



(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 158(3) EPC

(43) Date of publication:

01.06.2005 Bulletin 2005/22

(51) Int Cl.7: **D03D 47/30**

(21) Application number: **03791191.4**

(86) International application number:
PCT/JP2003/009869

(22) Date of filing: **04.08.2003**

(87) International publication number:
WO 2004/020716 (11.03.2004 Gazette 2004/11)

(84) Designated Contracting States:

**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IT LI LU MC NL PT RO SE SI SK TR**
Designated Extension States:
AL LT LV MK

(72) Inventors:

- **OHARA, Tetsuya**
Otsu-shi, Shiga 520-0827 (JP)
- **BANBA, Hideki**
Nomi-gun, Ishikawa 923-1226 (JP)

(30) Priority: **29.08.2002 JP 2002251153**

(74) Representative:

von Samson-Himmelstjerna, Friedrich R. et al
SAMSON & PARTNER
Widenmayerstrasse 5
80538 München (DE)

(71) Applicant: **TSUDAKOMA KOGYO KABUSHIKI
KAISHA**
Kanazawa-shi, Ishikawa-ken 921-8650 (JP)

(54) **PICKING DEVICE OF WEAVING MACHINE**

(57) The present invention aims at further reduction of the consumption of a compressed fluid in a picking device (10) of a loom. The picking device (10) of the loom comprises at least one of sub-nozzle units (34) in which a sub-nozzle (22) and an electromagnetic switching valve (38) are connected in one-to-one relationship through a pipe (40) so that a compressed air can flow, and is **characterized by** defining the effective sectional area of a fluid channel (K1) from a fluid outlet (48) of a fluid supply source (36) to the input end (22b) of the sub-nozzle (22) of the pipe (40), the effective sectional area of a fluid channel (K2) from an input port (52) of the electromagnetic switching valve (38) to an output port (56) of the electromagnetic switching valve (38), the content volume of the fluid channel (K3) from the valve body side end of the valve seat opening (72) of the electromagnetic switching valve (38) to the input end (22b) of the sub-nozzle (22), or the content volume of the fluid channel (K4) from the valve body side end of the valve seat opening (72) of the electromagnetic switching valve (38) to the output port (56) of the electromagnetic switching valve (38) in a specific range.

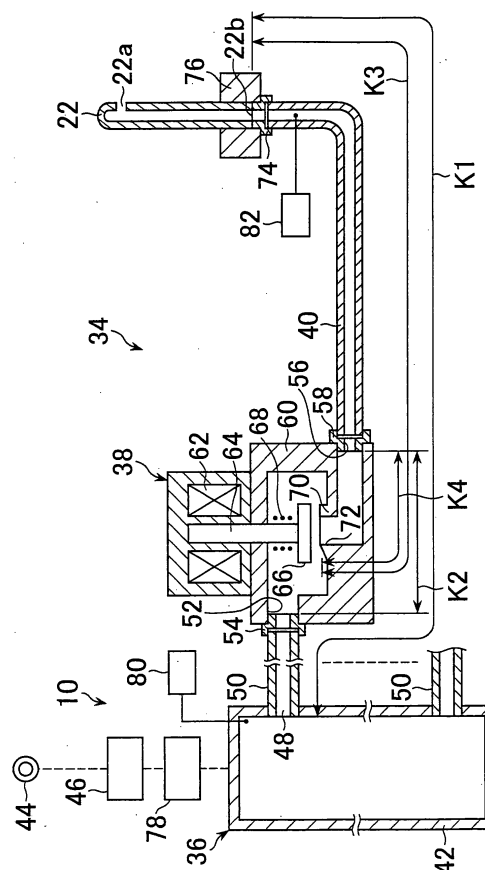


FIG. 2

Description

TECHNICAL FIELD

[0001] The present invention relates to a picking device of a loom, the device comprising one or more sub-nozzle units in which sub-nozzles and electromagnetic switching valves are connected through pipes in one-to-one relationship.

BACKGROUND ART

[0002] As examples of conventional picking devices of looms, arts described in the Official Gazettes of Japanese Patent Appln. Public Disclosures (KOKAI) No. 10-204750 and No. 57-210043 are known.

[0003] According to them, a picking device of a loom comprises one or more sub-nozzle units in which sub-nozzles and electromagnetic switching valves are communicated through pipes in one-to-one relationship, and a fluid supply source for supplying a compressed fluid to the electromagnetic switching valves.

[0004] These conventional arts have the electromagnetic switching valve corresponding to each sub-nozzle so as to be controlled individually and attempt to save consumption of the compressed fluid by setting the time for jetting the compressed fluid as well as the jet timing of the compressed fluid individually.

[0005] The above-mentioned conventional arts can reduce the consumption of the compressed fluid by controlling the time and the timing for jetting the fluid from each sub-nozzle. In recent energy-saving ages, however, further reduction in consumption of the compressed fluid is desired.

DISCLOSURE OF THE INVENTION

[0006] An object of the present invention is to realize further reduction in consumption of a compressed fluid of a picking device in a loom.

[0007] The inventors of the present application found that the consumption of the compressed fluid can be relatively easily reduced by setting an effective sectional area and a content volume of a fluid channel of each sub-nozzle unit within a predetermined range when the weft is inserted into warp shed, and invented the following technique.

[0008] Any one of the picking devices relative to the present invention comprises at least one sub-nozzle unit in which sub-nozzle and electromagnetic switching valve are connected through a pipe in one-to-one relationship.

[0009] A first picking device relative to the present invention further comprises a fluid supply source for supplying the compressed fluid to the electromagnetic switching valve of the sub-nozzle unit, wherein the effective sectional area of the fluid channel from a fluid outlet of the fluid supply source to an input end portion on the sub-nozzle side of the pipe is between 2.5 mm² and 3.5 mm², both inclusive.

[0010] In a second picking device relative to the present invention, the effective sectional area of the fluid channel from the input port of the electromagnetic switching valve to the output port of the electromagnetic switching valve is between 5 mm² and 15 mm², both inclusive.

[0011] In a third picking device relative to the present invention, the content volume of the fluid channel from the valve body side end portion of the valve seat opening of the electromagnetic switching valve to the input end of the sub-nozzle is between 2000 mm³ and 3000 mm³, both inclusive. The "content volume" herein means the volume of the inside of the fluid channel in the above-mentioned section.

[0012] In a fourth picking device relative to the present invention, the content volume of the fluid channel inside the electromagnetic switching valve from the valve body side end portion of the valve seat opening of the electromagnetic switching valve to the output port of the electromagnetic switching valve is 600 mm³ or less.

[0013] A fifth picking device relative to the present invention further comprises a fluid supply source for supplying the compressed fluid to the electromagnetic switching valve of the sub-nozzle device, wherein the effective sectional area of the fluid channel from the fluid outlet of the fluid supply source to the sub-nozzle side input end portion of the pipe is between 2.5 mm² and 3.5 mm², both inclusive, and the content volume of the fluid channel from the valve body-side end portion of the valve seat opening of the electromagnetic switching valve to the input end of the sub-nozzle is between 2000 mm³ and 3000 mm³, both inclusive.

[0014] In a sixth picking device relative to the present invention, the effective sectional area of the fluid channel from the input port of the electromagnetic switching valve to the output port of the electromagnetic switching valve is between 5 mm² and 15 mm², both inclusive, and the content volume of the fluid channel inside the electromagnetic switching valve from the valve body side end portion of the valve seat opening of the electromagnetic switching valve to the output port of the electromagnetic switching valve is 600 mm³ or less.

[0015] The result of the experiments conducted by the inventors has revealed that the effective sectional area and the content volume of the fluid channel in which the compressed fluid flows have a close relationship with the con-

sumption of the compressed fluid.

[0016] By setting the effective sectional areas or the content volumes of the fluid channels in which the compressed fluid flows at the values of the first through sixth picking devices, the consumption of the compressed fluid is reduced while the pressure and the jetting time of the compressed fluid jetted from the sub-nozzle are kept at proper values so that the weft may arrive at the non-weft insert side.

[0017] In particular, by providing at least one sub-nozzle unit in which sub-nozzle and electromagnetic switching valve are connected in one-to-one relationship through a pipe, the minimum jetting period corresponding to weft running can be set, and the resistance of the compressed fluid in the fluid channel can be controlled, so that the consumption of the compressed fluid is further reduced.

[0018] Also, according to the third through the sixth picking devices, since the content volumes of the fluid channels are set at the third to the sixth values mentioned above, the minimum jetting period corresponding to the weft running can be set, so that the residual pressure exhaustion (in other words, wasteful blowing) after the jetting of the compressed fluid jetted from the sub-nozzle is reduced, thereby saving the consumption of the compressed fluid.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Fig. 1 is a schematic view of the major portion of the picking device of a loom according to the present invention.

Fig. 2 is an enlarged schematic view of the sub-nozzle unit of the picking device of the loom shown in Fig. 1 and the major portion of the fluid supply source.

Fig. 3 is a graph showing the relation between the flow rate, the pressure loss and the consumption of the compressed air, relative to the effective sectional area of the first fluid channel from the fluid outlet for the compressed air from the fluid supply source to flow out to the end portion on the sub-nozzle side end of the pipe.

Fig. 4 is a graph showing the relation between the flow rate and the pressure loss of the compressed air, relative to the effective sectional area of the second fluid channel from the input port of the electromagnetic switching valve to the output port of the electromagnetic switching valve.

Fig. 5 is a graph for explaining the pressure waveform of the electromagnetic switching valve.

Fig. 6 is a graph showing the relation between the flow rate of the compressed air and the time for exhausting the residual pressure, relative to the content volume of the third fluid channel from the end portion on the valve body-side of the valve seat opening of the electromagnetic switching valve to the input end of the sub-nozzle.

Fig. 7 is a graph showing the relation of the consumption of the compressed air relative to the content volume of the fourth fluid channel inside the electromagnetic switching valve from the valve body side end portion of the valve seat opening of the electromagnetic switching valve to the output port of the electromagnetic switching valve.

BEST MODE FOR WORKING THE INVENTION

[0020] Referring to Figs. 1 and 2, the picking device 10 of a loom is used for an air jet loom which uses the compressed air, for example, as a fluid for weft insertion.

[0021] As shown in Fig. 1, in the air jet loom, the weft 14 wound around a weft package 12 is measured to be divided into a predetermined length by the length measurement and storage unit 16, engaged with the engagement pin device 18, and stored in the length measurement and storage unit 16 with the front end portion led into the main nozzle 20.

[0022] The weft 14 led into the main nozzle 20 is released for a certain period by an engagement pin device 18, jetted from the main nozzle 20 together with the compressed air and inserted into the shed of the warp 24 by the compressed air jetted from a plurality of sub-nozzles 22.

[0023] A release sensor 32 counts the number of times that the released weft 14 crossed a sensor region of the release sensor 32, and when it reached a predetermined number of times, engages the weft 14 again by the engagement pin device 18 and stores the weft 14 of a predetermined length by the length measurement and storage unit 16.

[0024] A portion of the inserted weft 14 is beaten by the reed 26 against the cloth fell of the cloth 28, cut off by the cutter 30 and cut away from the weft portion connected to the length measurement and storage unit 16 through the main nozzle 20.

[0025] As shown in Fig. 2, the picking device 10 to be used in an air jet loom comprises a plurality of sub-nozzle units 34 and a fluid supply source 36 for supplying the compressed air to the sub-nozzle units 34.

[0026] Each sub-nozzle unit 34 has the sub-nozzles 22 and electromagnetic switching valves 38 connected in one-to-one relationship through a sub-nozzle side pipe 40 and receives the compressed air from the fluid supply source 36 at the electromagnetic switching valve 38.

[0027] The fluid supply source 36 means one that supplies the compressed air to the electromagnetic switching valve 38; in other words, one that is in the upstream of the electromagnetic switching valve 38. In this figure, the fluid supply

source 36 is indicated by reference numeral 36, and for example, a tank 42 such as an air tank corresponds to it. The compressed air is supplied from a pressure source 44 such as a compressor to the tank 42 through a pressure regulator 46. The tank 42 as the fluid supply source 36 has the same number of fluid outlets 48 from which the compressed air flows out as the number of the electromagnetic switching valves 38.

[0028] The fluid outlet 48 of the fluid supply source 36 is formed by a tank side pipe 50 attached to the tank 42. The tank side pipe 50 is communicated to the electromagnetic switching valve 38 air-tightly through an input-side connector (inlet-said connector) 54 inserted into the input port 52 of the electromagnetic switching valve 38.

[0029] However, the tank side pipe 50 may be dispensed with, in which case the electromagnetic switching valve 38 is attached directly to the tank 42.

[0030] An output-side connector (outlet-said connector) 58 for making the inside compressed air flow out to the sub-nozzle side pipe 40 is inserted into the output port 56 of the electromagnetic switching valve 38.

[0031] The electromagnetic switching valve 38 generally includes an electromagnetic switching valve case 60, an annular exciting coil 62, an iron core 64 to be moved up and down by excitation or non-excitation of the exciting coil 62, a valve body 66 assembled into the lower end of the iron core 64, a compression spring 68 for applying the downward force to the valve body 66, and a valve seat 70 opposing the valve body 66.

[0032] The input port 52 and the output port 56 are communicated through a valve seat opening 72 formed inside the electromagnetic switching valve case 60. The compression spring 68 is disposed so that the valve body 66 comes into contact with the valve body-side end portion of the valve seat opening 72 to block the valve seat opening 72 when the exciting current is not supplied to the exciting coil 62 (when the exciting current is OFF).

[0033] The exciting coil 62 has a doughnut-like shape which enables to accommodate the upper end portion of the iron core 64. This exciting coil 62 is excited when the exciting current is supplied (when the exciting current is ON). By this, since the iron core 64 pulled upward, the compression spring 68 is compressed, and the valve body 66 is pulled up toward the exciting coil 62, resulting in opening the valve seat opening 72.

[0034] The exciting coil 62 is turned into a non-exciting state when the exciting current is not supplied. By this, the valve body 66 is moved toward the valve seat 70 and pressed against the valve seat 70 to block the valve seat opening 72 at its valve body-side end portion, by an accompanying force of the compression spring 68.

[0035] The sub-nozzle 22 is provided at its front end with a jet hole 22a for jetting the compressed air. The sub-nozzle 22 is communicated to the electromagnetic switching valve 38 through the sub-nozzle side pipe 40. The compressed air from the output port 56 of the electromagnetic switching valve 38 is supplied to the input end 22b of the sub-nozzle 22 through the sub-nozzle side pipe 40.

[0036] A sub-nozzle side connector 74 is air-tightly connected to the sub-nozzle side pipe 40, and air-tightly attached to the input end 22b of the sub-nozzle 22. A sub-nozzle support 76 is firmly assembled into a lead holder (not shown) which moves integrally with the reed 26 by a suitable fixture such as a bolt in a state of assembling the sub-nozzle 22.

[0037] In the picking device 10 as mentioned above, an investigation was conducted on the relation between the effective sectional areas as well as the content volumes of the first through fourth fluid channels K1 through K4 in which the compressed air flows and the consumption of the compressed air.

[0038] The first fluid channel K1 is a fluid channel from the fluid outlet 48 of the fluid supply source 36 to the input end 22b which is the end portion on the side of the sub-nozzle 22 of the sub-nozzle side pipe 40. The second fluid channel K2 is a fluid channel from the input port 52 of the electromagnetic switching valve 38 to the output port 56 of the electromagnetic switching valve 38, and more particularly, a fluid channel excepting a portion into which the input side connector 54 and the output side connector 58 are inserted. The third fluid channel K3 is a fluid channel from the valve body side end portion of the valve seat opening 72 of the electromagnetic switching valve 38 to the input end 22b of the sub-nozzle 22. The fourth fluid channel K4 is a fluid channel from the valve body side end portion of the valve seat opening 72 of the electromagnetic switching valve 38 to the output port 56 of the electromagnetic switching valve 38 (excepting a portion into which the output side connector 58 is inserted).

[0039] Also, in the following embodiments 1-4, the diameter of the jet hole 22a of the sub-nozzle 22 was set at 1.5 mm in all the embodiments.

(Embodiment 1: first picking device)

[0040] The flow rate of the compressed air and the difference in pressure, i.e., the pressure loss of the first fluid channel K1, when the effective sectional area of the first fluid channel K1 from the fluid outlet 48 of the fluid supply source 36 to the input end 22b of the sub-nozzle 22 was diversely varied, were measured. The conditions for the experiment and the method of measurement were as follows.

(Experiment 1-1: flow rate of compressed air)

[Conditions for experiment]

[0041] As a device to be tested (i.e., test device), in order to measure the flow rate and pressure loss of the picking device 10, a plurality of picking devices 10 provided with various first fluid channels K1 different in effective sectional areas were produced.

[0042] For effective sectional areas of each corresponding to the first fluid channel K1, two kinds of picking devices 10 which changed lengths and inner diameters of the sub-nozzle side pipe 40 or the electromagnetic switching valve 38 were prepared.

[0043] The value of the pressure of the compressed air of a pressure regulator 46 was made constant (0.5 MPa) throughout this experiment 1-1 and was not changed during the experiment.

[Method of measurement]

[0044] The respective flow rates of the compressed air were measured on the two kinds of the test devices for experiment by using a flow meter 78 provided between the pressure regulator 46 and the fluid supply source 36, and the average value of the flow rates of the compressed air obtained from these two test devices was adopted as the flow rate of the compressed air relative to the effective sectional area of the first fluid channel K1.

[0045] A tank side pressure sensor 80 was provided for measuring the inner pressure of the fluid supply source 36.

[0046] The "effective sectional area" herein is a synonym of "effective sectional area of a valve" in the JIS (Japanese Industrial Standards) terms for air pressure and hydraulics. According to its definition, it means "a sectional area in calculation by converting a pressure resistance into an equivalent orifice, based on an actual flow rate of a valve and used as an indication value of capability of the flow of an air pressure valve."

[0047] Accordingly, the effective sectional area of the first fluid channel K1 is the indication value representing the capability of the flow when the compressed air is discharged from the jet hole 22a of the sub-nozzle 22 of the sub-nozzle unit 34 communicated to the fluid supply source 36 in a state of choking flow, and a sectional area of an ideal contraction without any friction or contraction.

[Result of experiment]

[0048] The measurement result of the flow rate of the compressed air is shown in Fig. 3 by a line 101. As a result, the greater the effective sectional area of the first fluid channel K1, the more the flow rate of the compressed air. In other words, the supply pressure of the compressed air being the same in both cases, the greater the effective sectional area of the first fluid channel becomes, the more easily the compressed air flows.

(Experiment 1-2: pressure loss of compressed air)

[Conditions for experiment]

[0049] As the pressure values of the compressed air from the test device and the pressure regulator 46, the test device and the values used in experiment 1-1 were used, respectively.

[Method of measurement]

[0050] In order to measure the pressure loss, a tank side pressure sensor 80 was provided for measuring the internal pressure of the fluid supply source 36, and a nozzle side sensor 82 was provided in the neighborhood of the sub-nozzle side end portion of the sub-nozzle side pipe 40. As the pressure loss, a pressure difference obtained by subtracting the value of the measured pressure of the nozzle side pressure sensor 82 from the value of the measured pressure of the tank side pressure sensor 80 was used, and the average value of the pressure differences obtained from two kinds of the test devices for experiment pressure was adopted as the pressure loss with respect to the effective sectional area of the first fluid channel K1.

[Result of experiment]

[0051] The result of the measurement of the pressure loss is shown in Fig. 3 by a line 102. As a result, the greater the effective sectional area of the first fluid channel K1 becomes, the pressure difference decreased. That is to say, in view of this result and the result of experiment 1-1, the greater the effective sectional area of the first fluid channel K1

becomes, the compressed air can be more efficiently fed into the sub-nozzle 22. In other words, the greater the effective sectional area of the first fluid channel K1 becomes, the pressure which compresses the fluid inside the fluid supply source 36 can be made smaller, thereby lowering the set pressure of the pressure regulator 46.

(Experiment 1-3: consumption of compressed air)

[Conditions for experiment]

[0052] In order to measure the consumption of the pressure fluid of the picking device 10, a test device having the effective sectional area of the first fluid channel K1 used in the foregoing experiment 1-1 was prepared for each sub-nozzle, and each test device was attached to a loom to weave actually. The pressure of the compressed air from the pressure regulator 46 was set at the optimum value which enables to obtain jetting proper for picking with respect to two test devices having the same effective sectional area of the first fluid channel K1.

[0053] The set values of the loom were: the kind of the weft 14, polyester 84dtex; the cloth width, 170 cm; and the rotation frequency of main shaft of the loom, 800 rpm.

[Method of measurement]

[0054] The total consumption of the compressed air consumed by all the test devices when the loom was in operation was measured.

[Result of experiment]

[0055] The measurement result of the air consumption is shown in Fig. 3 by a line 103. As a result, when the effective sectional area of the first fluid channel K1 is 3.5 mm², the consumption of the compressed air becomes the minimum, while when the consumption of the compressed air increases or decreases from the value, the consumption of the compressed air increased.

[0056] The reason why the consumption of the compressed air increases when the effective sectional area of the first fluid channel K1 exceeds 3.5 mm² is considered to be that the content volumes of the electromagnetic switching valve 38 and the sub-nozzle side pipe 40 increase, thereby increasing the residual pressure exhaustion amount at the end of jetting of the compressed air of the sub-nozzle 22 ends.

[0057] When the effective sectional area of the first fluid channel K1 exceeds 3.5 mm², the electromagnetic switching valve 38 becomes larger and causes such problems as a space restriction for disposing the electromagnetic switching valve 38, and the electromagnetic switching valve 38 is costly; therefore, the effective sectional area of the first fluid channel K1 is preferably 3.5 mm² or less.

[0058] The effective sectional area of the first fluid channel K1 is determined according to the sectional area of each component of the first fluid channel K1. Consequently, the inner diameter and length of the sub-nozzle side pipe 40 are restricted by a quality (material) of the sub-nozzle side pipe 40, the location of the first fluid channel K1, etc. Furthermore, the inner diameter and length of the sub-nozzle side pipe 40 influence the pressure loss of the first fluid channel K1, the effective sectional area of the first fluid channel K1 depends on the inner diameter and length of the sub-nozzle side pipe 40. A result of study in terms of designing revealed that the lowest value of the effective sectional area of the first fluid channel K1 was 2.5 mm².

[0059] An example of the data obtained during this experiment is shown in the following. When the effective sectional area of the first fluid channel K1 was 6.6 mm² and the effective sectional area of the second fluid channel K2 was 3.6 mm², the consumption of the compressed air was 35.7 Nm³/H. On the other hand, when the effective sectional area of the first fluid channel K1 was 10 mm² and that of the second fluid channel K2 was 3.2 mm², the consumption of the compressed air was 32.9 Nm³/H. When comparing these two consumption amounts of the compressed air, it is understood that the consumption was 8.5 % lower in the latter than in the former.

[Summary of Embodiment 1]

[0060] From the results of experiments 1-1, 1-2 and 1-3, it was confirmed that the preferable effective sectional area of the first fluid channel K1 from the fluid outlet 48 of the fluid supply source 36 to the input end 22b of the sub-nozzle 22 of the sub-nozzle side pipe 40 is between 2.5 mm² and 3.5 mm², both inclusive.

(Embodiment 2: second picking device)

[0061] The range (the X-axis in Fig. 3) of the effective sectional area of the first fluid channel K1 obtained by the

experiments 1-1, 1-2 and 1-3 is converted, by using Formula (1), into the effective sectional area of the second fluid channel K2 from the input port 52 of the electromagnetic switching valve 38 to the output port 56 of the electromagnetic switching valve 38. Formula (1) can be changed to Formula (2).

$$\frac{1}{\bar{S}^2} = \frac{1}{S_1^2} + \frac{1}{S_2^2} + \dots + \frac{1}{S_n^2} + \frac{1}{S_x^2} \quad \text{Formula (1)}$$

$$S_x = \sqrt{\frac{1}{\frac{1}{\bar{S}^2} - \left(\frac{1}{S_1^2} + \frac{1}{S_2^2} + \dots + \frac{1}{S_n^2} \right)}} \quad \text{Formula (2)}$$

where $\bar{S}$ shows the total effective sectional area of the picking device 10; $S_1, S_2, \dots, S_n$ shows the effective sectional areas of the sub-nozzle side pipes 40 and connectors 54, 58, 74; and S_x shows the effective sectional area of the electromagnetic switching valve 38, respectively. Incidentally, the effective sectional area S_x of the electromagnetic switching valve 38 does not include the effective sectional area of a portion where the connectors 54 and 58 are to be inserted.

[0062] The result of the calculation of Formula (2) is shown in Fig. 4. In Fig. 4, the line 104 shows the pressure loss, and the line 105 shows the flow rate of the compressed air, respectively. From Fig. 4, it is understood that a range with a great flow rate of the compressed air and a small pressure loss of the compressed area is where the effective area S_x of the electromagnetic switching valve 38 is between 5 mm² and 15 mm², both inclusive.

(Embodiment 3: third picking device)

[0063] The time for exhausting the residual pressure and the flow rate, respectively, of the compressed air of the sub-nozzle unit 34, when the content volume of the third fluid channel K3 from the valve seat opening 72 of the electromagnetic switching valve 38 to the input end 22b of the sub-nozzle 22 were variously changed, were measured. The conditions for experiment and the method of measurement were decided as follows.

(Experiment 3-1: time for exhausting the residual pressure)

[Conditions for experiment]

[0064] As a test device, a plurality of picking devices 10 provided with various third fluid channels K3 having different content volumes were produced to measure the flow rate and pressure loss of the compressed air of the picking devices 10.

[0065] As for the picking devices 10 relative to respective content volumes of the third fluid channels K3, two kinds of them were prepared in which the lengths and inner diameters of the sub-nozzle side pipes 40 or the electromagnetic switching valves 38 were changed.

[0066] The set value of the supply pressure of the pressure regulator 46 was made a constant value (0.5 MPa) throughout the present experiment 3-1 and not changed halfway.

[Method of measurement]

[0067] In this experiment 3-1, the time for exhausting the residual pressure, after finishing of jetting of the sub-nozzle unit 34 when the content volume of the sub-nozzle unit 34 was varied, was measured.

[0068] The time for exhausting the residual pressure was computed, using a memory which stores signals of the electromagnetic switching valve 38 and signals of nozzle side pressure sensor 82, from their measured values.

[0069] The time for exhausting the residual pressure was defined as a time from when a closing output (stopping electricity to an exciting coil 62, i.e., turning off the exciting current) is commanded to the electromagnetic switching valve 38 till when the value of the nozzle side pressure sensor 82 is lowered to 50% of the maximum pressure before the command for the closing output (See Fig. 5). And the time for exhausting the residual pressure of test devices of which the third fluid channels K3 have the same content volume is measured respectively, the averaged value of the times for exhausting the residual pressure of the test devices of which the content volumes of the third fluid channels K3 are the same was defined as the time for exhausting the residual pressure relative to the content volume.

[Result of the experiment]

[0070] The relation between the content volumes of the third fluid channels K3 and the measured times for exhausting the residual pressure are shown by a line 106 in Fig. 6.

[0071] The greater the content volume of the third fluid channel K3, the longer the time for exhausting the residual pressure. The reason for this is considered: the greater the content volume of the third fluid channel K3 becomes, the exhaustion amount of the compressed air remaining within the fluid channel increases. Consequently, the smaller the content volumes of the third fluid channel K3, the smaller the consumption of the compressed air. In other words, the residual pressure jetting amount (the residual pressure exhaust amount after the compressed air jetting ended), which the compressed air remaining within the fluid channel K3 jets from the sub-nozzle 22, decreases.

(Experiment 3-2: Consumption of compressed air)

[Conditions for experiment]

[0072] In order to measure the consumption of the compressed air of the picking device 10, test devices having the content volumes of the third fluid channels K3 in the above-mentioned experiment 3-1 were produced and attached to looms, and actual weaving was carried out. The pressure of the compressed air from the pressure regulator 46 was set at an optimum value at which suitable jetting for weft insertion can be obtained from the sub-nozzle 22 relative to two test devices of which the content volumes from the third fluid channels K3 are the same.

[0073] As the set values of the looms, the kind of the weft selected was polyester 84dtex, the width of the cloth was 337 cm, and the rotation frequency of the main shaft of the loom was 750 rpm.

[Method of measurement]

[0074] For measuring the consumption of the compressed air, the consumption of the compressed air of all the sub-nozzles during operation of the looms was measured, similarly to the experiment 1-3. The total of the measured consumption was made the consumption of the compressed air.

[Result of the experiment]

[0075] The relation between the content volume of the third fluid channel K3 and the measured consumption of the compressed air is shown by a line 107 in Fig. 6.

[0076] It is recognized that, when the content volume of the third fluid channel K3 exceeds 3000 mm³, the consumption of the compressed air rapidly increases. Presumably, this is because some factors (e.g., the effective sectional area) other than the content volume of the third fluid channel K3 influences not a little.

[0077] To give an example of the data obtained during this experiment, the consumption of the compressed air was 65.8 Nm³/H when the content volume of the third fluid channel K3 was 3100 mm³ and when the content volume of the fourth fluid channel K4 was 1000 mm³. On the other hand, the consumption of the compressed air was 59.5 Nm³/H when the content volume of the third fluid channel K3 was 2500 mm³ and when the content volume of the fourth fluid channel K4 was 520 mm³, in the present invention. When these two consumption amounts of the compressed air are compared, it is understood that the latter is reduced by 10.5 % from the former.

[Summary of embodiment 3]

[0078] As a result of experiments 3-1 and 3-2, as shown in Fig. 6, the smaller the content volume of the third fluid channel K3, the smaller the consumption of the compressed air. The content volume is preferably 3000 mm³ or less.

[0079] To make the content volume of the third fluid channel K3 small, the inner diameter of the sub-nozzle side pipe 40 should be small; however, due to such a problem as a limit in strength of the sub-nozzle side pipe 40 and a pressure loss of the sub-nozzle side pipe 40, there is a lower limit of the inner diameter of the sub-nozzle side pipe 40. As a result of the inventors' study, the lower limit of the content volume of the third fluid channel K3 was set at 2000 mm³.

[0080] It is, therefore, understood that the content volume of the third fluid channel K3 from the valve body side end of the valve seat opening 72 of the electromagnetic switching valve 38 to the input end 22b of the sub-nozzle 22 is preferably between 2000 mm³ and 3000 mm³, both inclusive.

(Embodiment 4: fourth picking device)

[0081] The fourth fluid channel K4 from the valve seat opening 72 of the electromagnetic switching valve 38 to the

output port 56 of the electromagnetic switching valve 38 is a part of the third fluid channel K3. So, by subtracting the content volumes of the sub-nozzle side pipe 40 and connectors 58, 74 from the content volume of the third fluid channel K3, the content volume from the valve body-side end of the valve seat opening 72 of the electromagnetic switching valve 38 to the output port 56 can be obtained. That is to say, by using Formula (3), the range of the content volume (X-axis in Fig. 6) of the third fluid channel K3 obtained by experiments 3-1 and 3-2 is converted into the content volume of the fourth fluid channel K4 from the valve body side end of the valve seat opening 72 of the electromagnetic switching valve 38 to the output port 56 of the electromagnetic switching valve 38.

$$V_x = \bar{V} - (V_1 + V_2 + \dots + V_n) \quad \text{Formula (3)}$$

where $\bar{V}$ shows the content volume of the third fluid channel K3 from the valve body side end of the valve seat opening 72 of the electromagnetic switching valve 38 to the input end 22b of the sub-nozzle 22; $V_1, V_2, \dots, V_n$ show the content volumes of the sub-nozzle side pipe 40 and the connectors 58, 74; and V_x shows the content volume from the valve body side end of the valve seat opening 72 of the electromagnetic switching valve 38 to the output port 56. Incidentally, the content volume V_x of the electromagnetic valve 38 does not include the content volume of a portion where the output side connector 58 is to be inserted.

[0082] In Fig. 7, the consumption of the compressed air relative to the content volume provided by Formula (3) from the valve body side end of the valve seat opening 72 of the electromagnetic switching valve 38 to the output port 56 of the electromagnetic switching valve 38 is shown by a line 108. The proper range of the content volume V_x of the fourth fluid channel K4 is considered to be 600 mm³ or less.

(Embodiment 5: fifth picking device)

[0083] The consumption of the compressed air is reduced also by constituting a picking device and an electromagnetic switching valve which satisfy both the effective sectional area of the first fluid channel K1 and the content volume of the third fluid channel K3 as obtained in the above.

(Embodiment 6: sixth picking device)

[0084] Likewise, the consumption of the compressed air is reduced also by constituting a picking device and an electromagnetic switching valve which satisfy both the effective sectional area of the second fluid channel K2 and the content volume of the fourth fluid channel K4 as obtained in the above.

(Other picking devices)

[0085] Likewise, the consumption of the compressed air is reduced also by constituting a picking device and an electromagnetic switching valve which satisfy both the effective sectional areas of the first and second fluid channels K1, K2 and the content volumes of the third and fourth fluid channels K3, K4 as obtained in the above.

[0086] The foregoing picking devices can be applied to, besides the compressed air, compressed fluid having a similar property to the compressed air, as a result of which the consumption of the compressed fluid is reduced.

[0087] The present invention is not limited to the above embodiments and can be variously changed without departing from its spirit.

Claims

1. A picking device (10) of a loom comprising:

at least one of sub-nozzle units (34) in which a sub-nozzle (22) and an electromagnetic switching valve (38) are communicated in one-to-one relationship through a pipe (40); and
a fluid supply source (36) for supplying a compressed fluid to said electromagnetic switching valve (38);

wherein the effective sectional area of a fluid channel (K1) from a fluid outlet (48) of said fluid supply source (36) to an input end (22b) of said sub-nozzle (22) of said pipe (40) is between 2.5 mm² and 3.5 mm², both inclusive.

2. A picking device (10) of a loom comprising:

at least one of sub-nozzle units (34) in which a sub-nozzle (22) and an electromagnetic switching valve (38) are communicated in one-to-one relationship through a pipe (40);

wherein the effective sectional area of a fluid channel (K2) from an input port (52) of said electromagnetic switching valve (38) to an output port (56) of said electromagnetic switching valve (38) is between 5 mm² and 15 mm², both inclusive.

3. A picking device (10) of a loom comprising:

at least one of sub-nozzle units (34) in which a sub-nozzle (22) and an electromagnetic switching valve (38) are communicated in one-to-one relationship through a pipe (40);

wherein the content volume of a fluid channel (K3) from the valve body side end of the valve seat opening (72) of said electromagnetic switching valve (38) to an input end (22b) of said sub-nozzle (22) is between 2000 mm³ and 3000 mm³, both inclusive.

4. A picking device (10) of a loom comprising:

at least one of sub-nozzle units (34) in which a sub-nozzle (22) and an electromagnetic switching valve (38) are communicated in one-to-one relationship through a pipe (40);

wherein the content volume of a fluid channel (K4) from the valve body side end of the valve seat opening (72) of said electromagnetic switching valve (38) to an output port (56) of said electromagnetic switching valve (38) is 600 mm³ or less.

5. A picking device (10) of a loom comprising:

at least one of sub-nozzle units (34) in which a sub-nozzle (22) and an electromagnetic switching valve (38) are communicated in one-to-one relationship through a pipe (40); and
a fluid supply source (36) for supplying a compressed fluid to said electromagnetic switching valve (38);

wherein the effective sectional area of a fluid channel (K1) from a fluid outlet (48) of said fluid supply source (36) to an input end (22b) of said sub-nozzle (22) of said pipe (40) is between 2.5 mm² and 3.5 mm², both inclusive, and

wherein the content volume of a fluid channel (K3) from the valve body side end of the valve seat opening (72) of said electromagnetic switching valve (38) to an input end (22b) of said sub-nozzle (22) is between 2000 mm³ and 3000 mm³, both inclusive.

6. A picking device (10) of a loom comprising:

at least one of sub-nozzle units (34) in which a sub-nozzle (22) and an electromagnetic switching valve (38) are communicated in one-to-one relationship through a pipe (40);

wherein the effective sectional area of a fluid channel (K2) from an input port (52) of said electromagnetic switching valve (38) to an output port (56) of said electromagnetic switching valve (38) is between 5 mm² and 15 mm², both inclusive, and

wherein the content volume of a fluid channel (K4) from the valve body side end of the valve seat opening (72) of said electromagnetic switching valve (38) to an output port (56) of said electromagnetic switching valve (38) is 600 mm³ or less.

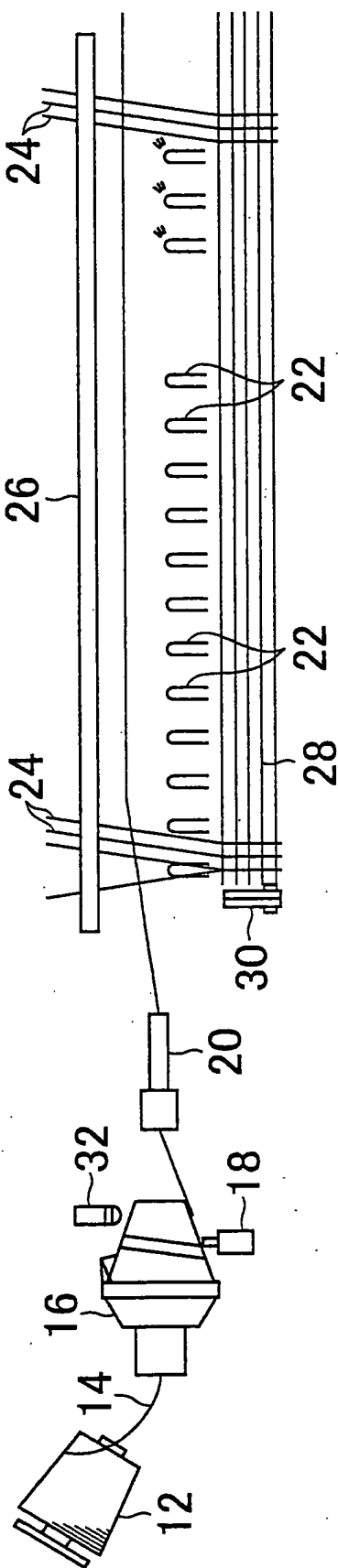


FIG. 1

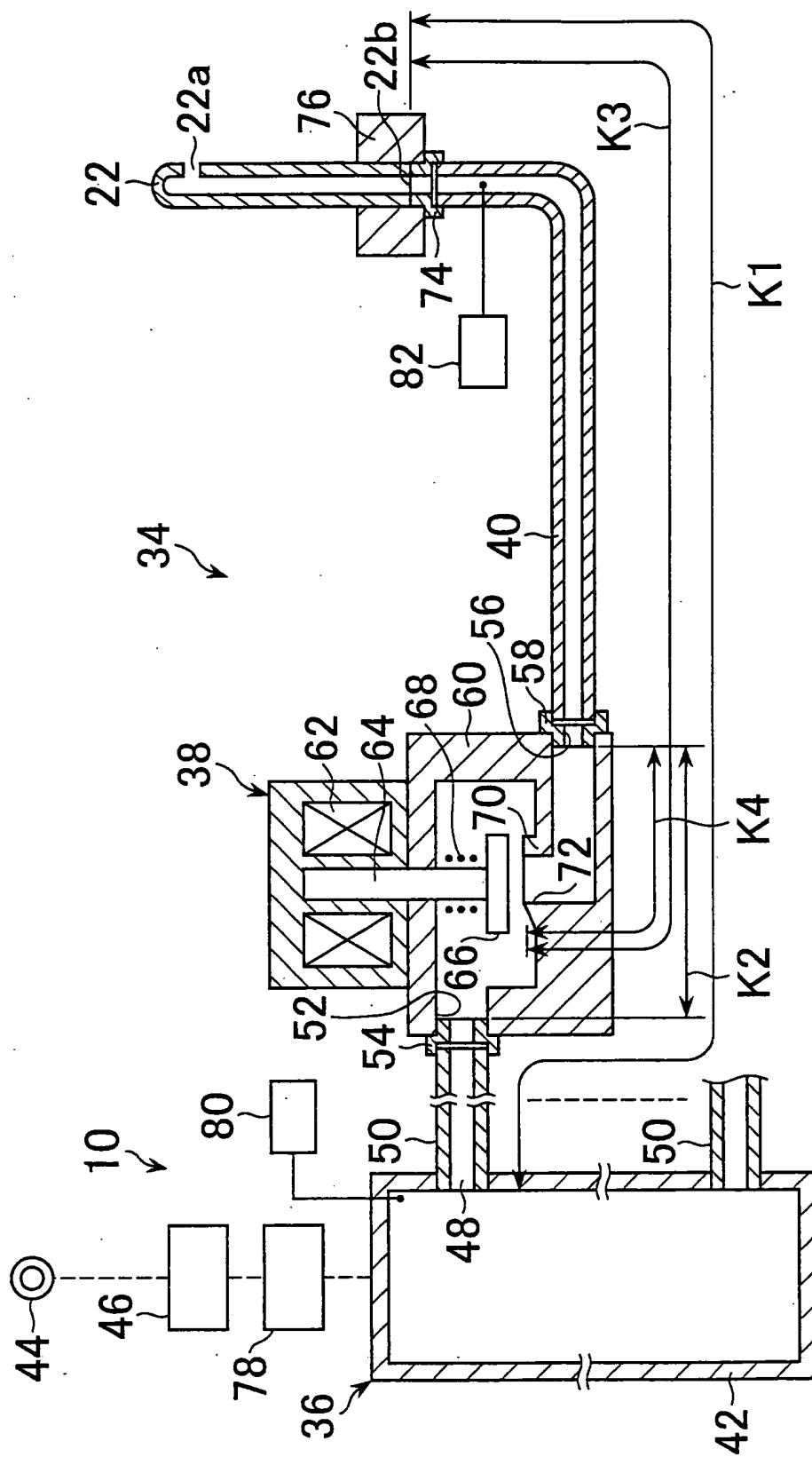


FIG. 2

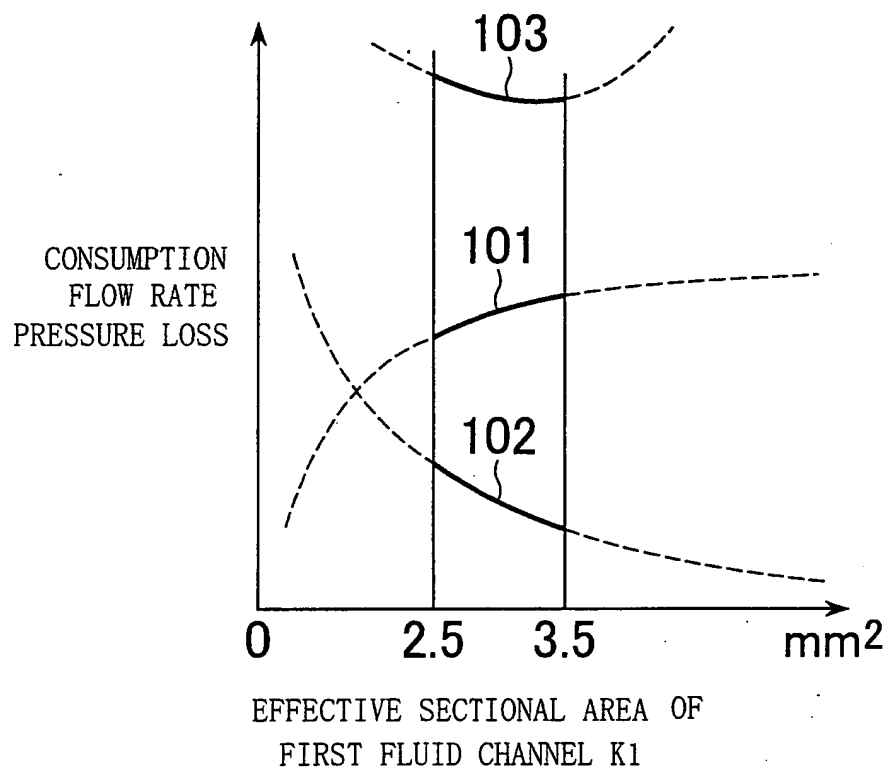


FIG. 3

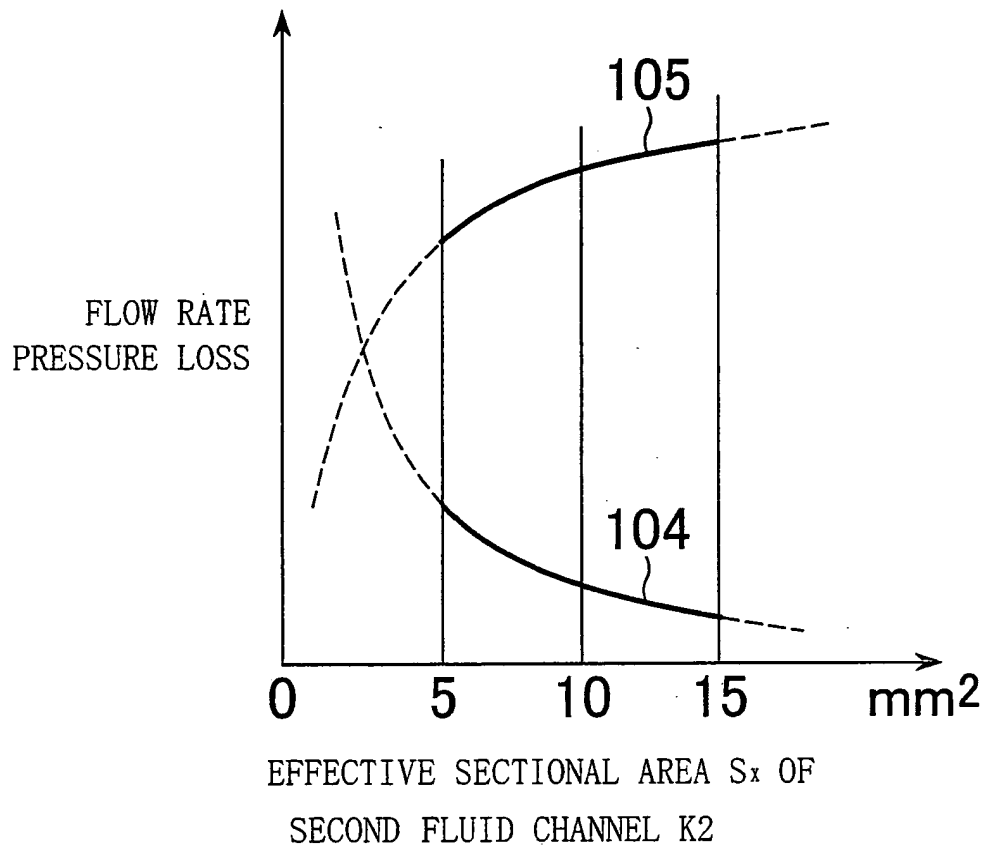


FIG. 4

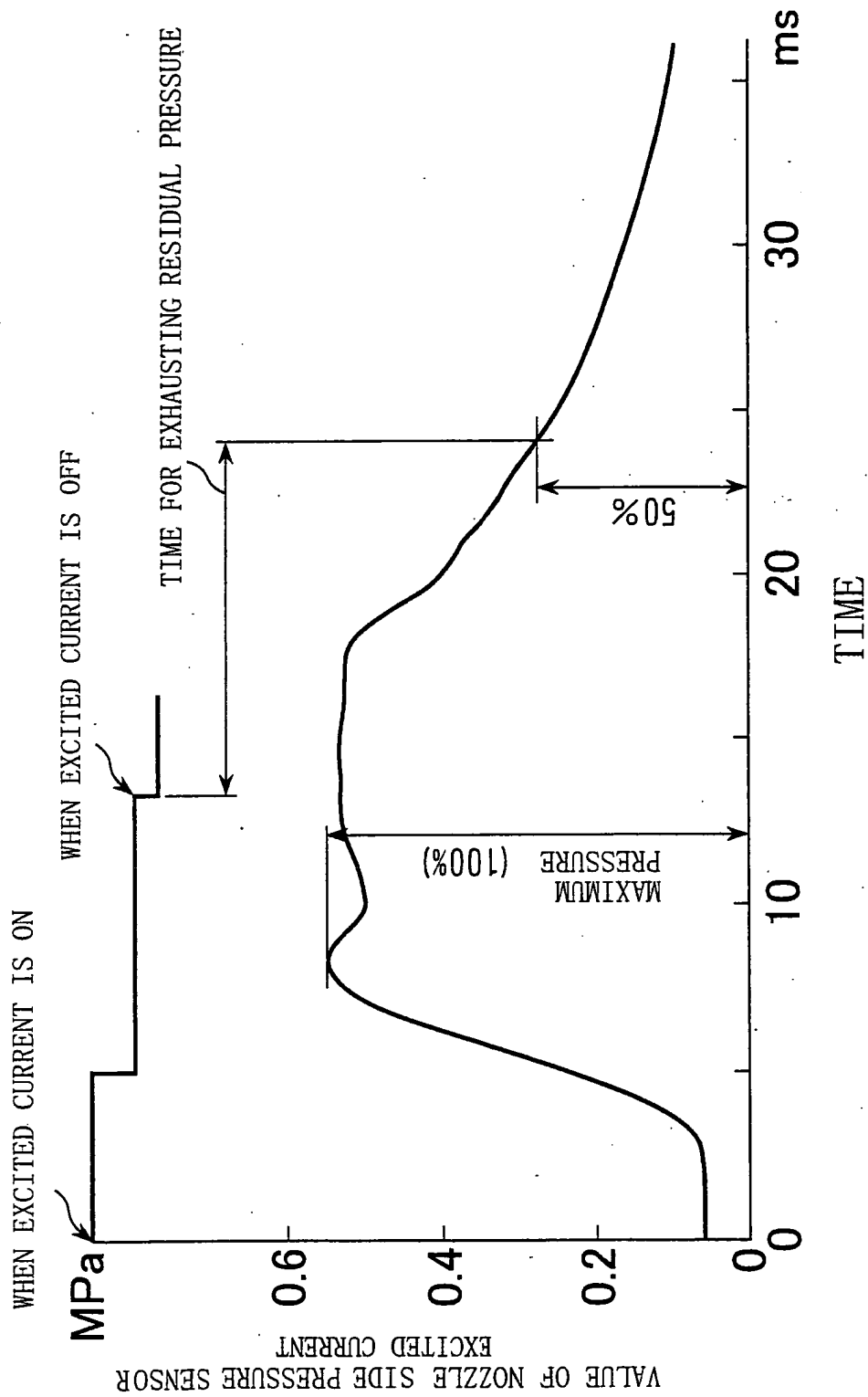


FIG. 5

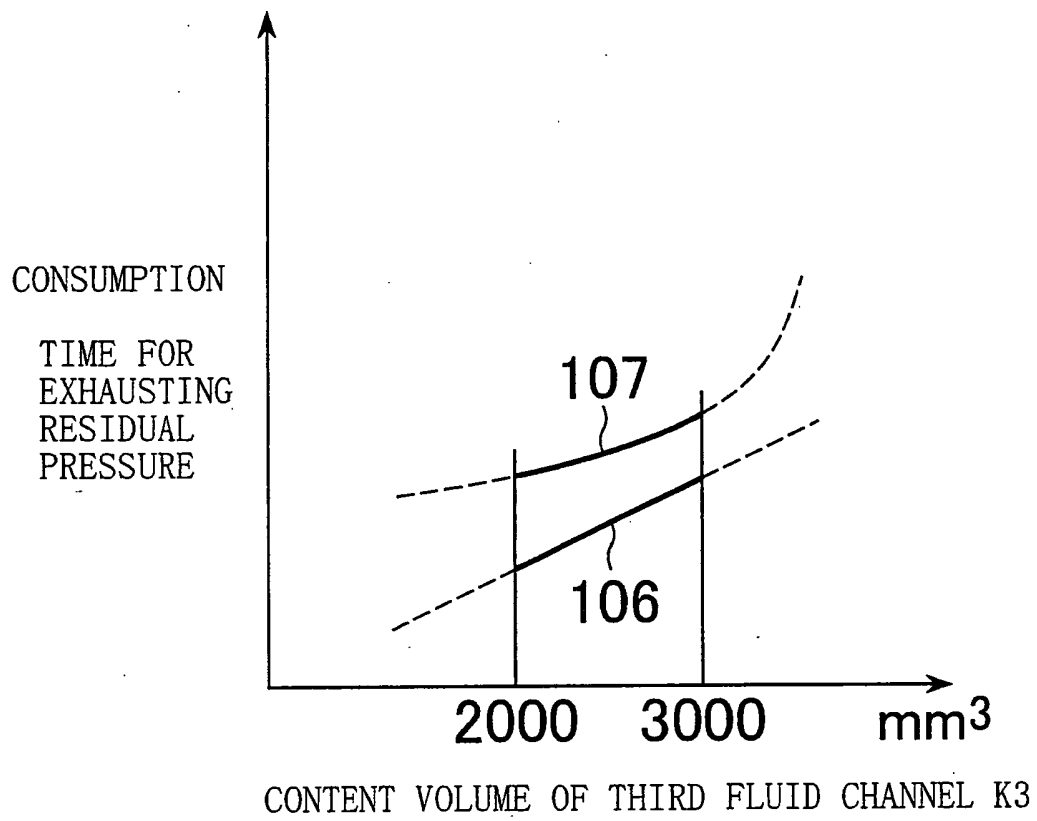


FIG. 6

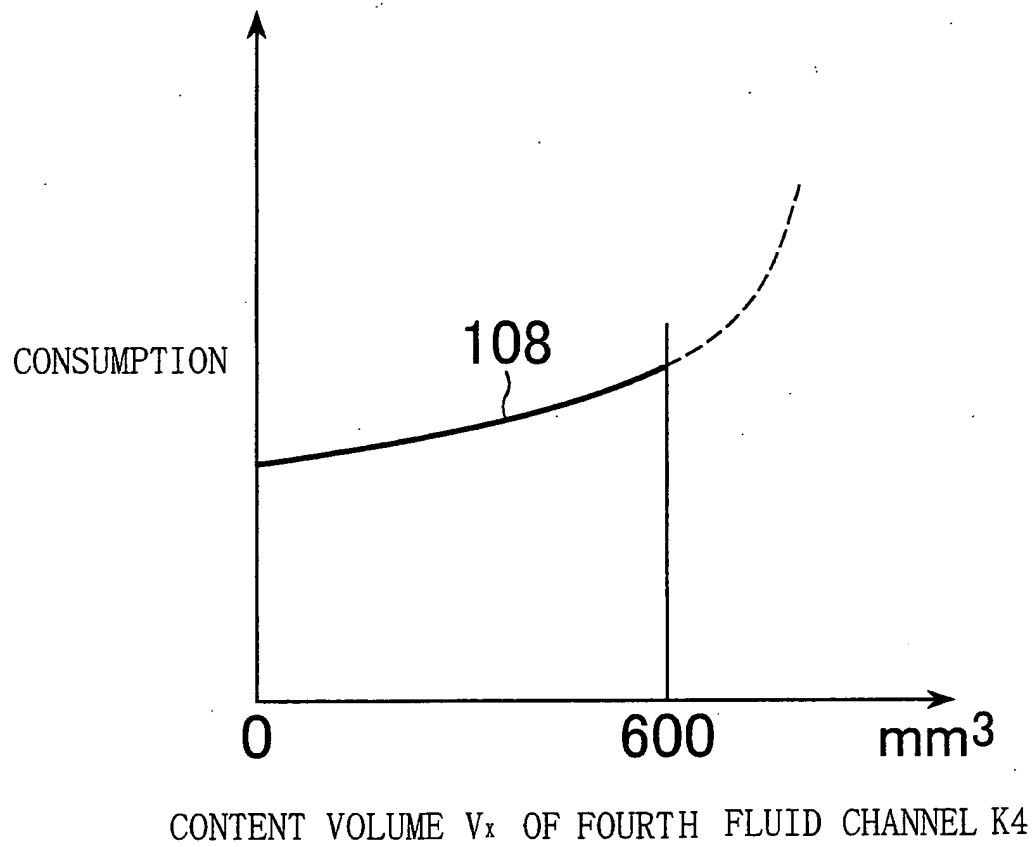


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP03/09869

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ D03D47/30		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) Int.Cl ⁷ D03D47/30		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2003 Kokai Jitsuyo Shinan Koho 1971-2003 Jitsuyo Shinan Toroku Koho 1996-2003		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 10-204750 A (Toyoda Automatic Loom Works, Ltd.), 04 August, 1998 (04.08.98), (Family: none)	1-6
Y A	JP 10-094769 A (SMC Corp.), 14 April, 1998 (14.04.98), (Family: none)	1, 2, 5, 6 3, 4
Y	JP 2000-096390 A (Toyoda Automatic Loom Works, Ltd.), 04 April, 2000 (04.04.00), (Family: none)	1-6
A	JP 5-222648 A (Asahi Chemical Industry Co., Ltd.), 31 August, 1993 (31.08.93), (Family: none)	1-6
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed		"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
Date of the actual completion of the international search 02 September, 2003 (02.09.03)		Date of mailing of the international search report 16 September, 2003 (16.09.03)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (July 1998)