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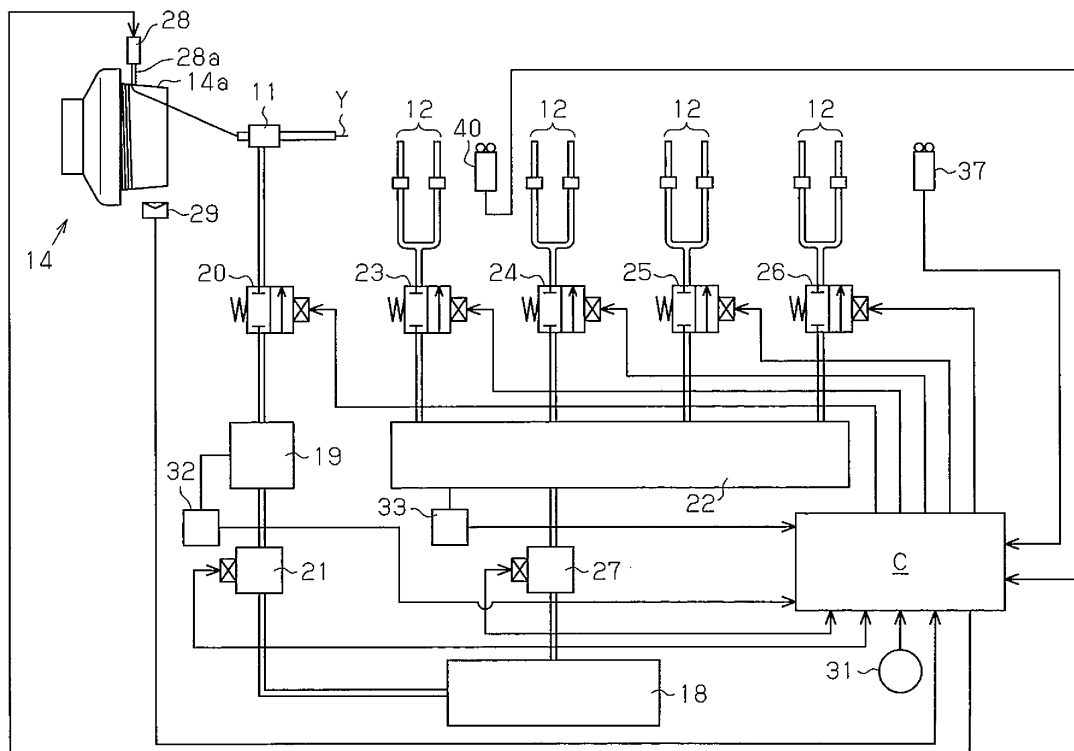
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(54) **Air-jet loom with weft yarn detector**

(57) A weft yarn detector is adapted to be used in an air-jet loom, in which weft insertion of a weft yarn through a reed passage is performed by air jet from a main nozzle

and auxiliary nozzles. An optical sensor for detecting the extent of slack of the weft yarn is located in the reed passage at a position close to the main nozzle.

Fig.1



Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a weft yarn detector for an air-jet loom. More specifically, the present invention pertains to a weft yarn detector for an air-jet loom that performs weft insertion through a passage in the reed by means of blow of air from the main nozzle and auxiliary nozzles.

[0002] In this type of air-jet loom, the state of the weft yarn during weft insertion largely depends on the pressure setting of pressurized air. Conventionally, Japanese Laid-Open Patent Publication No. 4-241135 discloses a pressure controlling device for weft insertion in an air-jet loom that is capable of improving the consumption efficiency of discharged fluid, while cancelling slack in the weft yarn in the latter half of weft insertion and reducing erroneous picks in weft insertion. The control device detects the weft yarn unwinding finish time in a device for measuring weft yarn measuring and storing weft yarn and the weft yarn leading end arrival time, and controls the jet pressure of the main nozzle based on the weft yarn leading end arrival time. Also, based on the difference between the weft yarn leading end arrival time and the weft yarn unwinding finish time, the control device controls the jet pressure of the main nozzle and the jet pressure of the auxiliary nozzles. Specifically, when the difference between the detected weft yarn leading end arrival time and the detected weft yarn unwinding finish time is greater than a target value, the control device increases the jet pressure of the auxiliary nozzles. When the time difference is less than the target value, the control device lowers the jet pressure of the auxiliary nozzles.

[0003] When the weft insertion is performed by flying the weft yarn stored in the weft yarn measuring and storing device through the passage in the reed, or the reed passage, by air jet from the main nozzle and the auxiliary nozzles, a part of the weft yarn Y closer to the trailing end undulate before the leading end of the weft yarn Y reaches a predetermined position that corresponds to the completion of the weft insertion, as shown in Fig. 6A. At the point in time close to the completion of the weft insertion, the undulation is cancelled as shown in Fig. 6B, so that the weft insertion is performed in a strained state of the weft yarn Y.

[0004] In a state in which the weft yarn leading end arrival point in time TW, which is the time at which the weft yarn leading end reaches the end of the weft insertion range, is maintained at a constant value, the relationship among the jet pressure of the auxiliary nozzles (auxiliary pressure), the difference between the weft yarn leading end arrival point in time TW and the weft unwinding finish point in time TBW in the weft yarn measuring and storing device (TW - TBW), and the time at which the weft yarn is strained is represented by the graph of Fig. 7. In Fig. 7, the angles of TW and TBW represent rotation angles of the loom. As shown in Fig. 7, the loom

rotation angle at the time when the weft yarn Y is strained decreases as the auxiliary pressure increases. That is, the higher the auxiliary pressure, the earlier the point in time of straining becomes.

[0005] When determining the optimum jet pressure of the auxiliary nozzles at weft insertion, a changing point of the difference between the weft yarn leading end arrival point in time TW, which is the time at which the weft yarn leading end reaches the end of the weft insertion range, and the weft unwinding finish point in time TBW in the weft yarn measuring and storing device (TW - TBW), is used as one of the indications. In this case, however, the state of the weft yarn in the warp shed is not directly monitored, and the changing point is merely an alternative indication. It is thus impossible to determine, based on the value of TW - TBW, the margin of the auxiliary pressure for optimizing the point in time of straining. Therefore, when regulating the machine, a stroboscope is used to visually check the state of the weft yarn, and the auxiliary pressure is set, accordingly. However, in a cloth construction in which the top warps are continuous, such as satin weaving, it is difficult in some cases to check the state of the weft yarn in the warp shed using a stroboscope.

SUMMARY OF THE INVENTION

[0006] Accordingly, it is an objective of the present invention to provide a weft yarn detector for an air-jet loom that is adapted to monitor the state of a weft yarn flying through the reed passage and display the timing at which the weft yarn is strained before the weft yarn leading end arrival point in time.

[0007] To achieve the foregoing objective and in accordance with one aspect of the present invention, a weft thread detector is provided that is used for an air-jet loom, in which weft insertion of a weft yarn through a reed passage is performed by air jet from a main nozzle and an auxiliary nozzle for weft insertion. The weft thread detector includes an optical sensor that detects the extent of slack of the weft yarn in a region of the reed passage close to the main nozzle.

[0008] Other aspects and advantages of the present invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The invention, together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

Fig. 1 is a schematic diagram showing a weft insertion device;

Fig. 2 is a schematic perspective view showing the main nozzle, the auxiliary nozzles, and the weft yarn sensor;

Fig. 3 is a cross-sectional side view showing the positional relationship between a dent and the weft yarn sensor;

Fig. 4 is a diagram showing the positional relationship between the reed passage, the weft yarn, and a phototransmitter/receptor;

Fig. 5 is a diagram showing an output waveform of the sensor;

Fig. 6A is a diagram showing a state of the weft yarn before being strained;

Fig. 6B is a diagram showing a state of the weft yarn after being strained; and

Fig. 7 is a graph showing the relationship between the auxiliary pressure and the weft yarn strained state.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] One embodiment of the present invention will now be described with reference to Figs. 1 to 5.

[0011] As shown in Figs. 1 and 2, an air-jet loom includes a main nozzle 11 used in weft insertion, auxiliary nozzles 12 used in weft insertion, a reed 13, and a weft yarn measuring and storing device 14 of a winding type. As shown in Fig. 2, the main nozzle 11, the auxiliary nozzles 12, and the reed 13 are fixed onto a sley 15. The reed 13 includes a plurality of dents 16 arranged in the direction of weft insertion. Each dent 16 has a guide recess 16a (shown in Fig. 3). The guide recesses 16a of the dents 16 form a passage in the reed 13, or a reed passage 17.

[0012] As shown in Fig. 1, the main nozzle 11 is connected to a tank 19 for the main nozzle 11 via piping. The main nozzle tank 19 is connected to a source pressure tank 18. An electromagnetic valve 20 is provided between the main nozzle 11 and the main nozzle tank 19. Jet of pressurized air for weft insertion from the main nozzle 11 is controlled by opening and closing the electromagnetic valve 20. An electric pressure control valve 21 is provided between the source pressure tank 18 and the main nozzle tank 19. The pressure of the main nozzle tank 19 is regulated by the pressure control valve 21.

[0013] The auxiliary nozzles 12 are connected to a tank 22 for the auxiliary nozzles 12 via piping. The auxiliary nozzle tank 22 is connected to the source pressure tank 18. Electromagnetic valves 23, 24, 25, 26 are provided between the auxiliary nozzles 12 and the auxiliary nozzle tank 22. Jet of pressurized air for weft insertion from the auxiliary nozzle tank 22 is controlled by opening and closing the electromagnetic valves 23, 24, 25, 26. The electromagnetic valves 23 to 26 control the supply of pressurized air to the auxiliary nozzles 12. The electromagnetic valves 23 to 26 are successively controlled to be opened and closed, so that so-called relay jet is gener-

ated by the auxiliary nozzles 12. An electric pressure control valve 27 is provided between the source pressure tank 18 and the auxiliary nozzle tank 22. The pressure of the auxiliary nozzle tank 22 is regulated by the pressure control valve 27.

[0014] The weft yarn measuring and storing device 14 has a thread winding face 14a. Winding of a weft yarn Y onto the thread winding face 14a and unwinding of the weft yarn Y from the thread winding face 14a are controlled by extension and retraction of a stopper pin 28a of an electromagnetic solenoid 28. Excitation and de-excitation of the electromagnetic solenoid 28 is performed through command control by a controller C. The controller C controls de-excitation of the electromagnetic solenoid 28 based on information related to unwinding of the weft yarn Y delivered by the weft yarn unwinding detector 29. The weft yarn unwinding detector 29 detects unwinding of the thread wound onto the thread winding face 14a.

[0015] Opening and closing of the electromagnetic valves 20 and 23 to 26 are controlled through commands from the controller C. Based on a signal indicating a detected rotation angle of the loom delivered from a rotary encoder 31, which detects the rotation angle of the loom, the controller C controls opening and closing of the electromagnetic valves 20 and 23 to 26 and excitation of the electromagnetic solenoid 28.

[0016] A pressure detector 32 is connected to the main nozzle tank 19, and a pressure detector 33 is connected to the auxiliary nozzle tank 22. Information of detected pressures from the pressure detectors 32, 33 is delivered to the controller C. The controller C feedback controls the pressure control valves 21, 27 based on the pressure information from the pressure detector 32, 33.

[0017] As shown in Fig. 2, the auxiliary nozzles 12 are fixed onto the sley 15 with support blocks 35. The auxiliary nozzles 12 can enter the shed of warp threads T through between the rows of the warp threads T as the sley 15 swings.

[0018] A weft yarn detector 37 is fixed to the sley 15 with a support block 38 such that the position of the weft yarn detector 37 is adjustable. The weft yarn detector 37 detects that the leading end of the weft yarn Y has reached the end of the range of weft insertion. As shown in Fig. 1, the weft yarn detector 37 is electrically connected to the controller C.

[0019] As shown in Figs. 2 and 3, an optical sensor 40 is fixed to the sley 15 via the support block 38 such that the position of the optical sensor 40 is adjustable. The optical sensor 40 detects the extent of slack of the weft yarn Y in a region close to the main nozzle 11 in the reed passage 17. The region close to the main nozzle 11 in the reed passage 17 refers to a region between the center of the reed passage 17 and the main nozzle 11. The optical sensor 40 is located in a range where the optical sensor 40 can detect the extent of slack of the weft yarn Y without being influenced by the jet pressure of the main nozzle 11.

[0020] As shown in Figs. 3 and 4, the optical sensor 40 is fixed to the sleigh 15 such that the distal end of a support body 41 faces the reed passage 17. Also, the optical sensor 40 is fixed to the sleigh 15 such that, during the beat-up, the distal end of the support body 41 moves in a space below a woven cloth W and a cloth fell W1 without interfering with the woven cloth W or the cloth fell W1. The support body 41 has a tubular shape. As shown in Fig. 4, a phototransmitter 42, which is a light-emitting diode, and a photoreceptor 43, which is a phototransistor, are provided in the distal end of the support body 41. The phototransmitter 42 and the photoreceptor 43 are electrically connected to the controller C via lead wires 44.

[0021] The optical sensor 40 includes an output section. The output section outputs pulse signals of different intervals depending on whether the optical sensor 40 detects that the weft yarn Y is flying in an undulating state or that the weft yarn Y is flying in a strained state based on an optical signal received by the photoreceptor 43. Specifically, the optical sensor 40 uses a polarized light to convert, into a pulse, the changing state of the signal representing the weft yarn Y from the photoreceptor 43 into a pulse, and outputs the obtained pulse signal. As a result, as shown in Fig. 5, when it is detected that the weft yarn Y is flying in an undulating state, the interval of the pulse signal P is relatively short. When it is detected that the weft yarn Y is flying in a strained state, the interval of the pulse signal P is relatively long. In Fig. 5, the point in time at which the output interval of the pulse signal P changes from the short interval to the long interval is referred to as the point in time of straining.

[0022] A display device (not shown) is connected to the controller C. The controller C includes a microcomputer and a memory. The controller C is configured to store, in the memory, data representing the points in time of straining, which are calculated based on the output state of the pulse signal shown in Fig. 5 for, for example, the last several hundreds of times of weft insertion, and to successively renew the data with the latest point in time of straining. The controller C displays on the screen either the points in time of straining as numeric data represented by the loom rotation angles in the last several times of weft insertion or the pulse waveforms in relation to the loom rotation angles as shown in Fig. 5. The controller C functions as a determining means that determines the time at which the weft yarn Y is strained prior to the weft yarn leading end arrival time based on the output signal of the optical sensor 40.

[0023] Operation of the weft yarn detector of the air-jet loom as described above will now be described.

[0024] When the air-jet loom is operating, the weft yarn detector emits polarized light from the phototransmitter 42 of the optical sensor 40 toward the reed passage 17 and receives the light reflected by the guide recesses 16a of the dents 16 using the photoreceptor 43. A detection signal of the photoreceptor 43 is converted into a pulse signal through signal processing and output to allow detection of the state of the weft yarn Y flying through

the reed passage 17. If the weft yarn Y flying through the reed passage 17 at a part that faces the phototransmitter 42 and the photoreceptor 43 is undulating, the interval of the output pulse signal is made short. If the weft yarn Y at the part facing the phototransmitter 42 and the photoreceptor 43 is strained, the interval of the output pulse signal is made long. As a result, at the point in time where the undulating flying state of the weft yarn Y changes to the strained state, the pulse signal interval changes from a short interval to a long interval as shown in Fig. 5.

[0025] For each weft insertion, the controller C stores, as the point in time of straining, the loom rotation angle at which the short pulse signal interval changes to the long pulse interval. From when a predetermined number of times of weft insertion have been performed or from when a predetermined period of weft insertion time has elapsed, the data of old points in time of straining starts being deleted and replaced by the data of new points in time of straining. The controller C displays the values of the loom rotation angles corresponding to the points in time of straining of a predetermined number of times from the data sets stored in the memory. By seeing the displayed data, the operator can easily check whether the weft insertion is being performed in a stable manner and under preset conditions.

[0026] When the type of the weft yarn Y, the cloth width, or both of these are changed, the compressed air discharged from the main nozzle 11 and the auxiliary nozzles 12 need to be adjusted. At this time, the auxiliary pressure of the auxiliary nozzles 12 is set to proper values by changing the pressure of compressed air discharged from the auxiliary nozzles 12, while checking the information related to the strained state of the weft yarn Y on the screen of the display device, which is connected to the controller C. This way, the adjustment operation is facilitated compared to the case in which strained state is checked using a stroboscope. If a stroboscope is used, the state of the weft yarn in the warp shed is difficult to monitor visually in some weaving conditions for example with a cloth construction in which the top warps are continuous as satin weaving. Even in such a weaving operation, the present embodiment allows the state of the weft yarn and the point in time of straining to be easily checked.

[0027] The present embodiment achieves the following advantages.

- (1) The weft yarn detector is adapted to be used in an air-jet loom, in which weft insertion of the weft yarn Y through the reed passage 17 is performed by air jet from the main nozzle 11 and the auxiliary nozzles 12. The optical sensor 40 for detecting the extent of slack of the weft yarn Y is located in the reed passage 17 at a position close to the main nozzle 11. According to this configuration, the optical sensor 40 detects whether the weft yarn Y is flying through the reed passage 17 with a part close to the trailing end either undulating or strained. Therefore, while mon-

itoring the state of the weft yarn Y flying through the reed passage, it is possible to display the point in time at which the weft yarn Y is strained before the weft yarn leading end arrival point in time.

(2) The optical sensor 40 detects the extent of slack of the weft yarn Y in a range that is not influenced by the jet pressure of the main nozzle 11. In the range that is influenced by the jet pressure of the main nozzle 11, it is difficult to determine whether the weft yarn Y is strained based on the detection signal of the optical sensor 40. However, if the extent of slack of the weft yarn Y is detected in the range that is not influenced by the jet pressure of the main nozzle 11, whether the weft yarn Y is in the strained state can be easily determined.

(3) The optical sensor 40 outputs pulse signals of different intervals between when the slack of the weft yarn Y is over a permissible range and when the slack is within the permissible range. Accordingly, it is possible to determine whether the weft yarn Y is strained by checking the pulse signal output by the optical sensor 40. Therefore, the determination is done more easily than a case in which the strained state of the weft yarn Y is determined based on the video picture of the flying weft yarn Y. Also, since the time point at which the pulse interval of the pulse signal output by the optical sensor 40 changes corresponds to the point in time of straining of the weft yarn Y, the point in time of straining is also easily determined.

[0028] The present invention is not limited to the above described embodiment, but may be embodied as follows, for example.

[0029] The controller C may issue a warning when determining that the point in time of straining is out of a permitted range of a predetermined operational state of the loom based on the data of the points in time of straining. As the method of warning, a warning lamp may be lighted, or a warning tone may be produced.

[0030] The controller C may control the jet pressure of the auxiliary nozzles 12 when determining, based on the data of the points in time of straining, that the point in time of straining has continued to be outside the permitted range of the predetermined operational state of the loom for a predetermined period of time or a predetermined number of times of weft insertion. Also, a warning may be issued while the jet pressure of the auxiliary nozzles 12 is controlled.

[0031] During operation of the loom, the controller C does not necessarily need to constantly operate the weft yarn detector (the optical sensor 40) to check the data related to the point in time of straining of the weft yarn Y and display the data. For example, the weft yarn detector may check the data related to the point in time of straining of the weft yarn Y and display the data only when activated by the operator. In this case, since the weft yarn detector is activated only when the machine is regulated

or when the operator requires, the energy consumption by the weft yarn detector is reduced.

[0032] The optical sensor 40 does not necessarily need to have independently constructed phototransmitter 42 and photoreceptor 43, but may have an integrated phototransmitter/receptor.

[0033] The weft yarn detector may include two or more sensors at different positions in the reed passage 17 to detect whether the weft yarn Y is present at the corresponding positions. In this case, the point in time of straining is determined when a specific one of the sensors outputs a signal indicating the presence of the weft yarn in a stable manner.

[0034] The weft yarn detector may have a sensor detection area at a position of stable flying of the weft yarn Y after the weft yarn Y is strained, and may determine the point in time of straining when the weft yarn presence signal has been output for a predetermined period of time.

[0035] The optical sensor 40 does not necessarily need to detect slack of the weft yarn Y in a range that is not influenced by the jet pressure of the main nozzle 11, but may detect slack in a range that is influenced by the jet pressure of the main nozzle 11, for example, at a position closest to the main nozzle 11.

[0036] The optical sensor 40 does not necessarily need to include the phototransmitter 42, which emits polarized light, and the photoreceptor 43, which outputs a detection signal to be converted to a pulse signal through signal processing. For example, a photoelectric sensor having multiple phototransmitters/receptors may be employed. In this case, the weft yarn is determined to be strained when a weft yarn presence signal from a specific photoreceptor has continued to be output for a predetermined period of time.

[0037] The optical sensor 40 does not necessarily need to be configured such that a phototransmitter and a photoreceptor arranged in the vicinity of the reed passage 17 are electrically connected to a power source for the phototransmitter and a power source for the photoreceptor by lead wires, respectively. For example, a phototransmitter and a photoreceptor may be provided on the sley 15, and the phototransmitter and the photoreceptor may be connected to ends of an optical fiber for the phototransmitter and an optical fiber for the photoreceptor, respectively. In this case, the other ends of the optical fibers are inserted into the support body 41 to face the reed passage 17. This configuration allows the width of the support body 41 to be reduced compared to the configuration in which a phototransmitter and a photoreceptor are provided in the support body 41.

[0038] An optical sensor may be employed in which phototransmitter optical fibers and photoreceptor optical fibers are inserted into the support body 41. In this case, the distal ends of the phototransmitter optical fibers and the photoreceptor optical fibers can be easily arranged in the direction of vibrations of the weft yarn Y within the reed passage 17.

[0039] Therefore, the present examples and embodi-

ments are to be considered as illustrative and not restrictive and the invention is not to be limited to the details given herein, but may be modified within the scope and equivalence of the appended claims.

[0040] A weft yarn detector is adapted to be used in an air-jet loom, in which weft insertion of a weft yarn through a reed passage is performed by air jet from a main nozzle and auxiliary nozzles. An optical sensor for detecting the extent of slack of the weft yarn is located in the reed passage at a position close to the main nozzle.

Claims

1. A weft thread detector for an air-jet loom, in which weft insertion of a weft yarn (Y) through a reed passage (17) is performed by air jet from a main nozzle (11) and an auxiliary nozzle (12) for weft insertion, the weft thread detector being **characterized by** an optical sensor (40) that detects the extent of slack of the weft yarn (Y) in a region of the reed passage (17) close to the main nozzle (11).
2. The weft thread detector for an air-jet loom according to claim 1, wherein the optical sensor (40) is located in a range where the optical sensor (40) can detect the extent of slack of the weft yarn (Y) without being influenced by the jet pressure of the main nozzle (11).
3. The weft thread detector for an air-jet loom according to claim 1 or 2, wherein the optical sensor (40) outputs pulse signals of different intervals depending on whether the optical sensor (40) detects that the weft yarn (Y) is flying in an undulating state or that the weft yarn (Y) is flying in a strained state.
4. The weft thread detector for an air-jet loom according to claim 1 or 2, comprising a determining means (C) that determines a point in time at which the weft yarn (Y) is strained prior to a weft yarn leading end arrival time based on an output signal of the optical sensor (40).
5. The weft thread detector for an air-jet loom according to claim 4, wherein the determining means (C) outputs, to a display device, data that shows points of time of straining of the weft yarn (Y) in a number of times of weft insertion, the date being represented by loom rotation angles.

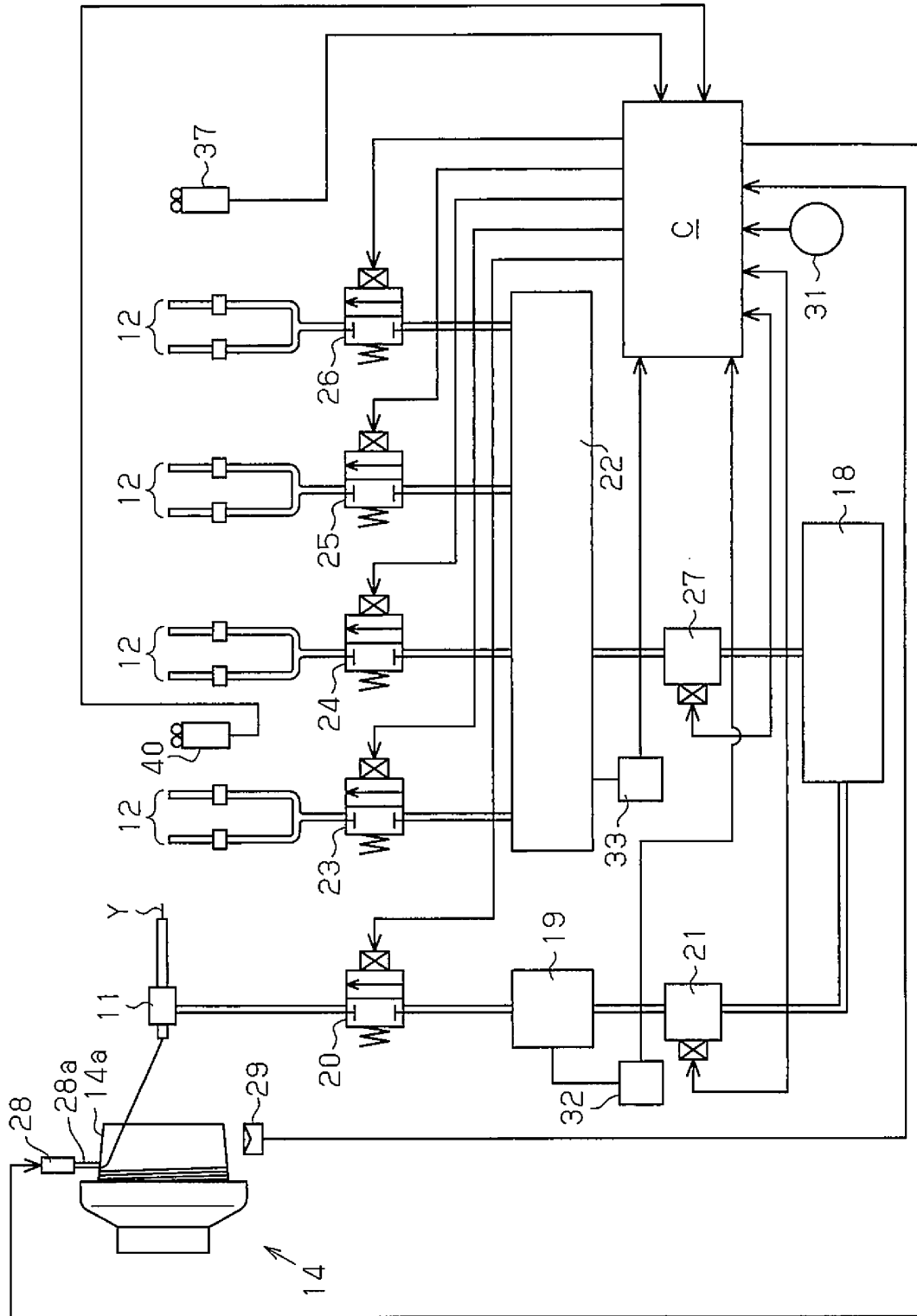
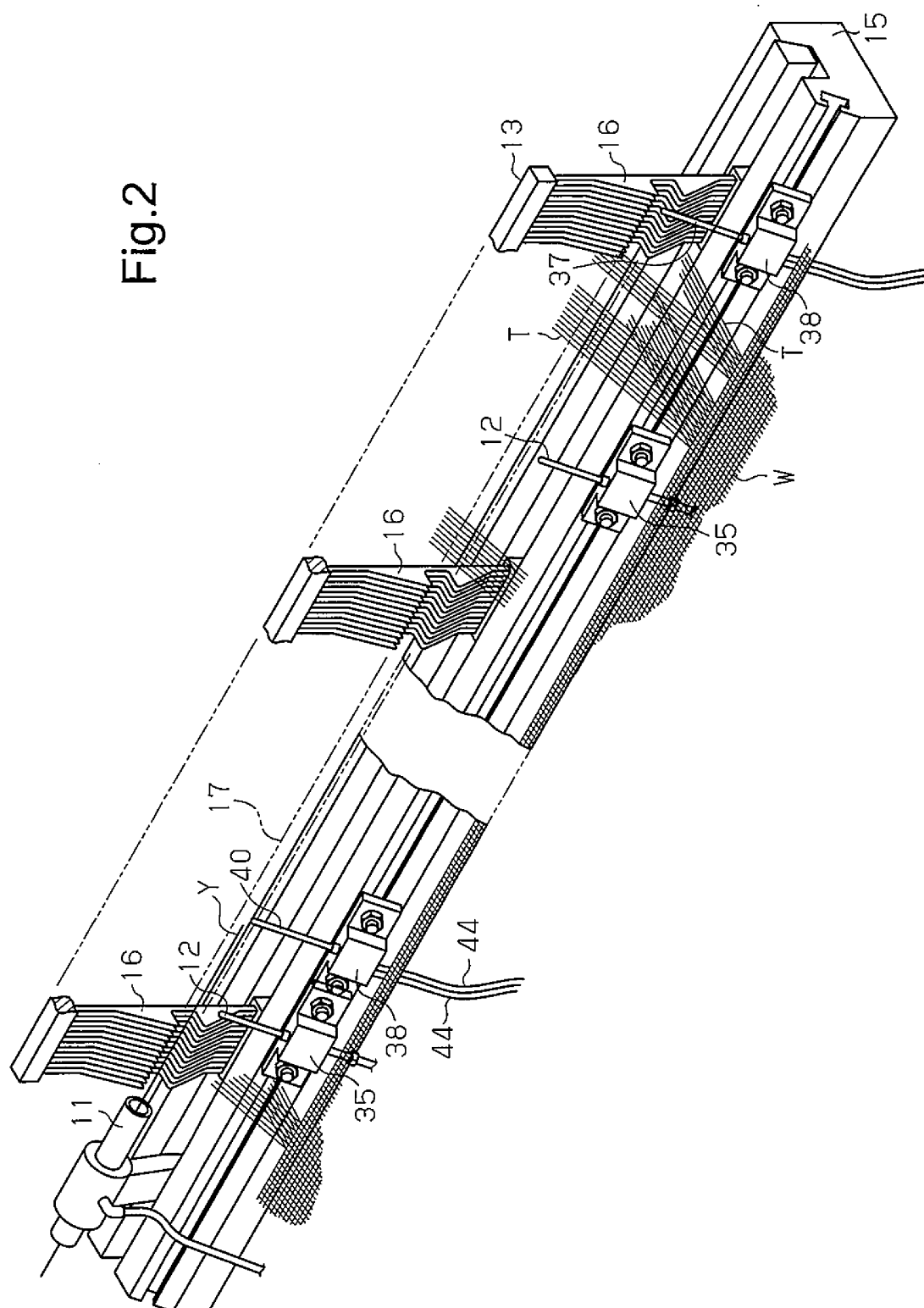


Fig.1

Fig. 2



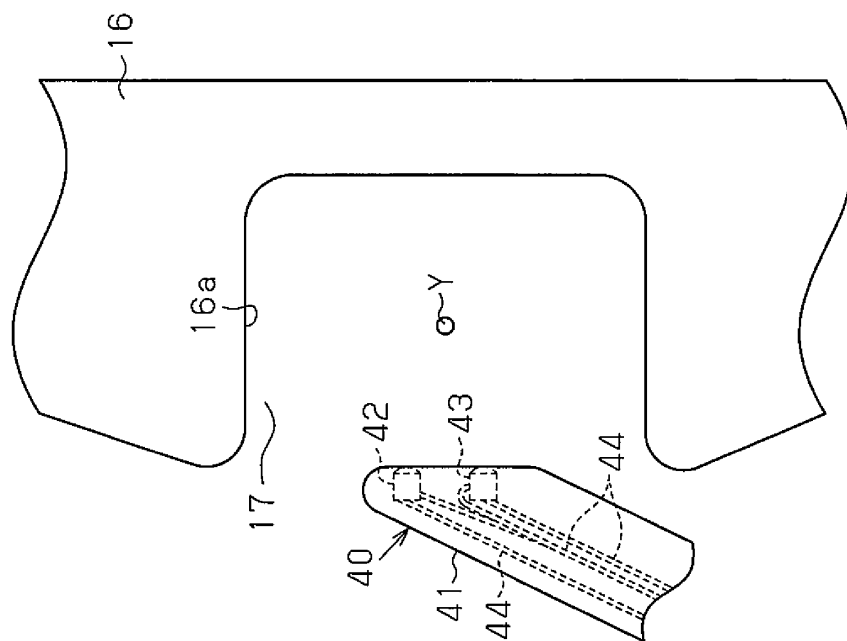


Fig. 4

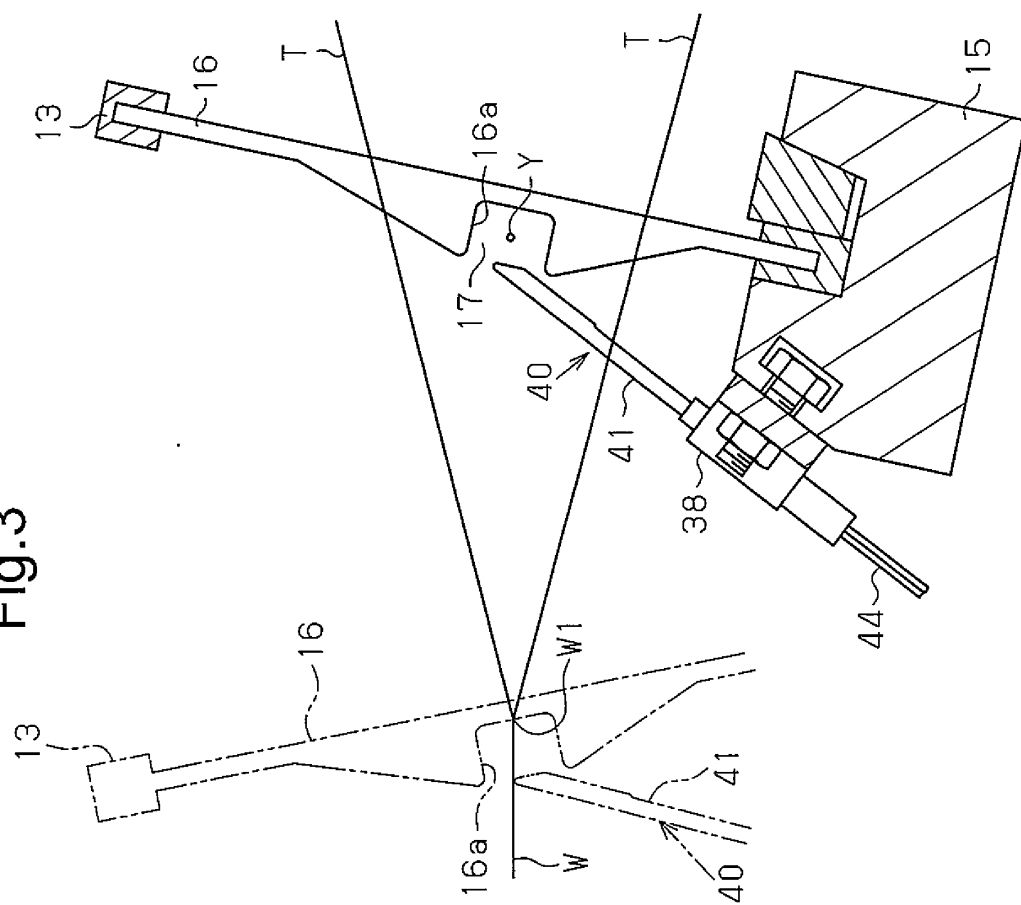


Fig. 3

Fig.5

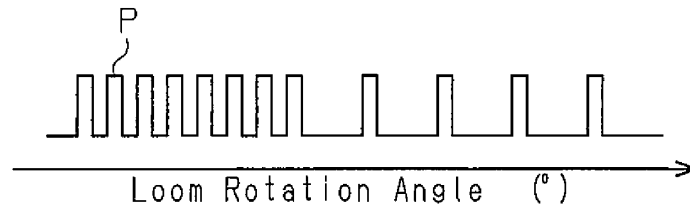


Fig.6A

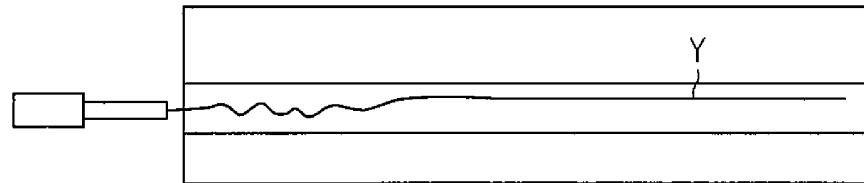


Fig.6B

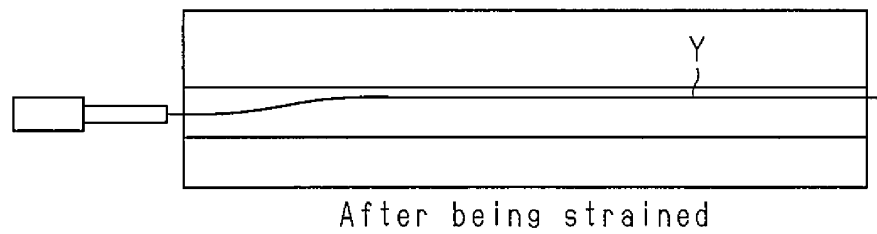
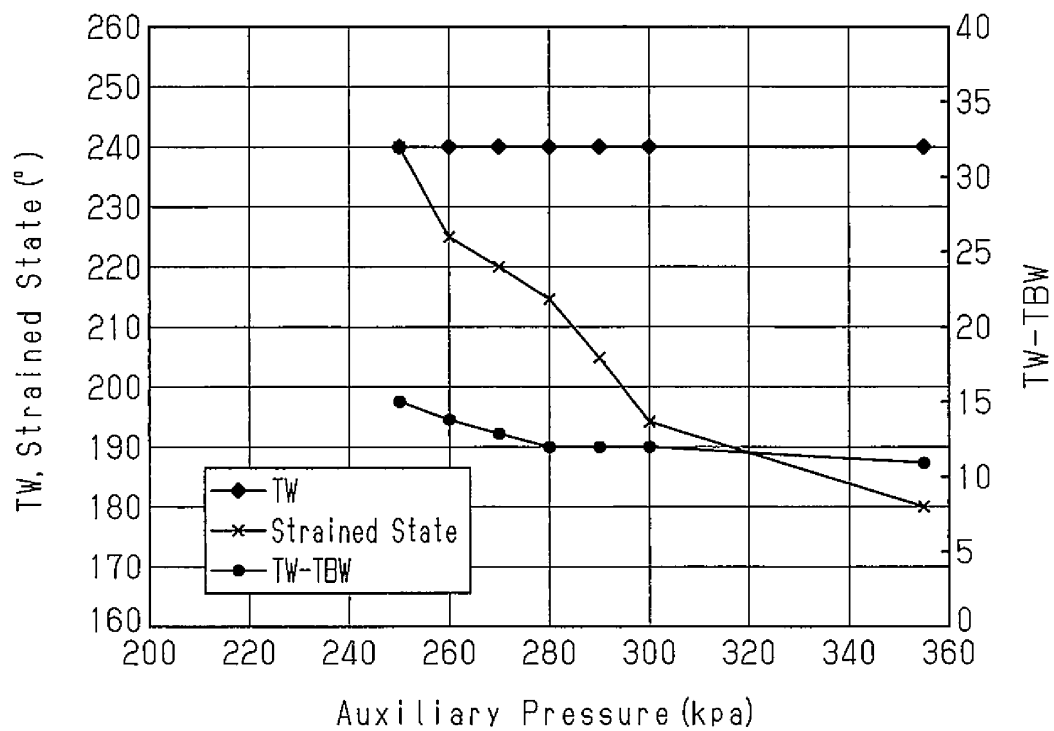


Fig.7





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Application Number
EP 14 19 1005

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Place of search Munich		Date of completion of the search 28 January 2015	Examiner Hausding, Jan
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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