific to the oscillator 100, and can

for example also take place outside a possibly present oscillator housing. The term "terminal" should consequently be understood merely as meaning that an electrical connection can be established or has been established between the oscillator 100 and the powder spray coating device 200.

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The oscillator 100 has for generating the oscillator voltage 34 a first signal generator 10 and a second signal generator 20. In the exemplary embodiment shown in Figure 1, a first pulse-width modulation unit 12 is integrated in the first signal generator 10. In a similar way, a second pulse-width modulation unit 22 is integrated in the second signal generator 20. By choosing a suitable pulse width, the first pulse-width modulation unit 12 generates a square-wave signal with a variable pulse duty factor, a variable pulse frequency or a combination of a variable pulse duty factor and a variable pulse frequency, whereby the effective mean value of the voltage amplitude of the intermediate circuit voltage 11 generated by the first signal generator 10 can be changed according to the choice of parameters of the first pulse-width modulation unit 12. For example, according to the exemplary embodiment shown in Figure 1, an appropriate choice of parameters allows the mean value of the generated intermediate circuit voltage 11 to be chosen between 0 and 24 V, but the invention is not restricted to this exemplary range of values for the intermediate circuit voltage 11. Rather, it may similarly be envisaged to provide negative intermediate circuit voltages with respect to the reference potential 33 or else to provide greater value ranges with a maximum value of more than 24 V. Similarly, the amplitude or mean-value amplitude of the output intermediate circuit voltage 11 may be definitively specified – according to the intended application. In the exemplary embodiment shown in Figure 1, an operating and controlling unit 300, on which, for example, settings with regard to the level of the intermediate circuit voltage can be performed, is provided. For instance, depending on the nature of the connected powder spray coating device 200 and depending on given coating parameters, such as for example different coating materials and different spraying distances, the value of the intermediate circuit voltage 11, and consequently indirectly also the value of the high voltage generated within the powder spray coating device 200, can be adapted to the parameters. For this purpose, the operating and controlling unit 300 transmits a suitable control signal 301 to the first signal generator 10, in order for example to adapt the pulse duty factor of the pulse-width-modulated voltage within the first pulse-width modulation unit 12 correspondingly to the specifications.

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The generated intermediate circuit voltage 11 is subsequently passed to a low-pass filter 13, in order to obtain a low-pass-filtered intermediate circuit voltage 11a, which corresponds substantially to a smoothed d.c. voltage of the mean value of the pulse-width-modulated intermediate circuit voltage 11.

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The second pulse-width modulation unit 22, which in the exemplary embodiment shown in Figure 1 is integrated in the second signal generator 20, generates - likewise by pulse-width modulation - a modulation signal 21, i.e. a high-frequency signal for the modulation of the d.c. voltage or low-pass-filtered intermediate circuit voltage 11a. Both this low-pass-filtered intermediate circuit voltage 11a and the generated modulation signal 21 are passed into a modulation unit 35, in which the corresponding modulation is performed. Such a modulation unit comprises in the simplest case a transistor, generally a field-effect transistor, possibly with a corresponding transistor driver block interposed.

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The modulation signal 21 is generally applied here to the gate of a field-effect transistor used for the modulation within the modulation unit, in order to modulate with the generally high-frequency modulation signal 21 the low-pass-filtered intermediate circuit voltage 11a dropping across the source-drain path and output it from the modulation unit 35 as oscillator voltage 34. For example, in the case of a square-wave modulation signal 21, the low-pass-filtered intermediate circuit voltage 11a is consequently applied in the pulse rate of the modulation signal 21 to an output (not represented) of the modulation unit 35 when the modulation signal 21 is logical 1 (e.g. "high"). In order to ensure a defined reference potential at the output of the modulation unit 35 in the pulse breaks, i.e. when the modulation signal 21 is logical 0 (e.g. "low"), a further transistor, generally a further field-effect transistor, may be provided for switching through this reference potential. For this, the transistor driver block will preferably be a half-bridge driver, which ensures such an alternating switching operation. This means that this half-bridge driver switches through the low-pass-filtered intermediate circuit voltage 11a to the output of the modulation unit 35 at points in time at which the modulation signal 21 is logical 1, and correspondingly switches through the defined reference potential to the output of the modulation unit 35 at points in time at which the modulation signal 21 is logical 0.

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However, this embodiment of a modulation unit 35 should be understood as merely given by way of example and not restrictive; the exact configuration of a suitable modulation unit 35 is familiar to a person skilled in the art.

As already mentioned, in the exemplary embodiment shown according to Figure 1, the oscillator voltage 34 output from the modulation unit 35 is supplied to a coupling capacitance 36, which particularly eliminates the d.c. voltage component of the oscillator voltage 34 and outputs a capacitively coupled oscillator voltage 34a to the first terminal 31.

A high-voltage transformer is generally provided within the powder spray coating device 200, i.e. the capacitively coupled oscillator voltage 34a supplied to the powder spray coating device 200 by way of a supply line 201 generally drops across the primary winding of such a high-voltage transformer and is returned to the second terminal 32 of the oscillator 100 by means of a return line 202. According to the exemplary embodiment shown in Figure 1, this returned voltage is subsequently passed through a current measuring device 40 to the reference potential 33. The current measuring device 40, which is generally of a very low-impedance design, serves the purpose here of determining the oscillator current 41, that is to say the current flowing from the first terminal 31 through the powder spray coating device 200, i.e. generally the primary winding of the high-voltage transformer, and subsequently through the second terminal 32 to the reference potential 33, and supplying it as a measured oscillator-current value 42 to a regulating unit 50.

Instead of arranging the current measuring device 40 as shown in Figure 1 in such a way that the returned voltage is passed through the current measuring device 40 to the reference potential 33, it is also possible, however, to measure the current in the forward-flowing branch. In particular, it is conceivable, as shown in Figure 1a, to arrange the current measuring device between the coupling capacitance 36 and the first terminal 31 for outputting the oscillator voltage 31. In turn, in this case the measured oscillator-current value 42 is also output to the regulating unit 50.

Within the regulating unit 50 there then takes place a continual comparison of this measured oscillator-current value 42, representing the oscillator current 41, with a static or variable reference value in the control engineering sense, in order continually to generate an actuating command 51 and supply it to the second signal generator 20. However, the term "continually" does not mean that only continuously operating analog controllers can be used for this; rather, the use of an appropriately designed digital controller may similarly come into consideration as regulating unit 50, regulation being performed here on the basis of digital sampling of the measured variable, that is to say the oscillator current 41, and corresponding analog or digital actuating signals or actuating commands 51 being transmitted to

the second signal generator 20. Apart from such continual recording and regulation, it may, however, equally well be envisaged to carry out such regulation merely at intervals, for example only during the actual phases of the powder spray coating or else only at specific points in time during a powder spray coating operation.

The regulating unit 50 is in this case designed to change by means of an appropriate actuating command 51 the frequency 23 of the modulation signal 21, which is generated by the second signal generator 20 or, in the exemplary embodiment represented according to Figure 1, in the second pulse-width modulation unit 22.

Here it is envisaged in particular to achieve a minimum of the oscillator current 41 during the operation of the powder spray coating device 200 by regulating the frequency 23 of the modulation signal 21. It should be noted here that, to ensure an optimum coating result, the amplitude of the oscillator voltage 34 or of the capacitively coupled oscillator voltage 34a, and consequently also the amplitude of the high voltage generated within the powder spray coating device 200, is not changed. Such regulation consequently relates merely to the adaptation of the frequency 23 of the modulation signal 21.

Such a minimum of the oscillator current 41 that can be achieved by the regulation by means of the regulating unit 50 should not be understood as an absolute minimum over time, but can change during the coating operation, in particular whenever parameters change during the coating operation, for example as a result of a changed distance from the object to be coated.

In particular, it is then envisaged to achieve a minimum of the oscillator current 41 by means of continual and corrected regulation by the regulating unit 50, and possibly keep the oscillator current 41 at such a minimum during a coating operation, i.e. during the operation of the powder spray coating device 200, by corrected regulation by means of the regulating unit 50.

By regulating the oscillator current 41 to an oscillator current minimum, the losses, i.e. in particular heat losses, are consequently reduced and, at the same time, coating results that are optimally low in losses are achieved as a result of the high efficiency of an oscillator voltage 34 or 34a generated in this way.

The variation of the low-pass-filtered intermediate circuit voltage 11a over time is explained on the basis of the voltage-time diagram represented in Figure 2. After switching on the oscillator 100, for example when commencing the powder spray coating operation at the point in time t1, the low-pass-filtered intermediate circuit voltage 11a increases to a value U_1 , it being possible for the value U_1 to be set in the range between the minimum voltage and the maximum voltage of the first signal generator 10, i.e. in particular of the first pulse-width modulation unit 12. As can be seen from Figure 2, the low-pass-filtered intermediate circuit voltage 11a is thereafter a substantially smoothed d.c. voltage of the potential U_1 chosen by way of example.

In Figure 3, the variation over time of the oscillator voltage 34 as output by the modulation unit 35 after modulation has taken place, and corresponding in terms of time to Figure 2, is represented. The variation shown should be understood here as given merely by way of example; in particular, the oscillator voltage 34 is not restricted to the variation over time represented, but deviates from the variation over time represented according to the type of modulation signal 21 that is supplied to the modulation unit 35. As can be seen, the low-pass-filtered intermediate circuit voltage 11a is modulated in time with the modulation signal 21, so that the oscillator voltage 34 in the exemplary embodiment represented fluctuates in a square-wave form between the minimum value of 0 V and the maximum value U_1 , chosen by way of example, of the intermediate circuit voltage 11 lying across the modulation unit 35.

Corresponding in terms of time to the variation over time of the voltage profiles represented in Figures 2 and 3, Figure 4 finally shows the variation over time of the capacitively coupled oscillator voltage 34a, as it drops with the coupling capacitance 36 interposed between the first terminal 31 and the second terminal 32 of the oscillator 100. It can be seen here in the voltage-time diagram according to Figure 4 that the capacitively coupled oscillator voltage 34a then does not have a d.c. voltage offset, but rather fluctuates about a mid-potential of 0 V between the voltages chosen by way of example $+U_1/2$ and $-U_1/2$.

Finally, Figure 5 shows the variation over time both of the oscillator current 41, as recorded by the current measuring device 40, and the variation over time of the frequency 23 of the modulation signal 21 corresponding thereto in terms of time as a result of the regulation. As the combined diagram according to Figure 5 reveals, the frequency 23 of the modulation signal 21 is increased by the regulation commencing from the point in time t2, chosen by way of example, whereby the

oscillator current 41 initially falls as desired. As from a point in time t3, chosen by way of example, however, a further increase in the frequency 23 of the modulation signal 21 brings about a renewed rise in the oscillator current 41, which is detected by the regulating unit 50 at a point in time t4, chosen by way of example. The
5 regulating unit 50, designed in the exemplary embodiment shown according to Figure 5 to minimize the oscillator current 41, introduces as a countermeasure to the renewed rising of the oscillator current 41 a lowering of the frequency 23 of the modulation signal 21, whereby, as from a point in time t5, chosen by way of example, the desired current minimum of the oscillator current 41 is established
10 with a corresponding frequency 23 of the modulation signal 21.

It is not shown in Figure 5 that renewed fluctuations of the oscillator current 41 may of course follow. These are caused, for example, by the changing of ambient parameters that cannot be influenced, such as the temperature, but also by
15 necessary influencing of coating parameters during operation, such as for example a change in distance from the surface to be coated or the like. Regulating measures which, by varying the frequency 23 of the modulation signal 21, once again establish an oscillator current minimum are then in turn taken by the regulating unit 50.

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It should be pointed out that all of the aspects described above are claimed as essential to the invention in themselves alone and in any combination, in particular the details that are represented in the drawings. Modifications thereof are familiar to a person skilled in the art.

List of designations

	10	first signal generator
	11	intermediate circuit voltage
5	11a	low-pass-filtered intermediate circuit voltage
	12	first pulse-width modulation unit
	13	low-pass filter
	20	second signal generator
	21	modulation signal
10	22	second pulse-width modulation unit
	23	frequency of the modulation signal
	31	first terminal for outputting an oscillator voltage
	32	second terminal for returning the used oscillator voltage to a reference potential
15	33	reference potential
	34	oscillator voltage
	34a	capacitively coupled oscillator voltage
	35	modulation unit
	36	coupling capacitance
20	40	current measuring device
	41	oscillator current
	42	measured oscillator-current value
	50	regulating unit
	51	actuating command
25	100	oscillator
	200	powder spray coating device
	201	supply line
	202	return line
	300	operating and controlling unit
30	301	control signal

Patent claims

1. An oscillator (100) for providing an oscillating voltage for a powder spray coating device (200), the oscillator (100) having the following:
 - 5 – a first signal generator (10) for generating an intermediate circuit voltage (11);
 - a second signal generator (20) for generating a modulation signal (21);
 - a modulation unit (35) for generating an oscillator voltage (34);
 - a first terminal (31) for outputting the oscillator voltage (34) to a powder
 - 10 spray coating device (200);
 - a second terminal (32) for returning the used oscillator voltage (34) to a reference potential (33), in particular earth potential; and
 - a current measuring device (40) for measuring an oscillator current (41), a regulating unit (50) being provided, designed for continually changing a
 - 15 frequency (23) of the modulation signal (21) of the second signal generator (20) in dependence on the measured oscillator current (41), and the modulation unit (35) being designed for generating the oscillator voltage (34) by modulation of the intermediate circuit voltage (11) with the modulation signal (21).
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2. The oscillator (100) as claimed in claim 1,
the regulating unit (50) being designed for continually changing the
frequency (23) of the modulation signal (21) of the second signal generator
(20) in such a way that the measured oscillator current (41) becomes
25 minimal.
3. The oscillator (100) as claimed in claim 1 or 2,
the current measuring device (40) being provided between the second
terminal (32), for returning the used oscillator voltage (34) to a reference
30 potential (33), and the reference potential (33).
4. The oscillator (100) as claimed in claim 1 or 2,
the current measuring device (40) being provided between the modulation
unit (35) and the first terminal (31) for outputting the oscillator voltage (34).
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5. The oscillator (100) as claimed in one of the preceding claims,
the first signal generator (10) having a first pulse-width modulation unit (12)
and at least one low-pass filter (13), arranged downstream of the first pulse-

width modulation unit (12), and being designed for outputting as an intermediate circuit voltage (11) a substantially smoothed d.c. voltage that can be influenced in its amplitude by changing the pulse width of the first pulse-width modulation unit (12).

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6. The oscillator (100) as claimed in one of the preceding claims, the second signal generator (20) having a second pulse-width modulation unit (22), and the frequency (23) of the modulation signal (21) being determined by the pulse width of the second pulse-width modulation unit (12).

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7. The oscillator (100) as claimed in one of the preceding claims, the frequency (23) of the modulation signal (21) being between 10 and 30 kHz.

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8. The oscillator (100) as claimed in one of the preceding claims, the oscillator voltage being capacitively coupled to the first terminal (31) for outputting the oscillator voltage (34).

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9. The oscillator (100) as claimed in one of the preceding claims, the intermediate circuit voltage (11) being 0 to 24 V.

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10. A method for regulating an oscillating voltage provided at an oscillator (100) for a powder spray coating device (200), the oscillator (100) having the following:

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- a first signal generator (10) for generating an intermediate circuit voltage (11);
 - a second signal generator (20) for generating a modulation signal (21);
 - a modulation unit (35) for generating an oscillator voltage (34);
 - a first terminal (31) for outputting the oscillator voltage (34) to a powder spray coating device (200);
 - a second terminal (32) for returning the used oscillator voltage (34) to a reference potential (33), in particular earth potential; and
 - a current measuring device (40) for measuring an oscillator current (41),
- the modulation unit (35) generating the oscillator voltage (34) by modulation of the intermediate circuit voltage (11) with the modulation signal (21), and a regulating unit (50) being provided, performing the following method step:

35

- continually changing a frequency (23) of the modulation signal (21) of the second signal generator (20) in dependence on the oscillator current (41) measured by means of the current measuring device (40).

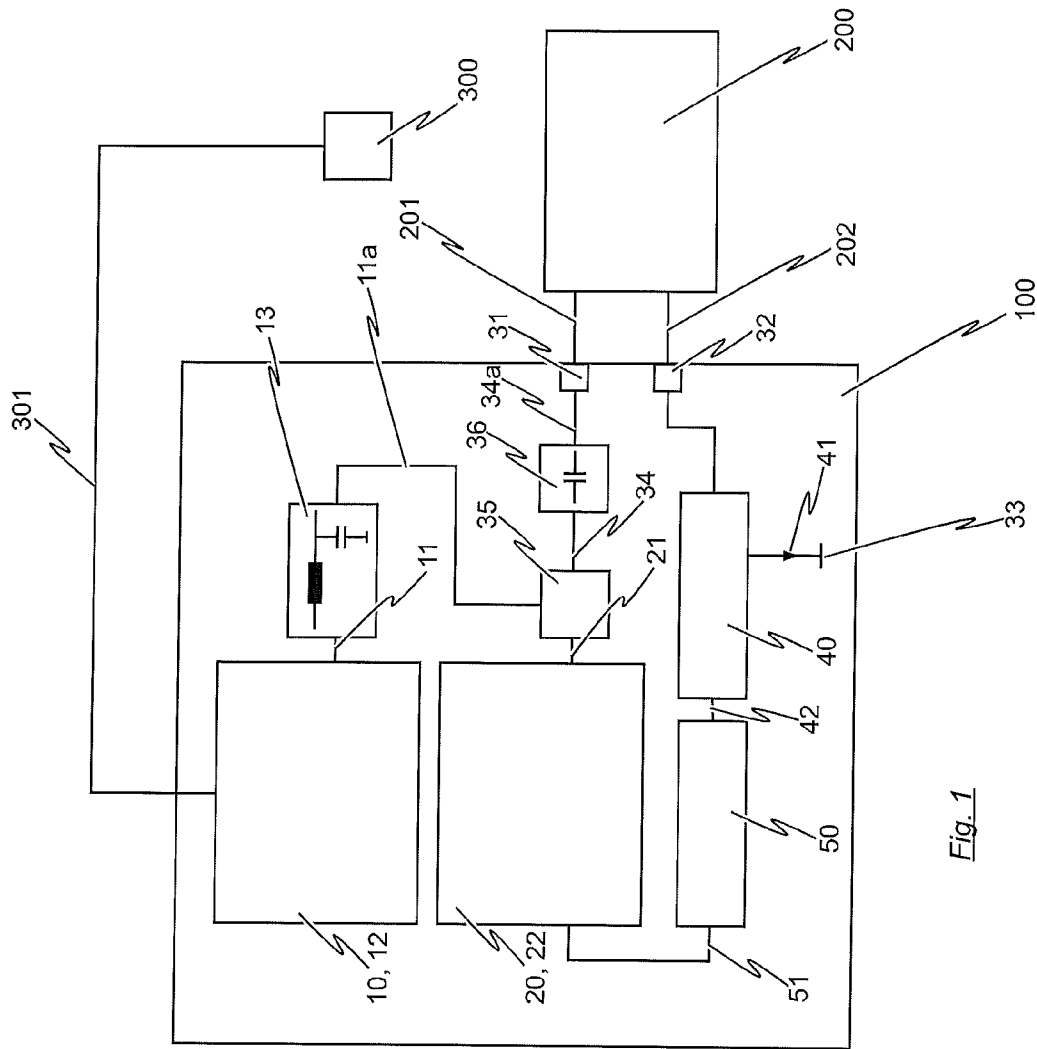


Fig. 1

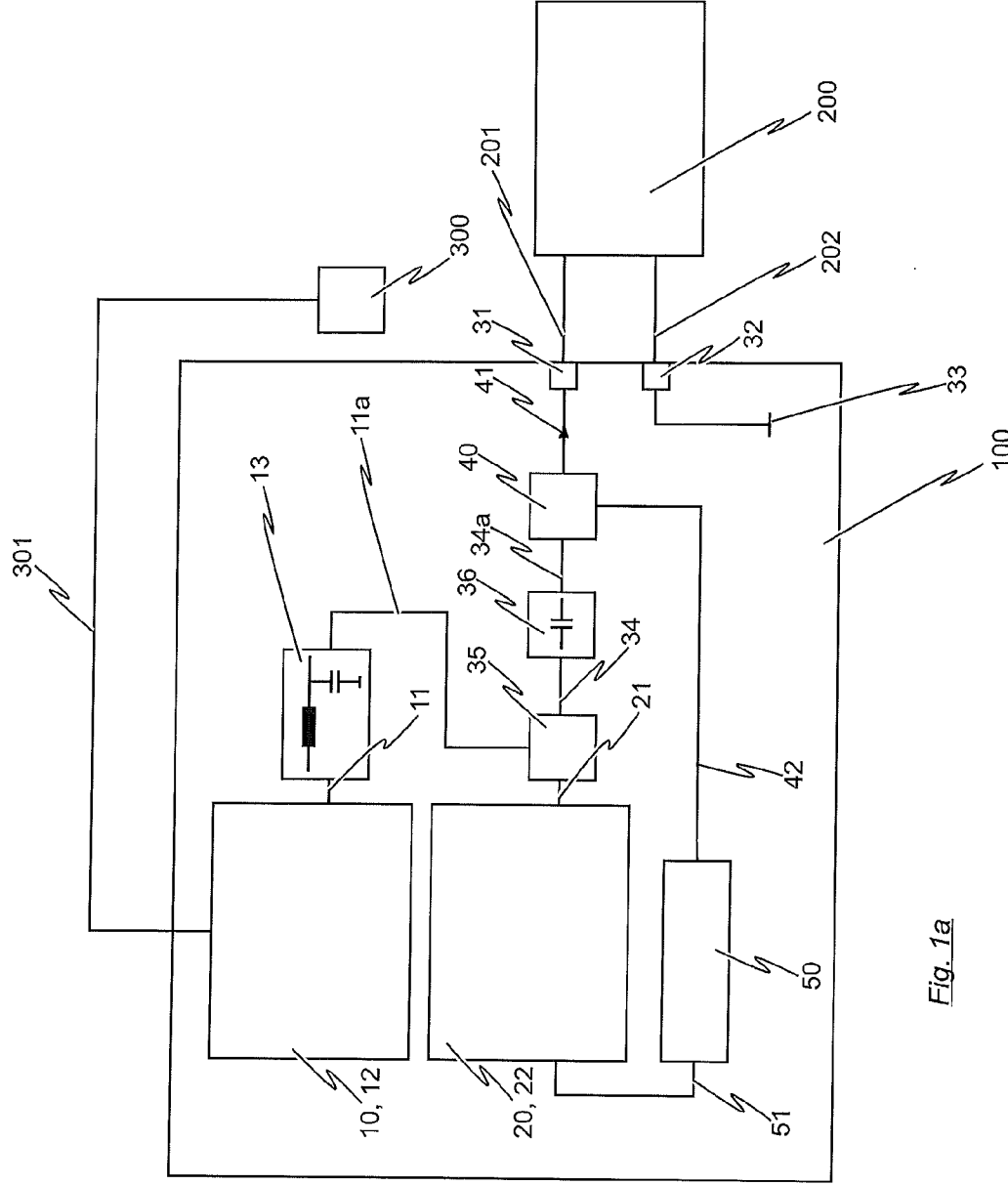


Fig. 1a

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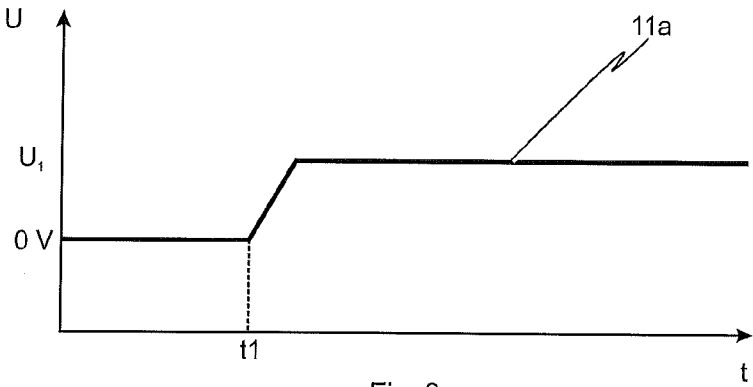


Fig. 2

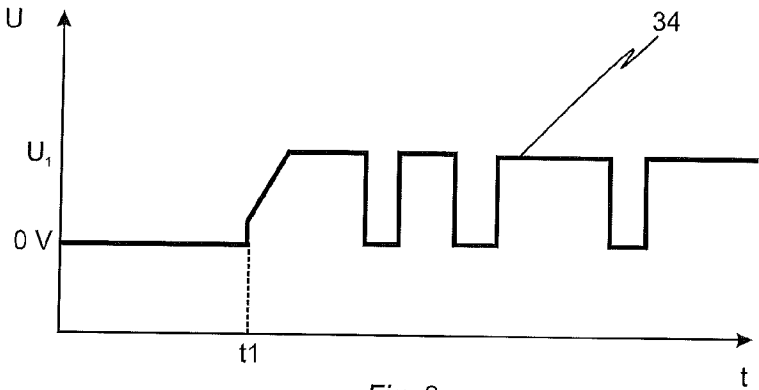


Fig. 3

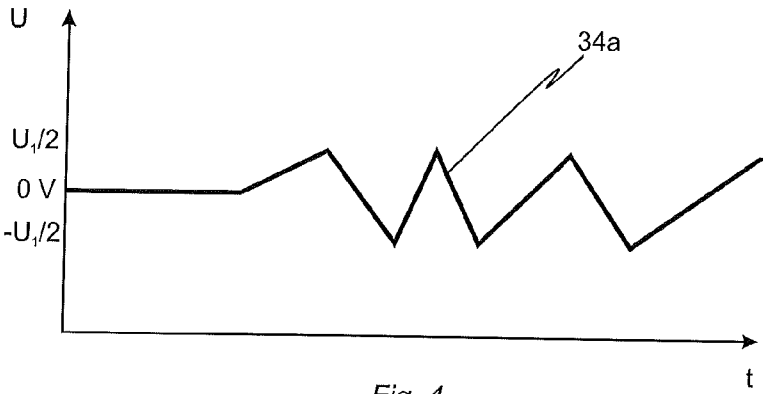


Fig. 4

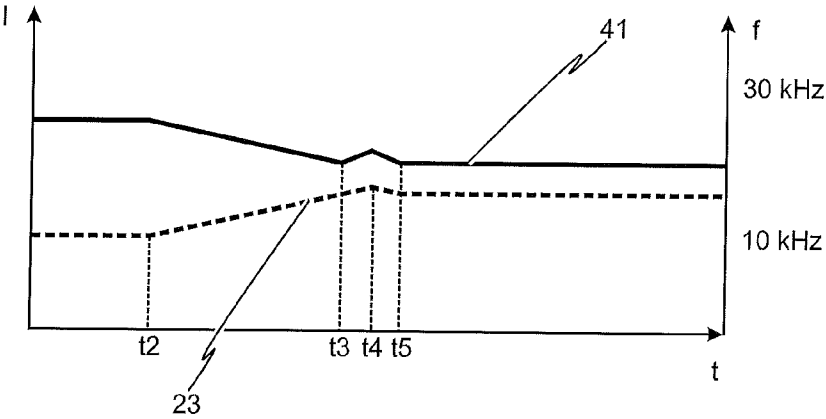


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2012/024951

A. CLASSIFICATION OF SUBJECT MATTER
 INV. B05B5/10 B05B5/03 H02M3/335
 ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 B05B H02M

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	FR 2 704 699 A1 (SAMES SA [FR]) 4 November 1994 (1994-11-04) the whole document	1-10
X	EP 1 897 621 A2 (MS OBERFLAECHESTECHNIK AG [CH]) 12 March 2008 (2008-03-12) paragraph [0010] - paragraph [0015]; figure 2	1-10
A	US 2005/040262 A1 (NAGAI KIMIYOSHI [JP]) 24 February 2005 (2005-02-24) paragraph [0050] - paragraph [0053]; figure 5 ----- -/-	1-10



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

8 May 2012

Date of mailing of the international search report

15/05/2012

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2012/024951

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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Information on patent family members

International application No

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