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(54) **A device for powering, controlling and commanding electric light sources**

(57) A device for powering, controlling and commanding lamps (6) of plants (1) for drying painted products (2), comprising a circuit (8) for supplying power to the lamps (6) at a determined value of power, which comprises a magnetic amplifier (27) connected to the circuit (8), first sensors (15) able to measure the value of the electrical parameters of the circuit (8), second sensors (18) able to measure the value of the working parameters of the lamp (6), a control and command unit (24) connected at the input to said first and second sensors (15, 18) and at the output to the magnetic amplifier

(27); the unit (24) being able continuously to monitor the signals coming from said first and second sensors (15, 18) comparing them with related pre-set reference values and, every time a variation of the aforementioned parameters occurs, being able to send a respective proportional signal to the amplifier (27) which varies its variable impedance (31) proportionately to said received signal, thereby contrasting in the circuit (8) the variation in the parameters, constantly to maintain the efficiency of the lamp (6) at a determined value.

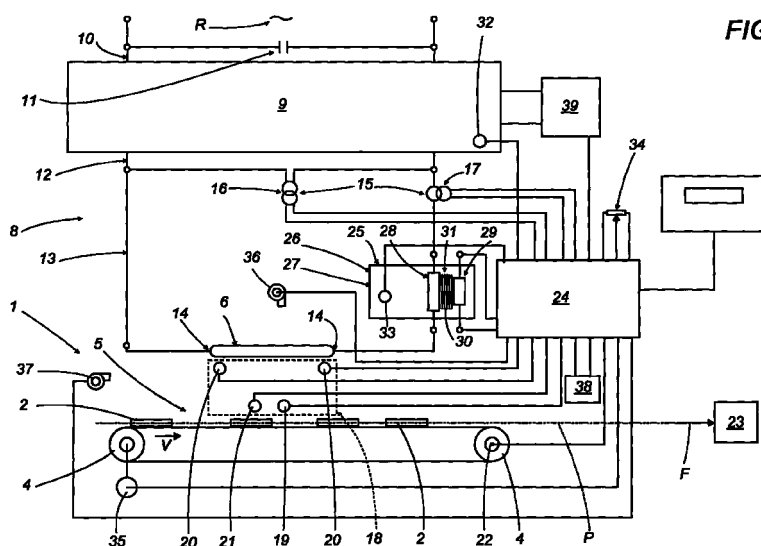


FIG. 2

Description

[0001] The present invention relates to a device for supplying power, controlling and commanding electric light sources in general.

[0002] In particular, the present invention relates to a device for supplying power, controlling and commanding light sources with electromagnetic radiation, such as halide vapour lamps so-called metal halogen lamps, lamps emitting infrared radiation and, specifically, discharge or luminescence lamps in which the emission is produced by an electric discharge (arc) within a gas, a vapour or a mixture of gas and vapours for the emission of ultraviolet radiation in the various wavelength bands. These types of lamps emitting ultraviolet rays are used in all plants for the application of a layer of protective substance, coating substance and the like, such as paints, enamels, glues, inks, and similar substances on semi-finished or finished support products such as wood, ceramic, or fibre glass reinforced plastic, paper and amorphous supports, and which use respective drying processes, in which the products after being provided with a layer of protective substances are moved by means of a conveyor belt underneath said lamps which allow for an effective and rapid drying of the aforesaid substances, whereto the present invention shall refer without thereby losing its general nature. It should also be specified that in the remainder of the present description the term "lamp" shall simply be used to indicate the various types of lamps mentioned above.

[0003] Currently, in the types of plants described above, the use is known of sets for supplying power to the lamps which substantially comprise a transformer to adapt the voltage of the electrical distribution mains to the power supply voltage of the lamp, and impedance connected in series to the lamp and able to limit the starting current at the time the lamp is turned on, a command electrical apparatus able to short circuit the aforementioned impedance once the lamp has exhausted the initial transitory and its electrical parameters have stabilised, and a possible power regulator connected in series to the lamp which allows a manual variation of the working point of the lamp itself. The secondary of the transformer is provided with a plurality of distinct outlets, each of which is connected in a determined point of the secondary to provide at the output a determined power which varies from outlet to outlet from a minimum value to a maximum value.

[0004] To be able to vary the emission power of the lamp, the operator must necessarily turn the plant off and manually change the outlet, disconnecting for instance an outlet with lesser power whereto the lamp was connected, to connect the lamp to a different outlet with greater power if a greater power supply is necessary, or, on the contrary, must disconnect the greater power outlet and connect the lamp to a lesser power outlet, if a lesser power supply is necessary to the lamp.

[0005] The aforementioned electrical command

apparatus, able to short circuit the aforementioned impedance once the lamp has exhausted the initial transitory and its electrical parameters have been stabilised, comprises a remote control switch connected in parallel to the aforementioned impedance. The remote control switch is connected to an auxiliary circuit which constitutes a device able to limit the insertion current of the lamp and favour its pre-heating. When the lamp is turned on, the auxiliary circuit is powered and it supplies power to a timer with an energising delay. Until the delay interval elapses, the timer does not energise the remote control switch that remains open and in the power supply circuit of the lamp the aforementioned impedance remains inserted, hence the lamp does not work at its maximum potential defined by one of the outlets with which it is connected to the secondary of the transformer, but is powered with voltage and current that are limited by the voltage drop on the impedance to limit the initial current of the arc inside the lamp itself. After the timer delay elapses, the timer energises the remote control switch which closes the power supply circuit and the lamp works at full power.

[0006] From the above description, it is evident that with such a power supply set it is not possible to obtain a direct and continuous control of the power of the lamp since the control is of the discrete ON-OFF type and it is effected by changing, manually and with the plant stopped, the connection of the power supply circuit with the various outlets positioned on the secondary of the transformer.

[0007] Moreover, once the remote switch is excited and it is closed by excluding the aforementioned impedance, the lamp remains continuously supplied with a determined power defined by the type of outlet previously chosen. The only possible intervention in such types of power supply sets provides for positioning a control on the aforesaid conveyor belt, which is fitted with a "drag" switch, which if a fault occurs so that the belt stops, the switch detects the stoppage of the belt and opens the remote switch allowing power to be supplied to the lamp through the aforesaid impedance, which, for the reasons described above, allows to lower the power supplied to the lamp and to prevent any erroneous drying of the aforesaid substances due, for instance, to an overly long exposition time of the painted products underneath the lamp. It is in any case evident that this type of control is also a discrete ON-OFF, and not continuous, type of control of the lamp.

[0008] From the above description, it follows that in such known power supply sets the lamps presents an instability of their emission, due to the fluctuation of the various electrical power supply parameters of the lamp itself, and the lack of emission stability leads to an imperfect drying process.

[0009] The aim of the present invention is to eliminate the aforesaid drawbacks, providing a device that is able to supply power, control and command lamps in a continuous, automatic manner and in real time, thereby

providing an emission stability of the lamps in order to prevent erroneous drying phases of the aforesaid employed substances.

[0010] According to the present invention, a device is provided for supplying power, controlling and commanding electric light sources, characterised in that it comprises a power supply circuit to supply power to said light source at a determined power value and comprising power providing means connected to said power supply circuit, first sensor means able to measure the value of at least an electrical parameter of said power supply circuit, second sensor means able to measure the value of at least a working parameter of said light source, a control and command unit connected at the input to said first and second sensor means and at the output to said power providing means; said control and command unit being able continuously to monitor the signals coming from said first and second sensor means comparing them with related pre-set reference values of said parameters whereto corresponds said determined power value and, every time at least one of said input signals indicates a variation in the related parameter with respect to the related reference parameter, being able to send a respective signal proportional to said variation to said power providing means, said power providing means being able to send a respective command signal, proportional to said received signal, to said power supply circuit in such a way as to act on the power supply circuit contrasting said variation in at least one of said parameters to maintain the efficiency of said light source constantly at a determined value.

[0011] The technical features of the invention shall become more readily apparent from the detailed description that follows, made with reference to the accompanying drawings, which represent an embodiment provided purely by way of non limiting example, in which:

- Figure 1 schematically shows a generic embodiment of a power supply, control and command circuit;
- Figure 2 schematically shows a first preferred and more complete embodiment of the circuit of Figure 1;
- Figure 3 schematically shows an alternative embodiment of the circuit of Figure 2.
- Figure 4 schematically shows a further embodiment of the circuit of Figure 2;
- Figure 5 shows a detail of the circuit of Figure 4.

[0012] With reference to the figures of the accompanying drawings, the reference 1 globally indicates a portion of a plant for drying protective substances, such as paints, enamels, glues, inks, and like substances, distributed on related semi-finished or finished support products 2 such as panels made of wood, ceramic, glass fibre reinforced plastic, paper and amorphous supports, which plant uses a respective drying process,

in which the products 2 after being provided with a layer of protective substances, hereafter generically indicated for the sake of simplicity with the term paints, are moved, by means of a conveyor belt 3 closed in a loop about two pulleys 4, whereof at least one motorised by a respective motor means 35, along a respective determined path P underneath a drying station 5 comprising lamps 6 which allow an effective and rapid drying of the aforementioned paints. The plant 1 is provided with a device 7 for supplying power, controlling and commanding the aforementioned lamps 6 (whereof only one is shown) which are constituted by lamps 6 emitting electromagnetic radiation, such as metal halogen lamps, lamps emitting infrared radiation and, in particular, discharge or luminescence lamps for the emission of ultraviolet radiation in the various wavelength bands, whose emitted light stream allows a rapid and suitable drying of the paints themselves.

[0013] The device 7 comprises a power supply circuit 8 presenting electrical parameters suited to the electrical characteristics of the lamps 6 and able to supply power to the lamps 6 themselves at a pre-determined power value.

[0014] As shown in greater detail in Figures 2 and 3, the circuit 8 comprises a step-up transformer 9 provided with a primary 10 connected to a mains grid, schematically indicated with R, and provided with a battery of re-phasing capacitors 11 and a secondary 12 connected through a respective electrical connection circuit 13 to the terminals 14 of the lamps 6, which in this specific case are constituted by a pair of cathodes 14.

[0015] As shown in Figure 2, the secondary 12 of the transformer 9 is connected, through the respective circuit 13 to first sensor means, generically indicated as 15, able to measure the value of the electrical parameters of the power supply circuit 8 and constituted by a voltage transformer 16 connected in parallel, and a current transformer 17 inserted along one of the two power supply branches of the lamp 6 in series therewith. The transformer 16 is able to measure the value of the output voltage from the secondary 12, whilst the transformer 17 is able to measure the value of the output current from the secondary 12 of the transformer 9.

[0016] The power supply circuit 8 further comprises second sensor means, globally indicated as 18, which are able to measure the working parameters of the lamps 6. In particular, the second sensor means 18 comprise a sensor 19 for measuring the actual irradiation power emitted by the lamps 6, a pair of sensors 20 for measuring the value of the temperature reached by the cathodes 14 of the lamps 6 during their operation as elements radiating electromagnetic emissions of ultraviolet rays, and a sensor 21 for measuring the value of the temperature reached by the paint of the products 2 during the respective drying phase.

[0017] The second sensor means 18 further comprise a sensor 22 located on one of the pulleys 4 and

able to measure the speed of advance of the conveyor belt 3, thereby providing at the output and in real time the value of the speed V of advance of the products 2 along the aforementioned path P in a direction F of advance of the products 2 themselves towards an operative station for the withdrawal of the products 2 presenting the respective dried paints, schematically indicated with a block 23.

[0018] The circuit 8 further comprises a control and command unit 24 which is connected at the input to the aforementioned first and, respectively, second sensor means 15, 18 and at the output of the actuator means 25 acting on the circuit 8 itself.

[0019] The unit 24 is able to monitor, in a continuous manner and in real time, all the respective signals coming from the aforementioned voltage transformer 16, current transformer 17, from the sensor 19 for measuring the actual irradiating power emitted by the lamps 6, from the sensors 20 for measuring the value of the temperature reached by the cathodes 14 of the lamps 6 during their operation, from the sensor 21 for measuring the value of the temperature reached by the paint of the products 2 during the respective drying phase, and from the sensor 22 able to measure the speed of advance of the conveyor belt 3, and for comparing such values with respective pre-set reference values of the aforementioned measured parameters whereto corresponds a value of the power supplied to the lamps 6, correctly determined and pre-set according to the type of required drying of the paint, and specifically drying time and drying value.

[0020] In use, every time at least one of said input signals indicates a variation in the related parameter with respect to the related reference value, the unit 24 is able to send a respective signal proportional to said measured variation of said parameters to the aforementioned actuator means 25.

[0021] As shown in Figure 2, the aforesaid actuator means 25 comprise respective electromechanical-electronic actuator means 26 able to vary the impedance of the aforesaid power supply circuit 8 in such a way as to vary the electrical parameters, constituted by voltage and current at the terminals 14 of the lamps 6 and being able to send a respective command signal, proportional to said signal received from the unit 24, to the power supply circuit 8 in such a way as to act on the circuit 8 itself contrasting the aforementioned variation of at least one of said parameters mentioned by the aforesaid sensors 15 and 18 and thereby constantly maintaining the efficiency of the lamps 6 at a determined value.

[0022] The aforesaid electromechanical-electronic actuator means 26 comprise a magnetic amplifier 27, which, according to the embodiment shown in Figure 2, comprises a power circuit 28 connected to a branch of the circuit 8 and in series to the lamps 6, and a command circuit 29 connected to the aforesaid control and command unit 24. The power circuit 28 and the command circuit 29 are mutually coupled by electromag-

netic induction through a ferromagnetic core 30.

[0023] In practice, the power circuit 28 and the command circuit 29 constitute an inductance 31 whose value of impedance connected to the circuit 8 is variable according to the signal received from the unit 24 and which powers the command circuit 29 itself.

[0024] As shown in the embodiment of Figure 3, the aforesaid magnetic amplifier 27 presents the respective power circuit 28 connected in series to the input of the primary 10 of the transformer 9 and the respective command circuit 29 connected to the aforesaid control and command unit 24, in such a way as to vary the impedance 31 of the primary circuit 10 according to the variations in electrical parameters measured by the sensors 15 on the secondary 12.

[0025] As shown in Figures 2 and 3 the power supply device 7 further comprises additional second sensor means 18, constituted by thermal pellets 32 and 33 positioned in proximity to the step-up transformer 9 and, respectively, to the magnetic amplifier 27 able to provide unit 24 with the value of the temperature reached, during the operation, by the aforesaid transformer 9 and magnetic amplifier 27 themselves, and by a work potentiometer 34 which is used by the operator at the start of a drying cycle to vary and set the power of the circuit 8 supplying power to the lamps 6 and which serves as a reference system for the unit 24 and for the magnetic amplifier 27.

[0026] As shown in Figures 2 and 3, to the unit 24 are also connected the motor 35 for motorising the motor-driven pulley 4, a first means 36 for cooling the lamps 6 and a second means 37 for cooling the products 2 supported by the conveyor belt 3, as well as a so-called drag switch 38, able to provide the unit 24 with a signal relating to the stoppage of the advance of the belt 3 along the aforementioned path P. The first and second cooling means 36, 37 are constituted by respective fans able to send a flow of cooling air, respectively to the lamps 6 and to the products 2.

[0027] Also as shown in Figures 2 and 3, the power supply and control device 7 comprises a known circuit 39 for protection against insulation losses and shown with a block 39.

[0028] In use, during a cycle of the drying process, with the power supply and control device 7 it is possible to command, by means of the unit 24, the magnetic amplifier 27 through its command circuit 29, varying in a continuous and real time manner the value of the impedance of the variable inductance 31, according to the signals coming from the aforementioned first and second sensor means 15 and 18 described above, so that when a variation of these parameters occurs, the power supplied to the lamps 6, and in particular the current that circulates in the circuit 13 of the secondary of the step-up transformer 9, thereby adapting the emission power of the lamps 6 according to a new work equilibrium imposed by the variations of the parameters whose signals reach the unit 24.

[0029] In this way the unit 24 itself acts on the magnetic amplifier 27 compensating for any variations incurred by the electrical power supply parameters of the lamps 6 or of the work parameters of the lamps 6 themselves.

[0030] It is important to stress that among the electrical parameters measured by the sensors 16 and 17 (TV and TA), the work parameters of the lamps 6 (lamp efficiency, emission power, etc.) measured by the sensors 19, 20, the temperature parameters of the products 2 measured by the sensors 19 and the speed parameters V of the belt 3 obtained by the sensors 22, there is a direct correlation. The signals that come from the sensors 16 and 17 measure the electrical parameters that determine the power supplied to the lamps 6 through the circuit 13, which supplied power can vary, for instance, upon variation of the mains voltage R of the transformer 9. If, from a work equilibrium condition imposed by a determined current that circulates in the circuit 13, the current changes, then the unit 24 measures this current variation through the sensor 17 and sends a signal, proportional to the value of the current change and derived from a comparison operation of the new current value with a pre-set current value, to the circuit 29 for commanding the magnetic amplifier 27 which circuit in turn, intervenes changing the inductance 31 of the magnetic amplifier 27, thereby providing the lamps 6 with the same steady-state power supply existing before the occurrence of the variation. It is evident that if the current increases the amplifier 27 increase the impedance 31, on the contrary if the current decreases, the amplifier 6 decreases the impedance 31.

[0031] If the sensors 20 detect an excessive temperature of the lamps 6, the unit 24 is able to cool the lamps 6 with the fan 36, or energises the magnetic 27 which makes a lower current circulate in the circuit 13 by increasing, for instance, the impedance 31 in the manners described above. Similarly if, for instance, the speed of advance of the belt 3 changes, the unit 24 as a result of the signal coming from the sensor 22, energises the magnetic amplifier 27 which will cause a lower current to circulate in the circuit 13 adapting the emission power of the lamps 6 to the new speed of advance V1, lower than speed V. The current in the circuit 13 will increase if the speed V1 is greater than speed V. This explains the correlation between speed of advance of the belt 3 and the time of permanence of the products underneath the lamps 3. The more the speed V increases, the shorter will be the time of permanence of the products 2 under the lamps 6 which shall thus be supplied with greater power by increasing, through the magnetic amplifier 27, the power supply current to the lamps 6 themselves.

[0032] On the contrary, the more the speed V decreases, the longer will be the time of permanence of the products 2 under the lamps 6, which shall thus be supplied with lesser power, to prevent excessively violent drying of the paint, by decreasing, through the mag-

netic amplifier 27, and in the manners described above, the power supply current to the lamps 6 themselves.

[0033] According to the embodiment of the power supply control and command device 7 shown in Figures 4 and 5, the aforementioned actuator means 25 comprise an actuator converter circuit, indicated globally with the reference number 40, which is interposed between the power grid R and the power supply circuit 8.

[0034] In particular, as shown in Figure 5, the circuit 40 comprises a rectifier circuit 41 which is connected at the input to the power grid R, which usually is at a frequency of 50 or 60 Hz, and at the output is connected to a frequency converter circuit 42 which, in turn, is connected at the output to an actuator circuit 43 that is connected, at the output to the primary 10 of the aforementioned transformer 9 which powers the power supply circuit 8.

[0035] The rectifier circuit 41 converts the alternating voltage input into a direct voltage and powers the converter circuit 42 which supplies at its output a pulsating square wave voltage with a frequency on the order of 20 kHz. The value of the output frequency from the converter circuit 42 can assume different values which may oscillate, for instance, between a minimum of 5 kHz and a maximum of 200 kHz and, therefore, we could indicate this frequency as an average frequency.

[0036] In this case both the magnetic amplifier 27, and the aforementioned actuator means 26 are replaced by the actuator converter circuit 40, which also controls the power supply to the circuit 8 and regulates the frequency of said circuit 8.

[0037] The circuit 40, and specifically the converter 42 is connected to the aforesaid control and command unit 24, and its operation does not differ from the operation described for the embodiments illustrated in Figures 2 and 3.

[0038] The advantages obtained from the embodiment illustrated in Figures 4 and 5 are the reduction in the dimensions of the transformer 9, and of its magnetic circuit for equal supplied power. Using an average frequency enables considerably to reduce the magnetic circuit of the transformer 9 and hence to obtain a reduction in size, losses and heating. Moreover, the ability to power the lamps 6 at a higher frequency allows to obtain much more uniform ray emissions compared to the oscillations obtained when powering the lamps 6 with lower frequencies of the order of 50/60 Hz.

[0039] Hence, to summarise, the invention allows, through the control and command device 7 described above, to maintain the irradiating efficiency of the lamps 6 always at an optimal value, according to the required type of drying of the paints of the products 2.

[0040] The invention thus conceived can be subject to numerous modifications and variations, without thereby departing from the scope of the inventive concept.

[0041] Moreover, all components can be replaced

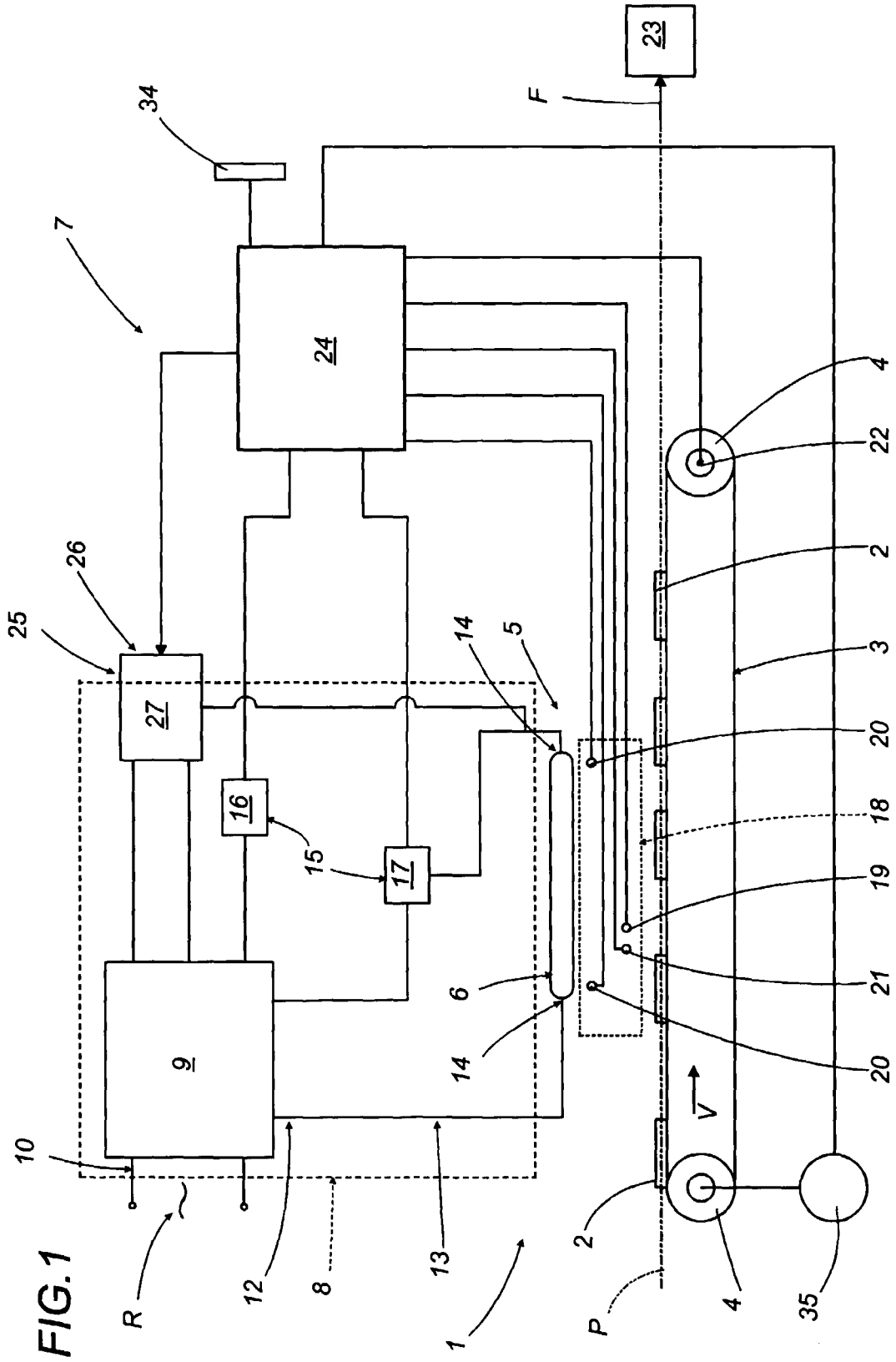
by technically equivalent elements.

Claims

1. A device for powering, controlling and commanding electric light sources (6), characterised in that it comprises a power supply circuit (8) for supplying power to said light source (6) at a determined power level and comprising power actuator means (25) connected to said power supply circuit (8), first sensor means (15) able to measure the value of at least an electrical parameter of said power supply circuit (8), second sensor means (18) able to measure the value of at least a work parameter of said light source (6), a control and command unit (24) connected at the input to said first and second sensor means (15, 18) and at the output to said power actuator means (25); said control and command unit (24) being able continuously to monitor the signals coming from said first and second sensor means (15, 18) comparing them with related preset reference values of said parameters whereto corresponds said determined power value and, every time at least one of said input signals indicates a variation of the related parameter with respect to the related reference value, being able to send a respective signal proportional to said variation to said power actuator means (25), said power actuator means (25) being able to send a respective command signal, proportional to said received signal, to said power supply circuit (8) in such a way as to act on the power supply circuit (8) itself contrasting said variation of at least one of said parameters to maintain the efficiency of said light source (6) constantly at a determined value.
2. A device as claimed in claim 1, characterised in that said power actuator means (25) act on said power supply circuit (8) by varying the value of at least one of its electrical power supply parameters to said light source (6).
3. A device as claimed in claim 1, characterised in that said first sensor means (15) measure the value of at least an electrical parameter that powers said power supply circuit (8).
4. A device as claimed in claim 1, characterised in that said second sensor means (18) comprise a sensor (19) for measuring the actual emitted irradiation of said light source (6).
5. A device as claimed in claim 1, characterised in that said second sensor means (18) comprise sensors (20) for measuring the temperature of the light source (6).
6. A device as claimed in claim 1, characterised in that said power actuator means (25) comprise respective electromechanical-electronic actuator means (26) able to vary the impedance (31) of said power supply circuit (8) in such a way as to vary the electrical parameters at the terminals (14) of said light source (6).
7. A device as claimed in claim 6, characterised in that said electromechanical-electronic actuator means (26) comprise a magnetic amplifier (27).
8. A device as claimed in claim 7, characterised in that said magnetic amplifier (27) comprises a power circuit (28) connected in series to said light source (6) and a command circuit (29) connected to said control and command unit (24), said power circuit and command circuit (28, 29) being mutually coupled by electromagnetic induction.
9. A device as claimed in claim 7, characterised in that said magnetic amplifier (27) comprises a power circuit (28) connected in series at the input (10) of said power supply and power circuit (8) and a command circuit (29) connected to said control and command unit (24), said power circuit and command circuit (28, 29) being mutually coupled by electromagnetic induction.
10. A device as claimed in claim 1, characterised in that said power actuator means (25) comprise an actuator converter circuit (40) interposed between a power grid (R) for powering said power supply circuit (8) and said circuit (8) and able to power the power supply circuit (8) at a higher frequency than the frequency of said power grid (R).
11. A device as claimed in claim 10, characterised in that the power supply frequency of said actuator converter circuit (40) is an average frequency.
12. A device as claimed in claim 10, characterised in that said actuator converter circuit (40) comprises a rectifier circuit (41) connected at the input to said power supply grid (R) and at the output to a frequency converter circuit (42) which is connected at the output to an actuator circuit (43) connected at the output to said power supply circuit (8); said actuator converter circuit (40) being connected to said control and command unit (24).
13. A device as claimed in claim 9, characterised in that the power circuit (28) and the command circuit (29) constitute a variable inductance (31), whose value of impedance which is connected to the circuit (8) is variable according to the signal received from the unit (24) and which powers the command circuit (29) itself.

14. A device as claimed in any of the previous claims from 1 to 13, characterised in that it is associated to at least a portion (1) of a plant for drying protective substances applied onto products (2) advancing along a first determined path (P) by means of a transferring conveyor (3) able to make said products (2) advance through a drying station (5) comprising at least one said light source (6). 5
15. A device as claimed in claim 14, characterised in that said light source (6) is a lamp (6) emitting ultra-violet rays. 10
16. A device as claimed in claim 14, characterised in that said second sensor means (18) comprise a sensor (22) of the speed of advance of said conveyor (3). 15
17. A device as claimed in claim 1, characterised in that said second sensor means (18) comprise a sensor (21) of the temperature reached by said protective substances applied onto said products (2). 20
18. A device as claimed in claim 1, characterised in that it comprises a first means (36) for cooling said light source (6) connected to said control and command unit (24). 25
19. A device as claimed in claim 14, characterised in that it comprises a second means (37) for cooling said products (2) positioned on said conveyor (3). 30
20. A device as claimed in one of the previous claims from 1 to 17, characterised in that said first sensor means (15) are able to measure the electrical parameters of said power supply circuit (8) and said second sensor means (18) are able to detect the work parameters of the lamp (6) according to the electrical parameters of said power supply circuit (8), said control and command unit (24) being also able to correlate said electrical parameters with said work parameters with respect to an equilibrium work state of the lamp (6) itself as a function of all parameters, so as to vary the impedance (31) of said power actuator means (25) which are able to vary the electrical parameters of said power supply circuit (8) in such a way as to bring the lamp (6) to its required working equilibrium condition upon variation of one of said parameters. 35 40 45 50

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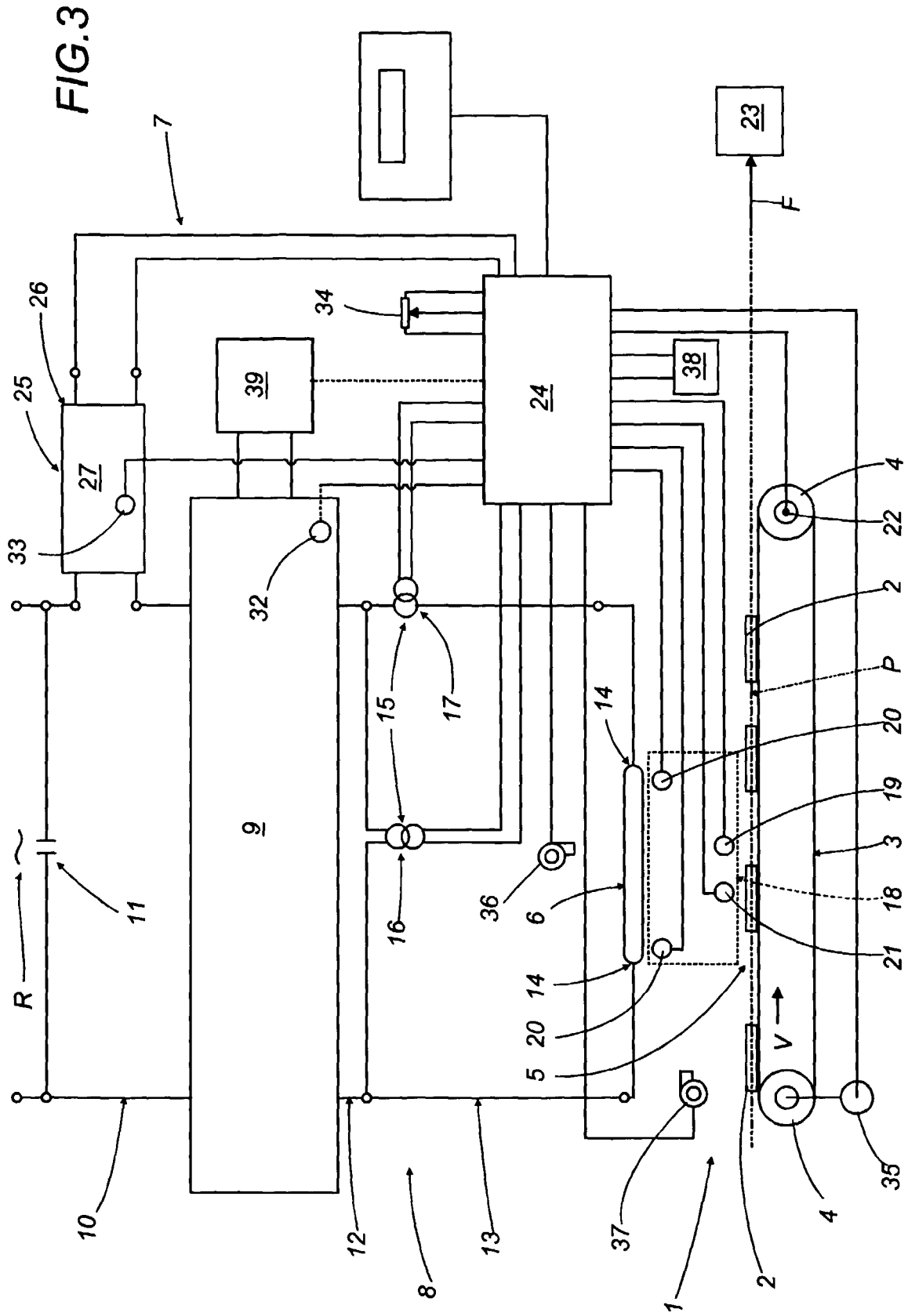


FIG. 4

