(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 245 905 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.09.2023 Bulletin 2023/38

(21) Application number: **22162258.2**

(22) Date of filing: **15.03.2022**

(51) International Patent Classification (IPC):
D03D 51/00 *(2006.01)* ***D03J 1/00*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
D03J 1/005; D03D 51/007

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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(54) METHOD AND SYSTEM FOR VISUALIZING OPERATION EVALUATION DATA OF A WEAVING MACHINE

(57) The invention relates to a method and a system for visualizing on a monitor operation evaluation data of a weaving machine with a weaving machine component, comprising determining an actual weaving machine speed, determining a representative value for an actual component load of the weaving machine component, determining an actual state information of a parameter influencing a component load and/or a movement characteristic of the weaving machine component, computing operation evaluation data based on a model of the weaving machine (1) comprising the weaving machine component by taking into account the actual weaving machine speed, the representative value for the actual component load, and the actual state information, and visualizing on the monitor (2) the operation evaluation data.

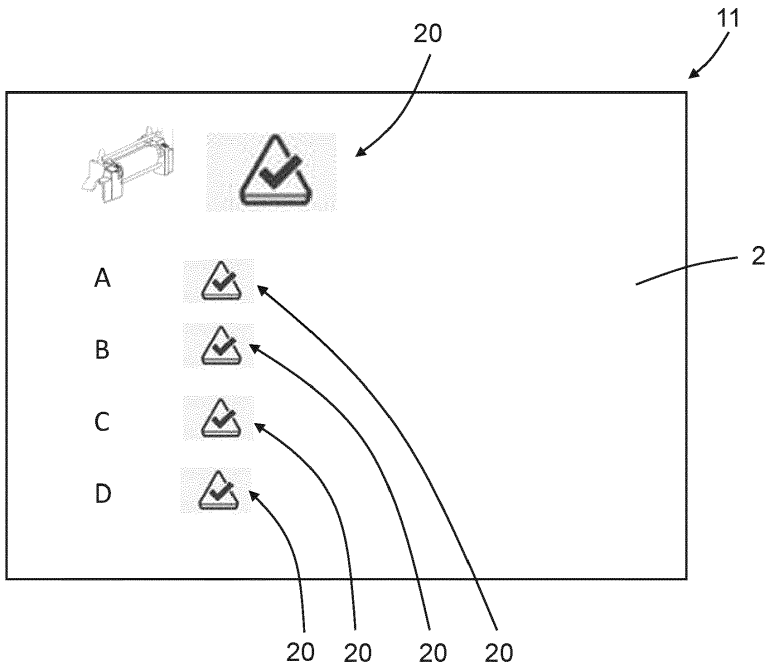

Fig. 2

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Description

TECHNICAL FIELD AND PRIOR ART

[0001] The invention relates to a method and a system for visualizing on a monitor operation evaluation data of a weaving machine.

[0002] A proper operation setup of a weaving machine, in particular an appropriate weaving machine speed of a weaving machine depends on several parameters, such as a type of weave and a type of thread. Setting a weaving machine speed too high can result in poor quality fabrics, and can also cause an electrical, thermal and/or mechanical load of a weaving machine component being high or even too high. In the context of the application, an electrical, thermal and/or mechanical load of a weaving machine component is defined as the stress or strain on the weaving machine component caused by electric power, temperature, forces, torques and/or others. In the context of the application, electrical, thermal and/or mechanical loads are conjointly referred to as component load. High component loads can cause excessive wear of a component and can even be a risk of a failure mechanism, such as, but not limited to, fractures due to fatigue, creep due to high temperature, demagnetization of motor magnets, oxidation of components, and/or others.

[0003] JPH0995840 shows a method and a device for setting a weaving machine speed, wherein a load on a drive motor of a shed forming drive is determined, and the weaving machine speed is adjusted so that the load on said drive motor converges to a pre-set value.

SUMMARY OF THE INVENTION

[0004] It is the object of the invention to provide a method and a system for visualizing on a monitor operation evaluation data of a weaving machine for guiding an operator to enhance an operation of the weaving machine and/or for an adjustment of the weaving machine to enhance an operation of the weaving machine.

[0005] This object is solved by the method and the system with the features of claim 1 and claim 8. Preferred embodiments are defined in the dependent claims.

[0006] According to a first aspect, a method for visualizing on a monitor operation evaluation data of a weaving machine, which weaving machine comprises a weaving machine component, is provided, wherein the method comprises the steps of determining an actual weaving machine speed, determining a representative value for an actual component load of the weaving machine component, determining an actual state information of a parameter influencing a component load and/or a movement characteristic of the weaving machine component, computing operation evaluation data based on a model of the weaving machine comprising the weaving machine component by taking into account the actual weaving machine speed, the representative value for the actual component load, and the actual state information, and visualizing on the monitor the operation evaluation data.

[0007] According to a second aspect, a system for visualizing on a monitor operation evaluation data of a weaving machine is provided, wherein the weaving machine comprises a weaving machine component. The system comprises a first determination device for determining an actual weaving machine speed, a second determination device for determining a representative value for an actual component load of the weaving machine component, a third determination device for determining an actual state information of a parameter influencing a component load and/or a movement characteristic of the weaving machine component, and a computer program comprising instructions for computing operation evaluation data based on a model of the weaving machine comprising the weaving machine component by taking into account the actual weaving machine speed, the representative value for the actual component load, and the actual state information, wherein the computer program further comprises instructions for visualizing on the monitor the operation evaluation data.

[0008] Throughout this specification and the following claims, the indefinite article "a" or "an" means "one or more". Reference to a "first element" does not mandate presence of a "second element". Further, the expressions "first" and "second" are only used to distinguish one element from another element and not to indicate any order of the elements.

[0009] The weaving machine component could be any component or assembly of a weaving machine, in particular selected from, but not limited to, the group comprising a main weaving machine drive, a sley drive, a shed forming drive, a weft cutter drive, a mechanical tuck-in drive, a fabric take-up drive, a warp let-off drive, a leno thread drive, a selvage thread drive, a weft selector drive, a prewinder drive, a rapier drive, a rapier guide, a rapier, individual moving parts of any of said drives, control elements for driving the drives, and moving parts driven by said drives.

[0010] It has been the findings of the inventor, that an optimal operation of a weaving machine is dynamic and depends on various parameters, such as, but not limited to installed speed-limiting devices, installed moving parts, such as frames, heddles, grippers, and others, dynamic forces of installed moving parts, used pattern and movement law of shed-forming, a heald frame stroke, a gripper stroke (in case of a rapier weaving machine), a weft tension, ambient factors such as temperature, humidity and dust formation in a weaving room, a rapier guide temperature, a rapier temperature, vibrations of the weaving machine, oil temperature, a weaving machine component temperature, such as a drive motor temperature, and others. Some of these parameters depend on a configuration or setting of the weaving machine and are static during an operation of the weaving machine, for example a weight of a heald frame. Other parameters are dynamic and subject to changes during the operation of the weaving machine, for example ambient

factors. In the context of the application, information on the static state or the dynamic state of any such parameter influencing a component load and/or a movement characteristic of the weaving machine component, is referred to as "actual state information". Such an actual state information for example, but not limited to, could be a mass of a heald frame, a size of a stroke of a heald frame, an oil temperature, and others.

[0011] According to the invention, at least one actual state information of any such parameter influencing a component load and/or a movement characteristic of the weaving machine component is determined, and an operation evaluation data is computed using a model of the weaving machine comprising the weaving machine component and in consideration of this actual state information as well as an actual weaving machine speed, and an actual component load.

[0012] In an embodiment, the model of the weaving machine comprising the weaving machine component is an active model, i.e. a model considering circumstances, wherein at least the actual state information is used to update the active model. In embodiments, the actual state information as well as an actual weaving machine speed, and an actual component load, are used to update the active model. In an embodiment, the model of the weaving machine is a kinematic model or multi-body simulation model of the weaving machine, wherein mechanical constraints and loads of the weaving machine are represented by mathematical equations. In other embodiments, the model is an artificial intelligence model, which has been trained. In still another embodiment, the model is a mixed-type model, wherein starting from a multi-body simulation model of the weaving machine the simulation model is trained using artificial intelligence.

[0013] In the context of the application, "operation evaluation data" is defined as any data, which allows an evaluation of an operation of the weaving machine, such as an actual weaving machine speed in relation to a maximum allowable weaving machine speed, an actual component load in relation to a maximum allowable component load, an actual efficiency of the weaving machine in relation to a desired efficiency of the weaving machine, an actual energy consumption of the weaving machine in relation to an expected energy consumption of the weaving machine, an actual wear of parts in relation to an allowable wear of parts, and others. By visualizing the operation evaluation data, an operator can be guided to enhance an operation of the weaving machine, i.e. for example to increase a weaving machine speed, to increase an efficiency, to decrease an energy consumption, and/or to decrease wear of parts. In alternative or in addition, the operation evaluation data can be used for an automated adjustment of the weaving machine speed to enhance the operation of the weaving machine.

[0014] In the context of the application, the expression "determine" is used to express that a value or information is identified or made certain for a further processing, wherein the information can be readily available such as an actual weaving machine speed, the information is identified using a sensor device or a similar device, for example for determining the representative value for the actual component load of the weaving machine component, the information is retrieved from a setup configuration of the weaving machine, and/or the information is gathered via an input using a man-machine interface.

[0015] Depending on the weaving machine component and/or the component load, the representative value for the component load can be a torque, a temperature, a force, a bending, a deflection, an electric current and/or any other property representing a mechanical, electrical and/or thermal load on the weaving machine component.

[0016] In an embodiment, the determined actual weaving machine speed, the determined representative value, and the determined actual state information are transmitted to an external computing device for computing the operation evaluation data.

[0017] The operation evaluation data is visualized on the monitor. The monitor in one example is a monitor of the weaving machine and/or a monitor arranged nearby the weaving machine. In other embodiments, the monitor is arranged physically separate from the weaving machine, for example at a control center of a weaving mill and/or at a support center. In alternative or in addition, the monitor is the monitor of a hand-held electronic device such as a smartphone or a tablet computer.

[0018] In an embodiment. the operation evaluation data is a relation of the actual weaving machine speed to a maximum allowable weaving machine speed, which maximum allowable weaving machine speed is computed based on the model of the weaving machine comprising the weaving machine component by taking into account the actual weaving machine speed, the representative value for the actual component load, and the actual state information. As the computing of the maximum allowable weaving machine speed is taking account of actual state information influencing the component load and/or the movement characteristic of the weaving machine component, this operation evaluation data allows conclusions to be drawn about a relation of the actual component load and a maximum allowable component load.

[0019] The relation of the actual weaving machine speed to the maximum allowable weaving machine speed is visualized on the monitor and indicates to the operator for example that it is possible to increase the weaving machine speed, in case the actual weaving machine speed is lower than the maximum allowable weaving machine speed, or that it is necessary to decrease the weaving machine speed, in case the actual weaving machine speed is close to or even higher than the maximum allowable weaving machine speed.

[0020] In an embodiment, the method comprises the steps of determining representative values for an actual component load of several weaving machine components, determining for each of the several weaving machine components an actual state information of a pa-

rameter influencing a component load and/or a movement characteristic of said weaving machine component, computing for each of the several weaving machine components operation evaluation data based on a model of the weaving machine comprising said weaving machine component by taking into account the actual weaving machine speed, the representative value for the actual component load, and the actual state information, and visualizing on the monitor for each of the several weaving machine components the operation evaluation data.

[0021] Likewise, in an embodiment, the system comprises several second determination devices for determining representative values for an actual component load of several weaving machine components, and several third determination devices for determining for each of the several weaving machine components an actual state information of a parameter influencing a component load and/or a movement characteristic of said weaving machine component, wherein the computer program comprises instructions for computing for each of the several weaving machine components operation evaluation data based on a model of the weaving machine comprising said weaving machine component by taking into account the actual weaving machine speed, the representative value for the actual component load, and the actual state information, and for visualizing on the monitor for each of the several weaving machine components the operation evaluation data.

[0022] The several weaving machine components can be chosen suitably by a person skilled in the art. In an embodiment, the weaving machine components are selected according to a configuration or setup of the weaving machine and/or according to the operation evaluation data to be visualized. It will be understood, that depending on the weaving machine components, the same model may be used for a group of weaving machine components, which model is adapted in consideration of the actual state information of each weaving machine component of said group.

[0023] It will be further understood that the number of second determination devices for determining representative values for the actual component load of the several weaving machine components in embodiments differs from the number of third determination devices for determining for each of the several weaving machine components an actual state information of a parameter influencing a component load and/or a movement characteristic of said weaving machine component, as for example two or more weaving machine components may use a common second determination device and/or a common third determination device.

[0024] In an embodiment, an extreme value of all operation evaluation data is identified. For example, in case the operation evaluation data indicates a maximum allowable weaving machine speed compared to the actual weaving machine speed, the lowest value of all maximum allowable weaving machine speeds is identified. This value represents the highest allowable weaving machine speed for an operation of the weaving machine. In other words, a weaving machine speed can be increased until it reaches the lowest value of all computed weaving machine speeds. Similar, in case the operation evaluation data indicates the actual component load in relation to a maximum allowable component load, the highest value of the component load is identified, as this value potentially limits any further increase in a weaving machine speed.

[0025] In an embodiment, the extreme value of the operation evaluation data is visualized as the overall operation evaluation data on the monitor.

[0026] In an embodiment, the operation evaluation data is visualized using a colour code and/or using an icon.

[0027] In an embodiment, the visualized operation evaluation data indicates whether or not the actual weaving machine speed is below a computed maximum allowable weaving machine speed. This can be indicated by a colour code, wherein a green activated light or a green field on the monitor is present in case the actual weaving machine speed is below the computed maximum allowable weaving machine speed and/or a red activated light or a red field on the monitor is present in case the actual weaving machine speed is above the computed maximum allowable weaving machine speed. In alternative or in addition, the information can be visualized by an icon, for example a checkmark in case the actual weaving machine speed is below the computed weaving machine speed and/or a stop-sign in case the actual weaving machine speed is above the computed maximum allowable weaving machine speed.

[0028] In an embodiment, more than two colour codes or icons are used so that in addition it can be visualized on the monitor that a limit is almost reached, for example using an orange activated light or an orange field on the monitor in case a limit value is almost reached, for example in case the actual weaving machine speed is below but close to the computed maximum allowable weaving machine speed. In an alternative embodiment, different colour levels are used. For example, in an embodiment light red is used to visualize on the monitor when the weaving machine speed is somewhat above the computed maximum allowable weaving speed and/or dark red is used when the weaving speed is substantially above the computed maximum allowable weaving speed. In alternative or in addition, in an embodiment a flashing light, for example a flashing red light is used to visualize on the monitor that the weaving speed is substantially above the computed maximum allowable weaving speed.

[0029] In an embodiment, a strategy for enhancing an operation of the weaving machine in consideration of the operation evaluation data is established, wherein in particular the strategy for enhancing the operation of the weaving machine is visualized on the monitor. The strategy in embodiments comprises instructions to exchange a weaving machine component, for example to exchange a heald frame so that a heald frame having a higher mechanical strength is used and/or to exchange a heald

frame so that a lighter heald frame is used. In alternative or in addition, the strategy comprises instructions to change a setup, for example to decrease or increase a weaving machine speed and/or to adapt settings so that the weaving machine speed can be increased.

[0030] In an embodiment, the actual weaving machine speed and/or an adjustable control variable of one or more weaving machine components is automatically adjusted according to the strategy. In the context of the application, the expression "adjustable control variable" is used for any parameter influencing a performance, a movement characteristic and/or a component load of a weaving machine component, which can be adjusted electronically without manual interventions by the operator.

[0031] In an embodiment, the strategy for enhancing the operation of the weaving machine is determined using an artificial intelligence model.

[0032] The artificial intelligence model in embodiments is used for making predictions about changing conditions and an operation of the weaving machine under the changing conditions and for making suggestions to increase a weaving machine speed and/or an efficiency of the weaving machine and/or to decrease an energy consumption, wherein the artificial intelligence model is self-learning.

[0033] In an embodiment, the operation evaluation data is a relation of the actual weaving machine speed to a maximum allowable weaving machine speed, wherein the computer program comprises instructions for computing the maximum allowable weaving machine speed based on the model of the weaving machine comprising the weaving machine component by taking into account the actual weaving machine speed, the representative value for the actual component load, and the actual state information.

[0034] In an embodiment, the computer program comprises instructions for visualizing the operation evaluation data on the monitor using a colour code and/or using an icon. In an embodiment, the computer program further comprises instructions for establishing a strategy for enhancing an operation of the weaving machine in consideration of the operation evaluation data, wherein in particular the computer program further comprises instructions for visualizing the strategy for enhancing the operation of the weaving machine on the monitor. In an embodiment, the computer program comprises instructions for an automated adjustment of an adjustable control variable of one or more the weaving machine components according to the strategy and/or for an automated adjustment of the actual weaving machine speed according to the strategy. In an embodiment, the computer program comprises instructions for determining the strategy for enhancing the operation of the weaving machine using an artificial intelligence model.

[0035] In embodiments, the system is used in a rapier weaving machine or in an air-jet weaving machine.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036] In the following, embodiments of the invention will be described in detail with reference to the drawings. Throughout the drawings, the same elements will be denoted by the same reference numerals.

Fig. 1 shows a weaving machine with a monitor, a determination system, and a computer system.

Fig. 2 shows a first image for display on a monitor for visualizing on the monitor operation evaluation data.

Fig. 3 shows a second image for display on a monitor for visualizing on the monitor operation evaluation data.

Fig. 4 shows a third image for display on a monitor for visualizing on the monitor operation evaluation data.

Fig. 5 shows a fourth image for display on a monitor for visualizing on the monitor operation evaluation data.

Fig. 6 shows a fifth image for display on a monitor for visualizing on the monitor operation evaluation data.

Fig. 7 shows a sixth image for display on a monitor for visualizing on the monitor operation evaluation data.

Fig. 8 shows a seventh image for display on a monitor for visualizing on the monitor operation evaluation data.

Fig. 9 shows an eighth image for display on a monitor for visualizing on the monitor operation evaluation data.

Fig. 10 shows a ninth image for display on a monitor for visualizing on the monitor operation evaluation data.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0037] Fig. 1 schematically shows a weaving machine 1 with a monitor 2 and with a system 3 for visualizing on the monitor 2 operation evaluation data of the weaving machine, i.e. data, which allows an evaluation of an operation of the weaving machine 1, such as an actual weaving machine speed in relation to a maximum allowable weaving machine speed, an actual component load in relation to a maximum allowable component load, an

actual efficiency of the weaving machine in relation to a desired efficiency of the weaving machine, an actual energy consumption of the weaving machine in relation to an expected energy consumption of the weaving machine, an actual wear of parts in relation to an allowable wear of parts, and others.

[0038] Depending on weaving machine type and/or configuration, for example a rapier weaving machine or an air-jet weaving machine, the weaving machine 1 comprises several weaving machine components such as, but not limited to, a main weaving machine drive, a sley drive, a shed forming drive, a weft cutter drive, a mechanical tuck-in drive, a fabric take-up drive, a warp let-off drive, a rapier drive, a rapier guide, a rapier, as well as individual moving parts of any of said drives, and moving parts driven by said drives.

[0039] The operation evaluation data is computed using a model of the weaving machine 1 comprising at least one weaving machine component by taking into account an actual weaving machine speed, a representative value for an actual component load of the at least one weaving machine component, and an actual state information of a parameter influencing a component load and/or a movement characteristic of the at least one weaving machine component.

[0040] In an embodiment, the model of the weaving machine is a kinematic model or multi-body simulation model of the weaving machine, wherein mechanical constraints and loads of the weaving machine are represented by mathematical equations. In other embodiments, the model is an artificial intelligence model, which has been trained. In still another embodiment, the model is a mixed-type model, wherein starting from a multi-body simulation model of the weaving machine the simulation model is trained using artificial intelligence.

[0041] The system 3 for visualizing the operation evaluation data comprises a determination system 4, and a computer system 5. The determination system 4 comprises a first determination device 6, a second determination device 7, and a third determination device 8.

[0042] The first determination device 6 is adapted or configured for determining an actual weaving machine speed. The first determination device 6 in embodiments reads the actual weaving machine speed from a control device of the weaving machine 1, also referred to as weaving machine controller, wherein it is assumed that the actual weaving machine speed is the same as a set weaving machine speed. In other embodiments, the first determination device 6 cooperates with a sensor system 9 for sensing an actual weaving machine speed. The sensor system 9 in embodiments is a sensor system present on the weaving machine 1 and used for the operation of the weaving machine 1 by the weaving machine controller.

[0043] The system 3 for visualizing the operation evaluation data further comprises at least one second determination device 7 adapted or configured for determining a representative value for an actual component load of a weaving machine component. Depending on the weaving machine component, the component load can be represented as a torque, a temperature, a force, a bending, a deflection, an electric current or any other property representing a component load such as an electrical, mechanical and/or thermal load on the weaving machine component. The at least one second determination device 7 is chosen according to the representative value, for example the second determination device 7 in embodiments cooperates with a sensor device 10, for example a torque sensor for determining a torque, a thermometer for determining a temperature, a force sensor for determining a force, a bend sensor for determining an amount of bending, a deflection sensor for determining an amount of deflection, an electric current sensor for determining an electric current. However, the invention is not limited to such sensor devices. Further, the representative value in embodiments is determined indirectly.

[0044] In an embodiment, the system 3 for visualizing the operation evaluation data comprises a plurality of second determination devices 7 for determining representative values for actual component loads of several weaving machine components. In one embodiment, the number of second determination devices 7 equals the number of weaving machine components for which actual component loads are to be determined. In other embodiments, two or more weaving machine components share a common second determination device 7.

[0045] The system 3 for visualizing the operation evaluation data further comprises at least one third determination device 8 adapted or configured for determining an actual state information of a parameter influencing a component load and/or a movement characteristic of the weaving machine component. The actual state information is the information about a static state or a dynamic state of the parameter influencing a component load and/or a movement characteristic of the weaving machine component. Depending on the weaving machine component, the parameter in embodiments is selected from an installation of a speed-limiting device, an installation of a moving part, such as a frame, a heddle, a gripper, and others, dynamic forces of the moving parts, a used pattern and movement law of a shed forming device, a heald frame stroke, a gripper stroke, a weft tension, an ambient factor such as temperature, humidity and dust formation in a weaving room, a rapier guide temperature, a vibration of the weaving machine, an oil temperature, a weaving machine component temperature, such as a drive motor temperature, and others. The static state information for example is a mass of a heald frame, a mass of a heddle, a mass of a gripper, and others. The dynamic state information for example is information about an ambient temperature, an oil temperature, a weaving machine component temperature, and others.

[0046] The determination device 8 can be chosen by the person skilled in the art for allowing a determination

of an actual state information of a selected one of any such parameter, for example using a detector device for detecting an installation, i.e. an absence or presence of elements, a sensor device for sensing properties of elements, and/or a device for retrieving information from the weaving machine controller. In embodiments, the third determination device 8 uses a man-machine-interface for prompting a user to enter and/or to verify an actual state information.

[0047] On the computer system 5 runs a computer program that uses a model of the weaving machine 1 comprising the at least one weaving machine component and that comprises instructions for computing the operation evaluation data based on the model of the weaving machine 1 comprising the at least one weaving machine component by taking into account the actual weaving machine speed, the representative value for the actual component load, and the actual state information.

[0048] Although the computer system 5 in the embodiment is represented in the system 3 for visualizing the operation evaluation data, the invention is not limited to embodiments in which the computer program is installed and runs on one single computing device, for example the weaving machine controller. For example, the computer program in embodiments is installed on a distributed computer system comprising a weaving machine controller and an external computing device, wherein the computer program comprises instructions for transmitting the determined weaving machine speed, the one or more determined representative values and the determined actual state information to the external computing device for computing the operation evaluation data.

[0049] The computer program further comprises instructions for visualizing on the monitor 2 operation evaluation data.

[0050] Figs. 2 to 10 show embodiments of images 11, 12, 13, 14, 15, 16, 17, 18, 19 for display on a monitor 2 in order to visualize on the monitor 2 the operation evaluation data.

[0051] The monitor, on which the images 11, 12, 13, 14, 15, 16, 17, 18, 19 are displayed, in embodiments of the invention is the monitor 2 of the weaving machine 1 as shown in Figs. 1 to 10. In other embodiments, in alternative or in addition, the images 11, 12, 13, 14, 15, 16, 17, 18, 19 are displayed on any other monitor than that of the weaving machine 1.

[0052] In the exemplary embodiments of a visualization shown in Figs. 2 to 10, operation evaluation data for four weaving machine components is displayed in four rows, wherein above the four rows an overall operation evaluation data of the weaving machine is displayed. In other embodiments, more or less operation evaluation data is displayed. Further, the images 11, 12, 13, 14, 15, 16, 17, 18, 19 using several rows are only by way of example. In other embodiments, the operation evaluation data of the weaving machine components and the overall operation evaluation data is displayed in several columns or in a matrix having rows and columns.

[0053] In Figs. 2 to 7 and 10, the four weaving machine components are represented by the four letters A, B, C, D. The letters are used as placeholders, and in embodiments of the invention, weaving machine component names or product names are displayed instead of the placeholders. In other embodiments, as shown in Figs. 8 and 9, pictures or pictograms representing the weaving machine components are displayed.

[0054] In the embodiments shown in Figs. 2 to 10, icons are used for visualizing the operation evaluation data of each of the weaving machine component as well as for visualizing the overall operation evaluation data of the weaving machine.

[0055] In the embodiments shown in Figs. 3 to 8, in addition to icons a percentage is displayed. In an alternative embodiment (not shown), only percentages are displayed. For example, the operation evaluation data of each weaving machine component indicates a relation between the actual weaving machine speed and a maximum allowable weaving machine speed at which for example a maximum allowable component load of said weaving machine component is reached. In another embodiment, the operation evaluation data of each weaving machine component indicates a relation between the actual component load and a maximum allowable component load of said weaving machine component. In both examples, the highest operation evaluation data of weaving machine component operation evaluation data is also the overall operation evaluation data.

[0056] In the images 11, 12, 13, shown in Figs. 2 to 4, the operation evaluation data is visualized using two icons 20, 21. A first icon 20 shows a checkmark and is used to indicate that the operation evaluation data is good, for example that the actual weaving machine speed is lower than the maximum allowable weaving machine speed or that the actual component load of a weaving machine component is lower than the maximum allowable component load of said weaving machine component. A second icon 21 shows a hand indicating a stop and is used to indicate that the operation evaluation data is not good, for example that the actual weaving machine speed is higher than the maximum allowable weaving machine speed or that the actual component load of a weaving machine component is higher than the maximum allowable component load of said weaving machine component.

[0057] As shown in Fig. 5, in embodiments, a third icon 22 is used, wherein in the embodiment shown, the third icon 22 is an exclamation mark. The third icon 22 is used to indicate that the operation evaluation data approaches a limit. Hence, an operator can take action to avoid that the limit value is exceeded, for example by adjusting a setting for the weaving machine component represented by the letter D. The image 14 shown in Fig. 5 also visualizes that the overall operation evaluation data is still good, which is indicated by the first icon 20.

[0058] As shown in Figs. 6 and 7, in embodiments, in alternative or in addition to the third icon 22, a fourth icon

23 is used, wherein in the embodiment shown, the fourth icon 23 is a light bulb. The fourth icon 23 is used to indicate that a setting of the weaving machine component should be checked.

[0059] For example, in case the computing of the operation evaluation data also revealed that a setting of the weaving machine component represented by the letter B could be modified to improve the operation evaluation data, this can be indicated by the fourth icon 23. In an embodiment, in addition a strategy for enhancing an operation of the weaving machine is established, which strategy can be visualized on the monitor 2.

[0060] In case the operation evaluation data of this weaving machine component and the overall operation evaluation data is good as shown in Fig. 6, via such a suggestion it may be possible to see how much it is possible to increase the weaving machine speed provided that a setting is adjusted.

[0061] In case the operation evaluation data of this weaving machine component and/or the overall operation evaluation data is not good or reaches a limit as shown in Fig. 7, via such a suggestion it may be possible to indicate how the setting can be adjusted to avoid that the overall operation evaluation data reaches or exceeds a limit.

[0062] In the embodiments shown, icons are used to visualize the operation evaluation data. In alternative or in addition, colour codes are used, wherein in particular traffic light colour codes are used allowing an operator to intuitively grasp a computed evaluation of the weaving machine operation.

[0063] As shown in Figs. 8 and 9 the letters A, B, C, D of Figs. 2 to 7 can be replaced by pictures or pictograms representing the weaving machine components. In Fig. 8, the picture or pictogram for the overall weaving machine is replaced by the letter M. In an alternative, only pictures or pictograms as shown in Fig. 9 or only letters may be used as shown in Fig. 10. In still another embodiment, no letter or pictogram is used in connection with the overall evaluation data, wherein letters and/or pictograms are only used in connection with operation evaluation data of the weaving machine components.

[0064] As shown in Fig. 9 also the actual weaving machine speed together with the maximum weaving machine speed is displayed for the overall weaving machine, instead of the percentage as shown in Figs. 3 to 8. In Fig. 9 it is shown that the maximum allowable weaving machine speed is 1400 RPM and that the actual weaving machine speed 1190 RPM is lower than 1400 RPM. If as shown in Fig. 10, the actual weaving machine speed is 1500 RPM, for the overall weaving machine the second icon 21 will be displayed together with "1500 RPM > 1400 RPM". As shown in Fig. 10, the operation evaluation data for two weaving machine components is not good.

Claims

1. Method for visualizing on a monitor (2) operation evaluation data of a weaving machine (1), wherein the weaving machine (1) comprises a weaving machine component, the method comprising the steps of

   - determining an actual weaving machine speed,
   - determining a representative value for an actual component load of the weaving machine component,
   - determining an actual state information of a parameter influencing a component load and/or a movement characteristic of the weaving machine component,
   - computing operation evaluation data based on a model of the weaving machine (1) comprising the weaving machine component by taking into account the actual weaving machine speed, the representative value for the actual component load, and the actual state information, and
   - visualizing on the monitor (2) the operation evaluation data.

2. The method according to claim 1, **characterized in that** the operation evaluation data is a relation of the actual weaving machine speed to a maximum allowable weaving machine speed, which maximum allowable weaving machine speed is computed based on the model of the weaving machine (1) comprising the weaving machine component by taking into account the actual weaving machine speed, the representative value for the actual component load, and the actual state information.

3. The method according to claim 1 or 2, **characterized in that** the method comprises the steps of determining representative values for an actual component load of several weaving machine components, determining for each of the several weaving machine components an actual state information of a parameter influencing a component load and/or a movement characteristic of said weaving machine component, computing for each of the several weaving machine components operation evaluation data based on a model of the weaving machine (1) comprising said weaving machine component by taking into account the actual weaving machine speed, the representative value for the actual component load, and the actual state information, and visualizing on the monitor (2) for each of the several weaving machine components the operation evaluation data.

4. The method according to claim 1, 2 or 3, **characterized in that** the operation evaluation data is visualized using a colour code and/or using an icon (20, 21, 22, 23).

5. The method according to any one of claims 1 to 4, **characterized in that** a strategy for enhancing an operation of the weaving machine in consideration of the operation evaluation data is established, wherein in particular the strategy for enhancing the operation of the weaving machine (1) is visualized on the monitor (2).

6. The method according to claim 5, **characterized in that** the actual weaving machine speed and/or an adjustable control variable of one or more weaving machine components is automatically adjusted according to the strategy.

7. The method according to any one of claims 5 or 6, **characterized in that** the strategy for enhancing the operation of the weaving machine (1) is determined using an artificial intelligence model.

8. System for visualizing on a monitor (2) operation evaluation data of a weaving machine (1), wherein the weaving machine (1) comprises a weaving machine component, the system comprising a first determination device (6) for determining an actual weaving machine speed, a second determination device (7) for determining a representative value for an actual component load of the weaving machine component, a third determination device (8) for determining an actual state information of a parameter influencing a component load and/or a movement characteristic of the weaving machine component, and a computer program comprising instructions for computing operation evaluation data based on a model of the weaving machine (1) comprising the weaving machine component by taking into account the actual weaving machine speed, the representative value for the actual component load, and the actual state information, wherein the computer program further comprises instructions for visualizing on the monitor (2) the operation evaluation data.

9. The system according to claim 8, **characterized in that** the operation evaluation data is a relation of the actual weaving machine speed to a maximum allowable weaving machine speed, wherein the computer program comprises instructions for computing the maximum allowable weaving machine speed based on the model of the weaving machine comprising the weaving machine component by taking into account the actual weaving machine speed, the representative value for the actual component load, and the actual state information.

10. The system according to claim 8 or 9, **characterized in that** the system comprises several second determination devices (7) for determining representative values for an actual component load of several weaving machine components, and several third determination devices (8) for determining for each of the several weaving machine components an actual state information of a parameter influencing a component load and/or a movement characteristic of said weaving machine component, wherein the computer program comprises instructions for computing for each of the several weaving machine components operation evaluation data based on a model of the weaving machine (1) comprising said weaving machine component by taking into account the actual weaving machine speed, the representative value for the actual component load, and the actual state information, and for visualizing on the monitor (2) for each of the several weaving machine components the operation evaluation data.

11. The system according to claim 8, 9 or 10, **characterized in that** the computer program comprises instructions for visualizing the operation evaluation data on the monitor (2) using a colour code and/or using an icon (20, 21, 22, 23).

12. The system according to any one of claims 8 to 11, **characterized in that** the computer program further comprises instructions for establishing a strategy for enhancing an operation of the weaving machine (1) in consideration of the operation evaluation data, wherein in particular the computer program further comprises instructions for visualizing the strategy for enhancing the operation of the weaving machine (1) on the monitor (2).

13. The system according to claim 12, **characterized in that** the computer program comprises instructions for an automated adjustment of an adjustable control variable of one or more the weaving machine components according to the strategy and/or for an automated adjustment of the actual weaving machine speed according to the strategy.

14. The system according to claim 12 or 13, **characterized in that** the computer program comprises instructions for determining the strategy for enhancing the operation of the weaving machine (1) using an artificial intelligence model.

15. The system according to any one of claims 8 to 14, **characterized in that** the system is used in a rapier weaving machine or in an air-jet weaving machine.

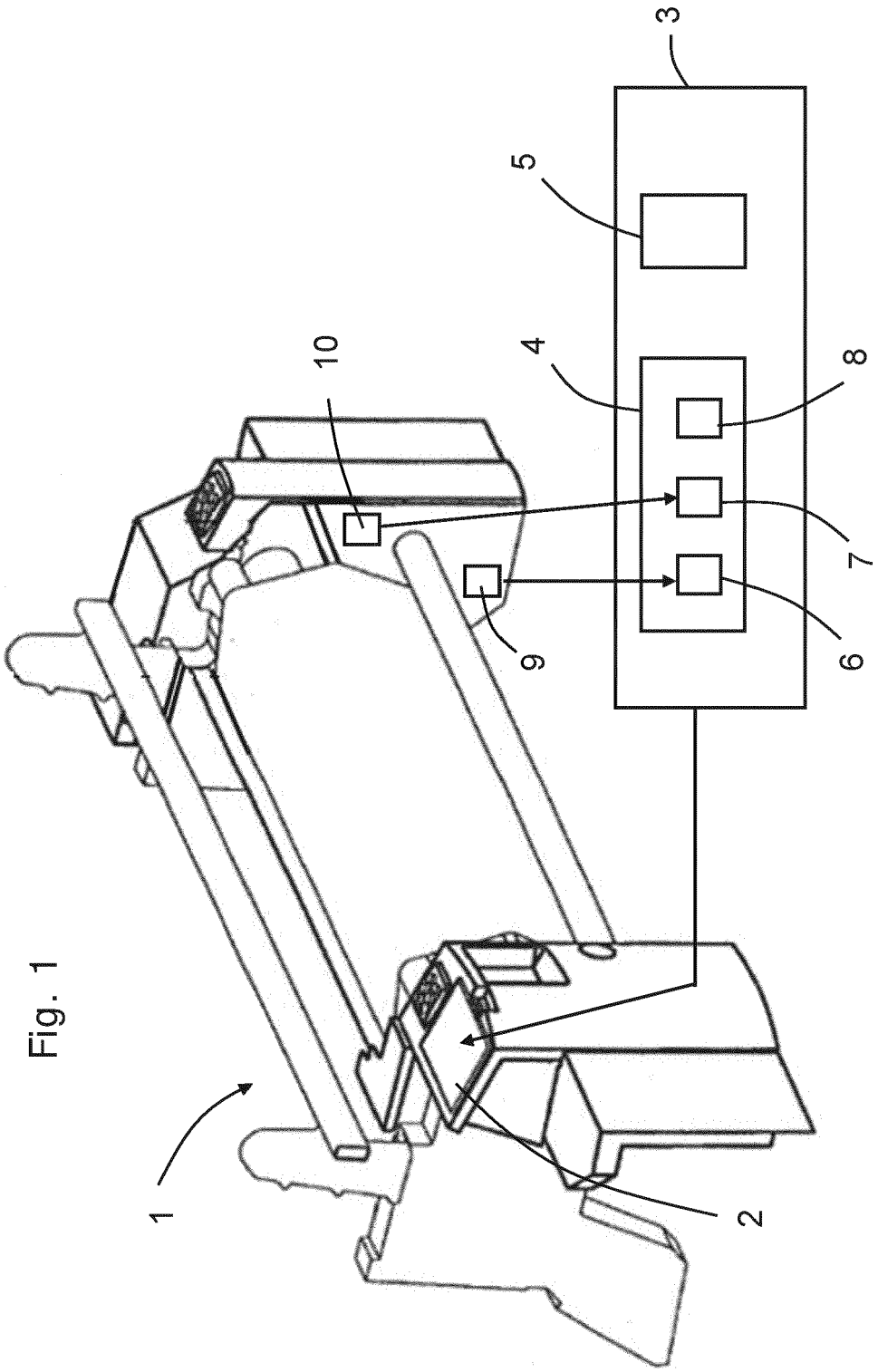
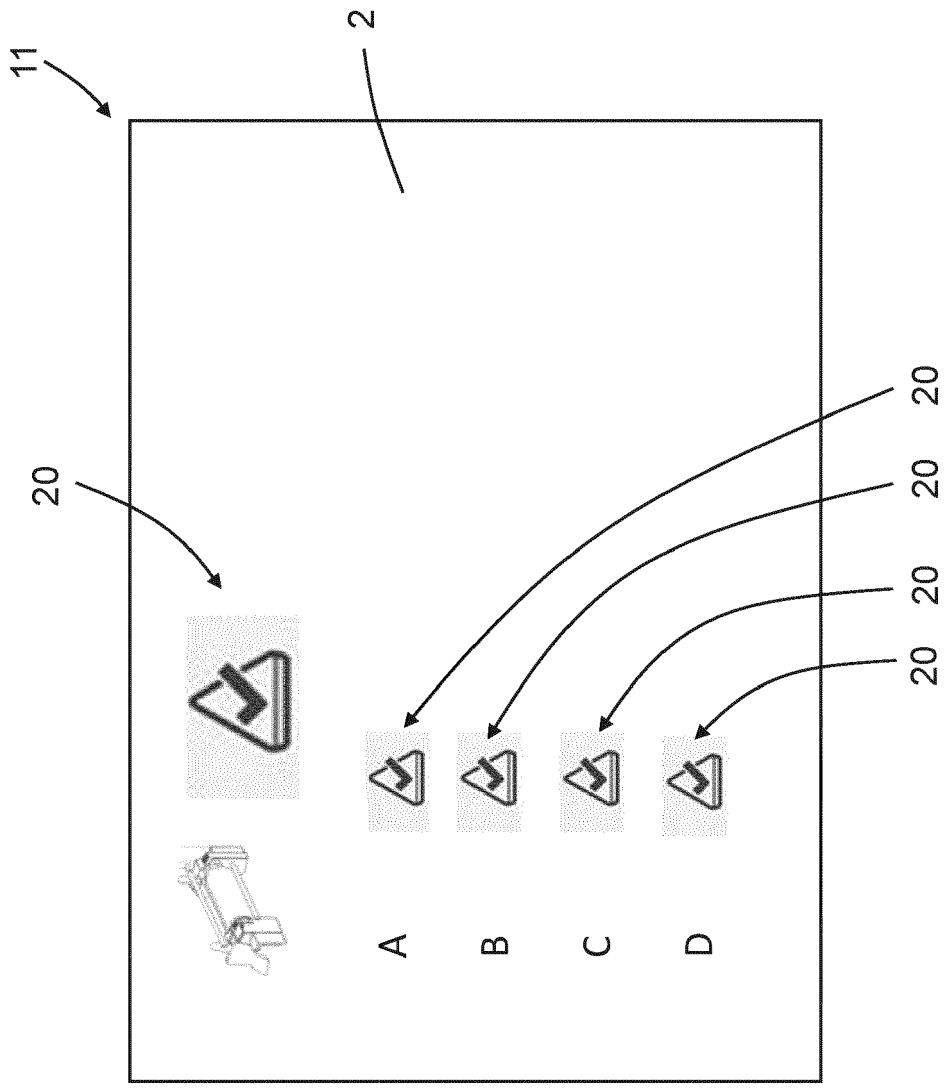


Fig. 1

Fig. 2



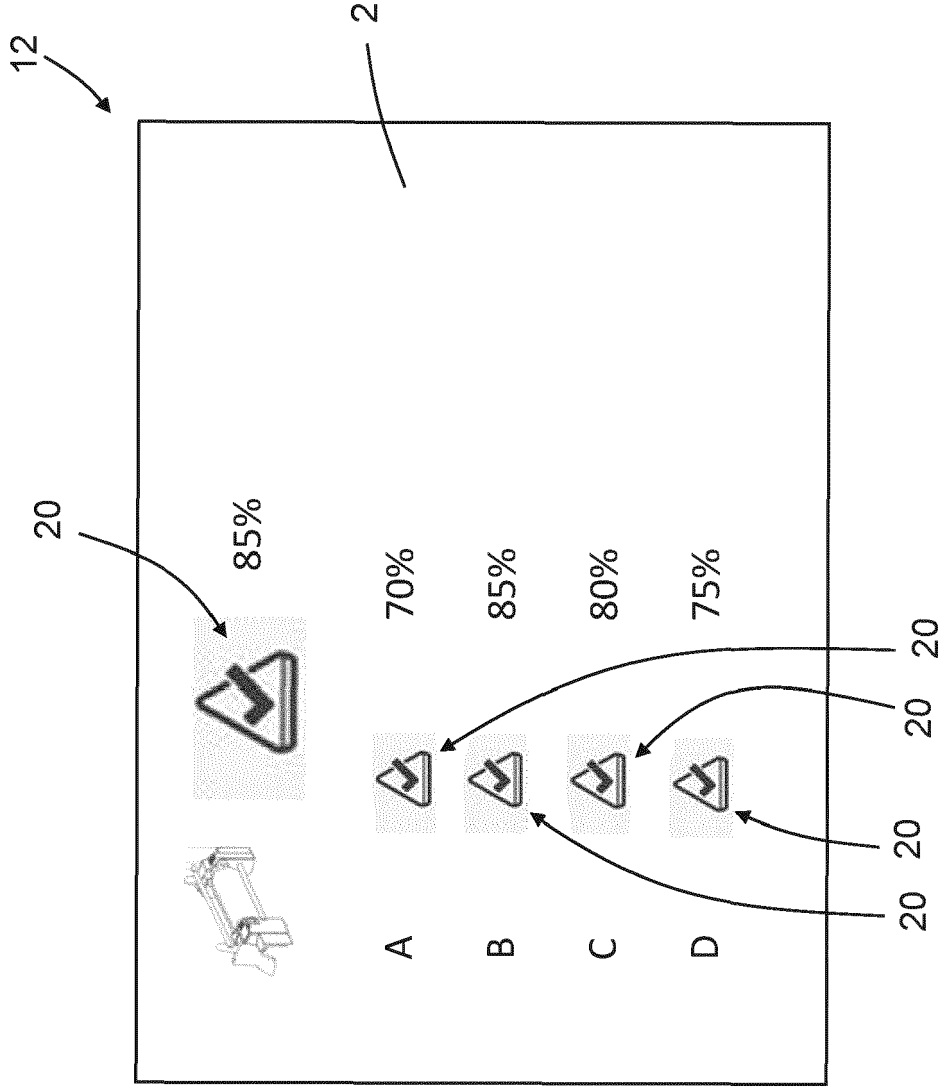


Fig. 3

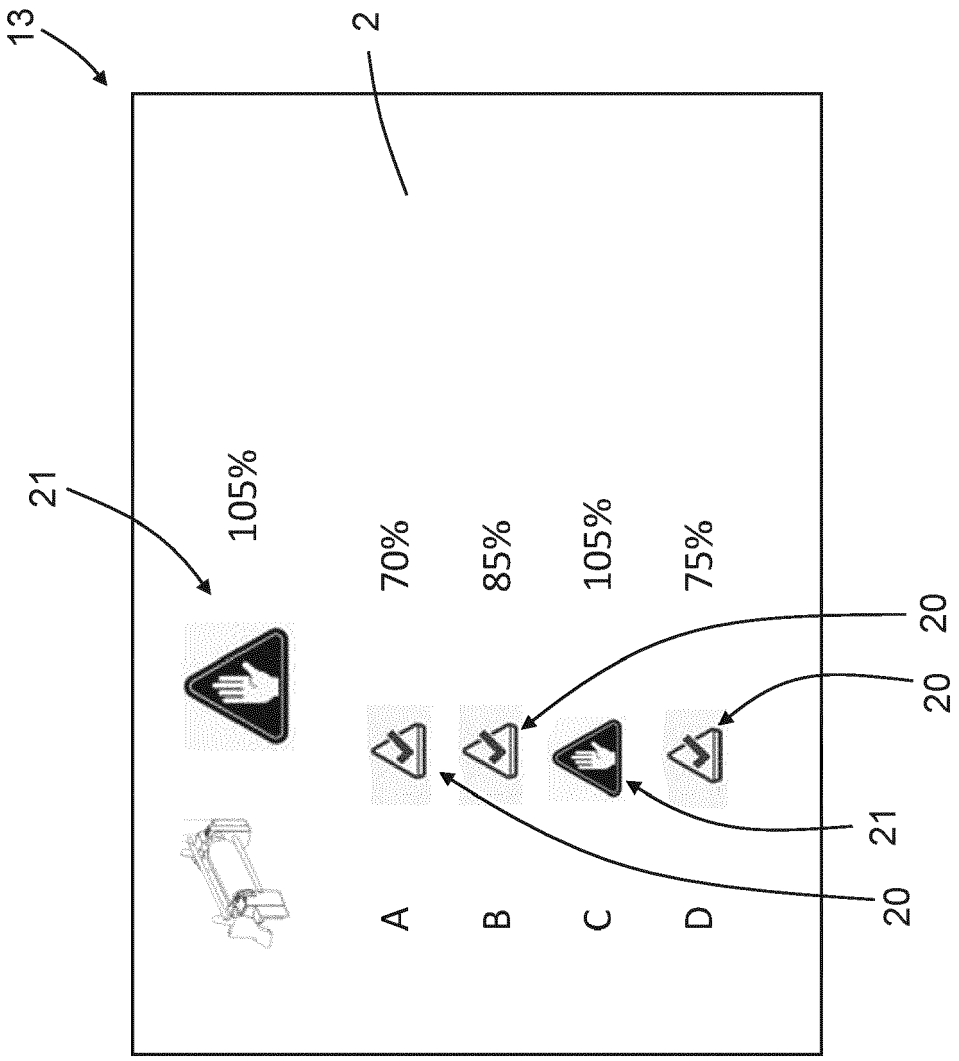


Fig. 4

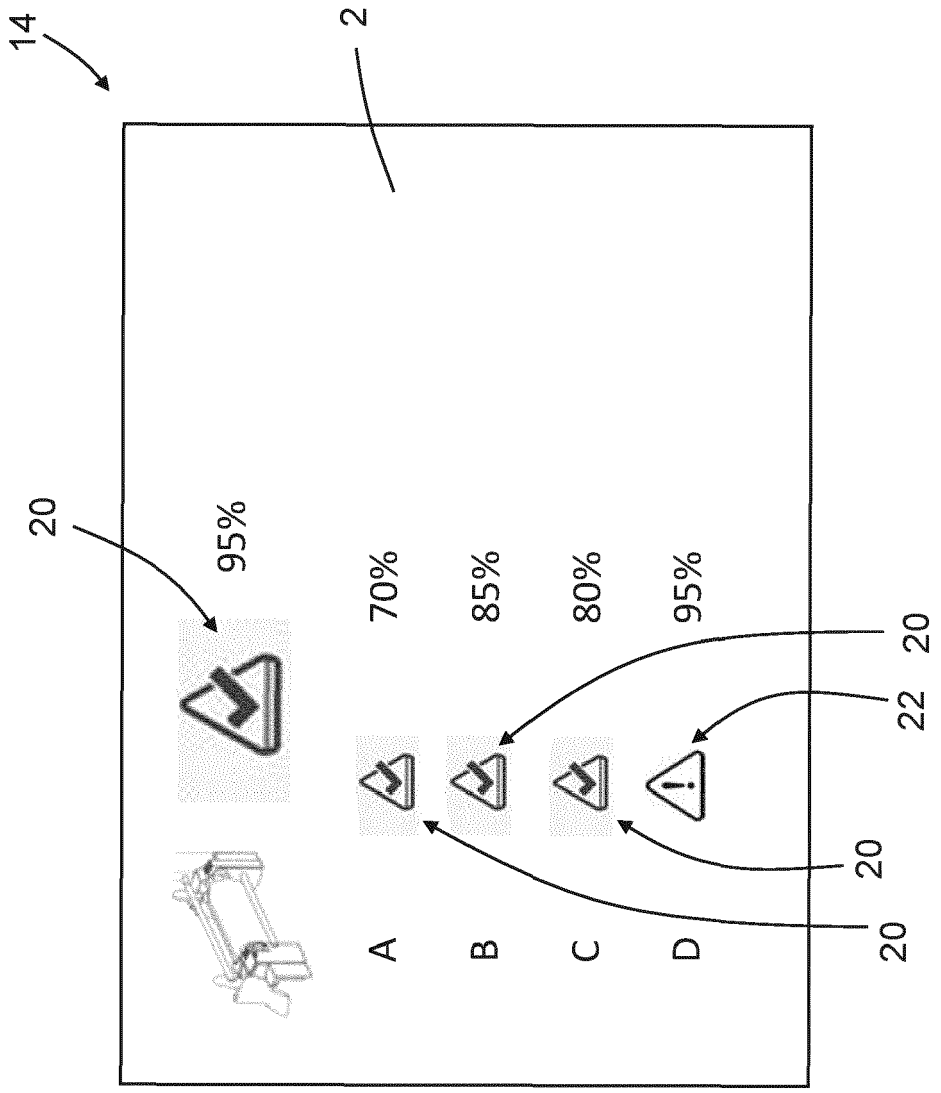


Fig. 5

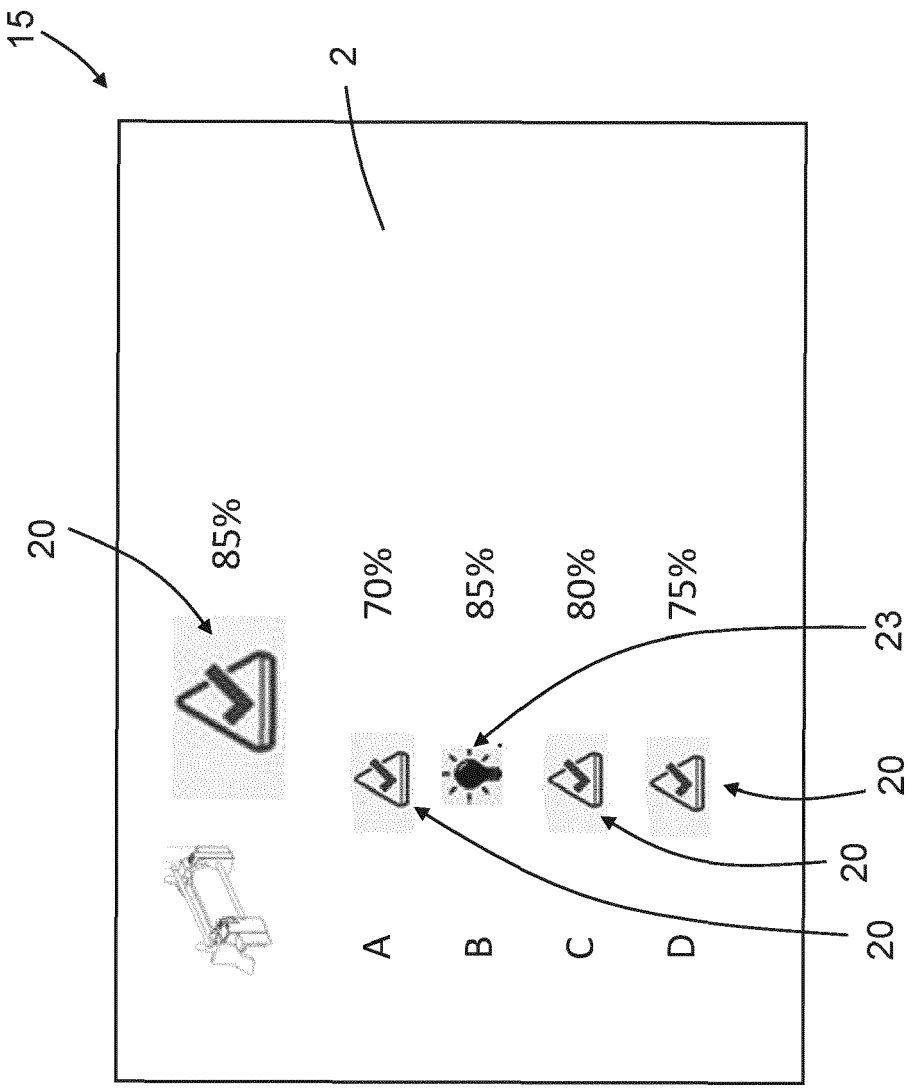


Fig. 6

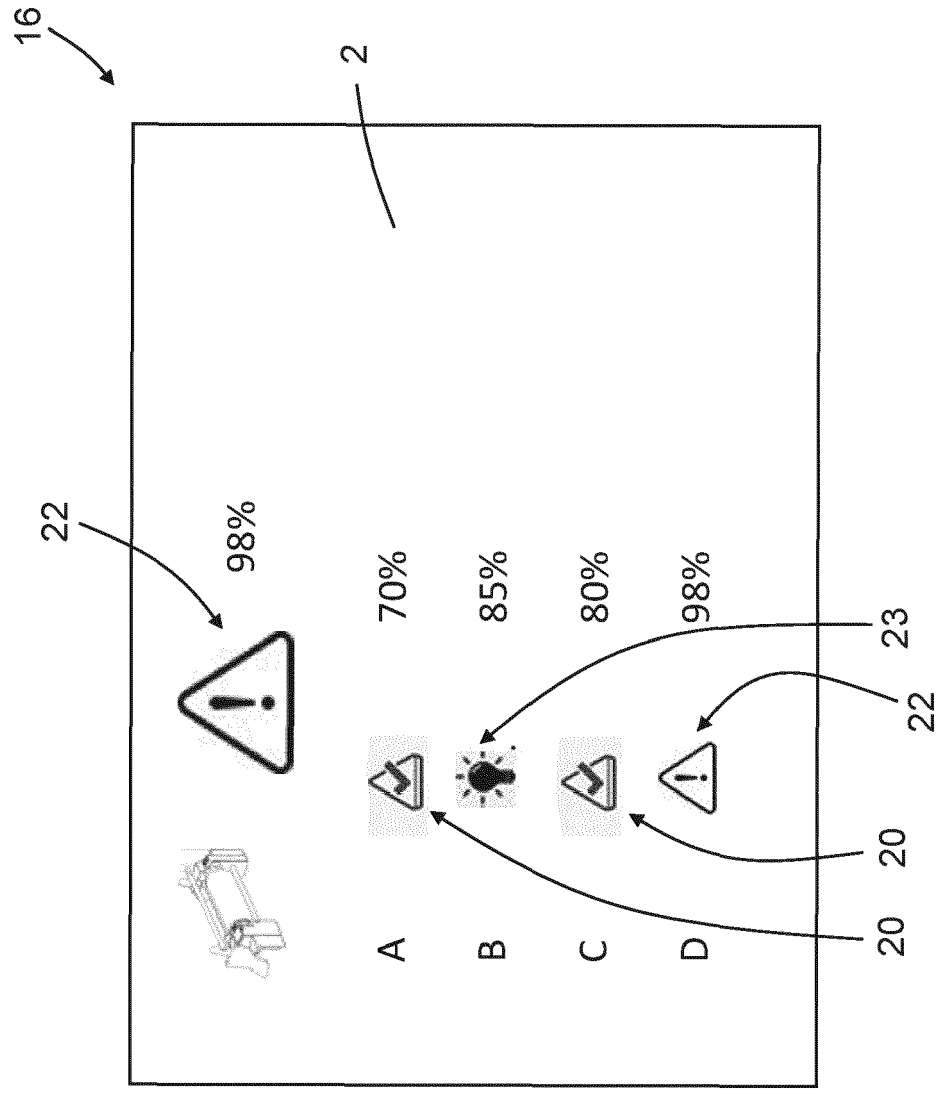


Fig. 7

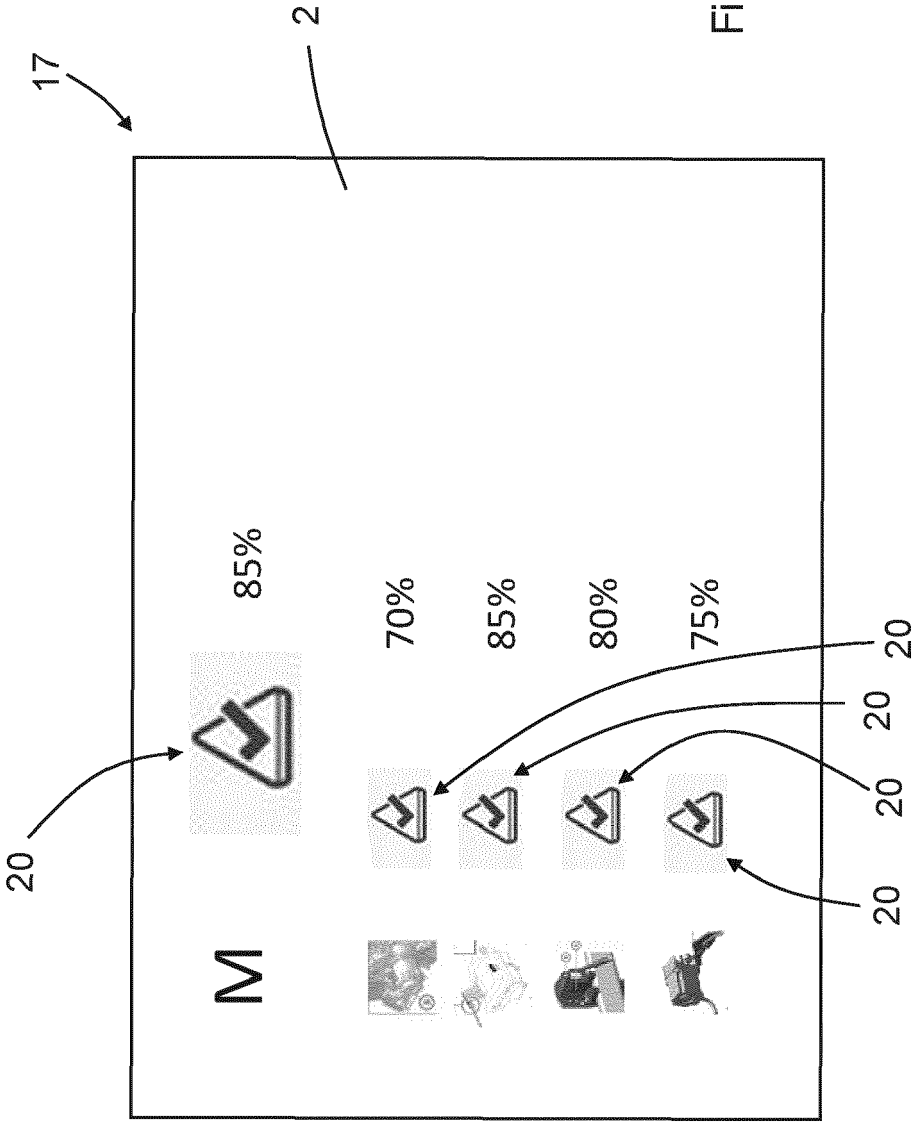


Fig. 8

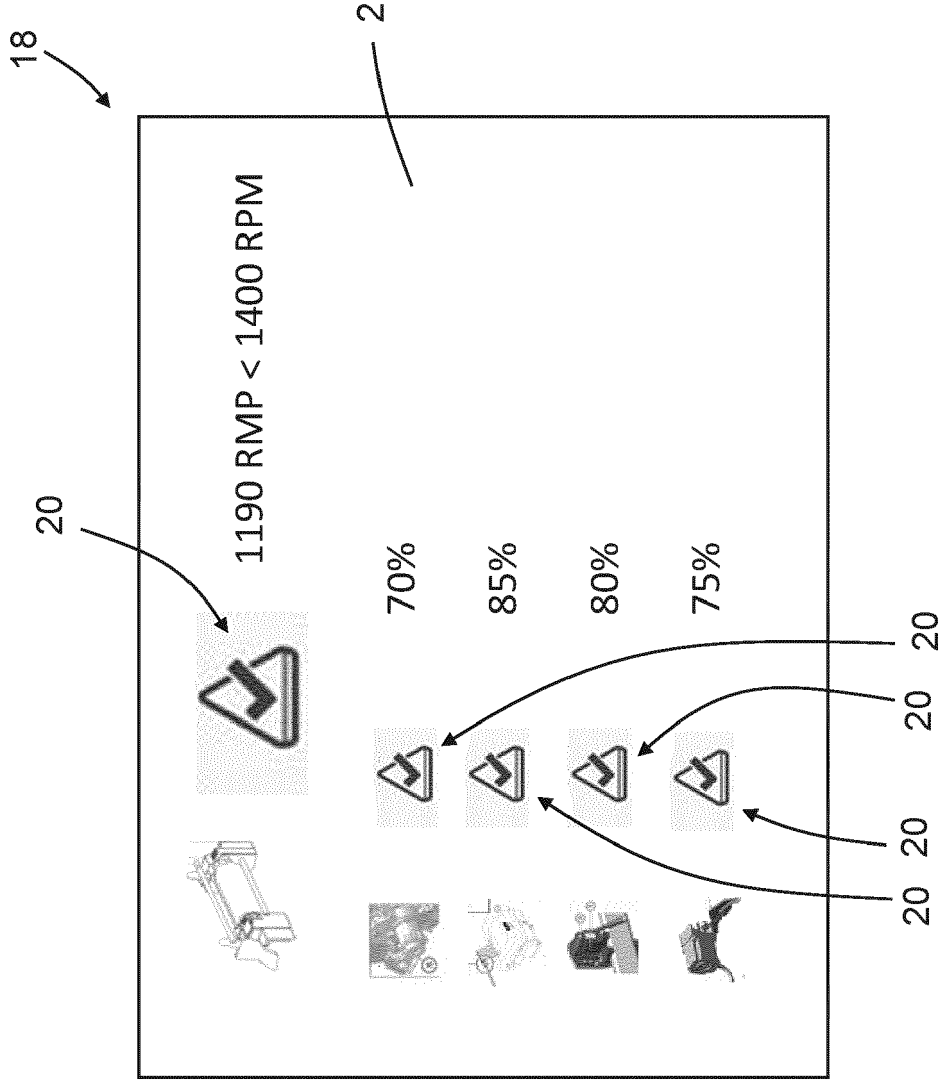


Fig. 9

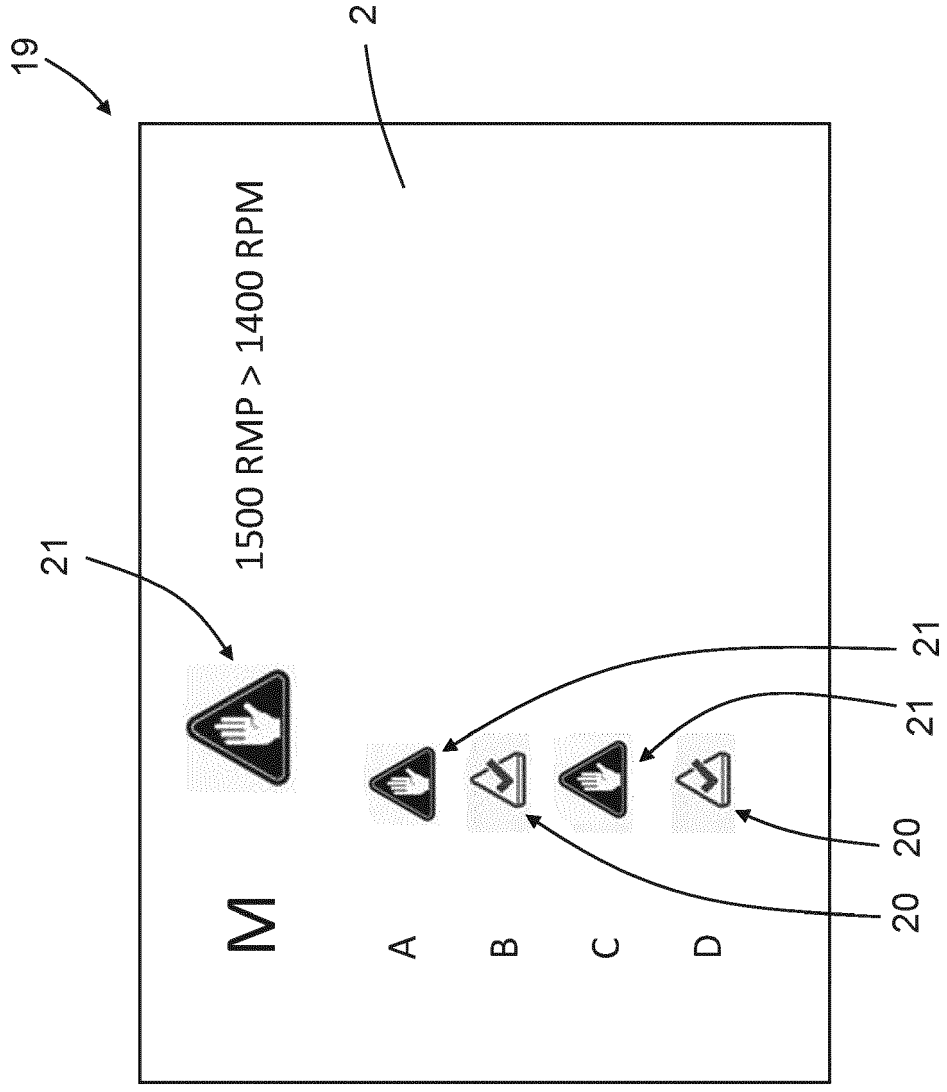


Fig. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 22 16 2258

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 0 759 485 A2 (TOYODA AUTOMATIC LOOM WORKS [JP]) 26 February 1997 (1997-02-26) * column 1, lines 14-26 * * column 2, line 29 - column 5, line 29 * * column 7, line 51 - column 8, line 46 * * column 9, line 41 - column 11, line 27; figures 1-9 *	1,3-13, 15	INV. D03D51/00 D03J1/00
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D03D
D03J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	5 August 2022	Louter, Petrus

CATEGORY OF CITED DOCUMENTS

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