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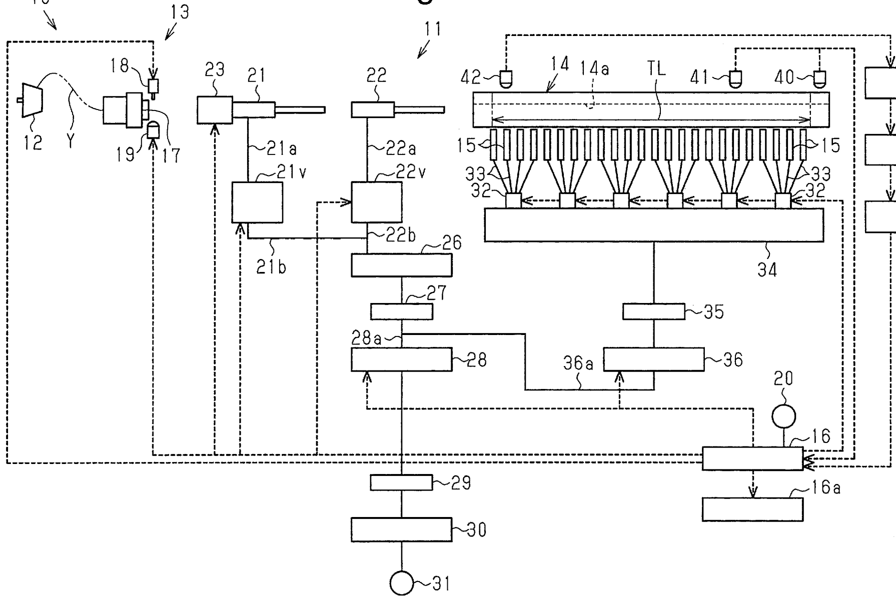
(54) WEFT DETECTING DEVICE FOR AIR-JET LOOM

(57) A weft detecting device for an air-jet loom includes a main nozzle, an auxiliary nozzle, a reed including a plurality of dents, a reflective photoelectric sensor, and a determination unit. The dents each include a guide recess, and the guide recesses define a reed passage. The main nozzle and the auxiliary nozzle eject air to insert a weft through the reed passage. The reflective photoelectric sensor is located at a position that allows for detection of the weft . The reflective photoelectric sensor includes a light projector and a light receiver. The light projector emits light. The light receiver receives reflected light that has been reflected by the weft. The determination unit is configured to determine a position of the weft relative to the reed passage in a depthwise direction based on a light amount level of the reflected light.

Fig.1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a weft detecting device for an air-jet loom that detects the position of a weft relative to a reed passage when the weft is inserted into the reed passage using a jet of air ejected from a main nozzle and auxiliary nozzles.

[0002] In an air-jet loom, a weft flies through a reed passage using a jet of air ejected from a main nozzle and auxiliary nozzles. Japanese National Phase Laid-Open Patent Publication No. 2001-504902 describes an example of a device including multiple light-sensitive elements, which are configured by photoelectric sensors. The light-sensitive elements are mounted in a region of an upper boundary of the reed passage. The light-sensitive elements each extend along the reed passage. The light-sensitive elements are lined in a depthwise direction of the reed passage. The light-sensitive elements can each receive light from a light source. A weft flying through the reed passage blocks some of the light. As a result, the light-sensitive elements blocked by the weft receive weak light. Thus, the detection of the light-sensitive elements that receive weak light allows for the detection of the position of the weft relative to the reed passage in the depthwise direction.

[0003] However, the device described in the above document requires multiple light-sensitive elements that increase costs. Further, when a reed swings back and forth in a front-to-rear direction of the air-jet loom during beat-up, the reed vibrates and applies impacts to the light-sensitive elements. This affects the durability of the light-sensitive elements.

SUMMARY OF THE INVENTION

[0004] It is an object of the present invention to provide a weft detecting device for an air-jet loom that reduces costs and improves the durability.

[0005] A weft detecting device for an air-jet loom that achieves the above object includes a main nozzle for weft insertion, an auxiliary nozzle for weft insertion, and a reed including a plurality of dents lined in a weft insertion direction. The dents each include a guide recess. The guide recesses define a reed passage. The main nozzle and the auxiliary nozzle eject air to insert a weft through the reed passage. The weft detecting device includes a reflective photoelectric sensor and a determination unit. The reflective photoelectric sensor is located at a position that allows for detection of the weft. The reflective photoelectric sensor includes a light projector and a light receiver. The light projector emits light. The light receiver receives reflected light that has been reflected by the weft. The determination unit is configured to determine a position of the weft relative to the reed passage in a depthwise direction based on a light amount level of the reflected light.

[0006] 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

[0007] 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 one embodiment of a weft detecting device for an air-jet loom;
Fig. 2 is a schematic perspective view partially showing the weft detecting device for the air-jet loom;
Fig. 3 is a schematic diagram showing the positional relationship of a dent and a second in-weaving width sensor;
Fig. 4 is a schematic diagram showing the light amount distribution of light emitted from the second in-weaving width sensor;
Fig. 5A is a schematic diagram showing a state in which a weft is flying normally through a reed passage;
Fig. 5B is a graph showing the relationship of sensor voltage and a crank angle;
Fig. 6A is a schematic diagram showing a state in which the weft is flying out of the reed passage;
Fig. 6B is a graph showing the relationship of the sensor voltage and the crank angle;
Fig. 7A is a schematic diagram showing a state in which the weft is flying out of the reed passage; and
Fig. 7B is a graph showing the relationship of the sensor voltage and the crank angle.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0008] One embodiment of a weft detecting device for an air-jet loom will now be described with reference to Figs. 1 to 7B. In the following description, in relation with a weft insertion direction in which a weft is inserted into and carried in a warp shed, the side toward the rear in the weft insertion direction is defined as the upstream side, and the side toward the front with respect to the weft insertion direction is defined as the downstream side.

[0009] As shown in Fig. 1, a weft insertion device 10 includes a weft insertion nozzle 11, a yarn feeding unit 12, a weft length-measurement storage device 13, a reed 14, a plurality of auxiliary nozzles 15 for weft insertion, and a controller 16. The controller 16 includes a display device 16a that has a display function and an input function.

[0010] The yarn feeding unit 12 is arranged at the upstream side of the weft insertion nozzle 11. A winding arm (not shown) of the weft length-measurement storage device 13 is rotated to draw out a weft Y from the yarn feeding unit 12 and wind the weft Y around a storing drum 17 for storage.

[0011] The weft length-measurement storage device 13 includes a weft engagement pin 18 and a balloon sensor 19 that detects unwinding of the weft Y from the weft length-measurement storage device 13. The weft engagement pin 18 and the balloon sensor 19 are arranged near the storing drum 17. The weft engagement pin 18 is electrically connected to the controller 16. The weft engagement pin 18 unwinds the weft Y from the storing drum 17 at a loom rotation angle that has been set to the controller 16 in advance. The weft engagement pin 18 unwinds the weft Y at a weft insertion initiation timing.

[0012] The balloon sensor 19 is electrically connected to the controller 16. The balloon sensor 19 detects the weft Y unwound from the storing drum 17 during weft insertion and transmits a weft unwinding signal to the controller 16. When the controller 16 receives the weft unwinding signal a predetermined number of times (four times in the present embodiment), the controller 16 activates the weft engagement pin 18. The weft engagement pin 18 engages the weft Y unwound from the storing drum 17 and terminates the weft insertion.

[0013] The activation timing at which the weft engagement pin 18 engages the weft Y is set in accordance with the number of winding times required to store the weft Y having a length corresponding to a weaving width TL in the storing drum 17. In the present embodiment, the controller 16 is set to transmit an operation signal to the weft engagement pin 18 so that the weft engagement pin 18 engages the weft Y when the controller 16 receives the weft unwinding signal of the balloon sensor 19 four times. Thus, in the weft insertion device 10 of the present embodiment, the weft Y that is inserted has a length corresponding to a weft storage length of four windings around the storing drum 17.

[0014] The weft detection signal of the balloon sensor 19 is an unwinding signal of the weft Y from the storing drum 17. The controller 16 recognizes the weft detection signal as a weft unwinding timing based on a loom rotation angle signal obtained from an encoder 20.

[0015] The weft insertion nozzle 11 includes a tandem nozzle 21 that draws the weft Y out of the storing drum 17 and a weft insertion main nozzle 22 that inserts the weft Y into a reed passage 14a of the reed 14. In the air-jet loom, the weft Y is inserted through the reed passage 14a by a jet of air ejected from the main nozzle 22 and the auxiliary nozzles 15. A brake 23 that brakes the flying weft Y before weft insertion is terminated is arranged at the upstream side of the tandem nozzle 21.

[0016] The main nozzle 22 is connected to a main valve 22v by a pipe 22a. The main valve 22v is connected to a main air tank 26 by a pipe 22b. The tandem nozzle 21 is connected to a tandem valve 21v by a pipe 21a. The tandem valve 21v is connected to the main air tank 26, which is shared by the main valve 22v, by a pipe 21 b.

[0017] The main air tank 26 is connected to a common air compressor 31, which is installed in a weaving factory, via a main pressure gauge 27, a main regulator 28, an original pressure gauge 29, and a filter 30. The main air tank 26 stores compressed air that is supplied from the air compressor 31 and adjusted to a set pressure by the main regulator 28. Further, the pressure of the compressed air supplied to the main air tank 26 is constantly detected by the main pressure gauge 27.

[0018] The auxiliary nozzles 15 are, for example, divided into six groups, each group including four auxiliary nozzles 15. Six auxiliary valves 32 are arranged in correspondence with each group, and the auxiliary nozzles 15 of each group are connected to the corresponding auxiliary valve 32 by pipes 33. Each auxiliary valve 32 is connected to a common auxiliary air tank 34.

[0019] The auxiliary air tank 34 is connected to an auxiliary regulator 36 via an auxiliary pressure gauge 35. Further, a pipe 36a connects the auxiliary regulator 36 to a pipe 28a that connects the main pressure gauge 27 and the main regulator 28. The auxiliary air tank 34 stores compressed air that is supplied from the air compressor 31 and adjusted to a set pressure by the auxiliary regulator 36. Further, the pressure of compressed air supplied to the auxiliary air tank 34 is constantly detected by the auxiliary pressure gauge 35.

[0020] The main valve 22v, the tandem valve 21v, the auxiliary valves 32, the original pressure gauge 29, the main pressure gauge 27, the auxiliary pressure gauge 35, and the brake 23 are electrically connected to the controller 16. The timing and period for activating the main valve 22v, the tandem valve 21v, the auxiliary valves 32, and the brake 23 are set in advance in the controller 16. Further, the controller 16 receives detection signals of the original pressure gauge 29, the main pressure gauge 27, and the auxiliary pressure gauge 35.

[0021] The controller 16 outputs an activation instruction signal to the main valve 22v and the tandem valve 21v at an earlier timing than the weft insertion initiation timing at which the weft engagement pin 18 is activated. This causes the main nozzle 22 and the tandem nozzle 21 to eject compressed air. The controller 16 outputs an activation instruction signal to the brake 23 at an earlier time than the weft distal end arrival timing at which the weft engagement pin 18 is activated to engage the weft Y of the storing drum 17. The brake 23 brakes the weft Y flying at a high speed to lower the flying speed of the weft Y and reduce the impact of the weft Y at the weft distal end arrival timing.

[0022] The controller 16 registers and stores various cloth conditions and weaving conditions. The cloth conditions include, for example, parameters like type of weft such as material and count of yarn used as the weft Y, weft density, type of warp such as material and count of yarn used as the warp, warp density, weaving width, and cloth construction. The weaving conditions include, for example, parameters like the rotation speed of the loom, the compressed air pressure of the main air tank 26 and the auxiliary air tank 34, open degrees of the main valve 22v and the tandem valve 21v, the weft insertion initiation timing, and the target weft distal end arrival timing.

[0023] As shown in Fig. 2, the main nozzle 22, the auxiliary nozzles 15, and the reed 14 are arranged on a sley 24 and swung back and forth in a front-to-rear direction of the air-jet loom. The auxiliary nozzles 15 are fixed onto the sley 24 by support blocks 25. The auxiliary nozzles 15 are allowed to enter and exit the shed of warps T from between the rows of the warps T as the sley 24 swings.

[0024] Further, the tandem nozzle 21, the brake 23, the weft length-measurement storage device 13, and the yarn feeding unit 12 are fixed to a bracket (not shown) that is coupled to a frame (not shown) or a floor surface (not shown) of the air-jet loom.

[0025] The reed 14 includes a plurality of dents 14c arranged in the weft insertion direction. The dents 14c each include a guide recess 14b. The reed passage 14a is defined by the guide recesses 14b of the dents 14c.

[0026] As shown in Figs. 1 and 2, an end sensor 40 is arranged at the downstream side of the reed passage 14a. The end sensor 40 is located outside the range of the weaving width TL of the reed passage 14a at the side opposite to the main nozzle 22.

[0027] When the weft Y is in a normal insertion state, the end sensor 40 is located outside the range of the weaving width TL so that the position detected by the end sensor 40 is the head position of the weft Y that corresponds to the weft storing length of four windings around the storing drum 17. The end sensor 40 is electrically connected to the controller 16. Further, a weft detection signal of the end sensor 40 is an arrival signal of the weft Y. The controller 16 recognizes the weft detection signal as the weft distal end arrival timing at which the head of the inserted weft Y arrives at the detection position of the end sensor 40 based on a loom rotation angle signal obtained from the encoder 20.

[0028] A first in-weaving width sensor 41 is arranged in the reed passage 14a inside the range of the weaving width TL at the upstream side of the end sensor 40. Thus, the first in-weaving width sensor 41 is located inside the range of the weaving width TL of the reed passage 14a and located closer to the side opposite to the main nozzle 22 than the middle section of the weaving width TL in the reed passage 14a. When the weft Y is in a normal insertion state, the first in-weaving width sensor 41 is located inside the range of the weaving width TL so that the position detected by the first in-weaving width sensor 41 is the head position of the weft Y that corresponds to the weft storing length of three windings around the storing drum 17. The first in-weaving width sensor 41 is electrically connected to the controller 16. The controller 16 recognizes the weft detection signal from the first in-weaving width sensor 41 as a weft intermediate position arrival timing at which the head of the inserted weft Y arrives at the detection position of the first in-weaving width sensor 41 based on a loom rotation angle signal obtained from the encoder 20.

[0029] A second in-weaving width sensor 42 is arranged in the reed passage 14a inside the range of the weaving width TL at the upstream side of the first in-weaving width sensor 41. Thus, the second in-weaving width sensor 42 is located inside the range of the weaving width TL of the reed passage 14a and located between the middle section of the weaving width TL and the main nozzle 22. The second in-weaving width sensor 42 is electrically connected to the controller 16.

[0030] As shown in Figs. 2 and 3, the end sensor 40, the first in-weaving width sensor 41, and the second in-weaving width sensor 42 are fixed onto the sley 24 by support blocks 43 such that the positions of the end sensor 40, the first in-weaving width sensor 41, and the second in-weaving width sensor 42 are adjustable. The first in-weaving width sensor 41 and the second in-weaving width sensor 42 are fixed to the sley 24 at positions that allow for detection of the weft Y in a range where the first in-weaving width sensor 41 and the second in-weaving width sensor 42 are not influenced by the ejection pressure of the main nozzle 22.

[0031] With reference to Fig. 3, the first in-weaving width sensor 41 and the second in-weaving width sensor 42 are opposed to the reed passage 14a. Also, as shown by the double-dashed line in Fig. 3, the first in-weaving width sensor 41 and the second in-weaving width sensor 42 are fixed to the sley 24 such that, during beat-up, the first in-weaving width sensor 41 and the second in-weaving width sensor 42 move below a woven cloth W and a cloth fell W1 without interfering with the woven cloth W.

[0032] As shown in Figs. 4 and 5A, the second in-weaving width sensor 42 is a reflective photoelectric sensor including a light projector 42a and a light receiver 42b. In the same manner as the second in-weaving width sensor 42, the end sensor 40 and the first in-weaving width sensor 41 each include a light projector and a light receiver.

[0033] The second in-weaving width sensor 42 includes a cylindrical main body 42c. The main body 42c includes two accommodation holes 42d. The light projector 42a and the light receiver 42b are optical fibers each accommodated in one of the accommodation holes 42d.

[0034] With reference to Fig. 5A, the light projector 42a and the light receiver 42b respectively include a distal end 421 a and a distal end 421 b that are located at positions closer to the woven cloth W than the guide recess 14b. The light projector 42a and the light receiver 42b are located on the main body 42c so that the two distal ends 421 a and 421b are arranged one upon the other. The distal end 421a of the light projector 42a is located at the upper side of the distal end 421b of the light receiver 42b.

[0035] When the air-jet loom is driven, light is emitted from the distal end 421a of the light projector 42a toward the reed passage 14a. The light emitted from the distal end 421a of the light projector 42a is reflected by the weft

Y flying through the reed passage 14a. Some of the reflected light, which has been reflected by the weft Y, is received by the distal end 421 b of the light receiver 42b.

[0036] As shown in Fig. 1, the reflected light received by the distal end 421b of the light receiver 42b is input to a amplifier 46. The amplifier 46 receives the input reflected light with a photodiode, converts the light into an electrical signal, amplifies the converted electrical signal, and then outputs the electrical signal to a band-pass filter 47. The band-pass filter 47 allows the output signal of the amplifier 46 to pass when the output signal is in the frequency range from 2 kHz to 5 kHz.

[0037] Further, the output signal of the band-pass filter 47 is input to the controller 16 via an A/D converter 48. The controller 16 estimates the time at which the value of an output signal from the band-pass filter 47 falls to a predetermined threshold value as a fully-strained timing. More specifically, the controller 16 receives analog signals that have been processed by the band-pass filter 47 via the A/D converter 48 at a sampling frequency of several tens of kHz. With the received signals, the controller 16 executes absolute value calculation, average value calculation for one-hundred weft insertions, movement average calculation, fully-strained timing calculation, and an estimation process. The controller 16 stores a threshold value for estimating the fully-strained timing as data of a graph or a relational expression related to a nominal diameter of the weft Y. The threshold value is set to the value of an average output voltage.

[0038] As shown in Fig. 4, the amount of light emitted from the distal end 421a of the light projector 42a is distributed. In a front view of the distal ends 421 a and 421 b of the light projector 42a and the light receiver 42b in the second in-weaving width sensor 42, the amount of light is distributed in a concentric manner in which the amount of light decreases as the central portion of the second in-weaving width sensor 42 becomes farther. More specifically, the highest region Z1 having the highest amount of light is located closest to the central portion of the second in-weaving width sensor 42. A high region Z2 having a smaller light amount than the highest region Z1 is located at the radially outer side of the highest region Z1. A middle region Z3 having a smaller light amount than the high region Z2 is located at the radially outer side of the high region Z2. A low region Z4 having a smaller light amount than the middle region Z3 is located at the radially outer side of the middle region Z3.

[0039] As shown in Fig. 5A, in a side view of the second in-weaving width sensor 42, in the distribution of the amount of light emitted from the distal end 421a of the light projector 42a, a major part of the highest region Z1 is located farther from a bottom surface 141 b of the guide recess 14b than a major part of the high region Z2 and a major part of the middle region Z3. The high region Z2 surrounds the entire highest region Z1, and the major part of the high region Z2 is located closer to the bottom surface 141 b of the guide recess 14b than the highest region Z1. The middle region Z3 surrounds the entire high region Z2, and the major part of the middle region Z3 is located closer to the bottom surface 141 b of the guide recess 14b than the high region Z2. The low region Z4 surrounds substantially the entire middle region Z3. The low region Z4 is partially continuous with the entire bottom surface 141b of the guide recess 14b. The signal strength of an electric signal based on the reflected light received by the light receiver 42b, that is, the level of light amount of the reflected light has a proportional relationship with the light amount distribution.

[0040] The operation of the present embodiment will now be described.

[0041] For example, as shown in Fig. 5A, when the head of the weft Y passes through an emission region of light emitted from the light projector 42a of the second in-weaving width sensor 42, the head of the weft Y passes through the low region Z4 in the light amount distribution. More specifically, the head of the weft Y passes through the low region Z4 located between the middle region Z3 and the bottom surface 141 b of the guide recess 14b in the reed passage 14a.

[0042] Fig. 5B shows the relationship of a crank angle and sensor voltage (signal output voltage) when the air-jet loom is operated in the state of Fig. 5A. The sensor voltage is the signal strength of an electric signal based on reflected light received by the light receiver 42b of the second in-weaving width sensor 42, that is, the level of light amount of the reflected light. In the present embodiment, the crank angle range from 80° to 270° is a weft insertion allowance period. The second in-weaving width sensor 42 detects movement of the warp T in a crank angle range outside the weft insertion allowance period.

[0043] When the crank angle is 105°, the head of the weft Y passes through the emission region of the light emitted from the light projector 42a of the second in-weaving width sensor 42. As shown in Fig. 5B, when the crank angle is 105°, there is no steep rise in the sensor voltage. The sensor voltage remains substantially constant from 105°.

[0044] As shown in Fig. 6A, when the head of the weft Y passes through the emission region of the light emitted from the light projector 42a of the second in-weaving width sensor 42, the head of the weft Y passes through the high region Z2 in the light amount distribution. Fig. 6B shows the relationship of the crank angle and sensor voltage when the air-jet loom is operated in the state of Fig. 6A.

[0045] As shown in Fig. 6B, when the head of the weft Y passes through the emission region of the light emitted from the light projector 42a of the second in-weaving width sensor 42, that is, when the crank angle is 105°, the sensor voltage rises steeply to approximately 2.6 V. Subsequently, the sensor voltage falls to approximately 2.0 V and then remains substantially constant.

[0046] As shown in Fig. 7A, when the head of the weft Y passes through the emission region of the light emitted from the light projector 42a of the second in-weaving width sensor 42, the head of the weft Y passes through the low region Z4 in the light amount distribution. More specifically, the head of the weft Y passes through the low region Z4, which is surrounded by the middle region Z3, at the side opposite to the bottom surface 141b of the guide recess 14b. Fig. 7B shows the relationship of the crank angle and sensor voltage when the air-jet loom is operated in the state of Fig. 7A. In this case, when a portion of the weft Y behind the head flies through the reed passage 14a, the portion is likely to pass through one of the highest region Z1, the high region Z2, and the middle region Z3.

[0047] As shown in Fig. 7B, when the head of the weft Y passes through the emission region of the light emitted from the light projector 42a of the second in-weaving width sensor 42, that is, when the crank angle is 105°, there is no steep rise in the sensor voltage. However, the sensor voltage subsequently rises steeply at the crank angle at which the part of the weft Y behind the head passes through one of the highest region Z1, the high region Z2, and the middle region Z3. Then, the sensor voltage falls to approximately 2.0 V and remains substantially constant.

[0048] The steep rising rate of the sensor voltage is proportional to the light amount distribution. Thus, the steep rising rate of the sensor voltage increases as the light amount distribution of the region through which the weft Y passes becomes higher, and the steep rise rate of the sensor voltage decreases as the light amount distribution of the region through which the weft Y passes becomes lower.

[0049] As shown in Fig. 5B, when there is no steep rise in the sensor voltage and the sensor voltage remains substantially constant in the weft insertion allowance period, the controller 16 determines that the weft Y is in a normal state in which the weft Y is flying normally through the reed passage 14a. Further, as shown in Figs. 6B and 7B, when the sensor voltage includes a steep rise in the weft insertion allowance period, the controller 16 determines that the weft Y is in a state in which the weft Y is flying outside the reed passage 14a or in an abnormal state in which the weft Y is just about to fly outside the reed passage 14a. Thus, in the present embodiment, the controller 16 determines the position of the weft Y relative to the reed passage 14a in the depthwise direction based on the sensor voltage of the second in-weaving width sensor 42. The depthwise direction refers to the direction of arrow A shown in Figs. 5A, 6A, and 7A.

[0050] The controller 16 determines the position of the weft Y relative to the reed passage 14a in the depthwise direction in accordance with the steep rising rate of the sensor voltage. The controller 16 determines that the weft Y is located closer to the distal ends 421 a and 421 b of the light projector 42a and the light receiver 42b as the sensor voltage increases, that is, as the light amount level of reflected light received by the light receiver 42b increases. In contrast, the controller 16 determines that the weft Y is located farther from the distal ends 421 a and 421 b of the light projector 42a and the light receiver 42b as the sensor voltage decreases, that is, as the light amount level of reflected light received by the light receiver 42b decreases. In this manner, the light projector 42a emits light that is reflected by the weft Y and received by the light receiver 42b. Thus, the controller 16 functions as a determination unit that is configured to determine the position of the weft Y relative to the reed passage 14a in the depthwise direction based on the light amount level of the reflected light. The second in-weaving width sensor 42 is used as a reflective photoelectric sensor to determine the position of the weft Y relative to the reed passage 14a in the depthwise direction.

[0051] Further, when the controller 16 determines the position of the weft Y relative to the reed passage 14a in the depthwise direction and determines that the weft Y is in a state in which the weft Y is flying outside the reed passage 14a or in an abnormal state in which the weft Y is just about to fly outside the reed passage 14a, the controller 16 executes feedback control on at least one of the ejection timing of the auxiliary nozzles 15 and the ejection pressure of the auxiliary nozzles 15 based on the determined position of the weft Y relative to the reed passage 14a in the depthwise direction. More specifically, the controller 16 executes feedback control to reduce situations in which the weft Y flies outside the reed passage 14a by advancing the ejection timing of the auxiliary nozzles 15 in the one of the six divided groups located at the extreme upstream side or by increasing the ejection pressure of the auxiliary nozzles 15.

[0052] In accordance with the determined position of the weft Y relative to the reed passage 14a in the depthwise direction, the controller 16 executes feedback control only on the ejection timing of the auxiliary nozzles 15 or only on the ejection pressure of the auxiliary nozzles 15. Additionally, depending on the determined position of the weft Y relative to the reed passage 14a in the depthwise direction, the controller 16 may execute feedback control on both the ejection timing and the ejection pressure of the auxiliary nozzles 15. Accordingly, the controller 16 also functions as a feedback control unit that is configured to execute feedback control on at least one of the ejection timing of the auxiliary nozzles 15 and the ejection pressure of the auxiliary nozzles 15 in accordance with the determined position of the weft Y relative to the reed passage 14a in the depthwise direction.

[0053] The above embodiment has the advantages described below.

(1) The light projector 42a emits light, and the light receiver 42b receives reflected light that has been reflected by the weft Y. The controller 16 determines the position of the weft Y relative to the reed passage 14a in the depthwise direction based on the light amount level of the reflected light. In this configuration, the controller 16 determines that the weft Y is located closer to the distal ends 421 a and 421 b of the light projector 42a and the light receiver 42b as the light amount level of reflected light received by

the light receiver 42b increases. The controller 16 determines that the weft Y is located farther from the distal ends 421 a and 421 b of the light projector 42a and the light receiver 42b as the light amount level of reflected light received by the light receiver 42b decreases. This allows the controller 16 to determine the position of the weft Y relative to the reed passage 14a in the depthwise direction.

Thus, the position of the weft Y relative to the reed passage 14a in the depthwise direction can be determined with a single second in-weaving width sensor 42. There is no need to use multiple photoelectric sensors like in the prior art. This reduces the costs for determining the position of the weft Y and improves the durability of the second in-weaving width sensor 42.

(2) The second in-weaving width sensor 42 is located inside the range of the weaving width TL of the reed passage 14a. This allows the position of the weft Y relative to the reed passage 14a in the depthwise direction to be determined more quickly than when, for example, a reflective photoelectric sensor is arranged outside the range of the weaving width TL of the reed passage 14a at the side opposite to the main nozzle 22 to determine the position of the weft Y relative to the reed passage 14a in the depthwise direction.

(3) The second in-weaving width sensor 42 is located between the middle section of the weaving width TL and the main nozzle 22 in the weaving width TL of the reed passage 14a. The head of the weft Y inserted into the reed passage 14a has a higher tendency to fly outside the reed passage 14a at a location between the middle section of the weaving width TL and the main nozzle 22 in the reed passage 14a than a location toward the side opposite to the main nozzle 22 from the middle section of the weaving width TL in the reed passage 14a. The position of the weft Y relative to the reed passage 14a in the depthwise direction can be determined at such a location where the head of the weft Y inserted into the reed passage 14a has a tendency to fly outside the reed passage 14a.

(4) When the controller 16 determines the position of the weft Y relative to the reed passage 14a in the depthwise direction and determines that the weft Y is in a state in which the weft Y is flying outside the reed passage 14a or in an abnormal state in which the weft Y is just about to fly outside the reed passage 14a, the controller 16 executes feedback control on the ejection timing of the auxiliary nozzles 15 and the ejection pressure of the auxiliary nozzles 15 based on the determined position of the weft Y relative to the reed passage 14a in the depthwise direction. This reduces weft insertion errors.

(5) The second in-weaving width sensor 42 also functions as a sensor that estimates the fully-strained timing of the weft Y. Thus, in the structure of the present embodiment, a reflective photoelectric sensor that determines the position of the weft Y relative to the reed passage 14a in the depthwise direction does not need to be arranged in addition to the sensor that estimates the fully-strained timing. This simplifies the structure of the present embodiment.

(6) The controller 16 executes feedback control on the ejection timing and the ejection pressure of the auxiliary nozzles 15 in the one of the six divided groups located at the extreme upstream side. This reduces the air consumption amount and conserves energy as compared to when the controller 16 executes feedback control on the ejection timing and the ejection pressure of the auxiliary nozzles 15 in all of the six groups.

[0054] It should be apparent to those skilled in the art that the present invention may be embodied in many other specific forms without departing from the spirit or scope of the invention. Particularly, it should be understood that the present invention may be embodied in the following forms.

[0055] In the above embodiment, instead of the second in-weaving width sensor 42, for example, the first in-weaving width sensor 41 may be used as the reflective photoelectric sensor used to determine the position of the weft Y relative to the reed passage 14a in the depthwise direction. That is, the reflective photoelectric sensor that determines the position of the weft Y relative to the reed passage 14a in the depthwise direction may function as a sensor that estimates the weft intermediate position arrival timing.

[0056] In the above embodiment, instead of the second in-weaving width sensor 42, for example, the end sensor 40 may be used as the reflective photoelectric sensor used to determine the position of the weft Y relative to the reed passage 14a in the depthwise direction. That is, the reflective photoelectric sensor that determines the position of the weft Y relative to the reed passage 14a in the depthwise direction may function as an end sensor that estimates the weft distal end arrival timing.

[0057] In the above embodiment, the reflective photoelectric sensor used to determine the position of the weft Y relative to the reed passage 14a in the depthwise direction may be located at the middle section of the weaving width TL of the reed passage 14a inside the range of the weaving width TL.

[0058] In the above embodiment, the reflective photoelectric sensor that determines the position of the weft Y relative to the reed passage 14a in the depthwise direction may be arranged separately from the sensor that estimates the fully-strained timing.

[0059] In the above embodiment, when the controller 16 determines that the weft Y is in a state in which the weft Y is flying outside the reed passage 14a or in an abnormal state in which the weft Y is just about to fly outside the reed passage 14a, a warning may be given to the user. In this case, for example, the controller 16 may show a warning on the display device 16a or may turn on a warning lamp on the display device 16a.

[0060] In the embodiment, the controller 16 may execute feedback control on at least one of the ejection timing and the ejection pressure of the auxiliary nozzles 15 in all of the six groups.

[0061] Therefore, the present examples and embodiments 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.

[0062] A weft detecting device for an air-jet loom includes a main nozzle, an auxiliary nozzle, a reed including a plurality of dents, a reflective photoelectric sensor, and a determination unit. The dents each include a guide recess, and the guide recesses define a reed passage. The main nozzle and the auxiliary nozzle eject air to insert a weft through the reed passage. The reflective photoelectric sensor is located at a position that allows for detection of the weft. The reflective photoelectric sensor includes a light projector and a light receiver. The light projector emits light. The light receiver receives reflected light that has been reflected by the weft. The determination unit is configured to determine a position of the weft relative to the reed passage in a depthwise direction based on a light amount level of the reflected light.

Claims

1. A weft detecting device for an air-jet loom, the weft detecting device comprising:

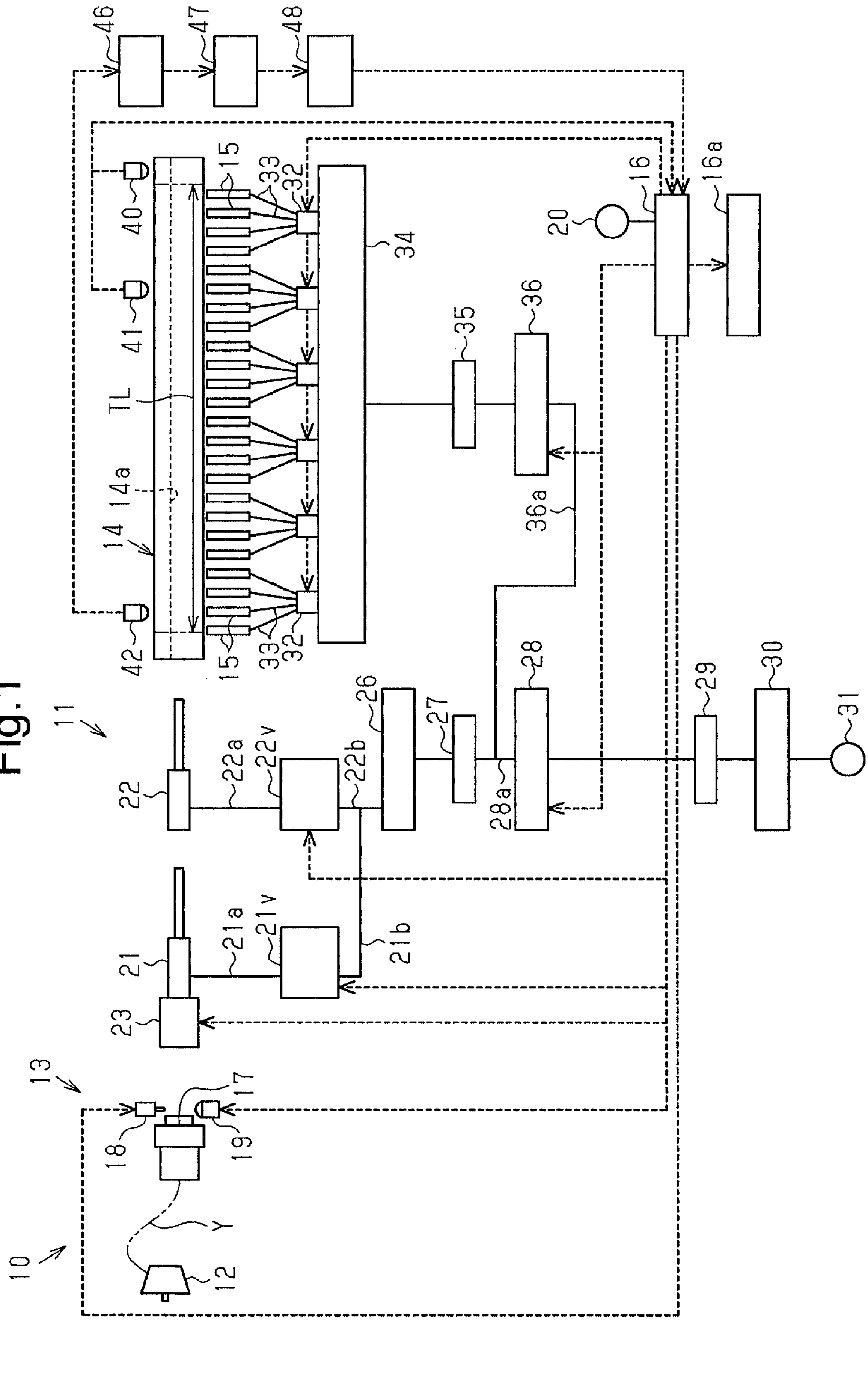
a main nozzle (22) for weft insertion;
an auxiliary nozzle (15) for weft insertion; and
a reed (14) including a plurality of dents (14c) lined in a weft insertion direction, wherein
the dents (14c) each include a guide recess (14b),
the guide recesses (14b) define a reed passage (14a),
the main nozzle (22) and the auxiliary nozzle (15) eject air to insert a weft (Y) through the reed passage (14a), and
a reflective photoelectric sensor (42) is located at a position that allows for detection of the weft (Y), wherein the reflective photoelectric sensor (42) includes a light projector (42a) and a light receiver (42b), the light projector (42a) emits light, and the light receiver (42b) receives reflected light that has been reflected by the weft (Y),
the weft detecting device being **characterized by**
a determination unit (16) configured to determine a position of the weft (Y) relative to the reed passage (14a) in a depthwise direction based on a light amount level of the reflected light.

2. The weft detecting device according to claim 1, wherein the reflective photoelectric sensor (42) is located inside a range of a weaving width (TL) of the reed passage (14a).

3. The weft detecting device according to claim 2, wherein the reflective photoelectric sensor (42) is located between a middle section of the weaving width (TL) and the main nozzle (22).

4. The weft detecting device according to any one of claims 1 to 3, further comprising a feedback control unit (16) configured to execute feedback control on at least one of an ejection timing of the auxiliary nozzle (15) and an ejection pressure of the auxiliary nozzle (15) in accordance with the position of the weft (Y) relative to the reed passage (14a) in the depthwise direction that has been determined by the determination unit (16).

Fig.1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22v
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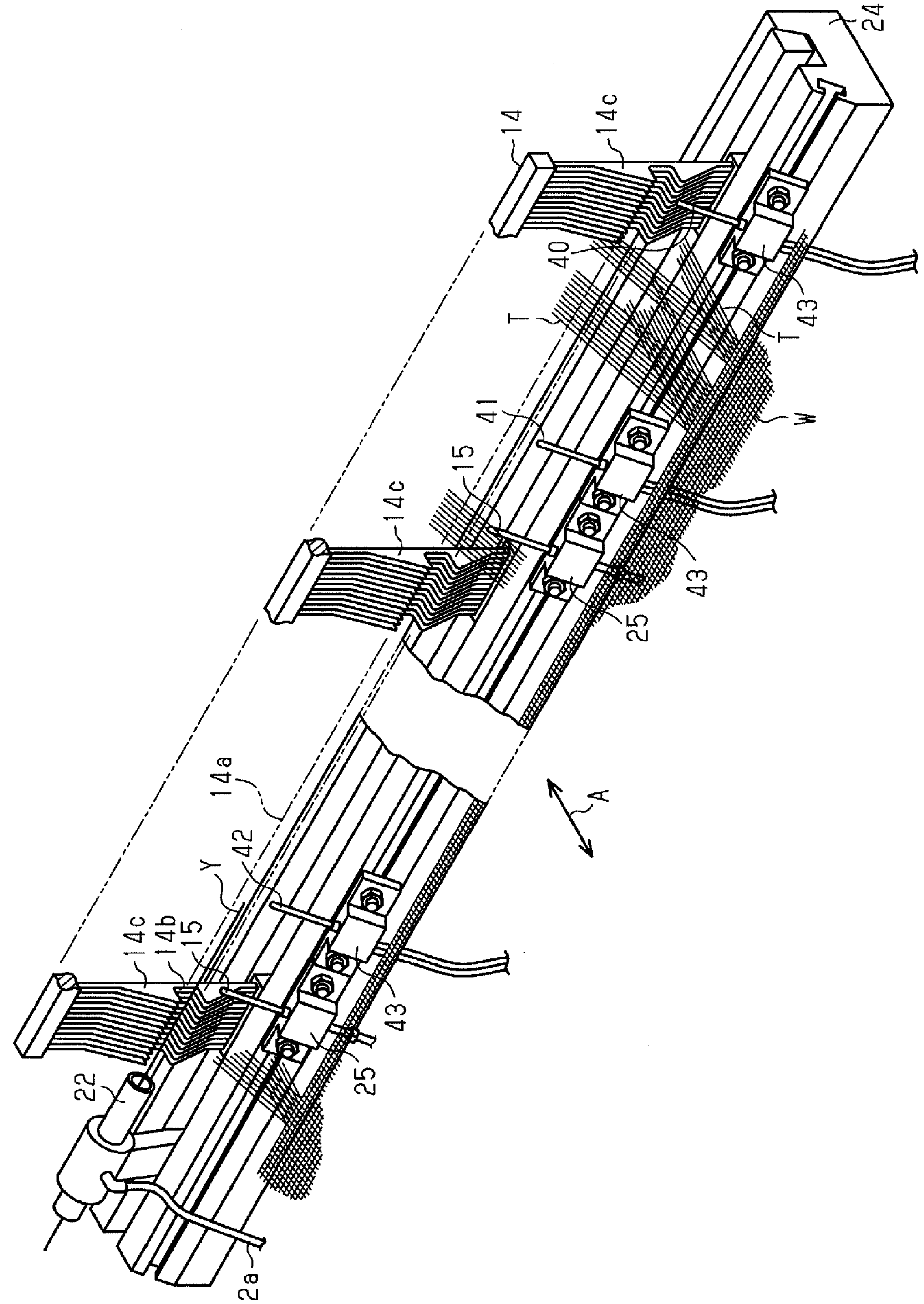
46
47
48
TL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40
T
T
43
W
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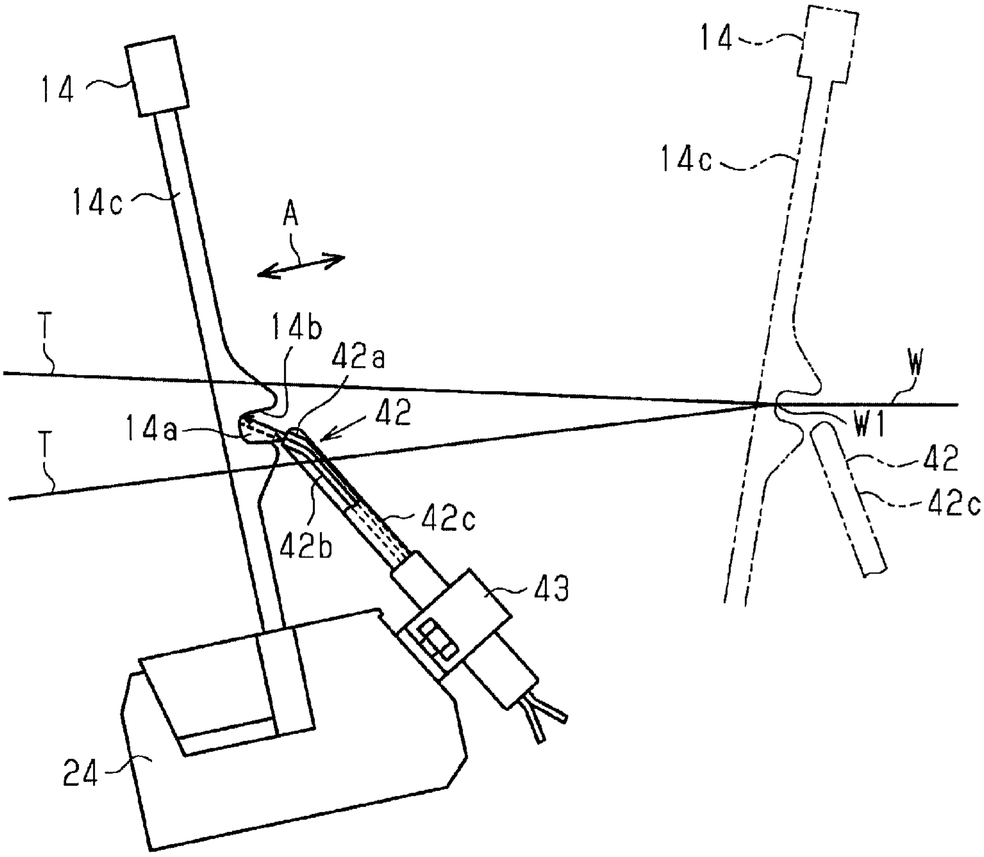
15
43
25
22
22a

Fig.2

Fig.3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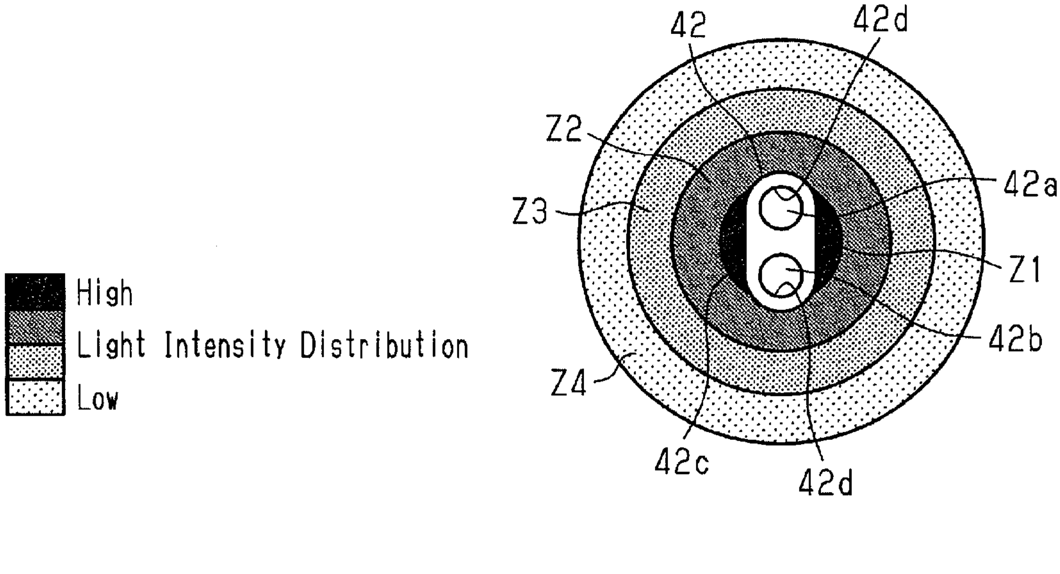
42c

Fig.4


High
Light Intensity Distribution
Low
42
42d
Z2
42a
Z3
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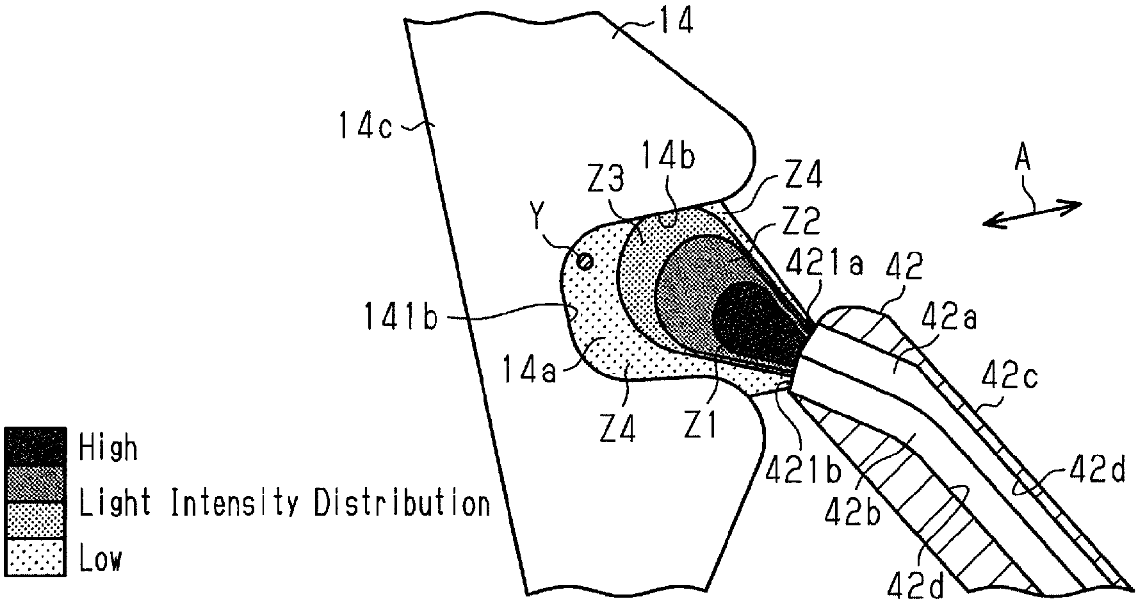
42b
Z4
42c
42d

Fig.5A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14c
14b
Z3
Z4
Z2
A
Y
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Z1
High
Light Intensity Distribution
Low
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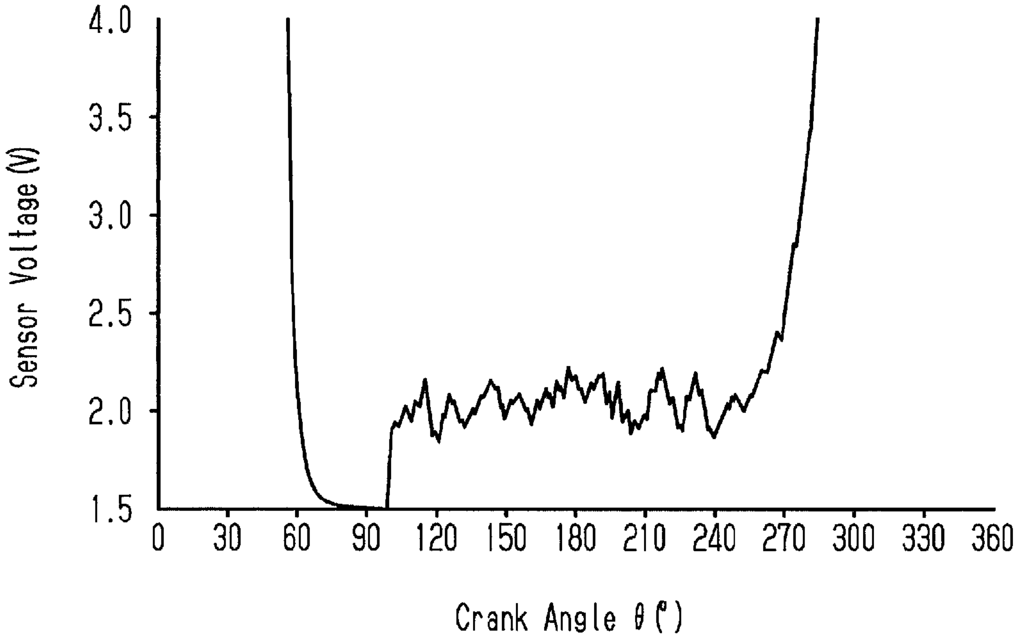
42d
42b
42d

Fig.5B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Sensor Voltage (V)
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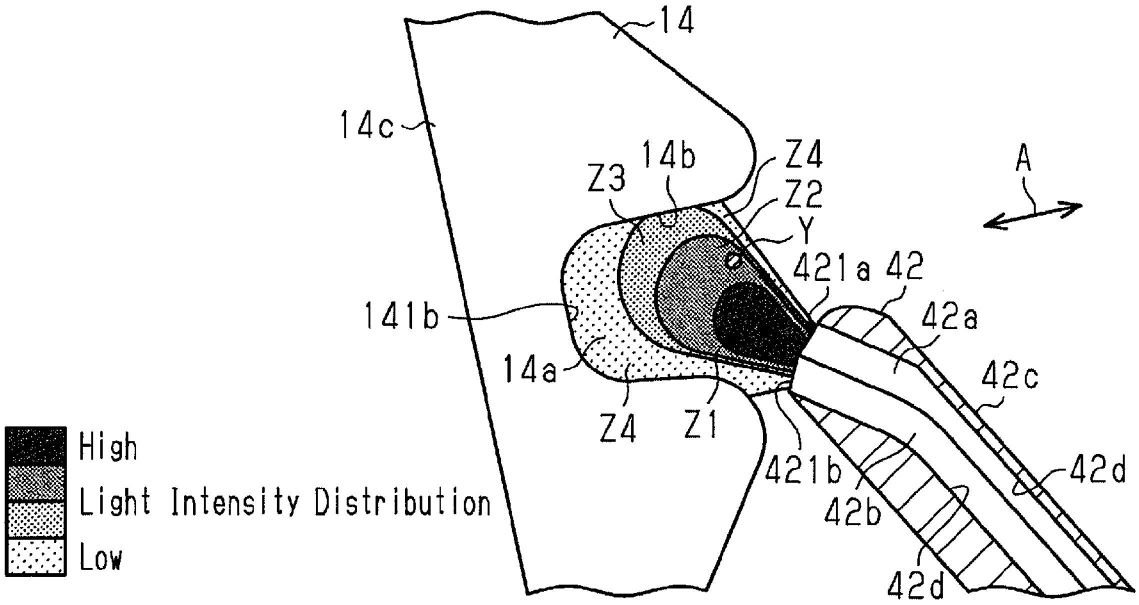
60
90
120
150
180
210
240
270
300
330
360
Crank Angle θ (°)

Fig.6A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Z3
Z4
Z2
Y
A
421a
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42c
Z4
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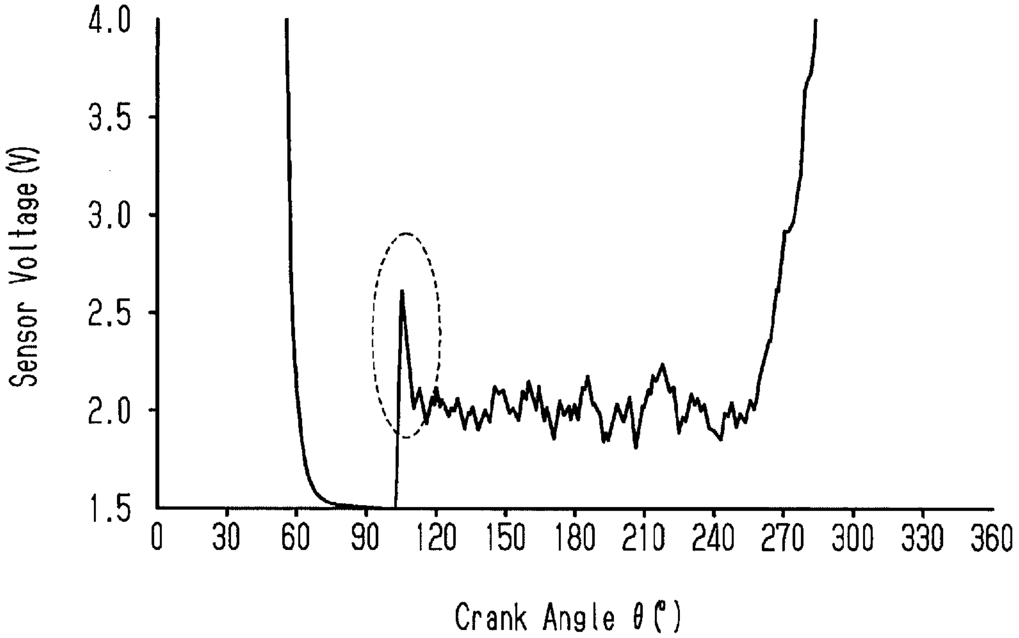
42d
42b
42d
High
Light Intensity Distribution
Low

Fig.6B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3.5
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Sensor Voltage (V)
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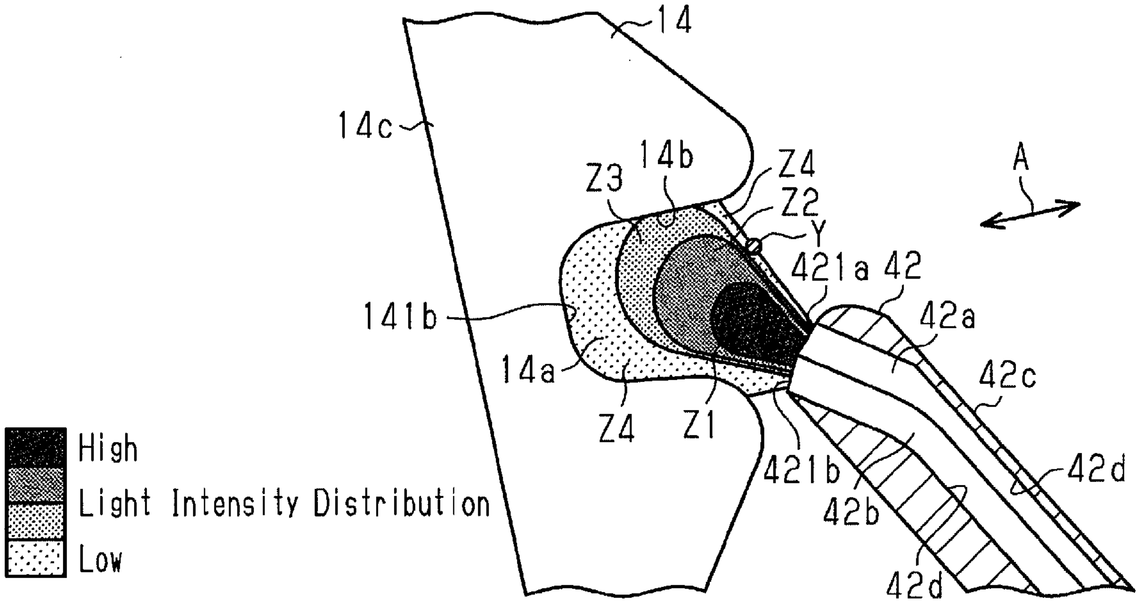
240
270
300
330
360
Crank Angle θ (°)

Fig.7A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Z4
Z2
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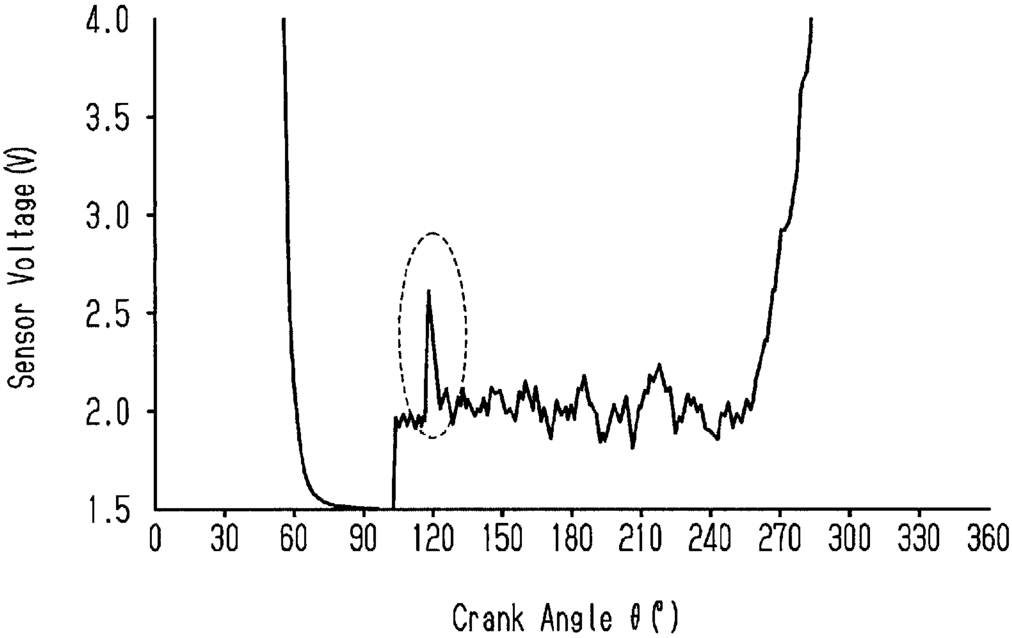
Z4
Z1
421b
42b
42d
42d
High
Light Intensity Distribution
Low

Fig.7B


Sensor Voltage (V)
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3.5
3.0
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1.5
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270
300
330
360
Crank Angle θ (°)

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EUROPEAN SEARCH REPORT

Application Number
EP 18 17 1780

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	JP 2016 186144 A (TOYOTA IND CORP; TOYOTA CENTRAL RES & DEV) 27 October 2016 (2016-10-27) * abstract * * figures 2-5 * * claim 1 * * paragraphs [0001] - [0008], [0017], [0026] - [0028], [0030], [0037], [0039] * -----	1-4	INV. D03D47/30 D03D51/34
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A	JP 2011 032592 A (TOYOTA IND CORP) 17 February 2011 (2011-02-17) * abstract * * figures 1,3a,3b,4a,4b,4c,5a,5b,6a,6b,6c * * claim 1 * * paragraphs [0001], [0002], [0006], [0011] * -----	1-4	TECHNICAL FIELDS SEARCHED (IPC) D03D
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1

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 July 2018	Heinzelmann, Eric

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09-07-2018

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