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(71) Applicant: **Kabushiki Kaisha Toyota Jidoshokki Kariya-shi, Aichi 448-8671 (JP)**

(72) Inventors:
• **Makino, Yoichi**
Kariya-shi, Aichi 448-8671 (JP)
• **Goto, Takuji**
Kariya-shi, Aichi 448-8671 (JP)
• **Makino, Isao**
Kariya-shi, Aichi 448-8671 (JP)
• **Suzuki, Fujio**
Aichi-gun, Aichi 480-1192 (JP)

(74) Representative: **TBK Bavariaring 4-6 80336 München (DE)**

(54) **Weft insertion apparatus in jet loom**

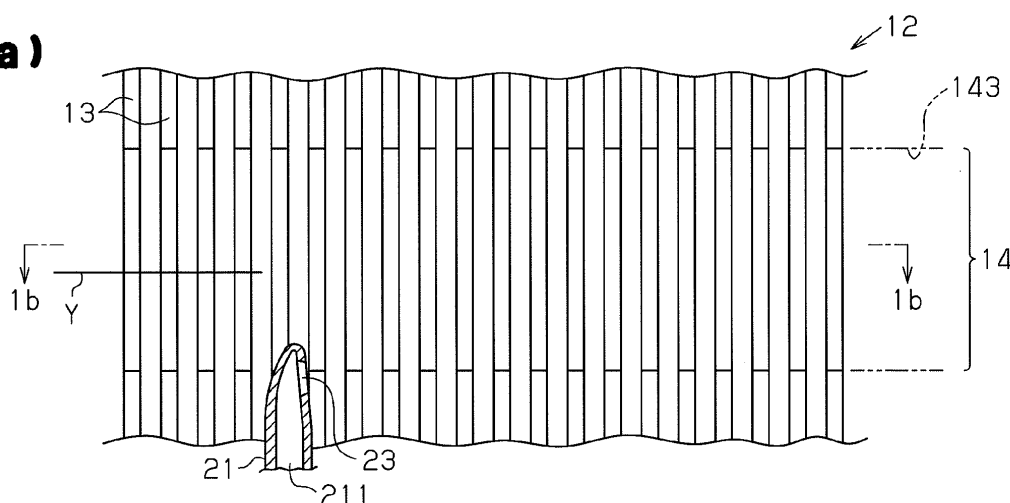
(57) A weft insertion apparatus in a jet loom, wherein the weft insertion apparatus includes an auxiliary nozzle (21) for weft insertion having an injection hole (23) from which air jet is ejected to deliver a weft (Y) in a weft guiding passage (14), is provided. The injection hole (23) is tapered so that the cross-sectional area of the hole (23) is decreased toward the direction of air injection of the auxiliary nozzle (21). The ratio A of a tapered angle γ of the injection hole (23) to a processing deflection angle β of the injection hole (23), $\gamma/\beta = A$, has the relationship expressed by an inequality (1):

pressed by an inequality (1):

$$A \geq A_0 \quad \dots(1)$$

wherein A0 is the value of γ/β when the variation range ($\Delta\delta_{\max}$) of the jet deflection angle (δ) becomes 0 when the injection pressure of the auxiliary nozzle (21) is changed from the maximum pressure (Pmax) for weft insertion to the minimum pressure (Pmin) for weft insertion.

Fig.1 (a)



Description

TECHNICAL FIELD

[0001] The present invention relates to a weft insertion apparatus in a jet loom, wherein the weft insertion apparatus includes an auxiliary nozzle for weft insertion having an injection hole from which an air jet is ejected to deliver a weft in a weft guiding passage.

BACKGROUND OF THE INVENTION

[0002] An injection hole 111 of an auxiliary nozzle 11 for weft insertion of the type as illustrated Figs. 9(a), (b) and (c) is directed to a weft guiding passage 14 that is formed by an array of weft guiding holes 131 formed in the dents 13 of a modified reed 12. Injection timing at the auxiliary nozzle 11 is matched with the flying timing of a weft Y that flies in the weft guiding passage 14. The weft Y in the weft guiding passage 14 is delivered to the end of weft insertion by air jet action from the injection hole 111. The numeral T is warps.

[0003] Internal pressure of air in the nozzle that is to be ejected from the injection hole 111 (i.e., air pressure inside the auxiliary nozzle 11) changes as indicated by the waveform Np in the graph of Fig. 3.

[0004] In an auxiliary nozzle for weft insertion disclosed in Japanese Laid-Open Patent Publication No. 3-97939, as illustrated as the injection hole 111 of Fig. 9 (c), a nozzle hole (an injection hole) is tapered so that the cross-sectional area of the hole is decreased toward the direction of air injection.

[0005] The inventors of this application conducted an experiment to see the variations in jet deflection angle δ when the internal pressure of the nozzle is changed, on the condition that the relationship between an apex angle θ and a processing deflection angle ψ in the tapered injection hole 111 disclosed in Japanese Laid-Open Patent Publication No. 3-97939 is expressed as $\theta/2 = 1.3 \times \psi$. As illustrated in Fig. 9(c), the processing deflection angle ψ is an angle between the direction of weft insertion Lo and the axial line of the injection hole 111 when viewed in the extending direction of the modified reed 12, and the jet deflection angle δ is an angle between the direction of weft insertion Lo and a line of the direction of air injection C when viewed in the extending direction of the modified reed 12. The line of the direction of air injection C is the line indicating the direction where the pressure of injection is maximum in an air jet. The line of the direction of air injection C does not match the axial line 112 of the injection hole 111. As described below, the direction of air injection C or the jet deflection angle δ changes depending on the internal pressure of the nozzle.

[0006] To measure the line of the direction of air injection C, for example, a measuring device for measuring a direction of air jet as disclosed in Japanese Laid-Open Patent Publication No. 9-176937 is used.

[0007] Fig. 10 is a graph showing results of the exper-

iment. An axis abscissa in Fig. 10 denotes internal pressure of the nozzle and an axis ordinate denotes the variation $\Delta\delta$ in the jet deflection angle δ . The axial line 112 of the injection hole 111 in the form of a truncated cone is the axial line of a cone having an apex angle θ , wherein the cone is formed by extending the generatrices (side lines) of the truncated cone. In the graph of Fig. 10, the jet deflection angle δ at the time when the internal pressure of the nozzle is Pmax is expressed as 0° at the axis ordinate. The curve $\Delta\delta$ represents the variation in the jet deflection angle δ with respect to the change in internal pressure of the nozzle, i.e., how the jet deflection angle δ is changed on the basis of Pmax as the internal pressure of the nozzle decreases from Pmax. As apparent from the curve $\Delta\delta$, when the internal pressure of the nozzle is the minimum pressure Pmin for weft insertion, the jet deflection angle δ is changed in a negative direction (i.e., a direction for the air jet to move away from the reed).

[0008] The minimum pressure Pmin for weft insertion refers to minimum pressure required for an air jet from the auxiliary nozzle 11 to reach the weft guiding passage 14 in a manner that the line of the direction of air injection C in the air jet can be defined. At pressures less than the minimum pressure Pmin, an air jet from the auxiliary nozzle 11 diffuses before reaching the weft guiding passage 14, failing to provide the weft Y with effective towing force.

[0009] According to the graph of Fig. 10, when the internal pressure of the nozzle decreases from the maximum pressure Pmax to the minimum pressure Pmin, the jet deflection angle δ changes in a negative direction. Thus, the line of the direction of air injection C is more likely to deviate upward from the weft guiding passage 14. As the maximum pressure Pmax of the internal pressure of the nozzle (or the pressure of an air tank that supplies air to the auxiliary nozzle 11) is set lower to reduce air consumption, the towing force of the auxiliary nozzle 11 is reduced. Thus, an adverse effect of the variation $\Delta\delta$ in the jet deflection angle δ on the flying position of the weft Y becomes prominent when the air injection from the auxiliary nozzle 11 is completed after the distal tip of the weft Y passes through the auxiliary nozzle 11.

[0010] An object of the invention is to provide an auxiliary nozzle for weft insertion that ensures the direction of air injection stays in a weft guiding passage with high reliability even when the pressure in an air tank supplying air to the auxiliary nozzle is set lower to reduce an amount of air jet.

SUMMARY OF THE INVENTION

[0011] According to one aspect of the invention, a weft insertion apparatus in a jet loom is provided. The weft insertion apparatus includes an auxiliary nozzle (21) for weft insertion having an injection hole (23) from which an air jet is ejected to deliver a weft (Y) in a weft guiding passage (14). The injection hole (23) is tapered so that the cross-sectional area of the hole (23) is decreased toward the direction of air injection of the auxiliary nozzle

(21). The ratio A of a tapered angle γ of the injection hole (23) to a processing deflection angle β of the injection hole (23), $\gamma/\beta = A$, has the relationship expressed by an inequality (1):

$$A \geq A_0 \quad \dots(1)$$

wherein A_0 is the value of γ/β when the variation range ($\Delta\delta_{\max}$) of the jet deflection angle (δ) becomes 0 when the injection pressure of the auxiliary nozzle (21) is changed from the maximum pressure ($P_{\max}$) for weft insertion to the minimum pressure ($P_{\min}$) for weft insertion.

[0012] In one embodiment, the ratio A is 2.5 or greater.

[0013] In another embodiment, the ratio A is 3 or greater.

[0014] In yet another embodiment, the ratio A is 4.5 or greater.

[0015] In still another embodiment, the injection hole is in the form of a truncated cone.

[0016] As used herein, maximum pressure for weft insertion refers to a maximum value for internal pressure of the nozzle.

[0017] Minimum pressure for weft insertion refers to the minimum pressure required for an air jet from the auxiliary nozzle to reach the weft guiding passage in a manner that the direction of air injection in the air jet can be defined.

[0018] A tapered angle γ is defined as an angle between the generatrix of the injection hole and the axial line of the injection hole.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Fig. 1(a) is a front view illustrating a part of an auxiliary nozzle for weft insertion and a part of a modified reed according to one embodiment of the invention; Fig. 1(b) is a cross-sectional view of Fig. 1(a) taken along the line 1 b-1 b;

Fig. 2(a) is a partial side view of the auxiliary nozzle; Fig. 2(b) is a cross-sectional view of Fig. 2(a) taken along the line 2b-2b;

Fig. 2(c) is a cross-sectional view of Fig. 2(b) taken along the line 2c-2c;

Fig. 3 is a graph showing the change in the internal pressure of the nozzle;

Fig. 4 is a graph representing the relationship between the internal pressure of the nozzle and the variation in jet elevation angle;

Fig. 5 is a graph representing the relationship between the internal pressure of the nozzle and the variation in jet deflection angle;

Fig. 6 is a graph representing the relationship between a ratio A and a variation range of jet elevation

angle;

Fig. 7 is a graph representing the relationship between the ratio A and a variation range of the jet deflection angle;

Fig. 8(a) is a partial cross-sectional view illustrating a part of an auxiliary nozzle for weft insertion and a part of a modified reed;

Fig. 8(b) is a graph of intersection points on an imaginary plane;

Fig. 9(a) is a side view of a weft insertion apparatus;

Fig. 9(b) is a partial side view of Fig. 9(a);

Fig. 9(c) is a cross-sectional view of Fig. 9(b) taken along the line 9c-9c; and

Fig. 10 is a graph showing the variation in jet deflection angle when the ratio A is 1.3.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] An embodiment of the invention will be described with reference to Figs. 1 to 8. An overall structure of a weft insertion apparatus including an auxiliary nozzle for weft insertion is the same as that of Fig. 9.

[0021] Fig. 1(a) is a front view of a part of an auxiliary nozzle 21 for weft insertion and a part of a modified reed 12. Fig. 1(b) is a cross-sectional view of Fig. 1(a) taken along the line 1b-1b. Fig. 2(a) is a side view of a distal end of the auxiliary nozzle 21. The distal end of the auxiliary nozzle 21 is rounded or arcuate when viewed in the direction of weft insertion L_o . Fig. 2(b) is a cross-sectional view of Fig. 2(a) taken along the line 2b-2b. Fig. 2(c) is a cross-sectional view of Fig. 2(b) taken along the line 2c-2c.

[0022] In the drawings, a single auxiliary nozzle 21 is provided. However, as appreciated by those skilled in the art, in the weft apparatus, each of the auxiliary nozzles 21 may be positioned for every specified number of the dents 13.

[0023] As illustrated in Fig. 2(b), the auxiliary nozzle 21 for weft insertion is in the form of a pipe and a distal tip of the auxiliary nozzle 21 is closed. The distal portion of the auxiliary nozzle 21 becomes smaller so that the width of the auxiliary nozzle 21 in the direction of weft insertion L_o becomes smaller toward upward. A flat portion 22 in the form of a plate is formed in the distal portion of the auxiliary nozzle 21. An outer surface 221 of the flat portion 22 faces slightly upward to face the direction of weft insertion L_o . The outer surface 221 is parallel to the direction in which each warp T extends.

[0024] As illustrated in Figs. 2(b) and (c), the flat portion 22 includes an injection hole 23 that communicates with an air supply passage 211 in the auxiliary nozzle 21. The injection hole 23 is configured in tapered form where the cross-sectional area of the hole is decreased toward the direction of air injection. That is, the injection hole 23 is a truncated cone-shaped hole. A cone is formed by extending the generatrices (side lines) of the truncated cone of the injection hole 23, and the axial line 231 of the cone

(or the injection hole 23) is inclined with respect to the reference line L1 perpendicular to the axial line 212 of the auxiliary nozzle 21 in the pipe form.

[0025] As illustrated in Fig. 2(b), an angle between the reference line L1 and the axial line 231 is defined as a processing elevation angle α when viewed in the front and rear direction of a weaving machine and in the direction perpendicular to the extending direction of the modified reed 12 (see Fig. 9(a)). The axial line 231 faces slightly upward. The injection direction of air actually injected from the injection hole 23 does not match the axial line 231. Thus, the jet elevation angle ε does not match the processing elevation angle α .

[0026] As illustrated in Fig. 2(c), a processing deflection angle β is defined as an angle between the direction of weft insertion Lo (the direction that goes from left to right in the drawing, as in the direction of weft insertion Lo of Fig. 9) and the axial line 231. Similar to the relationship between the processing elevation angle α and the jet elevation angle ε , the jet deflection angle δ does not match the processing deflection angle β .

[0027] A tapered angle of a cone formed by extending the generatrices (side lines) of the truncated cone of the injection hole 23 is defined as an angle γ between the generatrix of the cone and the axial line 231.

[0028] In this embodiment, the ratio A, which is a value of γ/β , is set to 3.6. The curve E0 in the graph of Fig. 4 represents the variation $\Delta\varepsilon$ in a jet elevation angle ε with respect to the change in the internal pressure of the nozzle when the ratio A is 3.6. The jet elevation angle ε is an angle between the line of the direction of air injection C and the reference line L1 viewed in the direction of weft insertion Lo as illustrated in Fig. 2(b). To measure the line of direction of air injection C, for example, a measuring device for measuring the direction of an air jet as disclosed in Japanese Laid-Open Patent Publication No. 9-176937 is used.

[0029] The curve E1 is the variation $\Delta\varepsilon$ in the jet elevation angle ε with respect to the change in the internal pressure of the nozzle when the ratio A is 1.3. An axis abscissa denotes internal pressure of the nozzle and an axis ordinate denotes the variation $\Delta\varepsilon$ in the jet elevation angle ε . In this graph, the jet elevation angle at the time when the internal pressure of the nozzle is Pmax is expressed as 0° at the axis ordinate. The positive change $\Delta\varepsilon > 0$ in the jet elevation angle ε is the situation where a jet elevation angle is directed more upward than the line of the direction of air injection C when the internal pressure of the nozzle is the maximum pressure Pmax.

[0030] As apparent from the comparison between the curve E0 and the curve E1, the positive change $\Delta\varepsilon > 0$ in the jet elevation angle ε is smaller in the ratio A of 3.6 than in the ratio A of 1.3. That is, the magnitude of the upward change in the line of the direction of air injection C from the situation where the internal pressure of the nozzle is the maximum pressure Pmax is smaller in the ratio A of 3.6 than in the ratio A of 1.3. This means that the ratio A of 3.6 is preferred to the ratio A of 1.3 to prevent

the line of the direction of air injection C from deviating upward from the weft guiding passage 14.

[0031] The curve D0 in the graph of Fig. 5 is the variation $\Delta\delta$ in the jet deflection angle δ of air jet with respect to the change in internal pressure of the nozzle when the ratio A is 3.6. The jet deflection angle δ is an angle between the line of the direction of air injection C and the direction of weft insertion Lo as illustrated in Fig. 2(c) when viewed in the extending direction of the modified reed 12 (see Fig. 9(a)). The curve D1 is the variation $\Delta\delta$ in the jet deflection angle δ with respect to the change in internal pressure of the nozzle when the ratio A is 1.3. An axis abscissa denotes internal pressure of the nozzle and an axis ordinate denotes the variation $\Delta\delta$ in the jet deflection angle δ .

[0032] In this graph, the jet deflection angle δ at the time when the internal pressure of the nozzle is Pmax is expressed as 0° at the axis ordinate. The positive change of the jet deflection angle δ , i.e., $\Delta\delta > 0$, means that the line of the direction of air injection C approaches the modified reed 12 than in the case when the internal pressure of the nozzle is the maximum pressure Pmax. The negative change of the jet deflection angle δ , i.e., $\Delta\delta < 0$, means that the line of the direction of air injection C moves away from the modified reed 12 than in the case when the internal pressure of the nozzle is the maximum pressure Pmax. As the negative change $\Delta\delta < 0$ of the jet deflection angle δ is greater, the line of the direction of air injection C moves away from the weft guiding passage 14 of the modified reed 12 greatly.

[0033] As apparent from the comparison between the curve D0 and the curve D1, the variation $\Delta\delta$ in the jet deflection angle δ is always positive when the ratio A is 3.6, and the value of the variation $\Delta\delta$ becomes greater as the internal pressure of the nozzle becomes smaller. When the ratio A is 1.3, the variation $\Delta\delta$ in the jet deflection angle δ is positive on the high-pressure side but negative on the low-pressure side. Since the line of the direction of air injection C is directed upward, if the line of the direction of air injection C moves away from the modified reed 12, the variation $\Delta\delta$ in the jet deflection angle δ is more likely to deviate upward from the weft guiding passage 14.

[0034] The graph of Fig. 5 indicates that deviation of the line of the direction of air injection C from the weft guiding passage 14 is less likely to occur in the ratio A of 3.6 than in the ratio A of 1.3 when the internal pressure of the nozzle is on the low-pressure side.

[0035] A curve Z in the graph of Fig. 6 represents the variation range $\Delta\varepsilon_{\max}$ between the maximum pressure Pmax and the minimum pressure Pmin of the jet elevation angle ε with respect to the change in the ratio A. The variation range $\Delta\varepsilon_{\max}$ is the variation in the jet elevation angle ε when the internal pressure of the nozzle is decreased from the maximum pressure Pmax for weft insertion to the minimum pressure Pmin for weft insertion. It is preferred that the minimum pressure Pmin is set as low pressure as possible to such an extent that the line

of the direction of air injection C can be measured with the measuring device for measuring a direction of air jet as disclosed in Japanese Laid-Open Patent Publication No. 9-176937. An axis abscissa denotes the ratio A and an axis ordinate denotes the variation range $\Delta\epsilon_{\max}$ of the jet elevation angle ϵ . In accordance with the curve Z, the greater the ratio A is, the smaller the variation range $\Delta\epsilon_{\max}$ of the jet elevation angle ϵ becomes. This means that the ratio A of a greater value is more preferable to prevent deviation of the line of the direction of air injection C upward from the weft guiding passage 14.

[0036] A curve H in the graph of Fig. 7 represents the variation range $\Delta\delta_{\max}$ of the jet deflection angle δ with respect to the change in the ratio A. The variation range $\Delta\delta_{\max}$ is the variation in the jet deflection angle δ when the internal pressure of the nozzle is decreased from the maximum pressure $P_{\max}$ for weft insertion to the minimum pressure $P_{\min}$ for weft insertion. An axis abscissa denotes the ratio A and an axis ordinate denotes the variation range $\Delta\epsilon_{\max}$ of the jet deflection angle δ . The positive variation range of jet deflection angle δ , i.e., $\Delta\delta_{\max} > 0$, means that the line of the direction of air injection C approaches the modified reed 12 compared to the case when the internal pressure of the nozzle is the maximum pressure $P_{\max}$. The negative variation range of the jet deflection angle δ , i.e., $\Delta\delta_{\max} < 0$, means that the line of the direction of air injection C moves away from the modified reed 12 compared to the case when the internal pressure of the nozzle is the maximum pressure $P_{\max}$.

[0037] As apparent from the curve H, the variation range $\Delta\delta_{\max}$ of the jet deflection angle δ is negative when the ratio A is 2 or less. On the condition where the ratio A is 2 or less, the smaller the ratio A is, the greater the negative variation range of the jet deflection angle δ ($\Delta\delta_{\max} < 0$) becomes. As the negative variation range of the jet deflection angle δ ($\Delta\delta_{\max} < 0$) becomes greater, the line of the direction of air injection C moves away from the modified reed 12 further. Since the line of the direction of air injection C faces upward, if the line of the direction of air injection C moves away from the modified reed 12, the line of the direction of air injection C is more likely to deviate upward from the weft guiding passage 14.

[0038] Provided that the ratio when the variation range $\Delta\delta_{\max}$ of the jet deflection angle δ becomes 0 when the internal pressure of the nozzle is changed from the maximum pressure $P_{\max}$ to the minimum pressure $P_{\min}$ is defined as A_0 , the variation range $\Delta\delta_{\max}$ of the jet deflection angle δ is positive when the ratio A is A_0 or greater. On the condition that the ratio A is the value of A_0 or greater, the positive variation range of the jet deflection angle δ ($\Delta\delta_{\max} > 0$) becomes greater as the ratio A is greater. The positive variation range of the jet deflection angle δ ($\Delta\delta_{\max} > 0$) indicates the situation where the line of the direction of air injection C is closer to the modified reed 12 compared to the case where the internal pressure of the nozzle is the maximum pressure $P_{\max}$. Since the processing elevation angle α faces upward, as the line of the direction of air injection C approaches the modified

reed 12, the line of the direction of air injection C turns lower. Thus, as the line of the direction of air injection C approaches the modified reed 12, the change in the jet elevation angle ϵ in an upper direction is offset to facilitate positioning of the line of the direction of air injection C in the weft guiding passage 14.

[0039] The value of A_0 is greater than 2 but smaller than 2.5. In this embodiment, A_0 is 2.2. As apparent from Fig. 7, the variation range $\Delta\delta_{\max}$ of the jet deflection angle δ is always positive when the ratio $A > A_0$. Thus, by determining the processing deflection angle β and the tapered angle γ so that the ratio A is equal to or greater than the ratio A_0 , the variation range $\Delta\delta_{\max}$ of the jet deflection angle δ will not turn negative, thereby facilitating positioning of the line of the direction of air injection C in the weft guiding passage 14 even when the internal pressure of the nozzle becomes the minimum pressure $P_{\min}$.

[0040] As the positive variation range ($\Delta\delta_{\max} > 0$) is greater, the line of the direction of air injection C is lowered and positioning of the line of the direction of air injection C in the weft guiding passage 14 is facilitated. Thus, when the ratio A is 3, the line of the direction of air injection C is easily positioned in the weft guiding passage 14 compared to the case where the ratio A is 2.5.

[0041] If the ratio A exceeds 3.6, an increment of the positive variation range ($\Delta\delta_{\max} > 0$) becomes smaller. When the ratio A is 4.5, the positive variation range $\Delta\delta_{\max} > 0$ is almost steady. When the processing deflection angle β is constant, the smaller the ratio A is, the smaller the taper angle γ is. The injection hole 23 is easier to process as the taper angle γ is smaller. Thus, the ratio A of 4.5 or less is desirable.

[0042] As illustrated in Fig. 8(a), the intersection between an imaginary plane 142 flush with the back wall surface 141 of the weft guiding passage 14 and the line of the direction of air injection C of air ejected from the injection hole 111 is defined as C_n .

[0043] Fig. 8(b) is a graph illustrating the changes in the intersection points C_n in the cases where the ratios A are 1.3, 2, 2.5, 3, and 3.6 when the internal pressure of the nozzle as illustrated in the waveform N_p in Fig. 3 is changed from the maximum pressure $P_{\max}$ for weft insertion to the minimum pressure $P_{\min}$ for weft insertion. An axis abscissa x denotes the direction of weft insertion L_0 while an axis ordinate y denotes the upper direction. The plane of x-y coordinates represents the imaginary plane 142.

[0044] When the internal pressure of the nozzle is the maximum pressure $P_{\max}$, the positions of the intersection points C_n in the cases where the ratios A are 1.3, 2, 2.5, 3 and 3.6 become almost the same. Thus, this intersection is denoted as C_0 collectively.

[0045] Intersection points C_0 and C_1 are the change in intersection points when the ratio A is 1.3. Intersection points C_0 and C_2 are the change in intersection points when the ratio A is 2. Intersection points C_0 and C_3 are the change in intersection points when the ratio A is 2.5.

Intersection points C0 and C4 are the change in intersection points when the ratio A is 3. Intersection points C0 and C5 are the change in intersection points when the ratio A is 3.6.

[0046] The intersection point C0 is the intersection point when the internal pressure of the nozzle is the maximum pressure Pmax. The intersection points C1, C2, C3, C4 and C5 are the intersection points when the internal pressure of the nozzle is the minimum pressure Pmin.

[0047] When the ratio A is 1.3, the intersection point C1 deviates upward from the back wall surface 141.

[0048] When the ratio A is 2, the intersection point C2 is near the upper edge 143 of the back wall surface 141.

[0049] When the ratio A is 2.5, the intersection points C0 and C3 are within the back wall surface 141.

[0050] When the ratio A is 3, the intersection points C0 and C4 are within the back wall surface 141.

[0051] When the ratio A is 3.6, the intersection points C0 and C5 are within the back wall surface 141.

[0052] In the situation where the intersection point Cn deviates upward from the back wall surface 141, an adverse effect on the flying position of the weft Y becomes prominent, and decrease in the flying speed of the weft and failure of weft insertion are likely to occur. The intersection point C2 is near the upper edge 143 of the back wall surface 141 when the ratio A is 2 while the intersection point C3 is within the back wall surface 141 when the ratio A is 2.5. That is, when the ratio A is 2.5, deviation of the intersection point Cn upward from the back wall surface 141 is inhibited with high reliability.

[0053] When the ratio A is 3, the intersection points C0 and C4 are both positioned within the back wall surface 141. Thus, when the ratio A is 3.0, deviation of the intersection point Cn upward from the back wall surface 141 is inhibited with higher reliability.

[0054] When the ratio A is 3, the intersection point C4 is positioned inside the upper edge 143 of the back wall surface 141. When the ratio A is 3.6, the intersection point C5 is positioned further inside (or lower than) the intersection point C4. That is, when the ratio A is 3.6, deviation of the intersection point Cn upward from the back wall surface 141 is inhibited with even higher reliability.

[0055] The above embodiment has the following advantages.

(1) As illustrated in Fig. 7, A0 is the value of γ/β when the variation range $\Delta\delta_{\max}$ of the jet deflection angle δ becomes 0 when the internal pressure of the nozzle is changed from the maximum pressure Pmax to the minimum pressure Pmin at the time of air injection at the auxiliary nozzle 21. The value of A0 is greater than 2 but smaller than 2.5. When the ratio A is greater than the value of A0, the variation range $\Delta\delta_{\max}$ of the jet deflection angle δ is positive. On the condition that the variation range $\Delta\delta_{\max}$ is positive, the line of the direction of air injection C approaches to-

ward the modified reed 12 even when the internal pressure of the nozzle changes from the maximum pressure Pmax to the minimum pressure Pmin at the end of air injection, and an effect due to increase in the variation $\Delta\epsilon$ of the jet elevation angle ϵ as illustrated in Fig. 4 is offset. Thus, the possibility of the line of the direction of air injection C to deviate upward from the weft guiding passage 14 is reduced. Thus, the auxiliary nozzle 21 for weft insertion that satisfies an inequality expression of the ratio A:

$$\gamma/\beta = A \geq A0$$

reduces the possibility of the line of the direction of air injection C of air ejected from the injection hole 23 to deviate from the weft guiding passage 14 due to a decrease in the internal pressure of the nozzle.

(2) The variation range $\Delta\delta_{\max}$ of the jet deflection angle δ when the ratio A is 2.5 is greater than that in the case where the ratio A is A0. The internal pressure of the nozzle at the time of completion of air injection at the auxiliary nozzle 21 is lower than the minimum pressure Pmin for weft insertion which is the pressure at which the line of the direction of air injection C is measurable. When the ratio is A0, it is possible that the variation range $\Delta\delta_{\max}$ of the jet deflection angle δ becomes negative when the internal pressure of the nozzle becomes lower than the minimum pressure Pmin. The configuration where A is 2.5 or greater facilitates positioning the line of the direction of air injection C in the weft guiding passage 14 with high reliability.

(3) The variation range $\Delta\delta_{\max}$ of the jet deflection angle δ when the ratio A is 3 is greater than that in the case where the ratio A is 2.5. Accordingly, the configuration where the A is 3 or greater facilitates positioning the line of the direction of air injection C in the weft guiding passage 14 with higher reliability.

(4) Even when the ratio A is greater than 4.5, the positive variation range $\Delta\delta_{\max}$ remains almost steady. Generally, the injection hole 23 is formed by electro spark machining. When the processing deflection angle β is constant, the smaller the ratio A is, the smaller the taper angle γ is. The injection hole 23 is easier to process as the taper angle γ is smaller. Thus, the configuration where A is 4.5 or greater is advantageous to facilitate the processing of the injection hole 23.

[0056] The present invention may be embodied in the following embodiment.

[0057] The injection hole may be a hole in the form of a truncated elliptic cone.

[0058] A weft insertion apparatus in a jet loom, wherein the weft insertion apparatus includes an auxiliary nozzle

(21) for weft insertion having an injection hole (23) from which air jet is ejected to deliver a weft (Y) in a weft guiding passage (14), is provided. The injection hole (23) is tapered so that the cross-sectional area of the hole (23) is decreased toward the direction of air injection of the auxiliary nozzle (21). The ratio A of a tapered angle γ of the injection hole (23) to a processing deflection angle β of the injection hole (23), $\gamma/\beta = A$, has the relationship expressed by an inequality (1):

$$A \geq A_0 \quad \dots(1)$$

wherein A_0 is the value of γ/β when the variation range ($\Delta\delta_{\max}$) of the jet deflection angle (δ) becomes 0 when the injection pressure of the auxiliary nozzle (21) is changed from the maximum pressure ($P_{\max}$) for weft insertion to the minimum pressure ($P_{\min}$) for weft insertion.

Claims

1. A weft insertion apparatus in a jet loom, wherein the weft insertion apparatus includes an auxiliary nozzle (21) for weft insertion having an injection hole (23) from which an air jet is ejected to deliver a weft (Y) in a weft guiding passage (14), wherein the injection hole (23) is tapered so that the cross-sectional area of the hole (23) is decreased toward the direction of air injection of the auxiliary nozzle (21), and wherein the ratio A of a tapered angle γ of the injection hole (23) to a processing deflection angle β of the injection hole (23), $\gamma/\beta = A$, has the relationship expressed by an inequality (1):

$$A \geq A_0 \quad \dots(1)$$

wherein A_0 is the value of γ/β when the variation range ($\Delta\delta_{\max}$) of the jet deflection angle (δ) becomes 0 when the injection pressure of the auxiliary nozzle (21) is changed from the maximum pressure ($P_{\max}$) for weft insertion to the minimum pressure ($P_{\min}$) for weft insertion.

2. The weft insertion apparatus according to claim 1 wherein the ratio A is 2.5 or greater.
3. The weft insertion apparatus according to claim 1 wherein the ratio A is 3 or greater.
4. The weft insertion apparatus according to any one of claims 1 to 3 wherein the ratio A is 4.5 or greater.

5. The weft insertion apparatus according to any one of claims 1 to 4 wherein the injection hole is in the form of a truncated cone.

Fig. 1 (a)

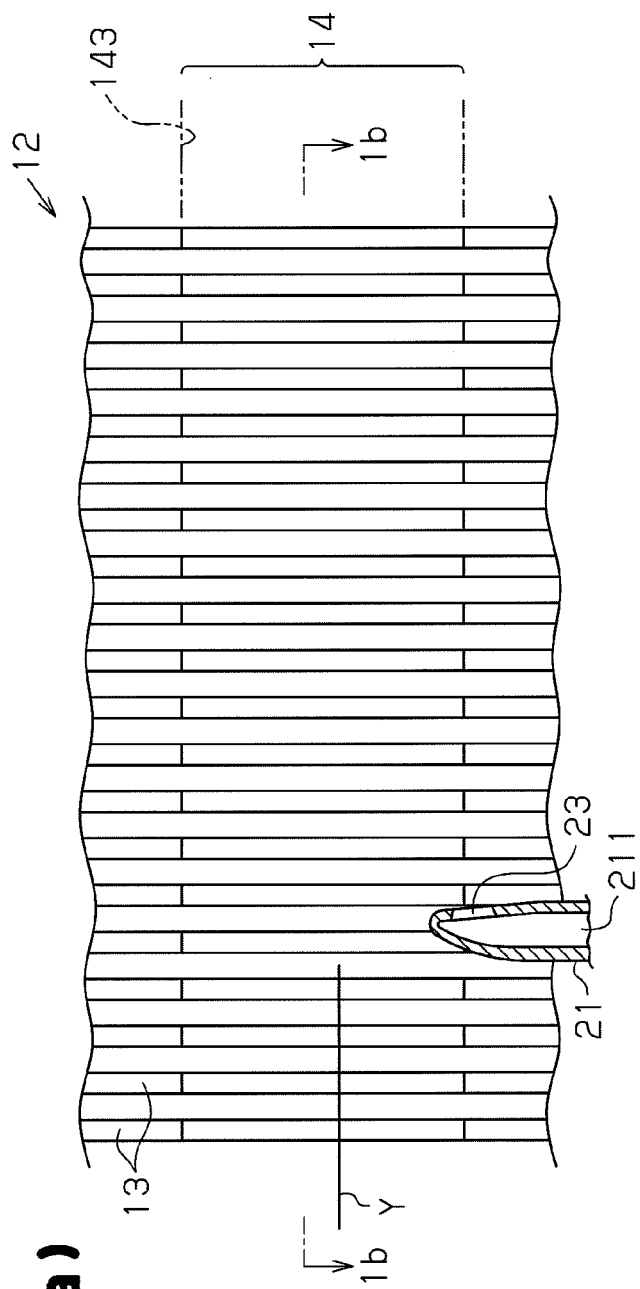


Fig. 1 (b)

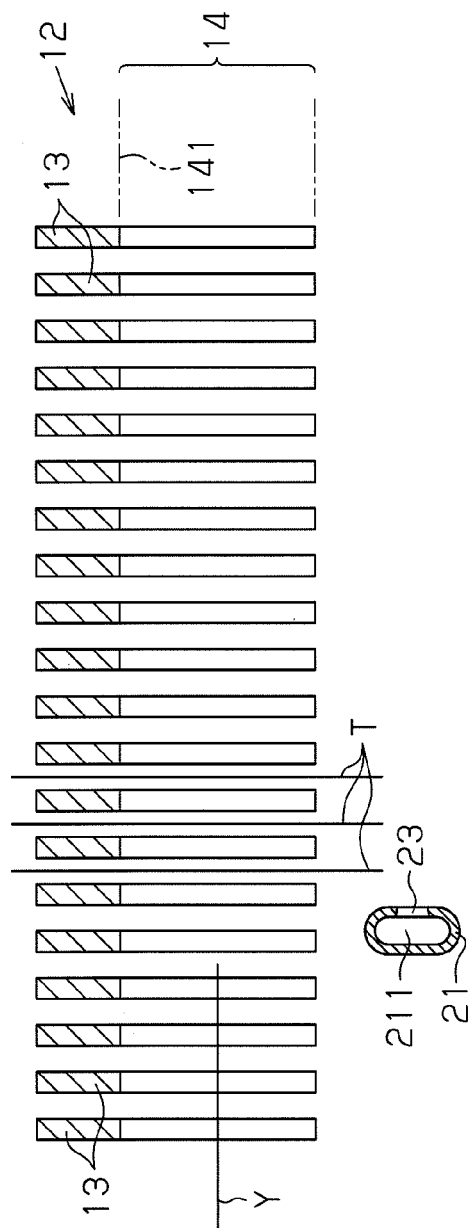


Fig. 2 (a)

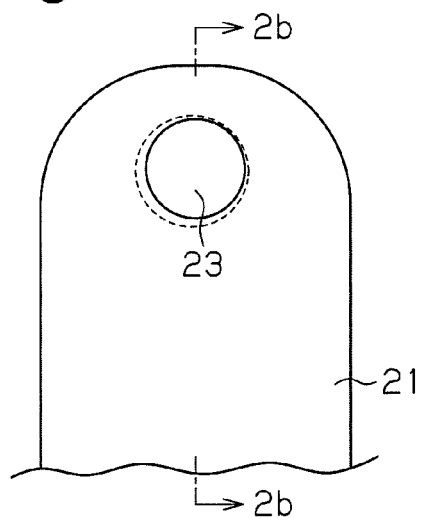


Fig. 2 (b)

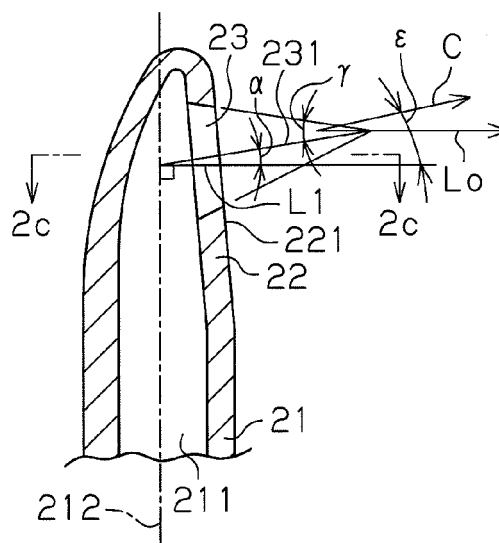


Fig.2 (c)

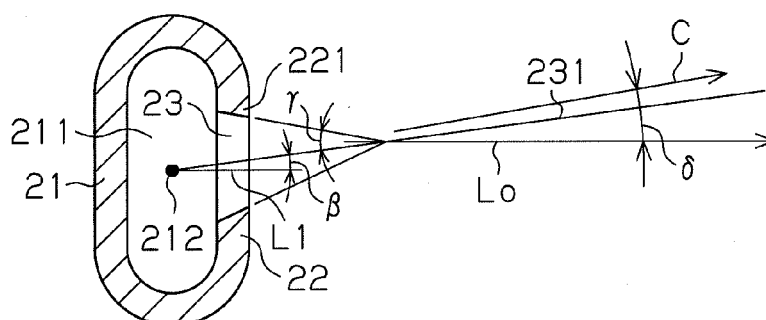


Fig.3

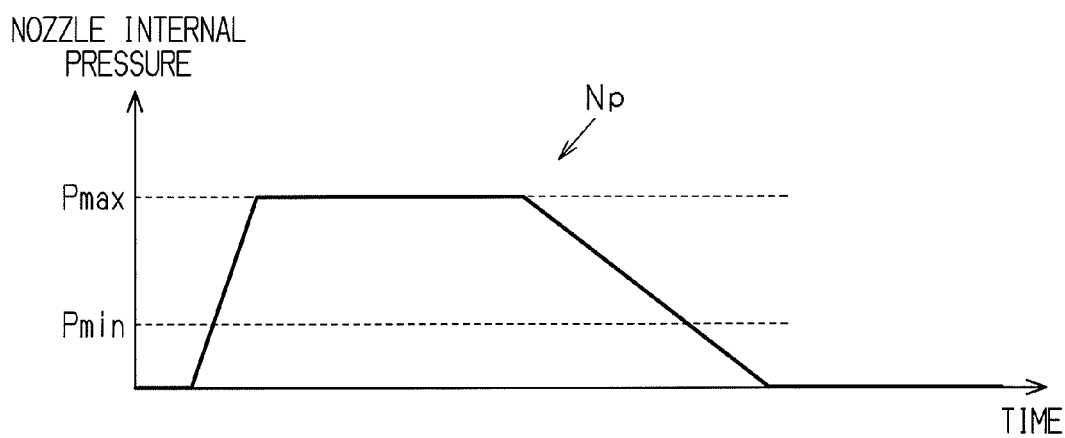


Fig.4

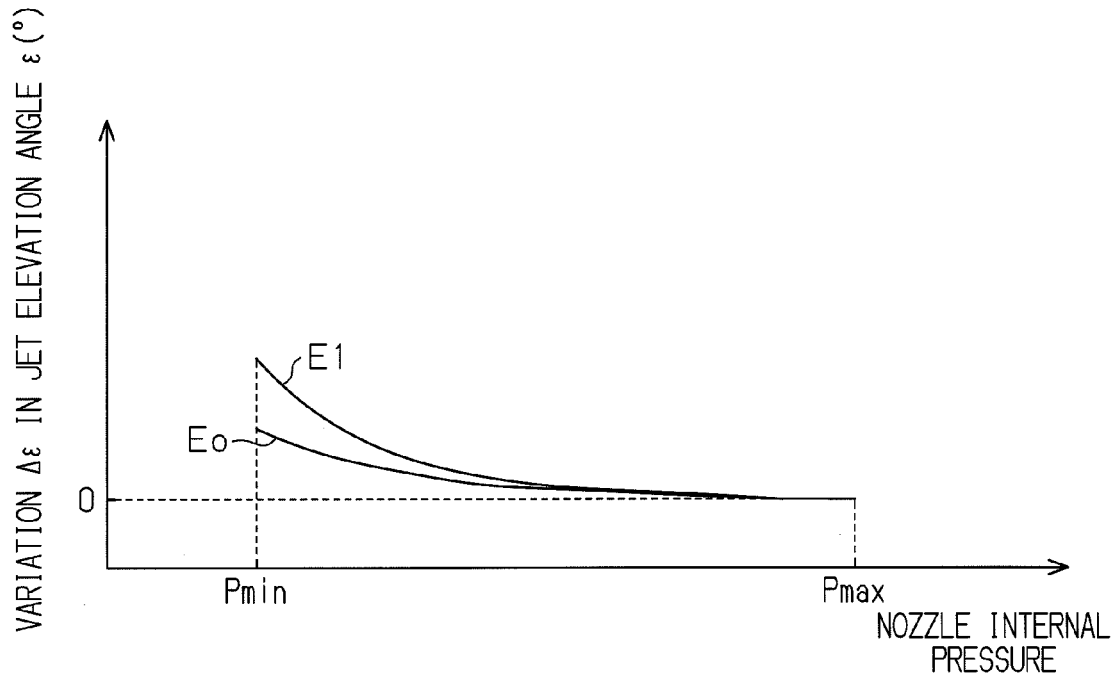


Fig.5

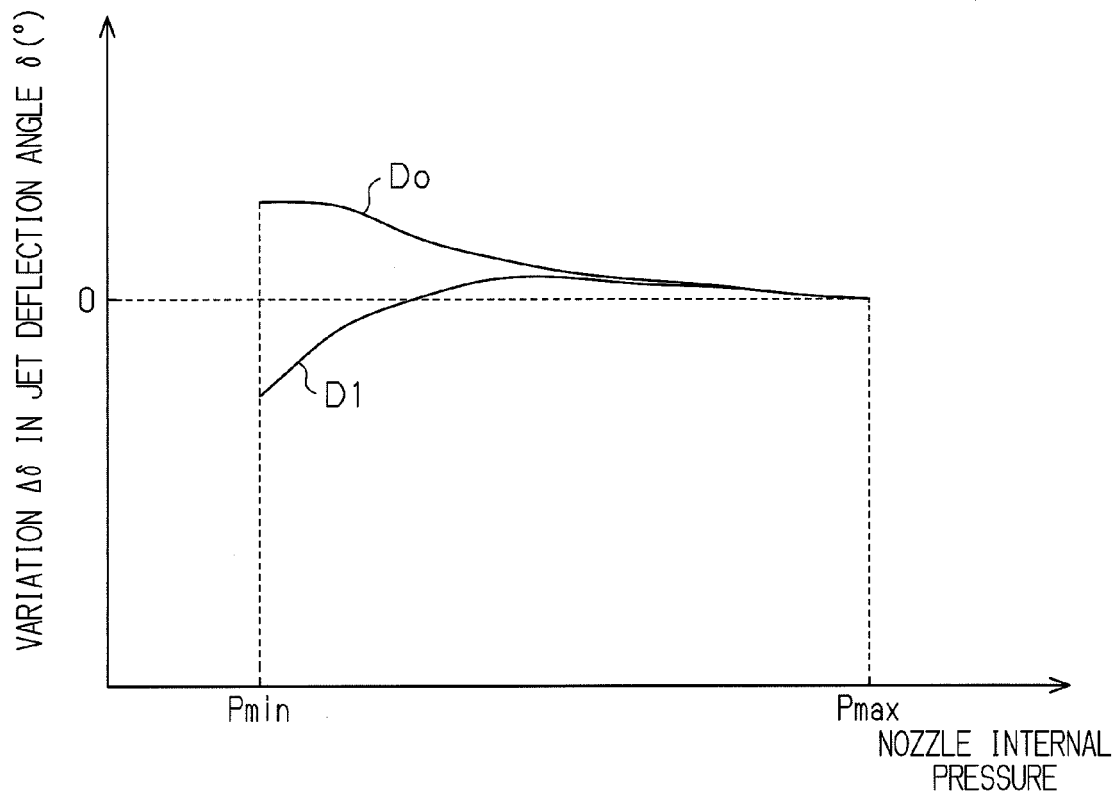


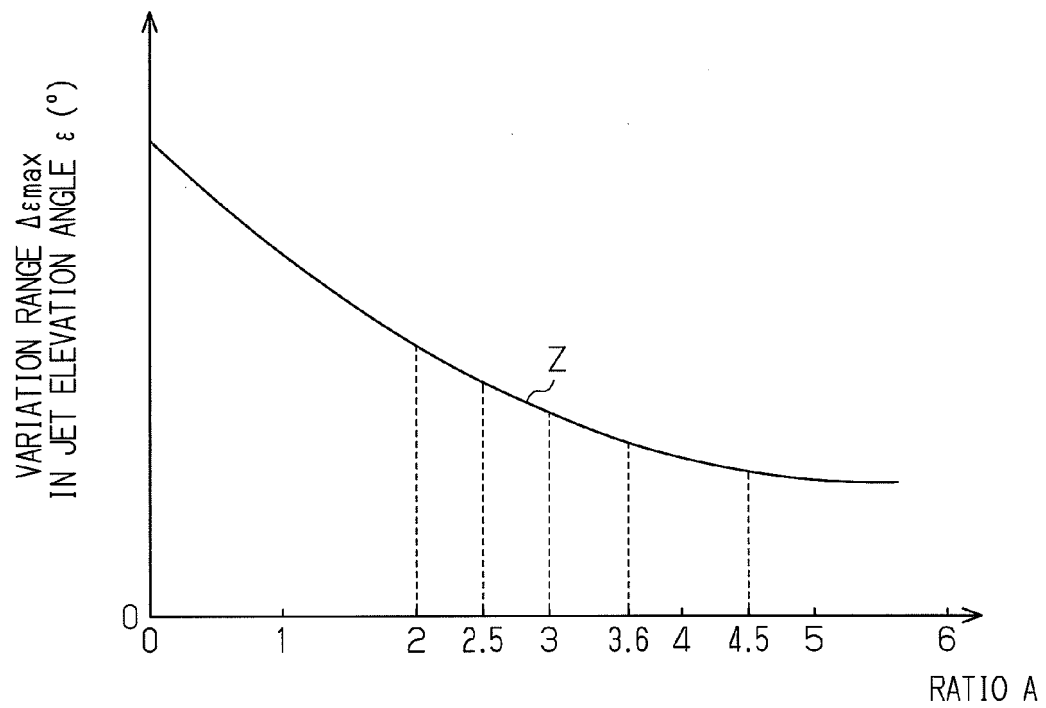
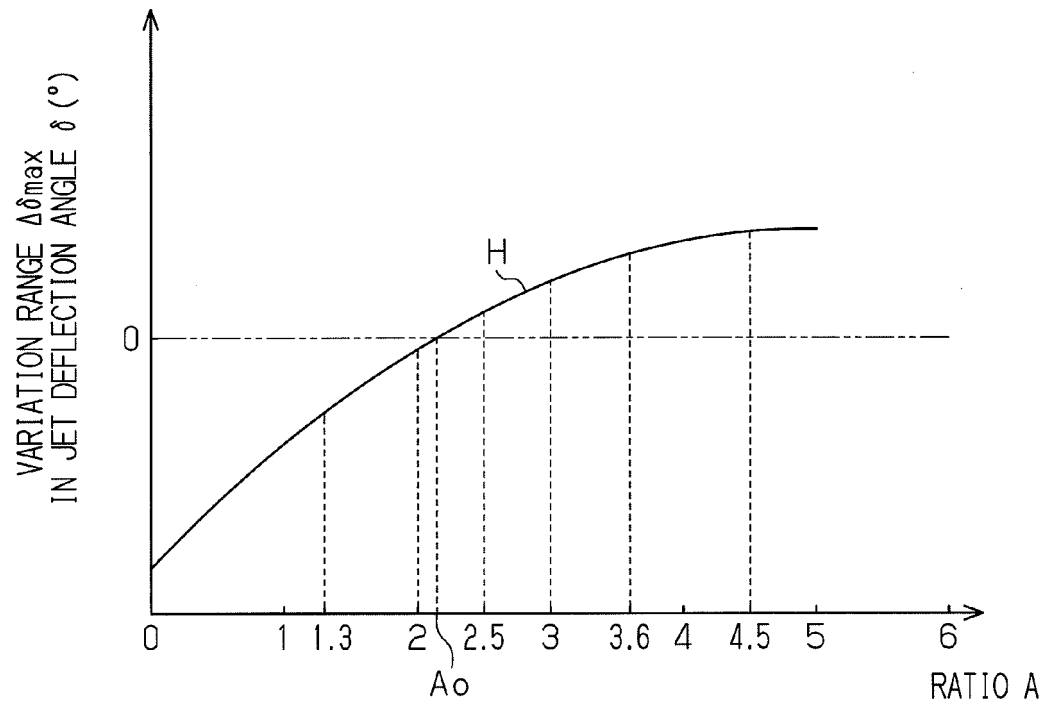
Fig.6**Fig.7**

Fig.8(a)

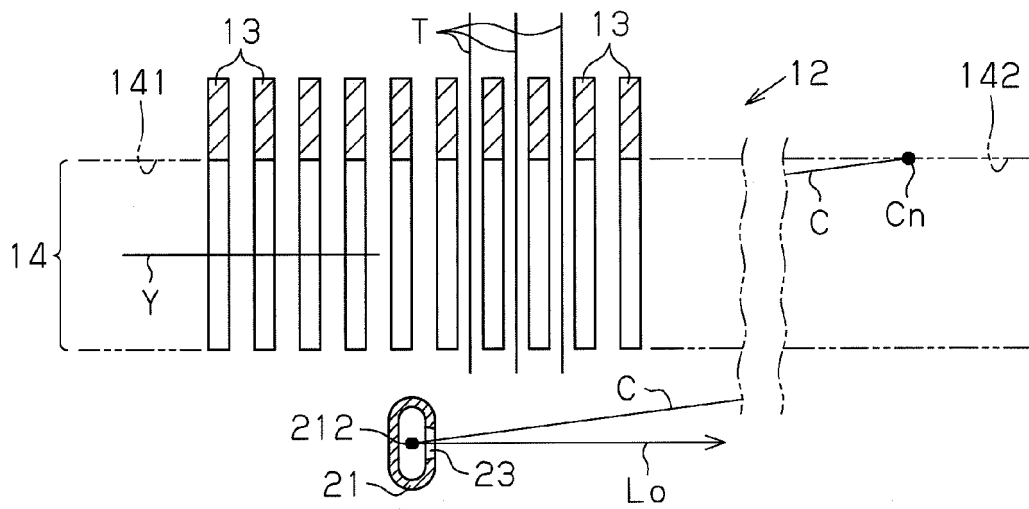


Fig.8(b)

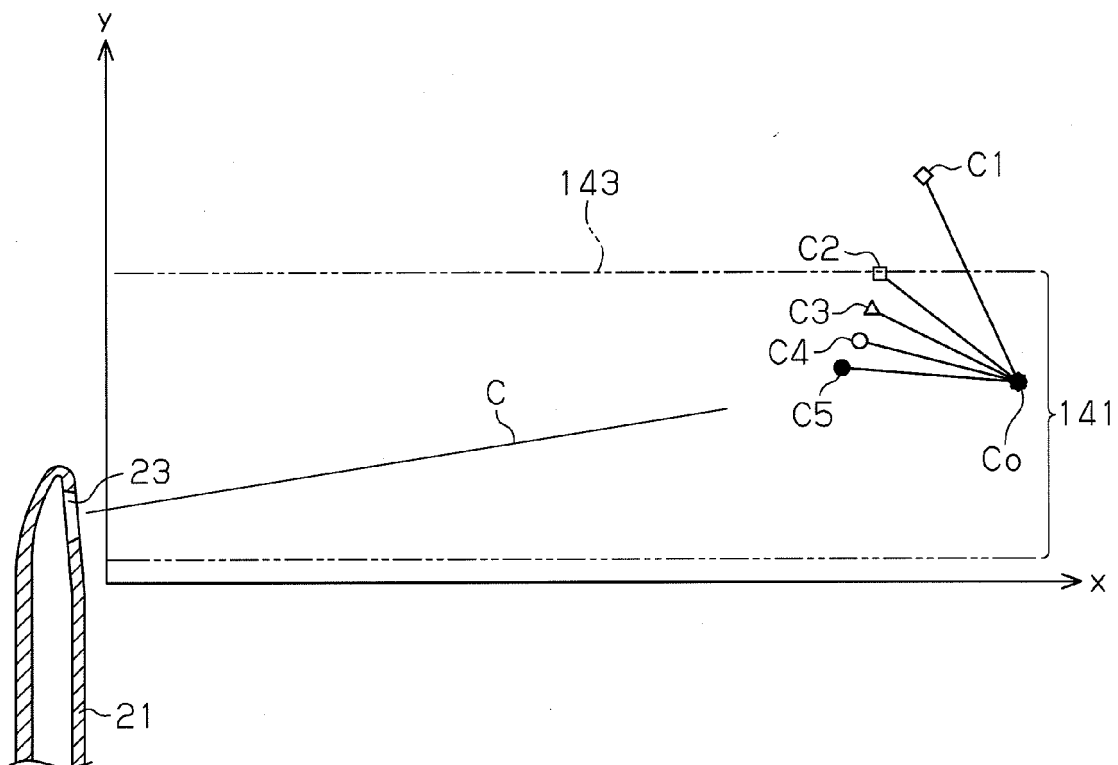


Fig.9(a)

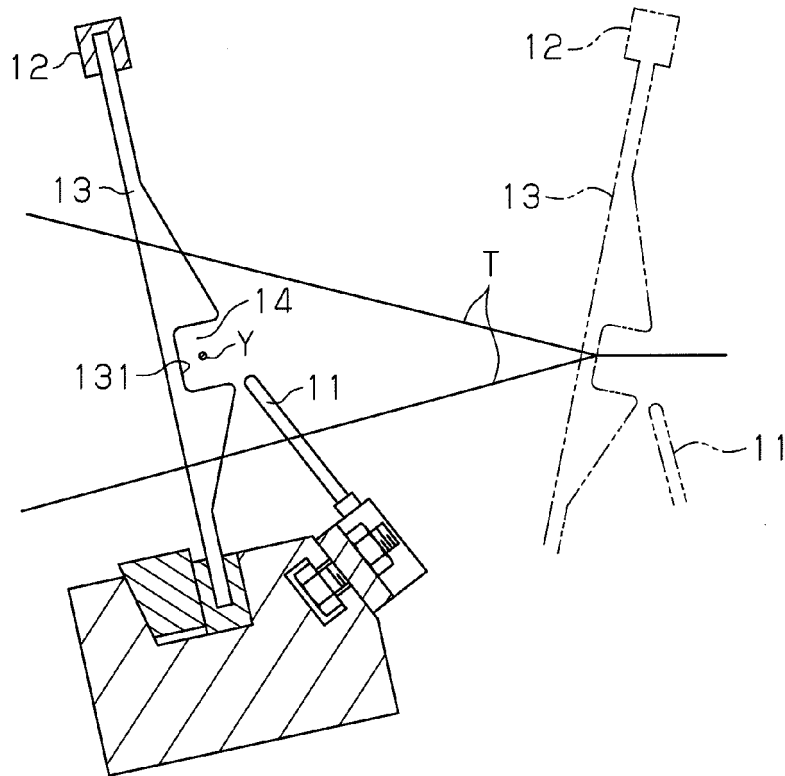


Fig.9(b)

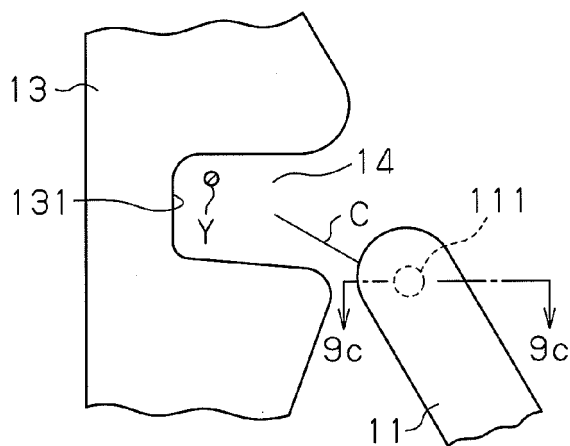


Fig.9(c)

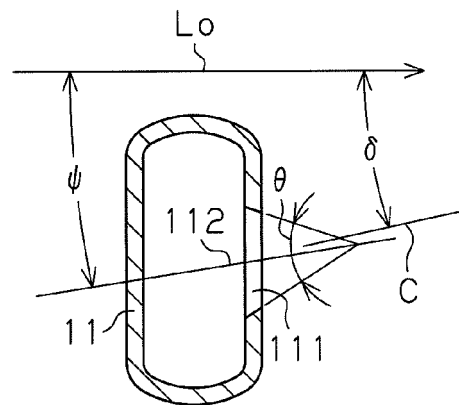
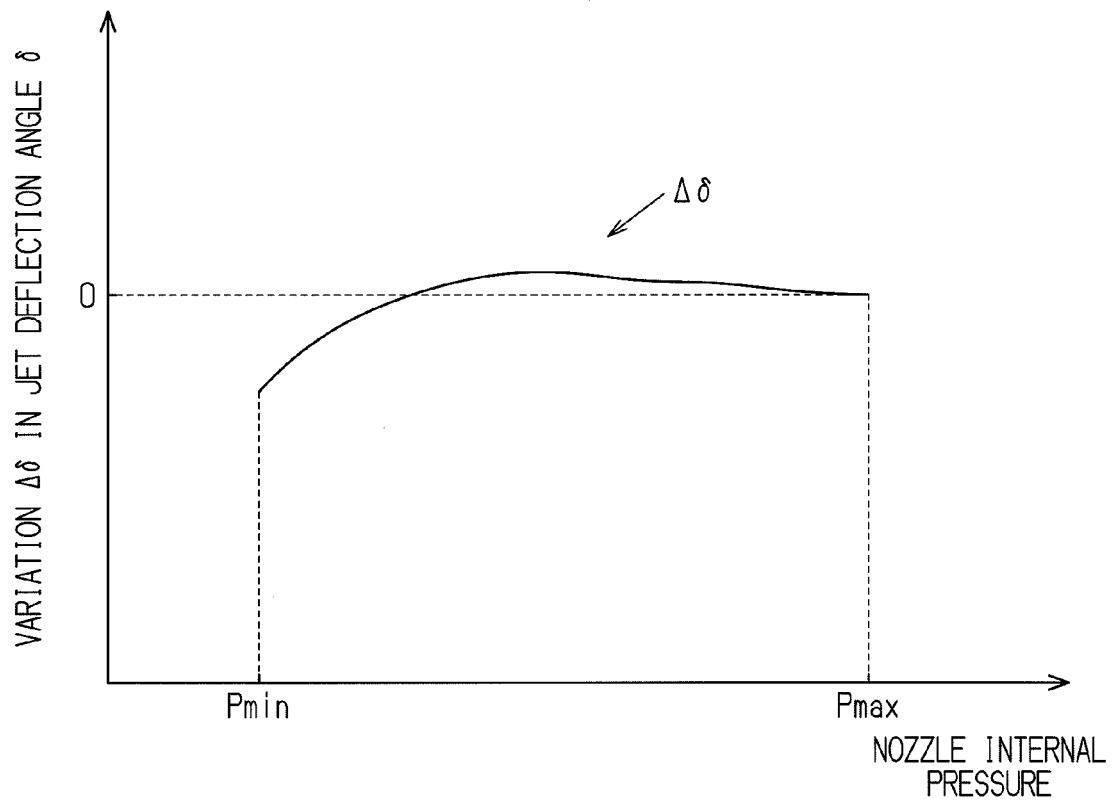


Fig.10



EUROPEAN SEARCH REPORT

Application Number
EP 11 17 8050

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	----- DE 37 20 492 C1 (DORNIER GMBH LINDAUER) 4 August 1988 (1988-08-04) * the whole document *	1-5	
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			D03D
Place of search		Date of completion of the search	Examiner
Munich		19 October 2011	Iamandi, Daniela
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ON EUROPEAN PATENT APPLICATION NO.**

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The members are as contained in the European Patent Office EDP file on
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19-10-2011

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