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(54) METHOD FOR CONTROLLING THE OPERATION OF A CONTINUOUS FLEXIBLE BAND TREATMENT MACHINE

(57) The invention relates to a method for controlling the operation of a treatment machine for treating a continuous flexible web, said proposed method comprising the acquisition of information about operating parameters of a treatment machine (1), referring to different operation states comprising at least: one preparation state (E1) in which element and/or parameter preparation and/or adjustment operations are performed in the feed unit (10), treatment unit (20) and/or take-up unit (30) of the treatment machine, one production state (E2) in which the treatment task is performed on a flexible web (3) as it is moving, and one stop state (E3) of the treatment machine in which none of the preparation or adjustment or treatment activities is being performed, the different states being detected automatically by means of analyzing the acquired data referring to the operating parameters.

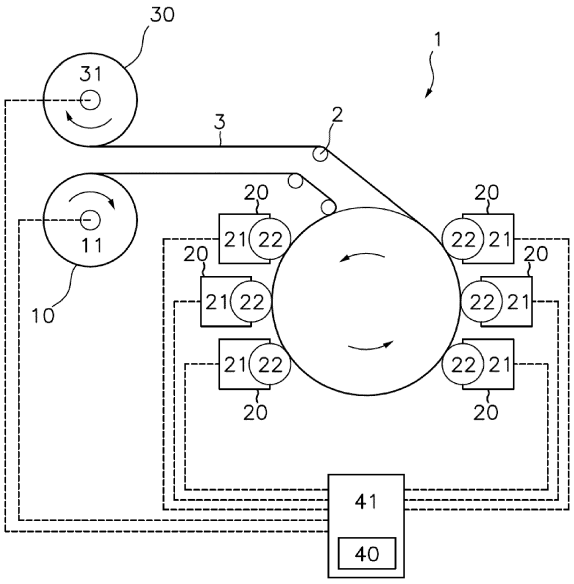

Fig. 1

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Description

Field of the Art

[0001] The present invention relates to the field of methods for controlling the operation of a treatment machine for treating a continuous flexible web the movement of which is guided in a conveyance direction obtaining, from detected data, relevant information referring to operating parameters of said treatment machine that allow automatically deducing and storing an operation state of said treatment machine selected from at least one preparation state, one production state and one stop state.

State of the Art

[0002] Remote control of the operation of a treatment machine for treating a flexible web from a control center, in which primarily data regarding production of the machine is collected, is known in this field of the art.

[0003] However, the applicant is unaware of any method that allows obtaining information about the operation of a machine of this type which automatically distinguishes a production state and a preparation state and that also takes into account the duration of each of said states and the transitions between same, which also allows differentiating a stop state from a preparation state.

Brief Description of the Invention

[0004] The present invention relates to a method for controlling the operation of a treatment machine for treating a continuous flexible web the movement of which is guided in a conveyance direction, said machine integrating a plurality of guiding rollers from a feed unit for feeding the flexible web to a take-up unit for taking up same, and at least one treatment unit therebetween.

[0005] It will be understood that a treatment machine is therefore a machine envisaged for applying a treatment which causes a change in a continuous flexible web by means of said treatment unit, the flexible web being conveyed and guided continuously in the conveyance direction inside said treatment machine, the flexible web being supplied by the feed unit, which is arranged upstream of the treatment unit, and recovered by the take-up unit arranged downstream of the treatment unit.

[0006] The mentioned flexible web can be, by way of non-limiting example, paper, cardboard, plastic sheets, etc., which are typically intended for the production of product wrappers. The treatment applied on said flexible web can also vary, such as, for example, printing, rolling, cutting, perforating, bending, welding, etc., depending on the treatment unit involved and on the type of treatment machine envisaged.

[0007] Therefore, in a novel manner, the present invention proposes the acquisition of diverse information, referring to different operating parameters including parameters referring to performing adjustments, to different operation states of the treatment machine over time, each of said different operation states being defined by a series of detected parameters of said feed unit, treatment unit and/or take-up unit, said operation states comprising at least:

- one preparation state of said machine in which element and/or parameter preparation and/or adjustment operations are performed in said feed unit, treatment unit and/or take-up unit; for example for preparing the treatment machine for a new job;
- one production state of said machine in which the treatment task is performed on said flexible web as it is moving, applied by means of said at least said one treatment unit;
- one stop state of the treatment machine in which none of the preparation or adjustment or treatment activities is being performed, i.e., the treatment machine is not in the preparation state or the production state.

wherein said acquisition of diverse information comprises the following steps:

a) monitoring the operating parameters of the different operation states of said at least one treatment unit, and/or feed unit, and/or take-up unit for treating, feeding or taking up the flexible web by means of sensors;

b) analyzing by means of a programmable control device the monitored operating parameters and automatically detecting a relevant variation or combinations of relevant variations exceeding predefined threshold values in at least one of the parameters of at least one of said units, and automatically inferring from said relevant variation the start of one of said operation states and/or the end of one of said operation states;

c) communicating and storing said start and/or end of an operation state together with a temporary register in a local or remote state register; and

d) performing the sequence of steps a) to c) throughout a control cycle of the treatment machine, at least at predefined points in time, detecting later starts and/or ends of operation states.

[0008] The invention therefore proposes obtaining information referring to different operating parameters of the different units integrated in the treatment machine by means of the use of sensors. The detected information referring to the mentioned parameters will include information relating to the performance of adjustments, and it will be communicated to a local or remote programmable electronic control device, provided with a memory and computing capacity, such as a programmable logic controller, a computer, a tablet or a smart phone, for example. Said programmable electronic control device will be responsible for analyzing the information referring to

the operating parameters by means of performing stored analysis algorithms in order to detect relevant variations or combinations of relevant variations exceeding given predefined and stored threshold values, thereby determining the operation state of the treatment machine selected from the different envisaged operation states.

[0009] It will be understood that there can be brief periods of time, having a predefined maximum duration, during which none of the conditions required for the automatic detection of a given operation state is met without bringing about a modification of the operation state assigned by the programmable control device. This allows operators to be able to perform, for example, inspection tasks, having a brief duration, which require modifying some parameters of the treatment machine, without this causing a change in the detected treatment state.

[0010] It will be understood that the mentioned parameters referring to performing adjustments are parameters undergoing variations during the adjustment tasks, which are those adjustments required by the treatment machine, the at least one treatment unit, the feed unit and/or the take-up unit, to assure production of a treated flexible web with optimal quality, said adjustments having to be performed during a test treatment on a flexible web as it is moving, or requiring the adaptation of the treatment machine, or of its units, by means of adjustment, removal or replacement of one of the mechanical components thereof.

[0011] The detection of variations or combinations of relevant variations mentioned above referring to pre-production adjustments determines the detection of the preparation state, as it is a sign that preparation tasks for preparing the treatment machine to start up production are being performed.

[0012] The production state is determined when a preparation state is not detected and when the treatment machine is performing a treatment, by means of the treatment unit, on a flexible web as it is moving in the conveyance direction. Therefore, the production state indicates that the treatment machine is correctly applying a adjusted treatment on a flexible web which can be used as it will foreseeably be free of errors. The determination of this state can be done by analyzing, for example, parameters relating to the quality of the treatment performed on the flexible web, for example, by means of analysis thereof by optical sensors, or by means of the detection of the rate of movement of the flexible web, and the inexistence of modifications of the treatment adjustments during a given period of time, which is indicative of the operators' acceptance of the treatment performed.

[0013] Finally, the stop state is determined when neither the preparation state nor the production state is detected.

[0014] The automatic detection of the operation state of the treatment machine allows knowing in detail the time during which the machine is producing and the time during which the machine is not producing, without the periods of preparation state being given incorrectly as periods of production state or stop state. It furthermore allows knowing the state of the treatment machine automatically and without a user having to identify said state of the treatment machine, from which the reasons for which it is not producing can be inferred. This allows better control and also allows locating possible inefficiencies or ways to increase the periods in which the treatment machine is in the production step.

[0015] Step a) of the proposed method mentioned above consists of collecting information referring to the actuation parameters of the different units constituting the treatment machine. This step will preferably be performed by sensors installed in said units.

[0016] Step b), referring to the detection of relevant variations in the detected parameters, will be performed by means of analyzing the information collected in step a) by the programmable electronic control device described above.

[0017] Step c) includes the transmission and storage of the changes in state detected during step b) to a state register, which can be, for example, a remote or local unit, or a module of the programmable electronic control device itself. Said storage will also include a temporary reference related to each of the registers for the purpose of knowing the time elapsed between the different stored registers.

[0018] Steps a), b) and c) of the method, corresponding to collecting data referring to the operating parameters, the analysis of said data, the detection of the operation state, and the subsequent storage of said operation state, are repeated at different points in time for the purpose of obtaining a temporary register that allows knowing the duration of each of the operation states between the start and the end thereof, which allows obtaining information relating to the productivity of the treatment machine and its operators.

[0019] The mentioned state register may be consulted through a display, for example, connected locally to the programmable electronic control device, or in a display of a piece of equipment connected remotely to said programmable electronic control device.

[0020] Optionally, according to one embodiment said preparation state occurs only before starting the production state of a new job for the first time, said new job being defined by an order form that can be accessed by the programmable control device that includes production requirements of a job that have not yet begun to be met.

[0021] It will be understood that the order form is a document containing information referring to the specifications of the treatment to be performed on the flexible web, including information relating to the amount of flexible web to be treated, referred to as production requirements. Said information can be accessed by the programmable control device and will be in a format that allows being analyzed by same. The control device can thereby determine the end of a prior job, when the established production requirements are completed, and the start of a new job, the production requirements of

which have not yet begun to be met. By knowing the start and end of a job, the programmable control device can recognize the preparation state, among other reasons, because it is prior to the start of a production state of a job the production of which has not yet started.

[0022] It is additionally contemplated that said stop state occurs when a production state of a job is interrupted before completing the established production requirements in said order form stored in the programmable control device. A stop state can also be established after completing the established production requirements in an order form stored in the programmable control device, and before starting a preparation state or a production state of a new job.

[0023] In other words, the programmable control device can recognize a stop state, among other reasons, because it occurs after the start of the production state of a job, either before or after completing the established production requirements, which can be indicative of an unscheduled stop due to a technical problem, or can be indicative of a scheduled stop but one that is not intended for making job changes, or can be indicative of the end of a treatment job but not indicative of the start of a preparation step for preparing a new job, for example for performing the preparation of cleaning, maintenance or set-up tasks of the treatment machine before starting a new job with a preparation step.

[0024] According to an alternative embodiment, the invention also proposes that said step b) includes automatically differentiating the preparation state into at least the following two sub-states:

- a job change state during which the removal or replacement of one or more mechanical elements of said feed unit and/or take-up unit for feeding or taking up the flexible web and/or of said treatment units of the treatment machine occurs; and
- a job adjustment state during which the flexible web moves through the treatment machine in the conveyance direction, and treatment tasks are performed on said flexible web, and relevant modifications are made in the operating parameters of the treatment machine.

[0025] During the job change state, parts of the treatment machine are being modified or replaced by the operators. In treatment machines of this type, said mechanical replacement of parts of the machine must be performed in order to adapt it to new treatment jobs for treating the flexible web, so said mechanical changes are not limited to repairs, but rather are part of the usual tasks required for the operation of treatment machines of this type. This state can be detected by analyzing, for example, parameters referring to the position of the elements that must be replaced, or of elements that must be moved in order to access the elements to be replaced, or analyzing parameters referring to the existence of an exchange of information between the mechanical element to be replaced and the rest of the treatment machine by means of a data connection in order to detect the disconnection of said data connection, or a combination of these and/or other parameters. Said job change state may or may not include the movement of the flexible web in the conveyance direction, as it may include the replacement of the material constituting the flexible web.

[0026] During said job step, which is performed until the quality of the treatment applied to the flexible web is approved, the flexible web will be moving through the treatment machine in the conveyance direction, and the at least one treatment unit will be applying a treatment on said flexible web, but furthermore adjustment tasks will also be performed on the operating parameters of the treatment machine. Therefore, the treated flexible web that is produced may not be marketed because until the adjustment step comes to an end, errors and deficiencies will occur in the treatment of the flexible web because the adjustments will not have been completed, so it would be convenient to have a precise record of the meterage of flexible web consumed during the adjustment step, so preferably this information, and/or other information that allows knowing said meterage, will also be stored in the state register as a temporary register and a register of the rate of the flexible web.

[0027] As set forth above, the determination of the job adjustment state can also be maintained during brief periods of time having a predetermined duration during which some of the conditions required for the determination of said job adjustment state are not met. For example, the adjustment state would be maintained even if during said brief periods of time the treatment applied to the flexible web does not undergo adjustments to its parameters, or if the flexible web is stopped during said brief periods of time.

[0028] Additional or alternatively, it is considered that said information referring to the detected operating parameters may include parameters referring to the presence of power supply in the treatment machine and/or in the feed unit, treatment unit and/or take-up unit, and wherein said step b) may include automatically differentiating in the stop state at least the two following states:

- a job stop state during which the treatment machine receives power supply, but does not perform treatment tasks, nor does movement of the flexible web occur; and
- a power supply absence state with respect to the treatment machine during which the treatment machine does not receive a supply of some of the power required for the correct treatment, such as electricity, gas, hydraulic fluid, etc.

[0029] This power supply absence state is distinguished from the job stop state in that in the mentioned job stop state, the treatment machine does receive a power supply.

[0030] The mentioned job stop state can include the

selection of a reason for the stop from a list of possible reasons for the stop. Said selection can be done manually by an operator or automatically by the programmable control device. The possible reasons for the job stop can be, by way of example, selected from the following reasons: job change, start or end of the factory's timetable, shift change, operator's break time, treatment machine maintenance, treatment machine malfunction, emergency stop of the treatment machine, machine cleaning. In the event that the treatment machine is a printing machine, the reasons can also include doctor blade change, lack of ink, ink adjustment, ink spill, cleaning the anilox rollers, anilox roller change, cleaning printing plate, assembly of the printing plate, passing of the flexible web through the treatment machine, deficiencies in the quality of the flexible web, change of the flexible web reel, breaking of the flexible web, failure in the change of reel, cleaning the drum, waiting for the ink supply, waiting for the printing sleeve supply, waiting for approval of test printing performed, waiting for the flexible web, job change, lack of clean solvent.

[0031] The invention also proposes that the aforementioned relevant variation in at least one of the parameters, included in step b), is defined from a comparison of the values of said monitored parameters with predefined threshold values, said threshold values being preferably defined to assure no overlap between operation states. Therefore, the values referring to the operating parameters are analyzed in comparison with stored threshold values as given values reach given thresholds, the start, the end or change in state of the treatment machine are determined. Said comparison is preferably performed by the programmable electronic control device, which will have said threshold values stored in its memory.

[0032] It is also contemplated as an option that said sequence of steps a) to c) of the method, performed during step d), is carried out continuously in real time, achieving constant monitoring of the operation state of the treatment machine.

[0033] According to another embodiment, information about the duration of said operation states and/or the duration of a transition between said operation states is obtained from said step b), which information will be stored in the state registers.

[0034] According to a proposed embodiment, the production state is determined by means of verifying the performance of the treatment task performed during a specific, predefined time uninterruptedly and without relevant variation in the mentioned parameters. As previously stated, it is understood that a relevant variation is that exceeding margins defined by stored threshold values. This allows determining the production state when the treatment machine remains in operation, performing the treatment on the flexible web for a given period of time without the adjustments of the machine being modified, or not being modified in a relevant manner, whereby deducing that the operators are not performing adjustments, which indicates that the adjustments are already correct. It is thereby possible to distinguish the preparation state from the production state.

[0035] It is also contemplated that the entire period of time during which said treatment task has been performed uninterruptedly and without relevant variation, prior to the determination of the production state, is assigned as part of said production state and is included in the mentioned state register. This feature allows, even though a given period of time for performing the treatment uninterruptedly and without relevant variation in order to detect the production state, all this time during which the machine is indeed in the production state, but during which this state has not been determined as it did not remain unaltered during the predefined time, being able to be detected and stored *a posteriori* in the state register as a production state.

[0036] It is also envisaged that said monitoring of step a) is performed by means of information provided by sensors associated with pieces or parts of a component of the treatment machine and/or feed unit and/or take-up unit and/or by means of an image acquisition system, which can focus the flexible web after it passes through the treatment unit.

[0037] The invention also proposes that said feed unit for feeding the flexible web comprises at least one flexible material reel, an unwinding device, and, optionally, also a reel replacement device, and wherein the parameters to be analyzed are selected from:

- amount of flexible web stored in the reel;
- depletion of the stored flexible web;
- duration of a replacement step for replacing a depleted reel with a spare reel.

[0038] The invention also proposes that said take-up unit for taking up the flexible web comprises at least one flexible material reel, a winding device, and, optionally, also a replacement device for replacing said reel, and wherein said parameters are selected from:

- amount of flexible web stored in the reel;
- formation of a complete reel from the stored flexible web;
- duration of a replacement step for replacing a complete reel with a spare empty reel.

[0039] According to another envisaged embodiment, the invention proposes that said treatment machine is a printing machine integrating one or more printing units provided with printing rollers and ink supply units, said printing units constituting said at least one treatment unit for printing continuously on said flexible web. In this case, the preparation state will be a state in which test printing will be performed on said flexible web, performing adjustments such as, for example, color adjustments, position adjustments, longitudinal or transversal register adjustments with respect to the conveyance direction, or other adjustments.

[0040] The invention proposes that said printing machine is preferably a rotogravure printing machine, or alternatively a flexographic or offset printing machine, which will typically have a central drum on which the mentioned flexible web will be supported, surrounded by a plurality of printing units the printing rollers of which will be pressed against said central drum, with the flexible web therebetween.

[0041] In the event that the treatment machine is a printing machine, said analyzed parameters can include parameters selected from:

- distance of said printing rollers with respect to the flexible web,
- relative position of a plurality of printing rollers with respect to the flexible web to assure correct alignment of printing motifs, which is known in the sector as lateral and longitudinal register in the conveyance direction;
- printing units involved in the operation.

[0042] It is alternatively contemplated that said treatment machine can be a rolling machine integrating at least one rolling unit, constituting said at least one treatment unit, for continuously rolling at least one additional flexible web onto said continuous flexible web. In such case, each of said at least one additional flexible webs will also be supplied to the rolling machine by means of additional feed units, for example.

[0043] According to another envisaged optional embodiment, said treatment machine will be a cutting machine integrating at least one cutting unit operating on said flexible web, constituting said at least one treatment unit, for continuously cutting said continuous flexible web. Said cutting unit will cut the flexible web into smaller sized parts, whether by means of longitudinal cuts in the conveyance direction and/or by means of transverse cuts in the conveyance direction.

[0044] It will also be understood that any range of values offered may not be optimal with respect to its upper and lower limit values and may require adaptations of the invention so that said upper and lower limit values are applicable, said adaptations being within reach of a person skilled in the art.

[0045] Other features of the invention will be seen in the following detailed description of an embodiment.

Brief Description of the Drawings

[0046] The foregoing and other advantages and features will be better understood from the following detailed description of an embodiment in reference to the attached drawings, which must be interpreted in an illustrative and non-limiting manner, in which:

Figure 1 shows a diagram of a first embodiment in which the method is applied to a printing machine provided with six printing units, in which the discontinuous lines show a connection for transmitting information from the different units integrated in the printing machine to a programmable electronic control device;

Figure 2 shows an example of the operation state register obtained from applying the method, showing a list of the different operation states detected, placed in chronological order and related to a temporary measurement, which allows determining the duration of each of the operation states.

Detailed Description of an Embodiment

[0047] Figure 1 shows, according to an illustrative and non-limiting embodiment, a diagram of a treatment machine 1 for treating a continuous flexible web the movement of which is guided in a conveyance direction in which a method is applied for controlling the operation of said treatment machine 1.

[0048] According to the present embodiment, the proposed treatment machine 1 is a printing machine provided with a plurality of printing units 21, constituting treatment units 20, surrounding a central drum on which a portion of a flexible web 3 is supported. Said printing machine can be an offset-, rotogravure-, or flexo-gravure-type printing machine. Said printing units 21 include printing rollers 22 that transfer ink onto the flexible web 3 supported on the central drum, printing on it. Said printing rollers 22 integrate printing sleeves which must be replaced to modify the printing motifs, or the size of the print to be performed, as well as printing adjustment tests to precisely regulate the correct position thereof and the print color.

[0049] During the replacement tasks for replacing the printing sleeves, the treatment machine 1 will be in job change state E1a, and during the adjustment tasks by means of test printing the machine will be in adjustment state E1b, but the two states will be part of the preparation state E1. In contrast, during the adjustment-free printing tasks the machine will be in production state E2. If it is not in any of the preceding states, it will be understood that the machine is in stop state E3.

[0050] The proposed method allows identifying each of said operation states of the treatment machine 1 automatically and determining the duration thereof.

[0051] It is also evidently contemplated that said treatment machine 1 can be a rolling machine, a cutting machine, or another type of treatment machine 1 for treating flexible webs 3.

[0052] The invention proposes that the flexible web is a flexible paper or plastic web 3 supplied by means of a feed unit 10, driven inside the printing machine guided by guiding rollers 2, where the printing units 21 apply a printing treatment on said flexible web 3, and taken up by a take-up unit 30 arranged downstream of the printing units 21 after printing.

[0053] The feed unit 10, the take-up unit 30, and all the intermediate treatment units 20 have sensors collecting

information relating to operating parameters of the treatment machine 1, detecting, for example, if there is an electric power supply in the treatment machine, if the flexible web is stopped or moving, the rate of movement of the flexible web, the distance of said printing rollers with respect to the flexible web, the relative position of a plurality of printing rollers with respect to the flexible web to assure correct alignment of printing motifs, the printing units which are operating at all times, ink consumption, the opening of maintenance covers or doors, the extraction of a printing sleeve from a printing unit, the amount of flexible web stored in the reel, depletion of the stored flexible web, duration of a replacement step for replacing a depleted reel with a spare reel, amount of flexible web stored in the reel, formation of a complete reel from the stored flexible web, duration of a replacement step for replacing a complete reel with a spare empty reel.

[0054] The information relating to the operating parameters collected by the sensors is transmitted to a programmable electronic control device, where said information is analyzed for the purpose of detecting the operation state of the treatment machine 1 according to the detection of certain operating parameters, and/or of a certain combination of operating parameters, and/or of certain values of the operating parameters regulated by predefined thresholds. Said information relating to the operating parameters allows the programmable electronic control device 41 to classify the operation state of the treatment machine 1 according to any one of a plurality of predefined operation states. Said predefined operation states are the following in the current example:

- a preparation state E1 of said machine in which element and/or parameter preparation and/or adjustment operations are performed in said feed unit 10, treatment unit 20 and/or take-up unit 30;
- a production state E2 of said machine in which the treatment task is performed on said flexible web 3 as it is moving, applied by means of said at least said one treatment unit 20;
- a stop state E3 of the treatment machine in which none of the preparation or adjustment or treatment activities is being performed.

[0055] After analyzing the received information, the operation state is classified as one of the preceding possible operation states, and is transmitted and stored in a state register integrated in the programmable electronic control unit 41 together with a temporary register, obtaining a state register such as the one shown in Figure 2.

[0056] It is additionally contemplated that the preparation state E1 contains at least two sub-states, which are:

- a job change state E1a during which no treatment tasks are performed nor does movement of the flexible web occur 3, but the removal or replacement of one or more mechanical elements of said feed unit 10 and/or take-up unit 30 for feeding or taking up the flexible web 3 and/or of said treatment units 20 of the treatment machine 1 occurs; and
- an adjustment state E1b during which the flexible web 3 moves through the treatment machine 1 in the conveyance direction, and treatment tasks are performed on said flexible web 3.

[0057] It is also envisaged that the stop state E3 is subdivided into at least two sub-states:

- a job stop state E3a during which the treatment machine receives a power supply, but does not perform treatment tasks nor does movement of the flexible web occur 3; and
- a power supply absence state E3b with respect to the treatment machine 1 during which the treatment machine does not receive a power supply, nor does it perform treatment tasks nor does movement of the flexible web occur 3.

[0058] It is therefore contemplated that the programmable control device 41 is capable of identifying, automatically by means of information obtained from sensors, up to five operation states, one of them being the production state E2, and two of them relating to the preparation state E1, and two others relating to the stop state E3.

[0059] It will be understood that the different parts constituting the invention described in one embodiment can be freely combined with the parts described in other different embodiments, even though said combination has not been explicitly described, provided that there is no detriment in the combination.

Claims

1. A method for controlling the operation of a treatment machine for treating a continuous flexible web which movement is guided in a conveyance direction, said treatment machine (1) integrating a plurality of guiding rollers (2) from a feed unit (10) for feeding the flexible web (3) to a take-up unit (30) for taking up same, and at least one treatment unit (20) placed between said feed unit (10) and said take-up unit (30), **characterized by** comprising the acquisition of diverse information referring to different operating parameters, including parameters referring to performing adjustments, to different operation states of the treatment machine (1) over time, each of said different operation states being defined by a series of detected parameters of said feed unit (10), treatment unit (20) and/or take-up unit (30), said operation states comprising at least:

    • one preparation state (E1) of said machine in which preparation and/or adjustment operations of element and/or parameter are performed in

said feed unit (10), treatment unit (20) and/or take-up unit (30),

• one production state (E2) of said machine in which a treatment task is performed on said flexible web (3) as it is moving, applied by means of said at least said one treatment unit (20);

• one stop state (E3) of the treatment machine in which none of the preparation and/or adjustment or treatment activities is being performed.

wherein said acquisition of diverse information comprises the steps:

a) monitoring the operating parameters of the different operation states of said at least one treatment unit (20), and/or feed unit (10), and/or take-up unit (30) for treating, feeding or taking up the flexible web (3) by means of sensors;

b) analyzing by means of a programmable control device (41) the monitored operating parameters and automatically detecting a relevant variation or combinations of relevant variations exceeding predefined threshold values in at least one of the parameters of at least one of said units (10, 20, 30), and automatically inferring from said relevant variation the start of one of said operation states (E1, E2, E3,) and/or the end of one of said operation states (E1, E2, E3,);

c) communicating and storing said start and/or end of an operation state (E1, E2, E3) together with a temporary register in a local or remote state register (40); and

d) performing the sequence of steps a) to c) throughout a control cycle of the treatment machine, at least at predefined points in time, detecting later starts and/or ends of operation states (E1, E2, E3).

2. The method according to claim 1, wherein said preparation state (E1) occurs only before starting the production state (E2) of a new job for the first time, said new job being defined by an order form that can be accessed by the programmable control device (41) that includes production requirements of a job that have not yet begun to be met.

3. The method according to claim 1 or 2, wherein said stop state (E3) occurs when a production state (E2) of a job is interrupted before completing the production requirements which are established in an order form that can be accessed by the programmable control device (41), or wherein said stop state (E3) occurs after completing the production requirements which are established in an order form that can be accessed by the programmable control device (41), and before starting a preparation state (E1) or a production state (E2) of a new job defined by an order form that can be accessed by the programmable control device (41) that includes production requirements of a job that have not yet begun to be met.

4. The method according to claim 1, 2 or 3, wherein said step b) includes automatically differentiating the preparation state (E1) into at least the following two sub-states:

• a job change state (E1a) during which the removal or replacement of one or more mechanical elements of said feed unit (10) and/or take-up unit (30) for feeding or taking up the flexible web (3) and/or of said treatment units (20) of the treatment machine (1) occurs; and

• a job adjustment state (E1b) during which the flexible web (3) moves through the treatment machine (1) in the conveyance direction, treatment tasks are performed on said flexible web (3), and relevant modifications are made in the operating parameters of the treatment machine.

5. The method according to any one of preceding claims 1 to 4, wherein said information referring to the detected operating parameters includes parameters referring to the presence of power supply in the treatment machine and/or in the feed unit (10), treatment unit (20) and/or take-up unit (30), and wherein said step b) includes automatically differentiating in the stop state (E3) at least the two following states:

• a job stop state (E3a) during which the treatment machine receives a power supply, but does not perform treatment tasks nor does movement of the flexible web (3) occur; and

• a power supply absence state (E3b) with respect to the treatment machine (1) during which the treatment machine does not receive a power supply.

6. The method according to any one of the preceding claims 1 to 5, wherein the predefined threshold values of step b) are defined to assure no overlap between different operation states.

7. The method according to any one of the preceding claims, wherein said sequence of steps a) to c), defined in step d), is performed continuously in real time.

8. The method according to any one of the preceding claims, wherein the production state (E2) is determined by means of verifying the performance during a specific predefined time, uninterruptedly and without relevant variation, of the treatment task performed on the flexible web (3).

9. The method according to claim 8, wherein the entire

period of time during which said treatment task has been performed uninterruptedly and without relevant variation, prior to the determination of the production state (E2), is assigned as part of said production state (E2) and is included in the mentioned state register (40).

10. The method according to any one of the preceding claims, wherein said information referring to the operating parameters is provided by sensors associated with pieces or parts of a component of the treatment machine (1) and/or feed unit (10) and/or take-up unit (30) and/or by means of an image acquisition system.

11. The method according to any one of the preceding claims, wherein said feed unit (10) for feeding the flexible web (3) comprises at least one flexible material reel (11), an unwinding device and a reel replacement device, and wherein the analyzed operating parameters include parameters selected from:

- amount of flexible web (3) stored on the flexible material reel (11);
- depletion of the stored flexible web (3);
- duration of a replacement step for replacing a depleted flexible material reel (11) with a spare flexible material reel (11).

12. The method according to any one of the preceding claims, wherein said take-up unit (30) for taking up the flexible web (3) comprises at least one flexible material reel (31), a winding device and a replacement device for replacing said reel, and wherein said analyzed operating parameters are parameters selected from:

- amount of flexible web (3) stored on the flexible material reel (31);
- formation of a complete flexible material reel (31) from the stored flexible web (3);
- duration of a replacement step for replacing a complete flexible material reel (31) with a spare empty flexible material reel (31).

13. The method according to any one of the preceding claims, wherein said treatment machine (1) is a printing machine integrating one or more printing units (21) provided with printing rollers (22) and ink supply units, said printing units (21) constituting said at least one treatment unit (20) for printing continuously on said flexible web (3).

14. The method according to claim 13, wherein said analyzed operating parameters include parameters selected from:

- distance of said printing rollers (22) with respect to the flexible web (3),
- relative position of a plurality of printing rollers (22) with respect to the flexible web (3), to assure correct alignment of printing motifs.
- printing units (21) involved in the operation.

15. The method according to any one of preceding claims 1 to 12, wherein said treatment machine (1) is a rolling machine integrating at least one rolling unit constituting said at least one treatment unit (20) for continuously rolling at least one additional flexible web on said continuous flexible web (3); or wherein said treatment machine (1) is a cutting machine integrating at least one cutting unit operating on said flexible web (3) and constituting said at least one treatment unit (20) for continuously cutting said continuous flexible web (3).

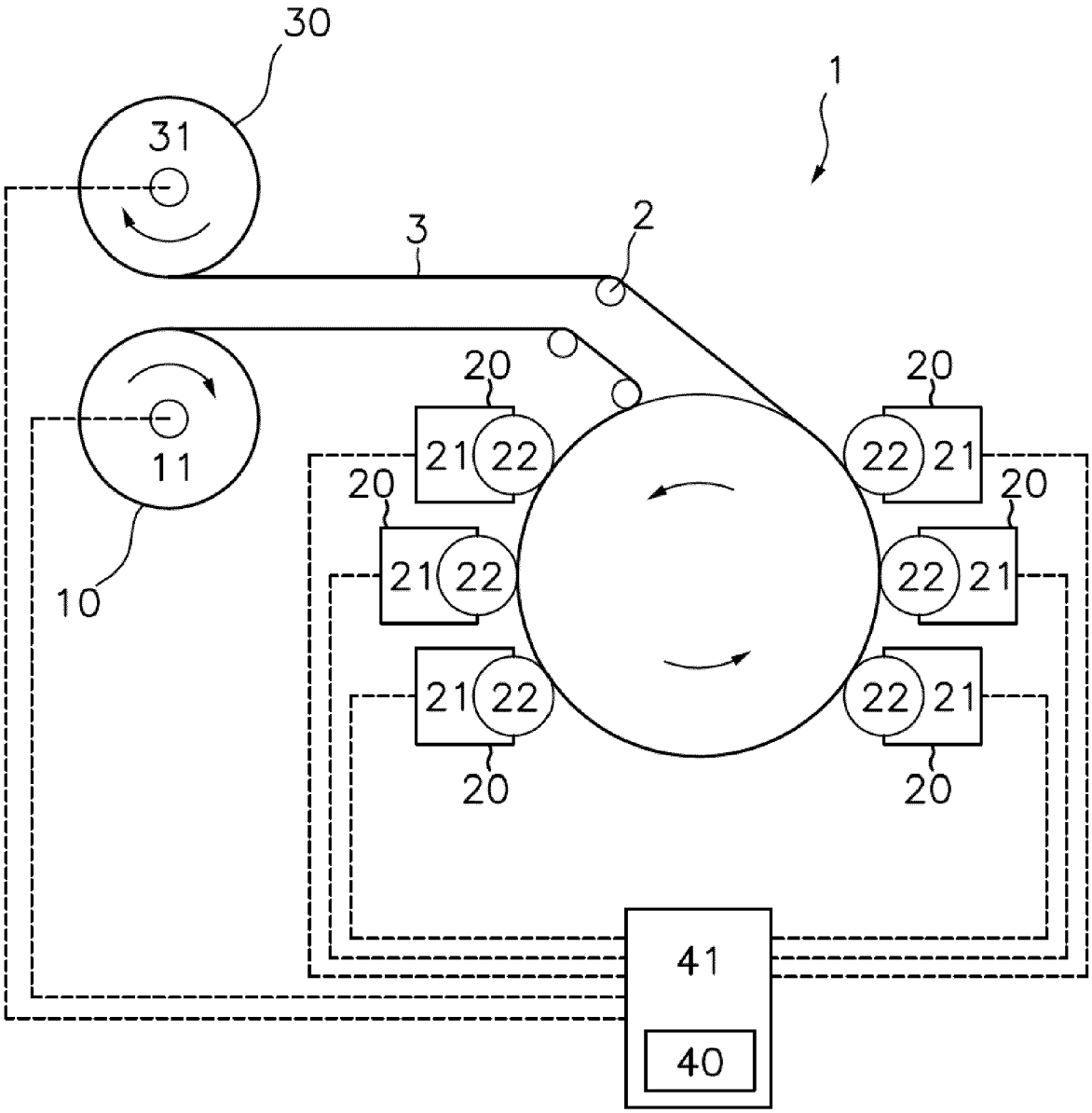

Fig. 1

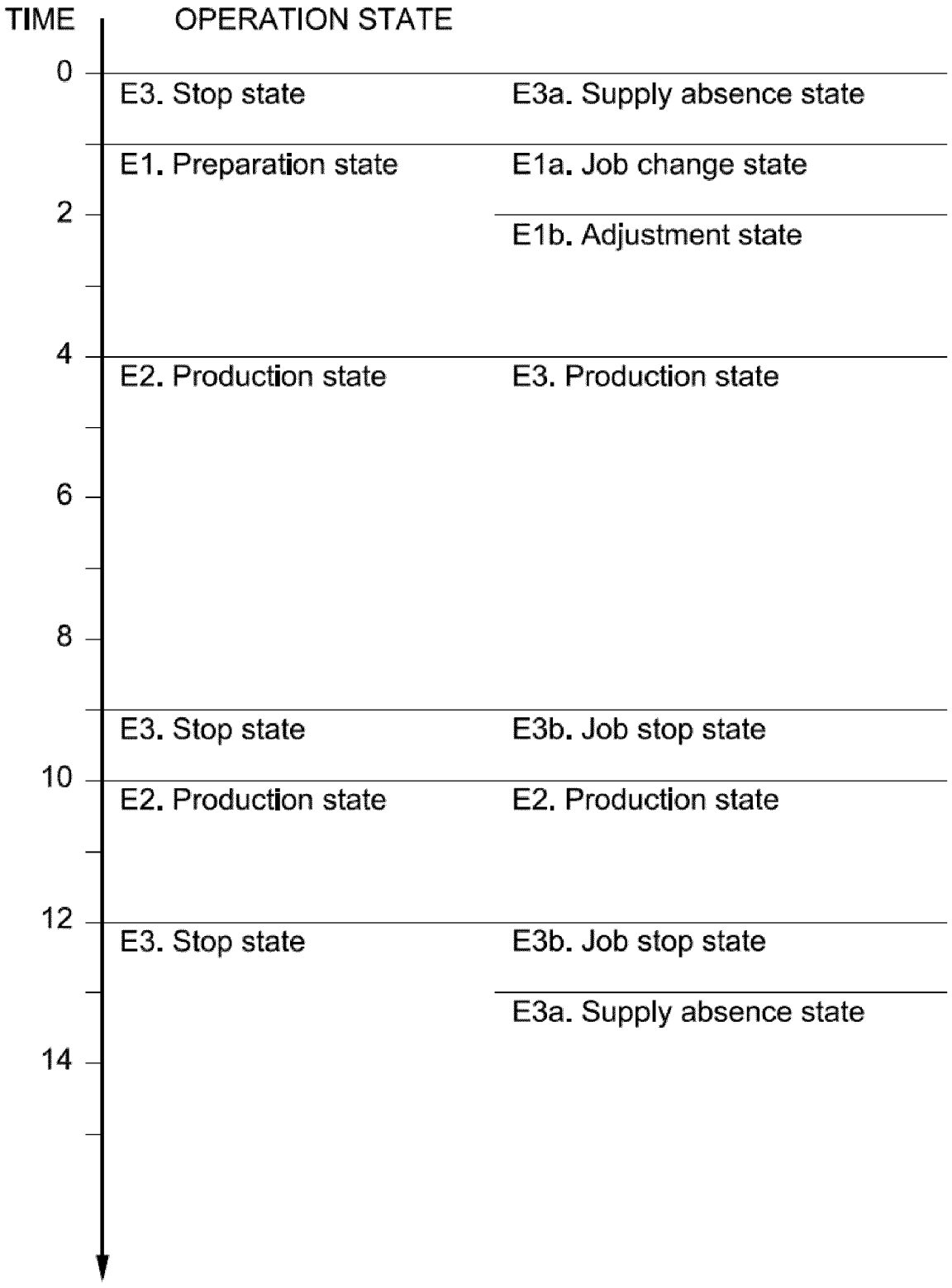
TIME
OPERATION STATE
0
E3. Stop state
E3a. Supply absence state
E1. Preparation state
E1a. Job change state
2
E1b. Adjustment state
4
E2. Production state
E3. Production state
6
8
E3. Stop state
E3b. Job stop state
10
E2. Production state
E2. Production state
12
E3. Stop state
E3b. Job stop state
E3a. Supply absence state
14

Fig.2

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EUROPEAN SEARCH REPORT

Application Number
EP 16 38 2244

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	8 December 2016	Bellofiore, Vincenzo

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