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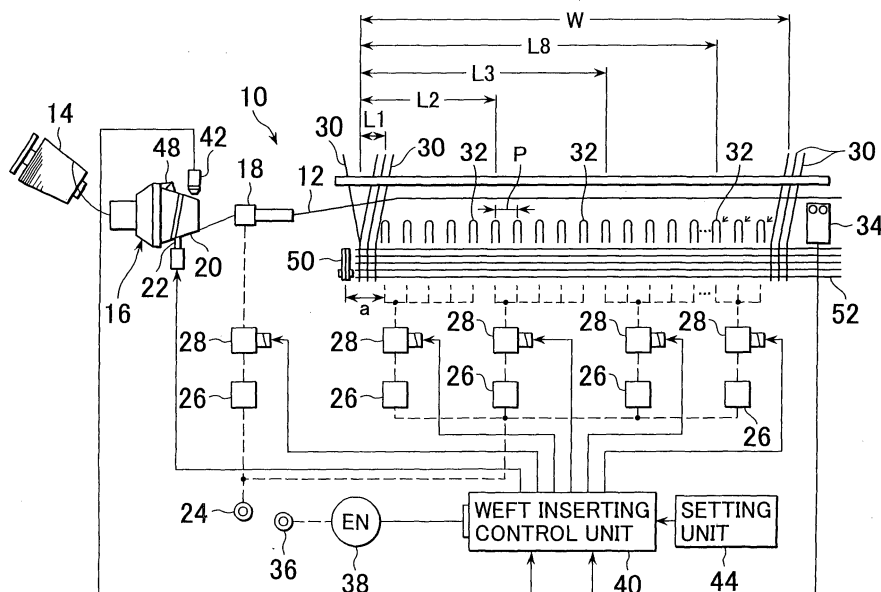
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(54) Method of calculating timing of weft picking and method of setting weft inserting condition in fluid jet loom

(57) A method of calculating the timing of weft picking is applicable to a fluid jet loom provided with a weft inserting nozzle (18) which is supplied with a pressure fluid enabling weft inserting to be normally performed and jets the pressure fluid together with a weft (12) at the weft inserting time, and a weft engaging member (22) for controlling the weft length, the weft engaging member (22) being arranged on the side of a weft length measuring storage unit (16) and releasing the weft in response to the start of jetting the fluid from the weft

inserting nozzle (18). The calculation method includes calculation of the timing for the weft to enter the warp shed based on the set values of the known weft inserting condition. The set values of the weft inserting conditions includes the jet start timing of the weft inserting nozzle (18), the weft release timing of the weft engaging member (22), and either the rotational number of the main shaft (36) of the fluid jet loom or the pressure value of the pressure fluid supplied to the weft inserting nozzle (18).

FIG.1



**Description**

## BACKGROUND OF THE INVENTION

## 1. Field of the Invention

**[0001]** The present invention relates to a method of calculating the timing of weft picking and a method of setting weft inserting condition, both being practicable in a fluid jet loom such as an air jet loom, a water jet loom or the like.

## 2. Description of the Prior Art

**[0002]** In a jet loom such as a fluid jet loom of the class wherein weft inserting is carried out by means of the fluid jetted from a nozzle, a weft is held in a device capable of measuring the length of the weft and storing the weft (referred to as "weft length measuring storage unit" hereinafter). At this time, the weft is in the state where the leading end portion of it is put into a weft inserting nozzle. At the time of starting the weft inserting, in other words, at the timing of weft picking, the weft is made free from a restrictive state caused by a weft engaging pin of the weft length measuring storage unit and is immediately inserted into a warp shed with assistance of the fluid jetting from the weft inserting nozzle.

**[0003]** The flying condition (weft inserting condition) of the weft varies depending on a sort of the weft as well as on the rotational number (r. p. m.) of the main shaft of the jet loom. Accordingly, the operator of the jet loom is requested to newly set the timing of weft picking whenever a sort of the weft and the rotational number of the main shaft have to be changed because of change in an objective fabric to be woven.

**[0004]** In the following, the procedure for setting the jet timing on the supplied pressure fluid of the weft inserting nozzle will be described by taking an air jet loom as an example of the fluid jet loom. In the air jet loom of this kind, the weft inserting is carried out by means of a relay jet of the pressure air as performed under the cooperation of a weft inserting nozzle (i.e. a main nozzle) into which the weft is put in advance and a plurality of sub-nozzles following it.

**[0005]** First of all, the weft flying start timing is determined, and then the jet start timing of the main nozzle and the release timing of the weft engaging pin are determined so as to correspond to the above weft flying start time. In the next, a weft inserting pattern graph (weft flying line) is made based on the jet start timing of the main nozzle, which is decided in order to set the jet timing of the sub-nozzle.

**[0006]** The abscissa of this pattern graph indicates a crank angle of the main shaft of the air jet loom while the ordinate of the same indicates a fabric width (a distance from one selvage on the main nozzle side to the other selvage on the side opposite thereto). The graph simply indicates the relation between the position of the leading end portion of the weft and the crank angle of the main shaft of the air jet loom in the form of a linear function i.e. a straight line.

**[0007]** The jet start timing of the sub-nozzle is set (decided) such that the jetting from the sub-nozzle starts preceding a crank angle (timing) determined from the above graph by a predetermined angle, the crank angle being given as an intersection of two lines, one line being a straight line (an imaginary flying line) drawn by connecting one point indicative of the timing of weft picking with the other point indicative of the timing of the objective weft arrival timing to the selvage on the side counter to the weft inserting side, and the other line being a normal line (a straight line in parallel with the abscissa) indicative of the position of the sub-nozzle.

**[0008]** The jet end timing for terminating the jetting from the nozzle is set as the time when a predetermined period of time has passed after from the jet start.

**[0009]** In the work for determining the jet timing like this, the worker will be able to determine the jet timing of each nozzle and others by drawing such a graph as mentioned above.

**[0010]** In the prior art as mentioned above, however, there sometimes happens that the timing of weft picking as obtained from the graph fails to coincide with the actual timing of weft picking. Because of this, in such a technique that the jet timing of the nozzle is set by using the timing of the weft picking, should the jet start timing of one sub-nozzle be set based on the timing of weft picking which is deviated from the actual timing of the weft picking, the jet start timing of the other sub-nozzles arranged on the downstream side of the one sub-nozzle is also deviated more or less. As a result, the weft inserting comes to end in failure.

**[0011]** To put it more in detail, if the jet start timing of the sub-nozzle is set based on the timing of weft picking which is deviated from the actual one, the weft flies up to a predetermined location of that sub-nozzle before it starts jetting the pressure air (fluid) in the process of the weft inserting, in other words, so-called insufficient preceding jet angle takes place. As the result of this, the weft goes into a stall and the weft inserting is apt to become unstable. In the opposite case to the above, that is, in case of the too early start of air jetting, the pressure air comes to be uselessly jetted from the sub-nozzle, which leads to the increase in the pressure air consumption amount.

**[0012]** Accordingly, in order to accurately set the jet start timing of the sub-nozzle, as the jet timing of the sub-nozzle is obtained based on the timing of weft picking and the objective weft arrival timing to the selvage, it is required to

obtain the accurate timing of weft picking most approximated to the actual measurement value of it.

**[0013]** Accordingly, in order to obtain the timing of weft picking with accuracy, it is preferable to actually measure it by using a proper means for example the stroboscopic flash technique. However, the measurement by using this technique is apt to become complex and difficult. Furthermore, it might be considered to use a sensor for detecting the timing of weft picking. However, this requires another space for installing it in the air jet loom and, moreover, the measuring instrument becomes expensive. These are problems to be avoided if possible.

**[0014]** On one hand, it is considered that the flying start timing of the weft, that is, the actual timing of weft picking is under the control of the jet start timing of the main nozzle and the release timing of the weft engaging pin.

**[0015]** Furthermore, there is such a case where the release timing of the weft engaging pin is set before or after the jet start timing of the main nozzle in response to the sort of the weft. In this case, the actual timing of weft picking is largely changed depending on whether the release timing of the weft engaging pin is set before or after the jet start timing of the main nozzle.

**[0016]** As the actual timing of weft picking is a parameter indicative of whether the setting of weft inserting (i.e. said set timing of the main nozzle and the weft engaging pin) is good or not, it is widely used not only for setting the jet timing of the sub-nozzle but also for adjustment of the weft inserting, as described above.

**[0017]** Accordingly, an object of the invention is to obtain the timing of weft picking most approximated to the actual value by calculation, based on the known weft inserting condition.

**[0018]** The inventors of this invention have invented the following method of calculation as a result of their best efforts.

## SUMMARY OF THE INVENTION

**[0019]** A calculation method according to the invention is applicable to calculation of the timing of weft picking in a fluid jet loom of the class

wherein there are provided a weft inserting nozzle which is supplied with a pressure fluid enabling normal weft inserting to be performed and jets the pressure fluid together with a weft in connection with a weft inserting command, and a weft engaging member for controlling the weft length, said weft engaging member being arranged on a weft length measuring storage unit and releasing the weft in connection with the fluid jet start by the weft inserting nozzle.

**[0020]** Such calculation method includes calculation of the timing of weft picking for the weft to enter a warp shed based on set values of known weft inserting conditions. Set values of the weft inserting conditions include the jet start timing of the weft inserting nozzle, the weft release timing of the weft engaging member, and either the rotational number of the main shaft of the fluid jet loom or the pressure value of the pressure fluid.

**[0021]** In the calculation method as mention above, the timing of weft picking is calculated based on set values of the known weft inserting condition, that is, the jet start timing of the weft inserting nozzle, the weft release timing of the weft engaging member, and either the rotational number of the main shaft of the fluid jet loom or the pressure value of the pressure fluid, which similarly affects the performance of accelerating the weft. Accordingly, even if the weft release timing of the weft engaging member is set earlier or later than the jet start timing of the weft inserting nozzle due to the sort of the weft, it is possible to obtain the timing of weft picking most approximated to the actual measurement value without carrying out actual measurement by means of the strobe flash technique.

**[0022]** With regard to the rotational number of the main shaft of the loom, based on which the timing of weft picking is calculated, the invention does not necessarily premise only the state where the loom is steadily operated. It adequately takes account of such a state that the loom is operated in a transition state, for instance, the state of starting up the loom, the state of changing the rotational number of the main shaft of the fluid jet loom, and so forth.

**[0023]** The weft engaging member may include at least either a weft engaging pin of the weft measuring storage unit of the fixed drum type or a clasper arranged between the weft length measuring storage unit and the weft inserting nozzle. Like this, if adopting a member actually concerned with the release of the weft as the weft engaging member, the timing of weft picking can be calculated with accuracy.

**[0024]** In case of using the rotational number of the main shaft of the fluid jet loom as one of set values of the weft inserting condition, the timing of weft picking can be calculated based on the following expression (1).

$$T = A \times x + B \times y + C \times z + D \quad (1)$$

**[0025]** On the other hand, in case of using the pressure value of the fluid pressure as one of set values of the weft inserting condition, the timing of weft picking can be calculated based on the following expression (2).

$$T = A \times x + B \times y + E \times z + F \quad (2)$$

**[0026]** In the above expressions (1) and (2), each alphabetical sign stands for as follows:

T: the timing of the weft picking  
 x: the jet start timing of the weft inserting nozzle  
 y: the weft release timing of the weft engaging member  
 z: the rotational number of the main shaft of the fluid jet loom;  
 v: the pressure value of the pressure fluid, and  
 A, B, C, D, E and F: predetermined coefficients.

**[0027]** If the timing of weft picking is calculated by using the above expressions (1) and (2), it becomes possible to obtain the almost same timing of weft picking as that which is attained by actual measurement using the strobe flash technique

**[0028]** A plurality of values of coefficients A, B, C, D or A, B, E, F in the above expressions (1) and (2) are set in advance corresponding to at least either the sort of the weft or the thickness of it, and when calculating the timing of weft picking, predetermined coefficients are selected corresponding to at least either the sort of the weft or the thickness of it.

**[0029]** A plurality of values of coefficients A, B, C, D or A, B, E, F in the above expressions (1) and (2) are set in advance corresponding to at least either the sort of the weft inserting nozzle or the number of it, and when calculating the timing of weft picking, predetermined coefficients are selected corresponding to at least either the sort of the weft inserting nozzle or the number of it.

**[0030]** Therefore, even though there is variously changed the sort of the weft for weft inserting or the thickness of it, or the sort of the weft inserting nozzle or the number of it, the timing of weft picking most approximated to the actual measurement value can be obtained by only selecting coefficients which are stored in advance in response to the above change and applying those coefficients to the expressions (1) and (2).

**[0031]** A method of setting weft inserting condition according to the invention is for use in a fluid jet loom of the class wherein there are provided a plurality of sub-nozzles are arranged so as to pass through the warp shed and the jet start timing of one or more sub-nozzles is calculated based on the timing of weft picking which is calculated according to any one of the calculation methods as mentioned above. With this method, it becomes possible to easily judge whether the weft inserting condition setting is properly adjusted or not and further, and also it becomes possible to properly set the jet timing of the sub-nozzle.

**[0032]** In the method of setting weft inserting condition as described above, the jet start timing of each sub-nozzle may be calculated according to the following expression (3):

$$SV(i) = T + (L(i) \times (TG - T - G)/W) - H \quad (3)$$

wherein;

i: a group number of the sub-nozzle counted from the side of the weft length measuring storage unit  
 SV(i): a jet start timing of the sub-nozzle in the ith sub-nozzle group  
 T: timing of weft picking  
 L(i): a distance up to the ith sub-nozzle group from the selvage on the side of the weft length measuring storage unit  
 TG: objective weft arrival timing  
 G: a coefficient for compensating the weft arrival timing dispersion  
 W: a reed drawing-in width, and  
 H: a coefficient for compensating preceding angle of jet start timing.

**[0033]** A proper setting value of the jet timing of the sub-nozzle group can be obtained by calculating the jet start timing of sub-nozzle based on the above expression (3).

**[0034]** The form of the sub-nozzle group is determined based on how many sub-nozzles a switching valve manages, for instance one form wherein a switching valve is provided corresponding to each of sub-nozzles, in other words, on the basis of the one-to-one correspondence and the other form wherein one switching valve manages two or more sub-nozzles, in other words, on the basis of the one-to-multiple correspondence. Besides, the number of the objective sub-nozzle groups of which the jet timing is to be set, may be only one sub-nozzle, plural sub-nozzles, or all of them. To put it more concretely, in case of setting the jet timing of one or more specific sub-nozzle groups, it may be possible to set the jet timing of only the nozzle group on the side near the weft length measuring storage unit or only the nozzle group on the side near the side opposite to the weft inserting side by making use of the above calculation method. In this case, the jet timing of remaining sub-nozzle groups may be set manually.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0035]**

Fig. 1 is a diagram schematically showing the system of a loom capable of executing a method of calculating the timing of weft picking and a method of setting a weft inserting condition according to the invention,  
 Fig. 2 is a perspective view showing an external appearance of a setting unit as shown in Fig. 1,  
 Fig. 3 is a block diagram showing an internal circuit of a setting unit as shown in Fig. 2,  
 Fig. 4 is a flowchart showing procedures for setting the timing of weft picking and a weft inserting condition in a loom as shown in Fig. 1,  
 Fig. 5 is a diagram showing an image as displayed on the display screen of a setting unit as shown in Fig. 2,  
 Fig. 6 is a diagram showing another image as displayed on the display screen of a setting unit as shown in Fig. 2,  
 Fig. 7 is a diagram showing still another image as displayed on the display screen of a setting unit as shown in Fig. 2,  
 Fig. 8 is a diagram showing still another image as displayed on the display screen of a setting unit as shown in Fig. 2,  
 Fig. 9 is a diagram showing still another image as displayed on the display screen of a setting unit as shown in Fig. 2,  
 Fig. 10 is a diagram showing still another image as displayed on the display screen of a setting unit as shown in Fig. 2,

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[Description on Weft Inserting in Jet Loom]

**[0036]** A fluid jet loom 10 as shown in Fig. 1, in which a method of calculating the timing of weft picking and a method of setting weft inserting condition according to the invention are practicable, is assumed as an air jet loom which adopts the compressed air as a pressure fluid. Accordingly, in the following description, the thing explicitly indicating or related to the fluid jet loom 10 may be expressed as "an (or the) air jet loom 10" or merely "an (or the) air jet loom" or "a (or the) loom 10" except claim recitations.

**[0037]** Referring to Fig. 1, a weft 12 extending from a weft package 14 is wound around the fixing drum 20 of a weft length measuring storage unit 16 (referred to "weft length measuring storage drum 20" hereinafter) and is stored there after its length is measured. The leading end portion of the weft 12 is inserted into the weft inserting nozzle i.e. a main nozzle 18, which blows off the weft 12 by means of the compressed air supplied thereto and jetted therefrom.

**[0038]** The weft length measuring storage unit 16 winds the weft 12 around the weft length measuring storage drum 20, controls the weft by a weft engaging pin 22 such that the weft once wound around the drum 20 is not unwound therefrom as long as the weft engaging pin 22 works effectively. The weft engaging pin 22 is constituted so as to engage with the drum 20 to control the length of the weft to be unwound therefrom. The weft engaging pin 22 is operated by an electromagnetic solenoid. At the weft inserting time, the weft length measuring storage unit 16 disengages the weft engaging pin 22 from the drum 20, thereby the weft 12 being unwound from the drum 20 by a length (unwinding turns of the drum 20) necessary for one weft inserting operation. Instead of the weft engaging pin 22, however, it may be possible to arrange a clamber (not shown) between the weft length measuring storage unit 16 and the main nozzle 18 to clamp the weft 12, thereby enabling the clamber to substantially act as a weft engaging member. In this embodiment, the weft length measuring storage unit 16 uses the clamber together with the weft engaging pin 22. To unwind the weft 12 from the weft length measuring storage drum 20 and to make the weft 12 free from the clamber is described by commonly using a term "release" and derivatives of it hereinafter.

**[0039]** If the clamber is used as the weft engaging member together with the weft engaging pin 22, the timing of disengaging the weft engaging pin 22 and the release timing of the weft from the clamber are compared with each other and the later timing is defined and used as the weft release timing.

**[0040]** A pool-case and an RDP are known as a weft length measuring storage unit using the clamber. These units measure the length of the weft by a length measuring roller and then, hold and store the measured weft in the air stream by clamping it until the weft inserting starts.

**[0041]** The main nozzle 18 is connected with a compressed air supply source 24 through several fluid control members. The compressed air from the compressed air supply source 24 is supplied to the main nozzle 18 through a pressure regulator 26, an air tank (not shown), and an electromagnetic switching valve 28. The compressed air supplied to the main nozzle 18 inserts the weft 12 into a warp shed formed by a lot of warps divided into two warp groups 30 made up of upper and lower warp groups. In the example as shown, the main nozzle 18 is firmly, immovably but detachably fitted to a reed slay (not shown) which is equipped with a reed 46.

**[0042]** Furthermore, a plurality of sub-nozzles 32 are also fitted to the above reed slay in the same manner as the main nozzle 18, that is, they are also firmly, immovably but detachably fitted to the reed slay. These sub-nozzles jets the weft only for further energizing the flying force of the weft. These sub-nozzles 32 are provided along the weft flying course and are divided into a plurality of sub-nozzle groups in the weft inserting direction from the warp shed on the

weft inlet side toward the warp shed on the weft outlet side such that each of sub-nozzle groups includes the respectively designed number of sub-nozzles.

**[0043]** In the air jet loom 10 as shown in Fig. 1, the sub-nozzles 32 are divided into 8-sub-nozzle groups, which we call the first sub-nozzle group, the second sub-nozzle group, ..., the seventh sub-nozzle group and the eighth sub-nozzle group, in the order from the weft inserting side, respectively. Each of the first through the seventh sub-nozzle groups includes five sub-nozzles while the eighth sub-nozzle group includes three sub-nozzles.

**[0044]** The pressure air from the pressure air supply source 24 is supplied to sub-nozzles 32 constituting each sub-nozzle group through the pressure regulator 26, the air tank and the electromagnetic switch valve 28, each of which corresponds to each sub-nozzle group on the basis of the one-to-one correspondence. Therefore, this makes it possible to set the pressure of the pressure air supplied to the sub-nozzle groups on the group by group basis. However, there are not always necessary for the pressure regulator 26 to be arranged so as to correspond to the sub-nozzle group on the one-to-one basis. For example, one pressure regulator 26 may be arranged so as to manage a plurality of sub-nozzle groups or entirety of the sub-nozzle groups. The same thing can be said about the air tank.

**[0045]** It has been described so far that the weft engaging pin 22 and the switching valve 28 are driven by an electromagnetic means such as an electromagnetic solenoid. However, the invention is not limited to this driving system. For example, it is possible to use a mechanical driving system and other driving systems.

**[0046]** A weft filler 34 and a stretch nozzle (not shown) are provided on the side opposing to the weft feeding side such that both of them are firmly, immovably, but detachably fitted to the reed slay. The weft filler 34 detects that the leading end portion of the weft 12 is rightly inserted up to the final position thereof, and the stretch nozzle jets the pressure air for giving tension to the weft 12 having been inserted into the warp shed.

**[0047]** The rotational angle of the main shaft 36 of the air jet loom 10 is detected at a real time by an encoder 38 and the detected angle is transmitted to a weft inserting control unit 40 as a crank angle signal.

**[0048]** Receiving the crank angle signal from the encoder 38, a weft release signal from a weft release sensor 42, and a weft arrival signal from the weft filler 34, the weft control unit 40 controls, with proper timing, the weft engaging pin 22, respective switching valves 28 for the main nozzle and sub-nozzle groups, and also the switching valve for the weft stretch nozzle, based on the weft inserting condition which is set in advance by a setting unit 44.

**[0049]** The main shaft 36 of the air jet loom being turned, the reed 46 is driven to start beating up through a crank mechanism (not shown) and others. In the beating-up process, therefore, the main nozzle 18, a plurality of sub-nozzles 32 and the weft filler 34 are moved toward the cloth fell side along with the reed 46.

**[0050]** At the weft length measuring time, the weft length measuring storage drum 20 is engaged with the weft engaging pin 22. At this stage, if a yarn guide 48 of the weft length measuring storage unit 16 is turned to go round the drum 20 by a predetermined number of times, the weft 12 is wound around the circumferential surface of the drum 20 and stored there. The leading end portion of the weft 12 is previously inserted into the main nozzle 18 such that the leading end portion projects from the end on the weft outlet side of the main nozzle 18.

**[0051]** At the weft inserting time, as the weft engaging pin 22 is disengaged from the weft length measuring storage drum 20, the weft 12 comes in a state where it is ready to be released from the drum 20. In this state, the weft 12 is jetted out of the main nozzle 18 along with the pressure air toward the warp shed to be inserted therein, and then, the leading end portion of the weft 12 flies toward the opposite side to the weft inserting side with the help of the relay jet performed by a plurality of sub-nozzle groups.

**[0052]** The weft release sensor 42 detects the weft 12 unwound and released from the above drum 20 and transmits the weft release signal to the weft inserting control unit 40.

**[0053]** Receiving the weft release signal from the weft release sensor 42, the weft inserting control unit 40 counts the weft release signal to examine and confirm whether or not the weft is rightly released by a predetermined length equivalent to one weft picking length. If confirmed, the electromagnetic solenoid is driven to engage the weft engaging pin 22 with the weft length measuring storage drum 20, thereby preventing the weft 12 from being further released from the drum 20. In this way, the weft inserting is carried out with the weft 12 having a length which is rightly measured so as to be equivalent to one weft picking length.

**[0054]** When the leading end portion of the weft gets in the position where the weft filler 34 is arranged, the weft filler 34 detects the weft 12 and transmits a signal telling that the weft inserting has been duly completed to the weft inserting control unit 40.

**[0055]** At the beating-up time, the portion of the weft 12 as has been inserted into the warp shed formed by warps 30 is moved toward the cloth fell by the reed 46 and is then beaten up against the cloth fell finally. At this time, the leading end portion of the weft 12 as has been inserted into the warp shed is further blown away by the pressure air current from a stretch nozzle (not shown) which is arranged outside the last one warp 30 on the opposite side to the weft inserting side, thereby tension being given not only to the leading end of the weft 12 but also to the other portion of the weft 12 having been inserted into the warp shed.

**[0056]** After beating-up operation, the weft 12 is cut by a cutter 50 and separated from the fabric being woven.

## [Description on Setting Unit]

**[0057]** Referring to Fig. 2, a setting unit 44 has a box shaped appearance as a whole and includes a display 54 arranged on the front side of it. The display 54 is able to display the state of the setting unit 44. There is no specific limitation about the type of a display as far as it can visually display necessary information. Accordingly, various type displays may be used if available, for example, displays of the liquid crystal panel type, of the liquid crystal touch panel type, of the CRT type, or others. In the following, there will be described about the embodiment wherein a display of the liquid crystal type touch panel is used as an example of the display 54.

**[0058]** Furthermore, on the left side of the setting unit 44, there is formed an opening portion for inserting and taking out a memory card 56. The memory card 56 as inserted into the opening portion 58 is exchangeably connected with a card interface 60 (referred to as "card I/F" hereinafter) as shown in Fig. 3.

**[0059]** A program for automatically setting coefficients A, B, C, D, E, F and the jet timing of the sub-nozzle in correspondence with the sort of a weft is renewably set up in the setting unit 44. The memory card 56 is utilized for renewing the program for setting the jet timing of the sub-nozzle corresponding to the weft sort, and is also utilized for reading the record of set values corresponding to the same.

**[0060]** Furthermore, there are shown on the left side of the display 54 (Fig. 2) five operational menu keys 62 of the push button type as aligned vertically. Each of five menu keys 62 is provided with a label put on the upper side of each operational menu key 62 indicative of respective sorts of them. These labels read "Host", "Operate", "Set", "Preserve", and "Weave" in order from upside to downside.

**[0061]** Furthermore, eight function keys 64 are laterally aligned at a short distance from the lower side of the display 54 to be in parallel therewith. Each of eight function keys 64 has a length of about 1/8 of the lower side of the display 54. Each of eight function keys 64 is given a sign, which reads " $f \cdot 1$ ", " $f \cdot 2$ ", ..., " $f \cdot 8$ " in order from left to right.

**[0062]** The cursor key 66 acting as an input means is located on the underside of the eight function keys 64. The cursor key 66 is used for moving the cursor appearing on the screen of the display 54 in the desired direction within the range of the screen.

**[0063]** There are arranged on the right side of the cursor key 66 thirteen keys in total, each of which acts as an input means. Twelve keys among them form a group of keys which is called a ten-key set 68. This ten-key set 68 is arranged about the right lower corner on the front face of the setting unit 44 as shown in Fig. 2. Twelve keys of the ten-key set 68 are arranged in the form of a matrix of 4-row by 3-column. A remaining key is separately located near the left side of the above 12-key matrix and is given a sign "CLR" (=clear). Three keys each in the three rows from the first to third rows of the 12-key matrix are given numerical signs "1", "2" ... "9" while signs "0", ".", and "ENT" (=enter) are given to three keys in the fourth row, respectively.

**[0064]** Fig. 3 shows an internal circuit 70 as used in the setting unit 44. The internal circuit 70 includes the display 54, the card I/F 60, an input unit 72 in the form of a keyboard which includes various keys 62, 64, 66 and 68 as described above, a central processing unit (referred to as "CPU" hereinafter) 74, an input and output port (referred to "I/O port" hereinafter) 76 connected with the CPU 74, and a main memory (referred to as "memory unit" hereinafter) 78 connected with the CPU 74.

**[0065]** The CPU 74 is connected with the card I/F 60, the display 54, the input unit 72 and the weft control unit 40. The CPU 74 is also connected with the memory unit 78 through an internal wiring.

**[0066]** The operator can interactively input various values for setting the weft inserting condition by properly operating the cursor key 66 as well as the ten-key set 68 to numerically input necessary values in response to various image forms as displayed on the display screen.

**[0067]** Operating the above operational menu keys 62, the operator is able to have the display 54 displayed various information relating to the information on the operational state, the preservation state, the weaving state and others with regard to the air jet loom 10. Besides, the setting unit 44 is connected with various units (not shown) other than the weft inserting unit of the air jet loom, for example, a let-off motion for controlling the tension given to the warp, a take-up motion for controlling the intermittent or continuous winding-up of the woven fabric, a main control unit for controlling the entire operation of the air jet loom such as the start and stop motion thereof. Therefore, the setting unit 44 is constituted such that it can interactively input suitable set values to each of the above units by carrying out the interactive input in the same manner as described above.

## [Description on Timing Calculation of Timing of Weft Picking and Setting of Weft Inserting Condition]

**[0068]** The calculation of timing of weft picking and the setting of the weft inserting condition are carried out according to the steps as shown in Fig. 4 by mean of the setting unit 44.

[Input Request on Parameter: Step 1]

**[0069]** Pushing the "Setting" button of the operational menu keys 62 of the setting unit 44, the air jet loom operator calls an image 80 as shown in Fig. 5 on the screen of the display 54 and inputs the values of various parameters as indicated in the image 80 to the setting unit 44 in the way as will be described later (Step 1). The image 80 corresponds to the case where an air jet loom for use in the 4-color weft inserting is used for the 2-color weft inserting.

**[0070]** In the uppermost space (headline space) of the image 80, there are indicated a headword "Basic Setting: Weft" relating to contents now to be set, and the date and time as "2002, 03, 13. 12:25", illustratively.

**[0071]** In the wide space under the above headline space of the image 80, there are enumerated various objective items to be set (referred to as "set item" or "set items" hereinafter). In the uppermost portion of the above wide space, there are laterally aligned a plurality of set items "Weft Color", "Weft Sort", "Release Number", "Weft Picking (°)", "Objective Weft Arrival (°)", and "Fluid Pressure MPa", which respectively indicate a weft color (number of the main nozzle), a weft sort, the number (turns) of release, a picking timing, an objective arrival angle and a fluid pressure with regard to each weft. The value (set value) of each set item corresponding to the weft color is inputted to a corresponding rectangular frame. In the example as shown in Fig. 5, as the air jet loom is set in advance for 2-color weft inserting use, only rectangular frames corresponding to weft colors "C1" and "C2" are filled up with set values as inputted.

**[0072]** With regard to the set item "Weft Sort", the information on various sorts of the weft, for example "chemical fiber filament yarn", "strong twisted yarn", "cotton yarn 20/1S", "cotton yarn 40/1S", "cotton yarn 50/1S" and so forth is stored in advance in the memory unit 78. Therefore, the operator is able to obtain necessary information thereabout from the memory unit 78 by using the cursor 66.

**[0073]** The weft is made up of various elements as known well. However, some of them give an ill influence to the weft flying characteristic in the weft inserting process. The following are considered as ill elements like that, for instance, the raw material of the weft, the thickness of it, the doubling ratio of it, the cross sectional shape of it, whether it twist-treated or not, whether it is stretch-treated or not, whether or not it has received sizing or oiling treatment, and so forth. Accordingly, the weft sort may be set in detail on the basis of every element or only selected elements which are deemed to cause such ill influence with ease.

**[0074]** Each of signs "C1" to "C4" vertically aligned below the set item "Weft Color" is an ordinary number given to each of 4-color wefts to be inserted into the warp shed. However, in the example as shown in Fig. 5, as only 2-color wefts are used, rectangular frames corresponding to "C3" and "C4" are kept in blank. The set value of the timing (start timing) of weft picking is indicated in the rectangular frames vertically aligned below the set item "Weft Picking (°)". This timing of weft picking is determined by using the rotational angle of the main shaft of the loom as a scale. The set value of the objective weft arrival timing is indicated in the rectangular frames vertically aligned below the set item "Objective Weft Arrival (°)". This objective weft arrival timing is determined also by using the rotational angle of the main shaft of the loom as a scale. The set value of the fluid pressure supplied to the main nozzle is indicated in the rectangular frames vertically aligned below the set item "Fluid Pressure MPa".

**[0075]** Three set items "Reed Drawing-in Width (cm)", "Number of Sub-nozzles" and "Rotational Number of Loom (r. p. m.)" are laterally aligned in the about middle portion of the wide space of the image 80. Each set value of these three set items is indicated in each rectangular frame next to each of these three set items. The set item "Reed Drawing-in Width (cm)" indicates the width of the fabric to be woven, in other ward, a distance W from one selvage to the other as shown in Fig. 1. The set item "Rotational Number of Loom (r. p. m.)" indicates the rotational number of the main shaft of the loom 10.

**[0076]** Below the above three set items, there are indicated another three set items: "Sub-nozzle (G)" indicative of an identification number given to each sub-nozzle group, "Pitch (mm)" indicative of a distance P between adjacent sub-nozzles 32 as shown in Fig. 1, and the "Number of Sub-nozzles" indicative of the number of sub-nozzles constituting each sub-nozzle group.

**[0077]** "Release Number" indicates the turning number of the weft length measuring storage drum 20 necessary for releasing or unwinding the weft 12 by a length needed for carrying out one weft picking. The jet start timing of the sub-nozzle is set by making use of the value as set with regard to each of set items "Objective Weft Arrival (°)", "Fluid Pressure MPa", "Reed Drawing-in Width (cm)", and "Number of Sub-nozzles", and further making use of the set value of set items "Number of Sub-nozzles" and "Pitch (mm)" with respect to the sub-nozzle group.

**[0078]** In the lowest portion of the image 80, there are displayed another function key menu plainly describing each function of function keys 64. The function key menu laterally enumerates each name of eight keys which read "Change", "Detail Setting", "Weft Inserting", "Timing", "Contrast", "Weft Bar Prevention", "Automatic Weft Inserting" and "Picking Calculation" from left to right of the image 80. These correspond to keys "f · 1", "f · 2", ..., "f · 8" of the function keys 64 of the setting unit 44.

**[0079]** Operating the cursor key 66, pushing one of the function keys 64, and then selecting and touching one of the function menu keys appearing on the screen of the display 54, the operator can display an image corresponding to the selected function menu key.

**[0080]** Besides, the operator operates the cursor key 66 to move the cursor on the image 80 to a predetermined rectangular frame of the set item "Weft Sort" and selects an objective yarn sort. Furthermore, the operator operates the cursor key 66 to move to each rectangular frame of set items "Release Number", "Weft Picking (°)", "Objective Weft Arrival (°)", and "Fluid Pressure MPa" corresponding to "C1" to "C4" of the set item "Weft Color". Then, the operator

inputs necessary values to each of the rectangular frames by using the ten-key set 68. With this, the Step 1 is completed. **[0081]** Fig. 5 shows a state where the set item "Weft Sort" are set to be a value of "cotton 40/1S" equally for "C1" and "C2", the set item "Release Number" is set to be a value of 3 equally for "C1" and "C2", the set item "Objective Weft Arrival (°)" is set to be a value of 210 equally for "C1" and "C2", and the set item "Fluid Pressure MPa" is set to be values of 0.30 and 0.29 so as to correspond to "C1" and "C2", respectively.

**[0082]** Furthermore, the reed drawing-in width, the number of sub-nozzle and the rotational number of the main shaft of the loom 10 are actually set to be 170 cm, 8 nozzles, and 800 r. p. m., respectively. Accordingly, Fig. 5 shows that the same setting is rightly done in the setting unit 44.

**[0083]** In the example as shown in Fig. 5, "cotton 40/1S" is selected as a sort of the weft. Accordingly, if the operator selects "Automatic Weft Inserting" from the function key menu and touches it for automatically setting the sub-nozzle jet timing, the CPU 74 reads, from the memory unit 78, pertinent values for coefficients A, B, C and D of an expression (1) necessary for calculating the timing of weft picking, that is,  $A=0.415$ ,  $B=0.585$ ,  $C=0.003$  and  $D=10.9$  (see Table 2 to be described later) in correspondence with the weft sort "cotton 40/1S". Incidentally, "40" in "cotton 40/1S" corresponds to the thickness of the weft, which concretely means the "yarn number count 40" according to the Japanese-style cotton count. Also, "1S" corresponds to a so-called single yarn, and in case of using two yarns, it is indicated as "2S".

[Input of Weft Inserting Condition: Step 2]

**[0084]** The operator pushes the function key "f · 3" assigned to the menu "Weft Inserting" to change the image 80 now on the screen of the display 54 as shown in Fig. 5 to an image 82 as shown in Fig. 6, and then inputs the weft inserting condition by operating keys of various sorts (Step 2).

**[0085]** In the headline space of the image 82 as shown in Fig. 6, contents now to be set are displayed. In this example, there are described [Setting of Timing for Weft Inserting], [Main 1~4], and the date "2002, 03, 13, 12:25".

**[0086]** In the middle part of the image 82, there are displayed a plurality of rectangular frames corresponding to each of the wefts [C1] ~ [C4], respectively. A set value regarding the timing of weft inserting is inputted to a predetermined rectangular frame.

**[0087]** In the lowest part of the image 82, there are displayed another function key menu which plainly indicates respective functions of function keys 64. The function key menu laterally enumerates eight keys of which the names are "Change", "Sub\_1", ..., "Sub\_4", "Main 5~ 8", "Automatic Setting" and "Picking Calculation" from the left to the right of the image 82. These correspond to keys "f · 1", "f · 2", ..., "f · 8" of the function keys 64 of the setting unit 44.

**[0088]** Each timing (ON and OFF) of set items "Weft engaging pin", "Main", "Auxiliary Main" and "Cutting" is set on the basis of the rotational angle of the main shaft 36 of the loom with regard to each of weft colors [C1]~[C4].

**[0089]** "ON" and "OFF" of the set item "Weft engaging pin" indicate the release timing and the stop timing of the weft 12 as stored around the weft length measuring storage drum 20, respectively. The set item "Main" stands for the main nozzle 18, and "ON" and "OFF" of it indicate the jet start timing and the jet end timing of the main nozzle, respectively. The set item "Auxiliary Main" stands for an auxiliary nozzle which is provided between the clamber and the main nozzle 18 in the same way as the main nozzle 18 into which the weft 12 is inserted. "ON" and "OFF" of set item "Auxiliary Main" indicate the jet start timing and the jet end timing of it, respectively.

**[0090]** Fig. 6 indicates a state where "ON" and "OFF" of the set item "Weft engaging pin" are set to be values of 60 and 180, "ON" and "OFF" of the set item "Main" are set to be values of 70 and 190, "ON" and "OFF" of the set item "Auxiliary Main" are set to be values of 70 and 190, and "ON" and "OFF" of the "Cutting" are set to be values of 320 and 30, respectively with regard to weft colors [C1] and [C2].

**[0091]** The set item "Cutting" indicates the jet timing of the main nozzle 18 for preventing the weft 12 tensioned at the beating-up time from slipping out of the main nozzle 18 when the weft 12 is cut by the cutter 50. "ON" and "OFF" of the set item "Cutting" indicate the start and end timing of the air jet from the main nozzle 18, respectively, at the time of cutting the weft 12 by the cutter 50.

**[0092]** The function key menu "Sub\_1", ..., "Sub\_4" indicate that an image for setting the jet timing of the sub-nozzles corresponding to the "C1" to "C4" of the set item "Weft Color" can be called on the display screen by operating function keys "f · 2", ..., "f · 5".

**[0093]** The condition as described above can be set by using the cursor key 66 and the ten-key set 68 after touching the corresponding key of the function keys 64.

[Calculation of Timing of weft picking: Step S3]

**[0094]** Setting the condition in the way as described above, the operator pushes the function key "f · 8" assigned to the menu "Picking Calculation" to instruct the CPU 74 to calculate the timing of weft picking by means of the main nozzle 18. At this time, the operator can explicitly select either an expression (1) or (2) for obtaining the timing of weft picking T.

**[0095]** The timing of weft picking is calculated by means of the expression (1) or (2) based on the values which have been already inputted by using images 80 and 82 with regard to the jet start timing of the main nozzle 18, the weft release timing by the weft engaging pin 22, and the rotational number as set of the main shaft 36 of the loom 10 or the pressure value of the pressure fluid.

$$T = A \times x + B \times y + C \times z + D \quad (1)$$

$$T = A \times x + B \times y + E \times v + F \quad (2)$$

wherein,

- T: timing of weft picking,
- x: jet start timing of main nozzle,
- y: weft release timing of weft engaging member,
- z: rotational number of main shaft,
- v: pressure value of pressure fluid, and
- A, B, C, D, E and F: coefficients selected at the time of calculating the timing of weft picking.

**[0096]** The expression (1) is obtained by replacing the pressure value v of the pressure fluid of the expression (2) by the rotational number z of the main shaft. If the rotational number of the main shaft 36 is set high, a period of time during which the warp shed is kept open is made short. Therefore, the weft 12 is required to complete its flight as fast as possible and the pressure value of the pressure fluid for flying the weft 12 is required to be set at a high value. In other words, as the rotational number z of the main shaft and the pressure value of the pressure fluid necessary for the weft inserting are mutually related with each other, the rotational number of the main shaft 36 is determined from the pressure value of the pressure fluid necessary for the weft inserting without any other condition. Accordingly, as described above, the expression (1) is obtainable by replacing the pressure value v of the pressure fluid jetted from the main nozzle 18 of the expression (2) with the rotational number z of the main shaft.

**[0097]** Predetermined coefficients A, B, C, D, E and F are calculated and memorized in advance based on the sort or the thickness of the weft as well as on the sort or the number of the main nozzle 18. Calculation is carried out according to a method as described later by using values as actually measured in advance.

**[0098]** If the switching valve 26 is driven by the electromagnetic actuator, an issue of delay, so-called delayed response issue, is caused with regard to the movement of the switching valve, that is, the delayed valve movement caused by that the valve can not completely open or close as soon as it receives a signal for opening or closing the valve (i.e. switching signal) from the weft control unit 40. In case of the loom 10 according to this embodiment, however, there is provided a means (e.g. delayed response compensating software of the built-in type) which can compensate such delayed response and drive the electromagnetic actuator for the switching valve 26 at the timing of weft inserting as calculated by means of the above expression (1) or (2). Therefore, there is no need for such response delay to be considered with respect to expressions (1) and (2) as well as their coefficients.

**[0099]** The timing of weft picking as calculated by means of the above expression (1) or (2) can be confirmed by displaying the image for setting the weft inserting condition as shown in Fig. 5 or images as shown in Figs. 6 and 7 described later. The operator may make use of the timing of weft picking obtained from these images for setting the weft inserting condition as the jet condition of the weft inserting nozzle of the weft inserting unit in the other loom.

**[0100]** In the example as shown in Fig. 6, with respect of both weft colors "C1" and "C2", "ON" of the set item "Weft engaging pin" indicative of the weft release timing of the weft engaging member is evenly set to be a value of 60 and "ON" of "Main" indicative of the jet start timing of the main nozzle 18 is evenly set to be a value of 70. Accordingly, the values of x and y in the expression (1) are x=70 and y=60, respectively. Besides, the timing of weft picking T with regard to the weft colors "C1" and "C2" equally becomes:

$$T = 0.415 \times 70 + 0.585 \times 60 + 0.003 \times 800 + 10.9 = 75.29 \square 75^{\circ}$$

[Selection of Automatic Calculation of Jet Timing of Sub-nozzle: Step S4]

**[0101]** If the operator prefers not to automatically set the jet timing of sub-nozzles, he may proceed to the Step S5. If he likes to do it automatically, he may proceed to the Step S6.

[Display of Calculation Results: Step S5]

**[0102]** If the operator pushes the function key "f · 1" of function keys 64 assigned to the menu "Change", he can display the image 80 as shown in Fig. 5 and confirm a value of 75 of the calculated timing of weft picking T.

**[0103]** The value of the calculated timing of weft picking T is also displayed in the corresponding rectangular frame of the set item "Weft Picking (°)" in the image 80. With this, the operator can judge whether the setting of the weft inserting unit is good or not, based on the value of the timing T. However, the operator may do such that the image now on the display screen is automatically changed to the image 80 as shown in Fig. 5 after completing the calculation of the timing of weft picking, thereby displaying the calculated value of the timing of weft picking T in the corresponding rectangular frame of the set item "Weft Picking (°)".

**[0104]** Furthermore, when the operator prefers to manually set the jet timing of each sub-nozzle, he first pushes the function key "f · 3" assigned to the menu "Weft Inserting" in the image 80 (Fig. 5) in order to change the image 80 to the image 82 (Fig. 6). Then, if he further pushes function keys "f · 2" and "f · 3" respectively assigned to the menu keys "Sub\_1" and "Sub\_2" on the image 82, he is guided to an image 84 (see Fig. 7) displaying various set values of the jet timing of various sub-nozzles corresponding to the weft colors "C1" and "C2".

**[0105]** Fig. 7 shows the image 84 displaying various values as set now of the jet timing of various sub-nozzles with regard to the weft color "C1". In the headline space of the image 84, contents now to be set are displayed. In this example, [Setting of Timing of Weft Inserting], [Sub\_Color-1] and the date "2002, 03, 13, 12:25" are shown in the headline space.

**[0106]** The most wide middle space of the image 84 displays the jet start timing "ON" and the jet end timing "OFF" for each of sub-nozzle groups in case of the weft color "C1". Respective values of the jet start timing and jet end timing are indicated in corresponding rectangular frames. In this embodiment, as sub-nozzles are divided into eight groups "Sub 1" through "Sub 8", the rectangular frames corresponding to "Sub 9" is kept open.

**[0107]** The set item "Stretch" in the image 84 indicates the jet start timing "ON" and the jet end timing "OFF" of the stretch nozzle giving tension to the weft 12 having been inserted into the warp shed.

**[0108]** The image 84 can be changed to an image 86 shown in Fig. 8 by pushing the function key "f · 1" assigned to the menu "Change" of the image 84. In the headline space of the image 86, contents of this image are displayed. In this example, [Weft Inserting Adjustment] and date the date "2002, 03, 13, 12:25" are shown in the headline space.

**[0109]** The jet start/end timing of the sub-nozzle group as now selected (e.g. "Sub 1" in Fig. 8) is indicated in the lower part of the image 86. The jet start/end timing of each sub-nozzle is displayed in the form of a graph occupying the approximately middle part of the image 86 so as to be recognized at a glance (Step 6 in Fig. 4). The abscissa of the graph indicates the rotational angle (°) of the main shaft 36 of the loom while the ordinate indicates the reed width (reed drawing-in width) W (cm), and the jet start/end timing of each sub-nozzle group is indicated in the form of a rectangle.

**[0110]** Besides, the image 86 also shows three thin rectangles elongated in the direction from left to right. They are put one upon another so as to form three steps under the abscissa of the above graph. The left and right ends of the top rectangle indicate the jet start/end timing of the main nozzle 18, the left and right ends of the middle rectangle indicate the release/engagement timing of the weft engaging pin 22, and the left and right ends of the bottom rectangle indicate the operation start/end timing of WBS.

**[0111]** WBS stands for a weft break control unit, which is provided between the clamber and the main nozzle and is able to decrease the velocity of the flying weft by bending the weft 12.

**[0112]** A long rectangle elongated in the direction from left to right is displayed above the right upper part of the graph. The right and left ends of this rectangle indicate the jet start/end timing of the stretch nozzle.

**[0113]** The operator can individually change the set value of the jet start/end timing of each sub-nozzle group by selecting and touching an objective icon shown on the image 86 and then inputting a new set value by means of the ten-key set 68.

**[0114]** A plurality of icons vertically aligned on the most right side of the image 86 are given ordinal numbers 1 through 8 so as to correspond to the sub-nozzle group number. The example as shown in Fig. 8 indicates the state where the icon No. 1 is selected.

**[0115]** If the operator prefers to change the calculation results as shown on the image 86, he can do it in the following way. The operator first selects one of sub-nozzle group icons by touching either one of two black triangular icons appearing between the graph and the eight icons vertically aligned on the image 86 and then changes the value of the jet start/end timing of the selected sub-nozzle group. The upper triangular icon is used for moving the icon selection

pointer in the direction toward the icon No. 1 while the lower one is used for moving the icon selection pointer in the reverse direction i.e. toward the icon No.1. On the other hand, if the operator touches a touch key "All Sub" on the left side of the icon No. 8, he can select all the sub-nozzle groups at a time and then change the value of the jet start/end timing of the selected sub-nozzle groups, if needed.

**[0116]** Furthermore, the operator can change the jet start/end timing of the selected sub-nozzle group by touching the following touch keys "<-ON", "->ON", "<-OFF" and "->OFF" which are displayed on the lowest part of the image 86. If the operator touches "<-ON" and "<-OFF", the jet start/end timing of the selected sub-nozzle group is made faster, and if he touches "->ON" and "->OFF", the jet start/end timing of the selected sub-nozzle group is made slow. In this embodiment, it is set such that the rotational angle of the main shaft 36 is increased or decreased by a several degrees (°) at every one touching either touch key.

**[0117]** The number of the sub-nozzle group as now selected and the values of the jet start/end timing corresponding thereto are indicated above the touch keys "<-ON", "->ON", "<-OFF" and "->OFF". In the example as shown in Fig. 8, it is indicated that there is selected the sub-nozzle group No. 1, of which the jet start/end timing is set to be values of 75° and 135°, respectively.

**[0118]** After confirming and changing the jet start/end timing of each sub-nozzle group, the image now on the display screen can go back to the image 84 (Fig. 7) by touching a touch key "END" shown at the lowest right corner of the image 86.

[Calculation of Jet Timing of Each Sub-nozzle]

**[0119]** Calculation of the jet timing of each sub-nozzle is carried out by pushing the function key "f · 7" assigned to menu "Automatic Setting" of the image 82 (Fig. 6), thereby instructing the CPU 74 to calculate the jet timing of the sub-nozzle.

**[0120]** The method of automatically calculating the jet start/end timing of the sub-nozzle 32 will now be described in the following with reference to Fig. 1.

**[0121]** Now, let a distance from the selvage on the side of the weft length measuring storage unit 16 to the leading sub-nozzle of each sub-nozzle group should be L1, L2,..., L(i),..., L8. These distances can be obtained by the following expression.

$$L(i) = a + p \times (k(1) + \dots + k(i - 1))$$

wherein,

$$L(1) = L1 = a, \text{ when } i = 1,$$

i: an ordinal number of the sub-nozzle group when counting it from the side of the weft length measuring storage unit,  
a: distance from the selvage on the weft inserting side to the leading sub-nozzle 32 of the first sub-nozzle group,  
p: a pitch between adjacent sub-nozzles, and  
K(n): the number of sub-nozzles in the nth sub-nozzle group.

**[0122]** In the example as shown in Fig. 1, the respective values of i, a, p and k(n) are: i = 1~8, a = 30mm, p = 45mm, k(1)~k(7) = 5, and k(8) = 3.

**[0123]** The jet start timing of each sub-nozzle group is calculated by the following expression (3) by using the distance L(i) as obtained with regard to each sub-nozzle group.

$$SV(i) = T + (L(i) \times (TG - T - G)/W) - H \quad (3)$$

wherein,

i: a group number of the sub-nozzle 32 counted from the weft length measuring storage side,  
SV(i): a jet start timing of the sub-nozzle 32 in the ith sub-nozzle group,  
T: timing of weft picking,  
L(i): a distance up to the ith sub-nozzle group from the selvage on the weft length measuring storage side,  
TG: objective weft arrival timing (the set item "Objective Weft Arrival (°)") as shown in Fig. 5),  
G: a coefficient for compensating the weft arrival timing dispersion depending on the rotational number of the main

shaft 36 of the loom,

W: a reed drawing-in width

H: a coefficient for compensating the preceding angle of the jet start timing depending on the revolution number of the main shaft 36 of the loom.

**[0124]** In this embodiment, TG is 210° from the value of the set item "Objective Weft Arrival (°)" as shown in Fig. 5. As the coefficient G for compensating arrival dispersion is obtained by the expression  $G = (\text{the revolution number of the main shaft 36}) \times 0.006 \times 1\text{ms}$ , it becomes  $800 \times 0.006 \times 1\text{ms} = 4.8^\circ$ . Besides, as the coefficient H for compensating preceding angle is obtained by the expression  $H = (\text{the revolution number of the main shaft 36}) \times 0.006 \times 4\text{ms}$ , it becomes  $800 \times 0.006 \times 4\text{ms} = 19.2^\circ$ .

**[0125]** Values "1ms" and "4ms" as used for calculating the coefficients G and H are empirical values to the last, which are attained through the experiences with the loom manufactured by Tsudakoma Kogyo K.K. and these values are usually within the range of several ms.

**[0126]** The jet end timing of each sub-nozzle group is calculated by an expression  $SV(i) + (60^\circ \sim 70^\circ)$ . The image 84 indicates a calculation result in which the jet end timing which are calculated by using an expression  $SV(i) + 60^\circ$ .

[Display of Calculation Results: Step 7]

**[0127]** An image 88 as shown in Fig. 9 indicates the jet start/end timing as calculated with regard to each sub-nozzle group by using the expression (3). The image 88 has the same image constitution as the image 84 as shown in Fig. 7.

**[0128]** Values of automatically calculated jet start/end timing regarding each sub-nozzle group are indicated in each of corresponding rectangular frame. Besides, if the operator pushes the function key "f □1", he can see and confirm the automatically calculated results by using a graph as displayed in the image 90 (Fig. 10). The image 90 has the same image constitution as the image 86 as shown in Fig. 8.

[How to Get Coefficients for Calculating Timing of Weft Picking]

**[0129]** The expressions (1) and (2) for calculating the timing of weft picking are derived by the inventors paying attention to the point that the timing of weft picking T depends on other things than the jet start timing of the weft inserting nozzle.

**[0130]** It is deemed that the relation as expressed by "T = x + compensation term 1" would be valid between the timing of weft picking T and the jet start timing x of the weft inserting nozzle.

**[0131]** Besides, it is deemed that the contents of the above compensation term 1 depends on the weft inserting condition (e.g. the weft release timing of the weft engaging pin) and the rotational number of the main shaft of the loom. This would be supported by some tests as described later.

**[0132]** The inventors assume that the expression for calculating the timing of weft picking T can be described by the following expression (4).

$$T = x + \alpha(y - x) + \beta z + \gamma \quad (4)$$

wherein,

T: timing of weft picking (°),

x: jet start timing of the weft inserting nozzle (°),

y: weft release timing by the weft engaging pin, (°),

z: rotational number (r. p. m.) of the main shaft of the loom, and

$\alpha$ ,  $\beta$  and  $\gamma$ : regression coefficients.

**[0133]** In order to obtain respective values of regression coefficients  $\alpha$ ,  $\beta$  and  $\gamma$  by using the above expression (4) as a regression expression, several measurement tests are carried out on T, x and y by using an actual loom, changing the weft sort and the rotational number (r. p. m.) of the main shaft of the loom.

[Test Condition]

**[0134]** The tests are carried out with an air jet loom ZAX (Product name of Tsudakoma Kogyo K.K.). In the test, the timing of weft picking is measured by means of the stroboscopic flash under the condition where the reed drawing-in width W is 170 cm, the jet start timing x of the weft inserting nozzle is 80° (rotational angle of the main shaft), and the

weft release timing of the weft engaging pin is varied from  $60^{\circ} \sim 100^{\circ}$  (rotational angle of the main shaft) at an interval of  $10^{\circ}$ .

**[0135]** With regard to the rotational number  $z$  of the main shaft of the loom, the test is carried out in two cases, that is,  $z = 500$  r.p.m. and  $z = 700$  r.p.m.

**[0136]** There is made no change throughout the tests with regard to the jet start and end timings of the main nozzle, the fluid pressure, the sort and arrangement of the main nozzle and sub-nozzles, and the arrangement pitch between adjacent sub-nozzles.

**[0137]** In the test, there are used five sorts of wefts, which are a chemical fiber yarn BB (Bemberg) 84dtex, a twisted yarn PE (Polyester) 84dtex/twist number 1000 t/m, a cotton yarn C20/1S, a cotton yarn C40/1S, and a cotton yarn C50/1S.

**[0138]** After performing the tests on the above five sorts of wefts, the computer-aided multiple regression analysis using the expression (4) as the regression expression is carried out with regard to the measured values obtained through the tests, thereby obtaining the values of regression coefficients  $\alpha$ ,  $\beta$  and  $\gamma$  and computing the value of a multiple correlation coefficient as well. The multiple regression analysis and the calculation of multiple correlation coefficients are carried out by adopting the algorism as known well.

**[0139]** Table 1 shows the values of the regression coefficients  $\alpha$ ,  $\beta$  and  $\gamma$  and the multiple correlation coefficients obtained on the basis of respective measurement values of  $T$ ,  $x$  and  $y$  in respect of each of the above five sorts of wefts. Furthermore, Table 1 indicates the average values of the regression coefficients  $\alpha$ ,  $\beta$  and  $\gamma$  as well as the multiple correlation coefficients, which represent all of the above-mentioned three sorts of cotton yarns i.e. C20/1S, C40/1S and C50/1S.

TABLE.1

| WEFT SORT                       |                      | $\alpha$ | $\beta$ | $\gamma$ | MULTIPLE<br>CORRELATION<br>COEFFICIENT |
|---------------------------------|----------------------|----------|---------|----------|----------------------------------------|
| CHEMICAL FIBER<br>FILAMENT YARN | BB84dtex             | 0.715    | 0.001   | 9.5      | 0.9799                                 |
| TWISTED YARN                    | PE84dtex/1000T/m     | 0.160    | 0.013   | 7.9      | 0.9719                                 |
| COTTON YARN 1                   | C20/1S               | 0.485    | 0.011   | 8.3      | 0.9325                                 |
| COTTON YARN 2                   | C40/1S               | 0.585    | 0.003   | 10.9     | 0.9742                                 |
| COTTON YARN 3                   | C50/1S               | 0.635    | 0.007   | 8.5      | 0.9656                                 |
| COTTON YARN<br>AVERAGE          | C20/1S,C40/1S,C50/1S | 0.568    | 0.007   | 9.233    | 0.9466                                 |

**[0140]** It will be understood from Table 1 that the value of each multiple correlation coefficient is within the range of 0.93 to 0.98 and very well approximates to a value of 1.0. Accordingly, this means that there is caused only a very small error between the timing of weft picking T as calculated by using the expression (4) and the measured value (true value). In other words, it is deemed that the timing of weft picking T as calculated by using the expression (4) is highly reliable.

**[0141]** The expression (4) may be transformed into an expression as shown in the following.

$$T = (1-\alpha)x + \alpha y + \beta z + \gamma = Ax + By + Cz + D \quad (5)$$

Wherein,

$$A = 1-\alpha, B = \alpha, C = \beta, \text{ and } D = \gamma$$

**[0142]** If coefficients  $\alpha$ ,  $\beta$  and  $\gamma$  as shown in Table 1 are replaced by coefficients A, B, C, and D of the expression (5), that is, the expression (1), coefficients A, B, C, and D come to take values as shown in Table 2.

TABLE.2

| WEFT SORT                       |                      | A     | B     | C     | D     |
|---------------------------------|----------------------|-------|-------|-------|-------|
| CHEMICAL FIBER<br>FILAMENT YARN | BB84dtex             | 0.285 | 0.715 | 0.001 | 9.5   |
| TWISTED YARN                    | PE84dtex/1000T/m     | 0.840 | 0.160 | 0.013 | 7.9   |
| COTTON YARN 1                   | C20/1S               | 0.515 | 0.485 | 0.011 | 8.3   |
| COTTON YARN 2                   | C40/1S               | 0.415 | 0.585 | 0.003 | 10.9  |
| COTTON YARN 3                   | C50/1S               | 0.365 | 0.635 | 0.007 | 8.5   |
| COTTON YARN<br>AVERAGE          | C20/1S,C40/1S,C50/1S | 0.432 | 0.568 | 0.007 | 9.233 |

**[0143]** Each of coefficients A, B, C, and D as shown in Table 2 is set and stored in advance in the memory unit 78 in correspondence with the sorts of wefts, and when calculating the timing of weft picking, the coefficient is selected corresponding to the sort of the weft.

5 [Verification]

**[0144]** Table 3 indicates the value of the timing of weft picking as actually measured, the value of the timing of weft picking as calculated by means of the expression (1), and the difference (error) between the above two values, with respect to each of the chemical fiber yarn and the twisted yarn.

10

15

20

25

30

35

40

45

50

55

TABLE.3

 ROTATIONAL NUMBER  
OF MAIN SHAFT

| WEFT SORT                              |                                                       | CHEMICAL FIBER<br>FILAMENT YARN<br>BB84dtex |                                                                     |                | TWISTED YARN<br>PE84dtex/1000T/m                                    |                |                                                                     |
|----------------------------------------|-------------------------------------------------------|---------------------------------------------|---------------------------------------------------------------------|----------------|---------------------------------------------------------------------|----------------|---------------------------------------------------------------------|
|                                        |                                                       | 500rpm                                      |                                                                     | 700rpm         | 500rpm                                                              |                | 700rpm                                                              |
|                                        |                                                       | MEASURED VALUE                              | CALCULATED<br>VALUE<br>(CALCULATED<br>VALUE<br>- MEASURED<br>VALUE) | MEASURED VALUE | CALCULATED<br>VALUE<br>(CALCULATED<br>VALUE<br>- MEASURED<br>VALUE) | MEASURED VALUE | CALCULATED<br>VALUE<br>(CALCULATED<br>VALUE<br>- MEASURED<br>VALUE) |
| RELEASE<br>TIMING OF<br>CONTROL<br>PIN | JET START<br>TIMING<br>OF WEFT<br>INSERTING<br>NOZZLE | TIMING<br>DIFFERENCE                        |                                                                     |                |                                                                     |                |                                                                     |
| 60                                     | 80                                                    | -20                                         |                                                                     |                |                                                                     |                |                                                                     |
| 70                                     | 80                                                    | -10                                         |                                                                     |                |                                                                     |                |                                                                     |
| 80                                     | 80                                                    | 0                                           |                                                                     |                |                                                                     |                |                                                                     |
| 90                                     | 80                                                    | +10                                         |                                                                     |                |                                                                     |                |                                                                     |
| 100                                    | 80                                                    | +20                                         |                                                                     |                |                                                                     |                |                                                                     |

\*

\*

\*

[0145] It is recognized from Table 3 that the above error is within the range of  $\pm 4^\circ$  even if either the weft release timing of the weft engaging pin 22 or the jet start timing of the main nozzle 18 precedes.

[0146] Table 4 indicates the value of the timing of weft picking as actually measured, the value of the timing of weft picking as calculated by means of the expression (1) using the coefficients for each cotton yarns and the average

coefficients for all the cotton yarns, and errors between the actually measured value and the value as calculated by the expression (1), with respect to respective cotton yarns.

ROTATIONAL ANGLE OF MAIN SHAFT  
ROTATIONAL NUMBER OF MAIN SHAFT

**TABLE.4**

| WEFT SORT  | COTTON YARN 1<br>C20/1S |                                                      |                |                                                      | COTTON YARN 2<br>C40/1S |                                                      |                |                                                      | COTTON YARN 3<br>C50/1S |                                                      |                |                                                      |
|------------|-------------------------|------------------------------------------------------|----------------|------------------------------------------------------|-------------------------|------------------------------------------------------|----------------|------------------------------------------------------|-------------------------|------------------------------------------------------|----------------|------------------------------------------------------|
|            | 500rpm                  |                                                      | 700rpm         |                                                      | 500rpm                  |                                                      | 700rpm         |                                                      | 500rpm                  |                                                      | 700rpm         |                                                      |
|            | MEASURED VALUE          | CALCULATED VALUE OF COTTON YARN AVERAGE (DIFFERENCE) | MEASURED VALUE | CALCULATED VALUE OF COTTON YARN AVERAGE (DIFFERENCE) | MEASURED VALUE          | CALCULATED VALUE OF COTTON YARN AVERAGE (DIFFERENCE) | MEASURED VALUE | CALCULATED VALUE OF COTTON YARN AVERAGE (DIFFERENCE) | MEASURED VALUE          | CALCULATED VALUE OF COTTON YARN AVERAGE (DIFFERENCE) | MEASURED VALUE | CALCULATED VALUE OF COTTON YARN AVERAGE (DIFFERENCE) |
| Pin        |                         |                                                      |                |                                                      |                         |                                                      |                |                                                      |                         |                                                      |                |                                                      |
| Main (P-M) |                         |                                                      |                |                                                      |                         |                                                      |                |                                                      |                         |                                                      |                |                                                      |
|            | 80                      | 84.1 (4.1)                                           | 81.4 (1.4)     | 86.3 (-3.7)                                          | 80.7 (2.7)              | 81.4 (3.4)                                           | 81.3 (-0.7)    | 82.8 (0.8)                                           | 79.3 (3.3)              | 81.4 (5.4)                                           | 80.7 (-2.3)    | 82.8 (-0.2)                                          |
| 60 80      | -20                     |                                                      |                |                                                      |                         |                                                      |                |                                                      |                         |                                                      |                |                                                      |
|            | 90                      | 89.0 (-1.0)                                          | 87.1 (-2.9)    | 91.2 (-1.8)                                          | 86.6 (-1.4)             | 87.1 (-0.7)                                          | 87.2 (-2.8)    | 88.5 (-1.5)                                          | 85.7 (-0.5)             | 87.1 (1.1)                                           | 87.1 (-2.9)    | 88.5 (-1.5)                                          |
| 70 80      | -10                     |                                                      |                |                                                      |                         |                                                      |                |                                                      |                         |                                                      |                |                                                      |
|            | 94                      | 93.8 (-0.2)                                          | 92.7 (-1.3)    | 96.0 (1.0)                                           | 92.4 (0.4)              | 92.7 (0.7)                                           | 93.0 (0)       | 94.1 (1.1)                                           | 92.0 (0)                | 92.7 (0.7)                                           | 93.4 (0.4)     | 94.1 (1.1)                                           |
| 80 80      | 0                       |                                                      |                |                                                      |                         |                                                      |                |                                                      |                         |                                                      |                |                                                      |
|            | 98                      | 98.7 (0.7)                                           | 98.4 (0.4)     | 100.9 (4.9)                                          | 98.3 (0.3)              | 98.4 (0.4)                                           | 98.9 (3.9)     | 99.8 (4.8)                                           | 98.4 (0.4)              | 98.4 (0.4)                                           | 99.8 (4.8)     | 99.8 (4.8)                                           |
| 90 80      | +10                     |                                                      |                |                                                      |                         |                                                      |                |                                                      |                         |                                                      |                |                                                      |
|            | 107                     | 103.5 (-3.5)                                         | 104.1 (-2.9)   | 105.7 (-0.3)                                         | 104.1 (-1.9)            | 104.1 (-1.9)                                         | 104.7 (-0.3)   | 105.5 (0.5)                                          | 104.7 (-3.3)            | 104.1 (-3.9)                                         | 106.1 (0.1)    | 105.5 (-0.5)                                         |
| 100 80     | +20                     |                                                      |                |                                                      |                         |                                                      |                |                                                      |                         |                                                      |                |                                                      |

NOTE) PIN:RELEASE TIMING OF CONTROL PIN; MAIN:JET START TIMING OF WEFT INSERTING NOZZLE  
(P-M):TIMING DIFFERENCE

[0147] It is recognized from Table 4 that the above error is within the range of  $\pm 7^\circ$ . Accordingly, it is preferable to set

in advance the coefficients A, B, C and D which are calculated regarding each thickness of the weft 12.

**[0148]** Actually, in the almost all cases, the weft release timing of the weft engaging pin 22 is set within the range of  $\pm 10\%$  of the jet start timing of the main nozzle 18 (sign \* in Table 4). In such range, the error between the measured value and the calculated value is within the range of  $\pm 5^\circ$ . Accordingly, even if there are adopted coefficients A, B, C and D which are obtained by calculation without paying any consideration to the weft thickness, it is deemed that they would be practically usable within the setting range as actually carried out.

**[0149]** In case of using the pressure value of the pressure fluid as one of the set values of the weft inserting condition, each of coefficients A, B, E and F of the expression (2) for calculating the timing of weft picking can be obtained by a procedure similar to that which is mentioned above. Each of these coefficients A, B, E and F is set in advance corresponding to the pressure value of the pressure fluid, and the predetermined coefficients can be selected when calculating the timing of weft picking.

**[0150]** The timing of weft picking is not only used for setting the jet timing of the sub-nozzle 32 but also used for adjustment of the weft inserting. Furthermore, the timing of weft picking is made use of not only in the air jet type loom but also in the liquid jet type loom. Still further, the timing of weft picking is utilized in the fluid jet loom which is provided with the weft length measuring storage unit 16 of the other type than the fixed drum type (for example, the type of using the clamber in place of the weft engaging pin).

**[0151]** Various types of memory cards are available as the memory card 56, for example, a Micro Card, a Compact Flash Card (CF card), a Smart Media (registered TM) Card (SM card), a Multi Media Card (MMC card), a Security Digital Memory Card (SD card), a Memory Stick Card (MS card) and so forth.

**[0152]** The timing of weft picking is influenced by some factors, for instance, the sort and number of the weft and the sort of the main nozzle 18, whether or not there is provided an auxiliary main nozzle, and so forth. Accordingly, if the coefficients are selected so as to correspond to these influential factors, the timing of weft picking can be calculated with higher accuracy. Besides, if it is required to store a lot of coefficients, the setting unit 44 may store them once in the host computer with a large memory capacity and read out necessary coefficients therefrom in response to the need.

**[0153]** In the air jet loom as described above, the calculated timing of weft picking is used for automatic setting of the jet timing of the sub-nozzle. However, the application of the calculated timing of weft picking is not limited to the above. It is used for the setting of the operational timing of the other devices relating to the weft inserting, for example, a weft brake, a stretch nozzle and so forth.

**[0154]** So far, expressions (1) through (4) have been described as a linear function, but they may be a quadratic function or other high order functions.

**[0155]** Furthermore, in the above description, the timing of weft picking has been described in connection with the rotational angle of the main shaft 36 of the loom. However, this is done just as one of preferable ways of describing the timing of weft picking and does not exclude other way of description. For example, the timing of weft picking may be described on the basis of the passage of time counted from the time at which the main shaft 36 has passed a reference rotational angle as set in advance. In this case, the weft inserting control unit 40 has to be constituted such that each switching valve and the electromagnetic solenoid is controlled by the passage of time counted from the moment at which the main shaft has passed the reference rotational angle.

**[0156]** The method of calculating the timing of weft picking according to the invention can be changed as follows.

**[0157]** The method of calculating the timing of weft picking as described above is practicable not only in the state where the loom 10 is steadily operated but also even when the loom is under the transition state, for instance, at the time of starting up the loom, at the time of changing the rotational number of the main shaft, and so forth. Needless to say, the actual measurement of the timing of weft picking is extremely difficult in such transition state. However, if the timing of weft picking can be calculated in such unsteady state, it becomes possible to easily judge whether the weft inserting condition is properly set or not.

**[0158]** In case of setting the jet start timing of the sub-nozzle by making use of the calculated timing of weft picking, with regard to the sub-nozzle group, there are considered some ways of arranging the switching valve and the sub-nozzle, for example, one way where the sub-nozzle and switching valve are arranged on the one-to-one basis and the other way where one switching valve manages two or more sub-nozzles, in other words, on the one-to-multiple basis.

**[0159]** The number of sub-nozzle group of which the jet timing is to be set, may be only one, plural, or all of them. To put it more concretely, in case of setting the jet timing of one or more specific sub-nozzle groups, it may be possible to set the jet timing of only the nozzle group near the weft length measuring storage unit side or only the nozzle group near the opposite side to the weft inserting side by making use of the above calculation method. In this case, the jet timing of remaining sub-nozzle groups may be set manually.

**[0160]** The method of calculating the timing of weft picking and the method of setting the weft inserting condition according to the invention are applicable not only to the air jet loom but also to the liquid jet loom.

**[0161]** While some embodiments of the invention have been shown and described in the above with reference to the accompanying drawings, the invention is not limited to those embodiments. Various changes and modifications will be possible without departing from the gist of the invention.

## Claims

1. A method of calculating the timing of weft picking in a fluid jet loom of the class wherein there are provided a weft inserting nozzle (18) which is supplied with a pressure fluid enabling normal weft inserting to be performed and jets said pressure fluid together with a weft (12) in connection with a weft inserting command, and a weft engaging member (22) for controlling the weft length, said weft engaging member (22) being arranged on a weft length measuring storage unit (16) and releasing the weft in connection with the fluid jet start by said weft inserting nozzle (18), said method of calculating the timing of weft picking comprising the step of:

calculating the timing of weft picking for the weft (12) to enter a warp shed based on set values of known weft inserting conditions,

wherein said set values of said weft inserting conditions includes the jet start timing of said weft inserting nozzle (18), the weft release timing of said weft engaging member (22), and either the rotational number of the main shaft (36) of said fluid jet loom or the pressure value of said pressure fluid.

2. A method as claimed in claim 1, wherein said weft engaging member (22) includes at least either a weft engaging pin (22) of a weft measuring storage unit (16) of the fixed drum type or a clasper arranged between said weft length measuring storage unit and said weft inserting nozzle.

3. A method as claimed in claim 1 or 2, wherein if the rotational number of the main shaft (36) of the fluid jet loom is used as one of set values of said weft inserting condition, the timing of weft picking is calculated based on the following expression (1):

$$T = A \times x + B \times y + C \times z + D \quad (1)$$

wherein,

T: timing of weft picking,  
 x: jet start timing of the weft inserting nozzle (18),  
 y: weft release timing of the weft engaging member (22),  
 z: rotational number of the main shaft (36) of the fluid jet loom, and  
 A, B, C and D: predetermined coefficients.

4. A method as claimed in claim 1 or 2, wherein if the pressure value of said pressure fluid is used as one of set values of said weft inserting condition, the timing of weft picking is calculated based on the following expression (2):

$$T = A \times x + B \times y + E \times v + F \quad (2)$$

wherein,

T: timing of weft picking,  
 x: jet start timing of the weft inserting nozzle (18),  
 y: weft release timing of the weft engaging member (22),  
 v: pressure value of the pressure fluid, and  
 A, B, E and F: predetermined coefficients.

5. A method as claimed in claim 3 or 4, wherein a plurality of values of coefficients A, B, C, D or A, B, E, F in said expressions (1) or (2) are pre-set in accordance with at least one of the sort of the weft (12) and the thickness of it, and when calculating the timing of weft picking, predetermined coefficients are selected corresponding to at least one of the sort of the weft and the thickness of the weft.

6. A method as claimed in any one of claim 3 through 5, wherein a plurality of values of coefficients A, B, C, D or A, B, E, F in said expressions (1) or (2) are pre-set in accordance with at least one of the sort of the weft inserting nozzle (18) and the number of it, and when calculating the timing of weft picking, predetermined coefficients are selected corresponding to at least one of the sort of the weft inserting nozzle and the number of it.

7. A method of setting weft inserting condition in a fluid jet loom of the class wherein there are provided a plurality of sub-nozzles (32) arranged inside the warp shed, said method of setting weft inserting condition comprising the step of:

calculating the jet start timing at least one of sub-nozzles (32) based on said timing of weft picking which is calculated according to the calculation method as claimed in any one of claims 1 through 7.

8. A method as claimed in claim 7 wherein said jet start timing of the sub-nozzles (32) are calculated according to the following expression (3):

$$SV(i) = T + (L(i) \times (TG - T - G)/W) - H \quad (3)$$

wherein,

i: a group number of the sub-nozzle (32) counted from the side of the weft length measuring storage unit (16),

SV(i): a jet start timing of the sub-nozzle in the ith sub-nozzle group,

T: timing of weft picking,

L(i): a distance up to the ith sub-nozzle group from the selvage on the side of the weft length measuring storage unit,

TG: objective weft arrival timing,

G: a coefficient for compensating the weft arrival timing dispersion,

W: a reed drawing-in width

H: a coefficient for compensating preceding angle of jet start timing.

FIG.1

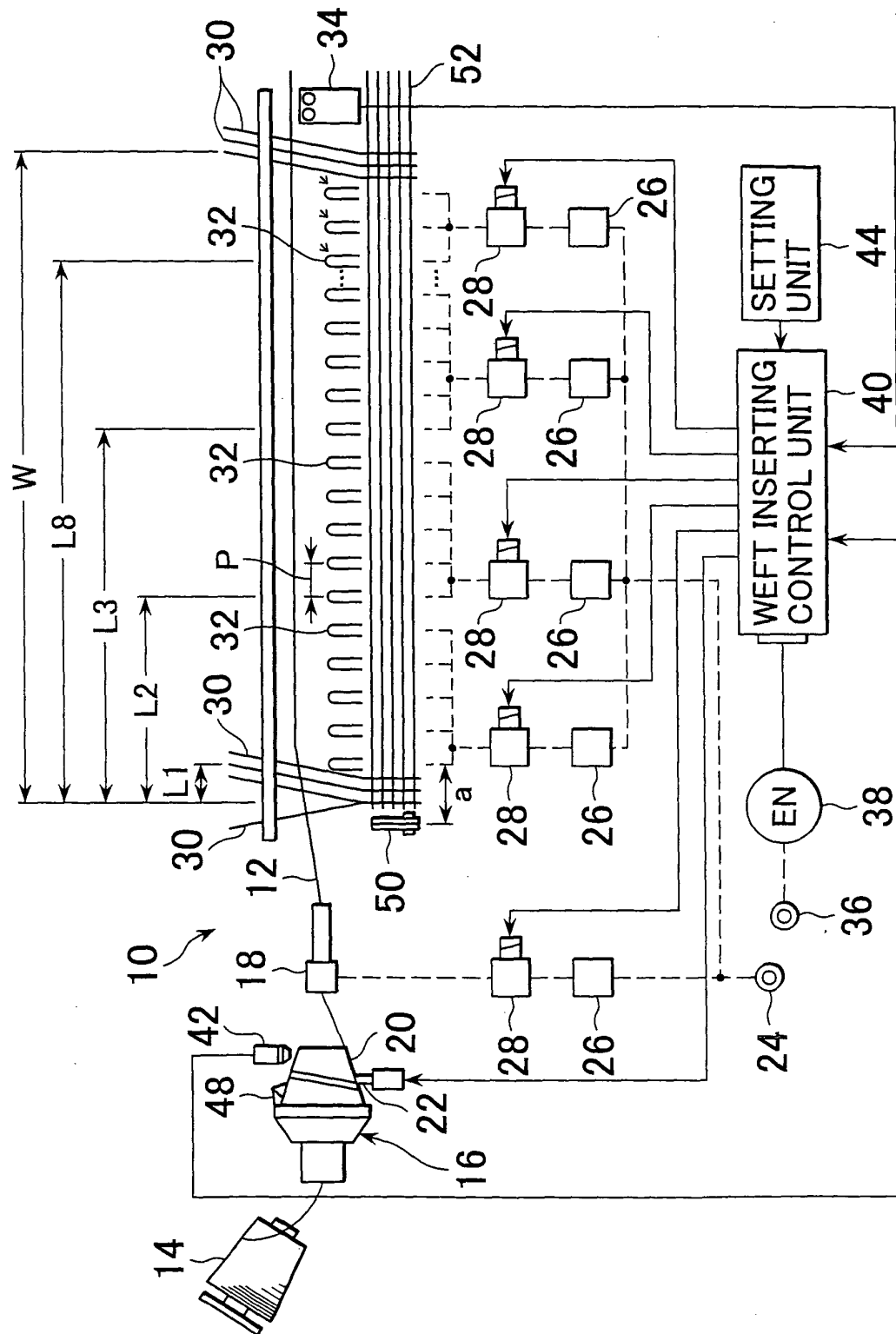


FIG.2

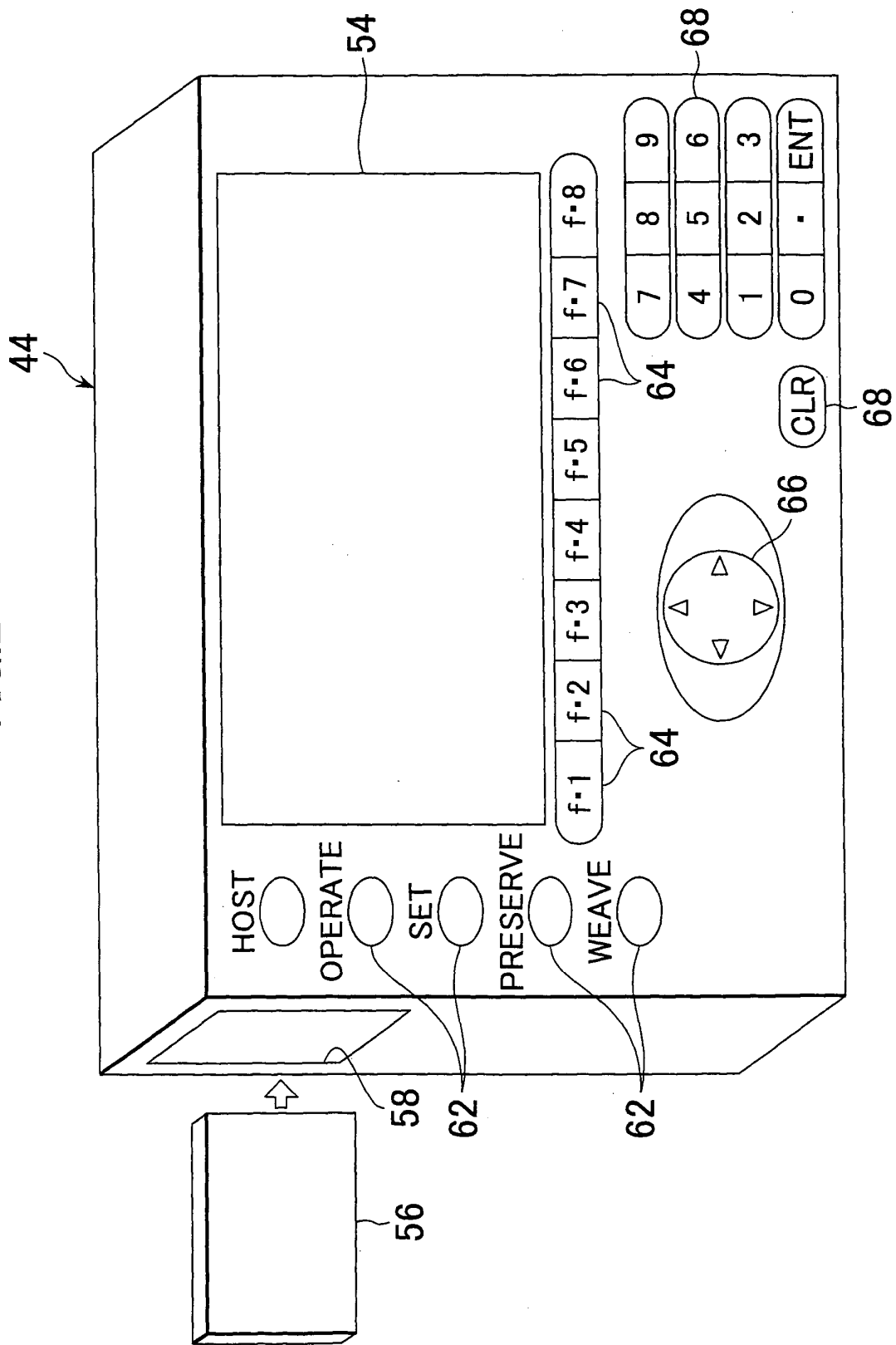


FIG.3

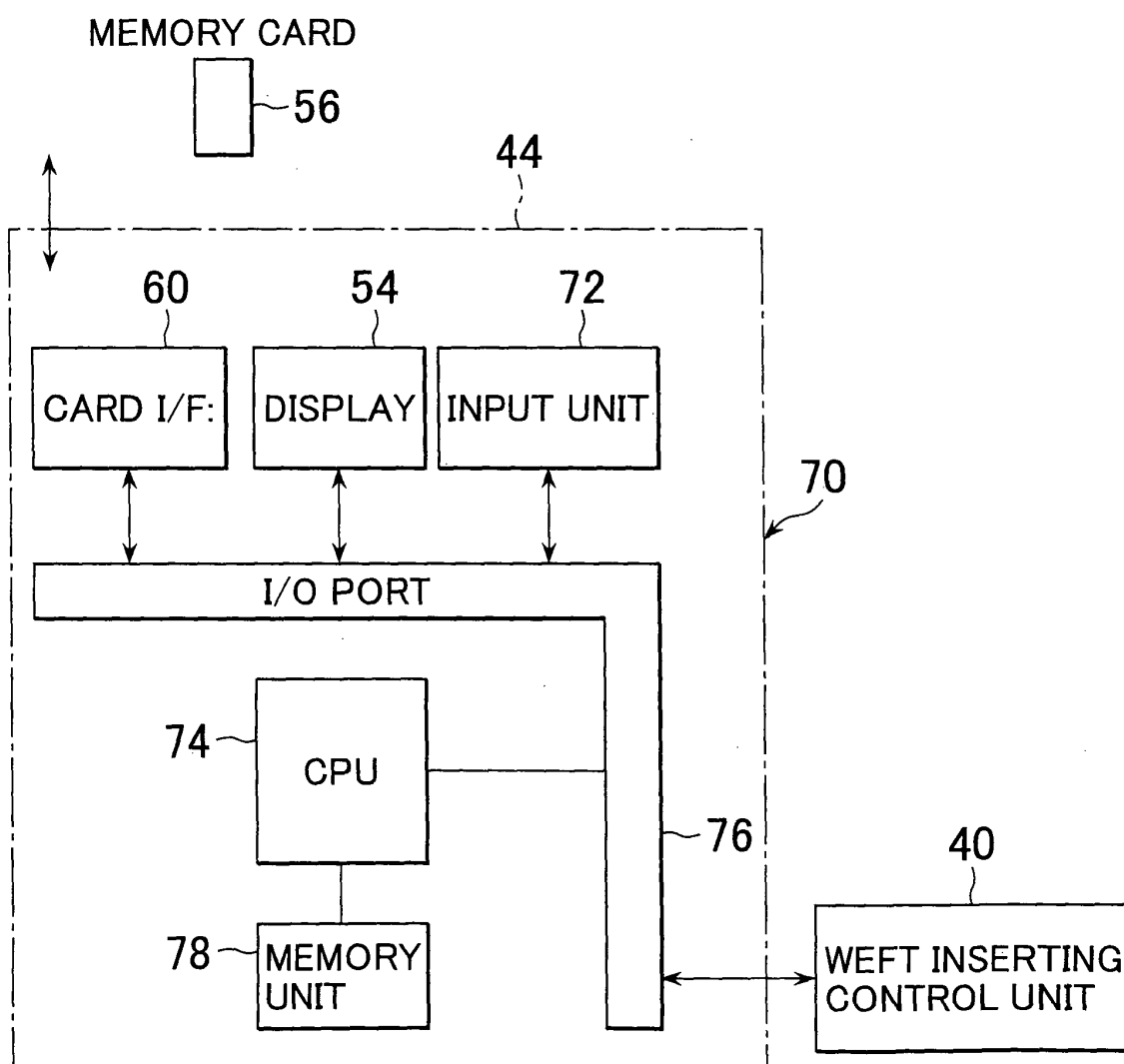


FIG.4

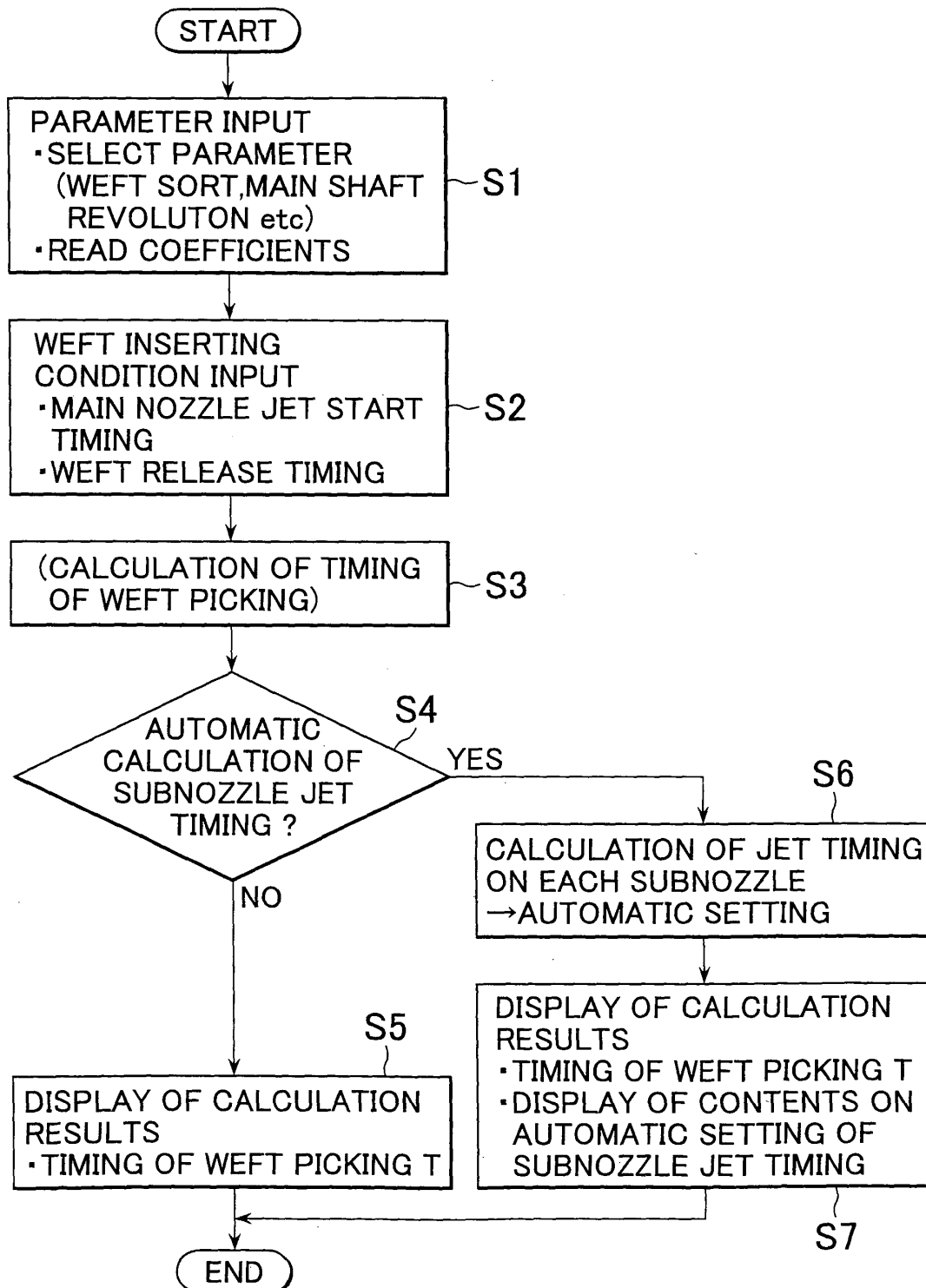


FIG.5

| [BASE SETTING:WEFT] |                |                |                 | 2002.03.13 12:25          |                      |
|---------------------|----------------|----------------|-----------------|---------------------------|----------------------|
| WEFT COLOR          | WEFT SORT      | RELEASE NUMBER | WEFT PICKING(°) | OBJECTIVE WEFT ARRIVAL(°) | FLUID PRESSURE (MPa) |
| C1:                 | COTTON 40/1S △ | 3              |                 | 210                       | 0.30                 |
| C2:                 | COTTON 40/1S △ | 3              |                 | 210                       | 0.29                 |
| C3:                 | △              |                |                 |                           |                      |
| C4:                 | △              |                |                 |                           |                      |

|                        |          |                      |   |                                   |     |
|------------------------|----------|----------------------|---|-----------------------------------|-----|
| REED DRAWING -IN WIDTH | 170 (cm) | NUMBER OF SUBNOZZLES | 8 | ROTATIONAL NUMBER OF LOOM(r.p.m.) | 800 |
|------------------------|----------|----------------------|---|-----------------------------------|-----|

| SUBNOZZLES (G) | PITCH (mm) | NUMBER OF SUBNOZZLES (G) | PITCH (mm) | NUMBER OF SUBNOZZLES (G) | PITCH (mm) | NUMBER OF SUBNOZZLES (G) | PITCH (mm) |
|----------------|------------|--------------------------|------------|--------------------------|------------|--------------------------|------------|
| 1-1:           | 45         | 5                        | 1-4:       | 45                       | 5          | 1-7:                     | 45         |
| 1-2:           | 45         | 5                        | 1-5:       | 45                       | 5          | 1-8:                     | 45         |
| 1-3:           | 45         | 5                        | 1-6:       | 45                       | 5          | 1-9:                     |            |

|        |                |                |        |          |                     |                          |                     |
|--------|----------------|----------------|--------|----------|---------------------|--------------------------|---------------------|
| CHANGE | DETAIL SETTING | WEFT INSERTING | TIMING | CONTRAST | WEFT BAR PREVENTION | AUTOMATIC WEFT INSERTING | PICKING CALCULATION |
|--------|----------------|----------------|--------|----------|---------------------|--------------------------|---------------------|

80

**FIG. 6**

SETTING OF TIMING OF WEFT INSERTING

2002.03.13 12:25

MAIN1~4

WEFT ENGAGING PIN

ON

60

OFF

180

MAIN

ON

70

OFF

190

AUXILIARY MAIN

ON

70

OFF

150

CUTTING

ON

320

OFF

30

MAIN5~8

WEFT ENGAGING PIN

ON

OFF

MAIN

ON

OFF

AUXILIARY MAIN

ON

OFF

CUTTING

ON

OFF

CHANGE

SUB\_1

SUB\_2

SUB\_3

SUB\_4

MAIN5~8

AUTOMATIC SETTING

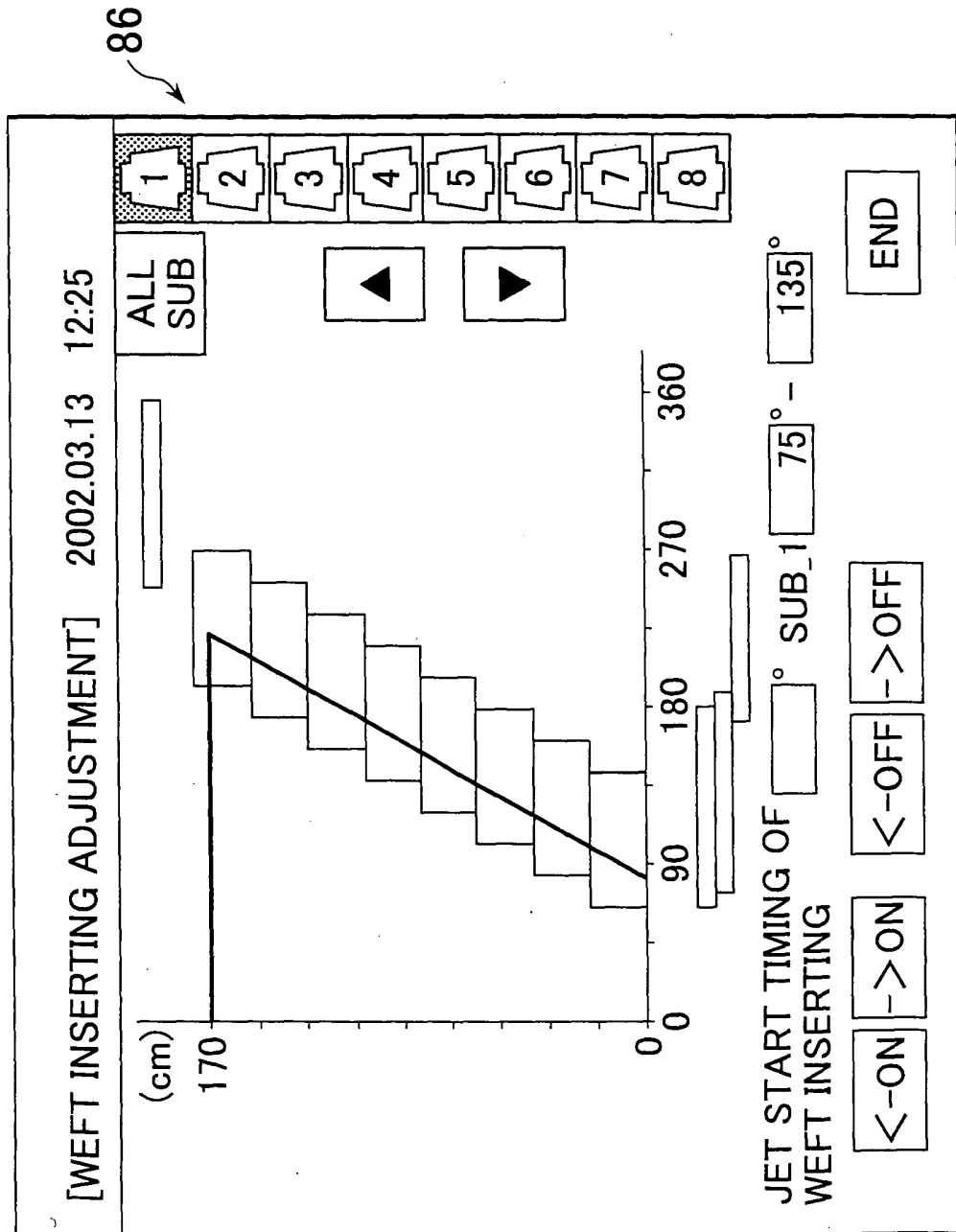
PICKING CALCULATION

FIG. 7

84

| [SETTING OF TIMING OF WEFT INSERTING] |        | [SUB_COLOR-1] |       | 2002.03.13        | 12:25       |
|---------------------------------------|--------|---------------|-------|-------------------|-------------|
| [C1]                                  |        |               |       |                   |             |
|                                       | ON     | OFF           |       | ON                | OFF         |
| SUB_1                                 | 75° -  | 135°          |       | ° -               | °           |
| SUB_2                                 | 80° -  | 140°          |       | SUB_9             |             |
| SUB_3                                 | 100° - | 160°          |       | STRETCH           | 250° - 330° |
| SUB_4                                 | 110° - | 170°          |       |                   |             |
| SUB_5                                 | 125° - | 185°          |       |                   |             |
| SUB_6                                 | 145° - | 210°          |       |                   |             |
| SUB_7                                 | 160° - | 230°          |       |                   |             |
| SUB_8                                 | 170° - | 270°          |       |                   |             |
| CHANGE                                |        | SUB_1         | SUB_2 | SUB_3             | SUB_4       |
|                                       |        | MAIN5~8       |       | AUTOMATIC SETTING |             |

FIG.8



**FIG. 9**

| [SETTING OF TIMING OF WEFT INSERTING] |       | [SUB_COLOR-1] |         | 2002.03.13 12:25 |                   |
|---------------------------------------|-------|---------------|---------|------------------|-------------------|
| [C1]                                  |       |               |         |                  |                   |
|                                       | ON    | OFF           |         | ON               | OFF               |
| SUB_1                                 | 57°   | 127°          |         |                  |                   |
| SUB_2                                 | 73°   | 143°          |         |                  |                   |
| SUB_3                                 | 88°   | 158°          |         |                  |                   |
| SUB_4                                 | 104°  | 174°          |         |                  |                   |
| SUB_5                                 | 119°  | 189°          |         |                  |                   |
| SUB_6                                 | 134°  | 204°          |         |                  |                   |
| SUB_7                                 | 150°  | 220°          |         |                  |                   |
| SUB_8                                 | 165°  | 235°          |         |                  |                   |
|                                       |       |               | SUB_9   |                  |                   |
|                                       |       |               | STRETCH | 260°             | 330°              |
| CHANGE                                | SUB_1 | SUB_2         | SUB_3   | SUB_4            | MAIN5~8           |
|                                       |       |               |         |                  | AUTOMATIC SETTING |

FIG.10

