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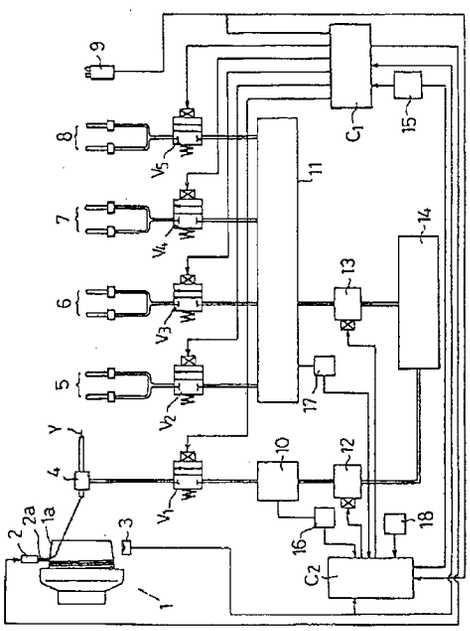
(54) Apparatus for controlling weft inserting air pressure in a jet loom.

(57) The apparatus allows to achieve dependable controlling of weft inserting air pressure in a jet loom while improving i.e. reducing air consumption.

The air injection pressure of the main weft inserting nozzle (4) is controlled by the computer control (C_2) which then controls the pressure control valve (12) according to the arrival time detected by the weft sensor (9). The air injection pressure of the auxiliary weft inserting nozzles (5-8) is controlled by the computer control (C_2) which then controls the pressure control valve (13) according to the difference between the above arrival time and the weft released time detected by the weft release detector (3).

Fig. 1



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The present invention relates to an apparatus for controlling weft inserting air pressure in a jet loom of the type wherein a weft is inserted by air jets injected from a main weft inserting nozzle and auxiliary weft inserting nozzles the pressures of which are controlled according to the information representative of the time at which the leading end of an inserted weft arrives at a predetermined position in the loom.

In a jet loom wherein a weft is inserted by air jet injected from a main weft inserting nozzle, the condition of weft insertion is largely dependent on the air injection pressure setting of the nozzle. Even if an optimum injection pressure is established for a given weft during trial weaving operation, flying condition of the weft may be varied during the subsequent actual production weaving operation due to various influencing factors such as varying weft supply cheese diameter, irregularities of the weft itself, etc., with the result that successful weft insertion may not be achieved with use of the initially established air injection pressure.

Publication of Examined Japanese Patent Application No.64-3969 (1989) proposes an apparatus having an electrically operated air pressure control valve which is provided in the passage for supplying air under pressure to a main weft inserting nozzle for controlling the air injection pressure of the nozzle according to the information representative of the time at which the leading end of an inserted weft arrives at a weft sensor located at the terminating end of weft inserting passage for detecting the leading end of such inserted weft. The air pressure controlling is performed in such a way that the arrival time of the weft end is converged within a predetermined range of target arrival time.

Publication of Examined Japanese Utility Model Application No. 63-24147 (1988) discloses an apparatus using an electrically-operated pressure control valve which is provided in the passage for supplying air under pressure to a main weft inserting nozzle and operable according to the information of detected amount of weft released from a weft measuring and storage device for controlling the air injection pressure of the main nozzle so as to converge the free flying speed of the weft within a predetermined range of target weft speed.

Publication of Unexamined Japanese Patent Application No. 61-34259 (1986) shows an apparatus in a weaving loom for controlling the air injection pressure of a main weft inserting nozzle according to the time difference between the detected time at which weft releasing from the weft measuring and storage device is completed and the time at which the leading end of an inserted weft arrives at a predetermined terminating end position of weft inserting passage.

Even when an inserted weft arrives at the weft sensor at a time within the range of target arrival time, the weft may be slackened or formed with a loop at its leading end if the weft is released too early from the weft measuring and storage device, thereby causing failure in weft insertion. The apparatus according to the Publication No. 64-3969 is unable to cope with such a situation.

The apparatus according to the Publication No. 63-24147, which relies on the information regarding the time when the weft releasing from the weft measuring and storage device is completed, without using the information of the weft end arrival time, for controlling the air injection pressure of the main weft inserting nozzle so as to permit the weft end arrival time to fall within the target range, lacks controlling precision and hence certainty of allowing the weft to reach a terminating end of weft insertion at a time within a predetermined target range of such time.

The apparatus according to the Publication No. 61-34259, which controls the air injection pressure of the main weft inserting nozzle in response to the information of both the weft released time at the weft measuring and storage device and the weft end arrival time at the terminating end of the weft inserting passage, can solve the above problems to a certain extent. With this apparatus, however, it is difficult to permit the weft end arrival time to fall within the target range because the information of the arrival time is not used directly in this apparatus for controlling of the air injection pressure. Furthermore, the effect of the controlled air injection pressure of only the main weft inserting nozzle cannot be maintained in the latter half of the weft insertion, so that the problems of the above-mentioned slackening of the weft and looping of its leading end cannot be prevented with certainty by this apparatus. Additionally, the apparatus which controls the air injection pressure of only the main weft inserting nozzle cannot cope with the problem associated with air consumption by air injection from auxiliary weft inserting nozzles.

Therefore, an object of the present invention is to provide an apparatus which is capable of solving the problems of weft slackening taking place during the latter half of weft insertion and failure in weft insertion and also of improving, or reducing, the air consumption.

According to the present invention, there is provided an apparatus for controlling weft inserting air pressure in a jet loom comprising weft released time detecting means for detecting the time at which releasing of a weft from a weft winding and storage device is completed, weft end arrival time detecting means disposed at a predetermined position for detecting the time at which the leading end of an inserted weft arrives at said arrival time detecting means, first adjusting means for adjusting the air injection pressure of a main weft inserting nozzle, second adjusting means for adjusting the air injection pressure of auxiliary weft inserting nozzles, and control

means for controlling the air injection pressure adjustments by said first and second adjusting means, wherein said control means is provided with functions of controlling the air injection pressure of said main weft inserting nozzle according to the detected weft end arrival time and of controlling the pressure difference between the air injection pressure of said main weft inserting nozzle and that of said auxiliary weft inserting nozzles according to the time difference between the detected weft end arrival time and the detected weft released time.

If the detected arrival time is too early, the air injection pressure adjustment control means adjusts the injection pressure of the main weft inserting nozzle to be decreased. If the detected arrival time is too late, on the other hand, the air injection pressure of the main nozzle is adjusted to be increased. After such injection pressure controlling, the control means makes adjustment to increase the pressure difference between the air injection pressure of the main weft inserting nozzle and that of said auxiliary weft inserting nozzles by increasing the air injection pressure of the latter auxiliary nozzles if the time difference between the detected weft end arrival time and the detected weft released time is greater than a target value. If the time difference is less than the target value, the above pressure difference is adjusted to be decreased by decreasing the air injection pressure of the auxiliary weft inserting nozzles.

The following will describe an embodiment of the apparatus for controlling the weft inserting air pressure in a jet loom according to the present invention while referring to FIGS. 1 through 3.

FIG. 1 is a schematic diagram showing combination of the weft inserting apparatus and the air pressure control circuit;

FIG. 2 provides a diagram showing the relationship between the difference between the arrival time and the weft released time, and the difference between the air injection pressure of the main weft picking nozzle and that of the auxiliary weft inserting nozzles;

FIG. 3 provides a chart showing a program for controlling the weft inserting air pressures according to the present invention;

FIG. 4 provides a chart showing a program for controlling the weft inserting air pressures in a modified embodiment according to the present invention.

Reference numeral 1 designates a weft measuring and storage device of winding type in a jet loom wherein formation of windings of reserve weft on a weft winding surface la of the device and releasing of the reserve weft is controlled by a solenoid 2 which is adapted to actuate a stop pin 2a to move into and away from engagement with the winding surface la. The solenoid 2 is connected to a computer control C_1 which receives information from a weft release detector 3 adapted to detect the time at which weft releasing from the weft measuring and storage device is completed, such time being referred to as "weft released time" hereinafter. Thus, the on/off operation of the solenoid 2 is controlled from commands transmitted by the computer control C_1 according to the information from the weft release detector 3.

A weft Y released from the weft winding surface la of the weft measuring and storage device 1 and then ejected from a main weft inserting nozzle 4 is assisted in passing through a shed by relayed air jets from a plurality of auxiliary weft inserting nozzles, or sub-nozzles, 5, 6, 7, 8. If weft insertion is done properly, the leading end of the inserted weft can be detected by a weft sensor 9 within a predetermined range of rotational angle of the weaving loom. Signal from the weft sensor 9, which represents the time at which the leading end of the inserted weft has arrived at that weft sensor 9, such time being referred to as "arrival time" hereinafter, is transmitted to the computer control C_1 which in turn commands the loom to continue or to interrupt its operation depending on whether or not the signal is received by the control C▪within the above range of rotational angle of the loom.

Injection of air from the main weft inserting nozzle 4 is controlled by a solenoid-operated valve V_1, while and injection of air from the auxiliary weft inserting nozzles 5-8 is
controlled by similar solenoid-operated valves V_2, V_3, V_4, V_5. That is, air injection from the respective nozzle takes place when the solenoid of its associated valve is energized, or turned on, thereby to open the valve, and the air injection is stopped when the same solenoid is deenergized, or turned off, thereby to close the valve. The valve V_1 is connected to an air tank 10 for holding therein air under pressure and supplying the air to the valve V_1, while the valves V_2-V5 are connected to a common air tank 11 for holding air under pressure and supplying the air to the respective valves V_2-V_5. The air tanks 10, 11 are connected to a main tank 14 for holding therein source air under pressure, via electrically-operated air pressure control valves 12, 13, respectively, for controlling the air pressures in the respective air tanks 10, 11, hence the air injection pressures of the main weft inserting nozzle 4 and the auxiliary weft inserting nozzles 5-8.

Each of the solenoid-operated valves V_1-V_5 is actuated to open or close according to commands from the control C_1 which provides such commands in response to signals transmitted from a rotary encoder 15 monitoring the current angle of rotation of the weaving loom. Data for such commands to control the valves V_1-V_5 are stored in a data memory of the control C_1. Thus, the computer control C_1 functions to control the operation of the weft inserting nozzles 4-8 according to the above command data and also to a weft insertion control program stored in its program

memory.

There are provided pressure detectors 16, 17 which are connected at their input to the air tanks 10, 11, respectively, for detecting the air pressures in the tanks, and at their output to a computer control C_2 for transmitting thereto information of the detected air pressures, thus the control C_2 providing a feedback control for the pressure control valves 12, 13 according to the current air pressures detected by the pressure detectors 16, 17.

In operation, the computer control C_2 functions to control the operation of the pressure control valves 12, 13, thereby controlling the air injection pressures of the main and auxiliary weft inserting nozzles 4-8, in accordance with the pressure control program shown in FIG. 3. The following will describe in detail the manner in which controlling of the air injection pressure of the nozzles is performed.

The computer control C_2 successively samples the weft released times TBW and the arrival times TB of a predetermined sampling number "n" from the weft release detector 3 and the weft sensor 9, respectively. The control C_2 then calculates an average arrival time $<TW>_n$. When the absolute valve of the difference between a predetermined target arrival time TW_o and the above calculated average arrival time $<TW>_n$, or TW_o-$<TW>_n$, is equal to or less than a permissible value of difference ρ, the current air injection pressure P_M of the main weft inserting nozzle 4 is maintained as it is without being changed by adjustment. If the above absolute value is greater than ρ, however, the air injection pressure P_M is changed for adjustment. To be more specific, in the event that $<TW>_n-TW_o > \rho$, i.e. if the arrival time is too late, the air injection pressure P_M of the main weft inserting nozzle 4 is adjusted for an increase; on the other hand, in the event that $<TW>_n-TW_o < -\rho$, i.e. if the arrival time is too early, the air injection pressure P_M is adjusted for a decrease.

After such controlling of the air injection pressure of the main weft inserting nozzle 4, the control C_2 operates to control the air injection pressure Ps of the auxiliary weft inserting nozzles 5-8 in accordance with the line "f" in FIG. 2.

Referring to the diagram of FIG. 2, $<TW-TBW>_n$ on the ordinate thereof represents the average difference between the arrival time TW detected by the weft sensor 9 and the weft released time TBW detected by the weft release detector 3, and P_f on the abscissa indicates the difference between the air injection pressure P_s of the auxiliary weft inserting nozzles 5-8 and the air injection pressure P_M of the main weft inserting nozzle 4. That is, the line "f" in the diagram represents the function to correlate the average difference $<TW-TBW>_n$ and the pressure difference P_f, which may be determined from experiments. As seen in the diagram of FIG. 2, the average difference between the arrival time TB and the weft released time TBW, or $<TW-TBW>_n$, is decreased with an increase of the pressure difference P_f until P_β is reached and, thereafter, the average difference $<TW-TBW>_n$ becomes constant.

Supposing that a is an optimum as the difference $<TW-TBW>_n$ for given weaving conditions such as weaving width, loom speed, kind of weft to be handled, etc., data of $<TW-TBW>_n=\alpha$ is inputted into the computer control C_2 through an input device 18 (FIG. 1) connected to the control. Accordingly, the control C2 functions to control the injection pressure of the auxiliary nozzles 5-8 toward the target pressure difference α. That is, when the absolute value of difference between $<TW-TBW>_n$ and α is equal to or less than a predetermined permissible value δ, the current air injection pressure of P_s the auxiliary nozzles 5-8 is maintained as it is without being changed by adjustment. If the difference is greater than δ, the air injection pressure P_s is changed by adjustment. Though, in the embodiment, the air injection pressure P_s of the auxiliary nozzles 5-8 is set higher than the pressure P_M of the main nozzle 4, the pressures P_M and P_s may be established in opposite relation.

In the event that $<TW-TBW>_n-\alpha > \delta$, i.e. if the pressure difference P_f (P_s-P_M) is too large, adjustment is made so as to decrease the injection pressure $P_s(=P_M+P_f)$ of the auxiliary nozzles 5-8. This reduction in pressure is made with respect to the pressure difference P_f without changing the injection pressure P_M of the main nozzle 4. On the other hand, in the event that $<TW-TBW>_n-\alpha < -\delta$, i.e. if the pressure difference P_f is too small, adjustment is made so as to increase the injection pressure $P_s(=P_M+P_f)$. This increase in pressure is made with respect to the pressure difference P_f without changing the injection pressure P_M.

The above-described controlling of the air injection pressures P_M, P_s of the main and auxiliary weft inserting nozzles 4 and 5-8 is performed repeatedly for each predetermined sampling number "n" of detected arrival times TW and weft released times TBW.

The injection pressure P_M of the main weft inserting nozzle 4 determines the weft flying speed during the initial period of weft insertion, and the arrival time TW is largely dependent on this weft flying speed. Therefore, the leading end of an inserted weft can be permitted to reach the weft detector 9 at an appropriate time within the target range of arrival time TW by properly controlling the injection pressure PM of the main weft inserting nozzle 4 according to the detected arrival times TW.

With the injection pressure P_M of the main weft inserting nozzle 4 thus once determined, the injection pressure P_s of the auxiliary weft inserting nozzles 5-8 largely influences the condition or attitude of the weft being flown during the remaining period of the weft insertion. That is, failure in weft insertion resulting from irregularities of weft flying, e.g., weft slackening or loop forming at its leading end, is caused by impro-

per setting of the injection pressure P_s. Therefore, the above irregular motion of weft can be prevented successfully by controlling the pressure difference P_f between P_s and P_M, or specifically by adjusting the pressure P_s of the auxiliary weft inserting nozzles 5-8 according to the average difference between the arrival time TW detected by the weft sensor 9 and the weft released time TBW detected by the weft release detector 3.

The air flow rate by such air injection with prevention of the above troubles such as weft slacking and looping taken into account is determined by the line "f" of FIG. 2. That is, once the target value of $<TW-TBW>_n$ is established, the air flow rate by air injection from the main and auxiliary weft inserting nozzles 4, 5-8 can be specified, so that no more air will be consumed than necessary. Particularly, when the target value of $<TW-TBW>_n$ is set at, for example, β, the pressure difference P_f may be set at P_β, at which only minimum air consumption is required, but while maintaining successful weft inserting operation.

It is noted that the present invention is not limited to the above illustrated embodiment, but may be practiced in other modifications, as exemplified by flow chart in FIG. 4. In this modified embodiment, if $<TW-TBW>_n$ falls stably within the permissible difference δ, the pressure difference P_f is adjusted toward the target difference P_a. This manner of controlling can further reduce the air consumption.

Alternatively, the difference between $P_f(<TW-TBW>_n)$ and P_α, instead of the difference between $<TW-TBW>_n$ and α, may be used for controlling the pressure difference P_f.

As it is now apparent from the foregoing, the apparatus according to the present invention, wherein the air injection pressure of the main weft inserting nozzle is controlled according to the detected weft end arrival time, and the pressure difference between the air injection pressure of the main weft inserting nozzle and that of the auxiliary weft inserting nozzles is controlled according to the time difference between the detected weft end arrival time and the detected weft released time, is capable adequately controlling both the air injection pressure of the main weft inserting nozzle that would otherwise affect the arrival time and the air injection pressure of the auxiliary weft inserting nozzles that would otherwise cause troubles such as weft slackening and looping of its leading end, thus realizing dependable controlling of weft inserting air pressure in a jet loom without allowing consumption of unnecessary excess air.

The apparatus allows to achieve dependable controlling of weft inserting air pressure in a jet loom while improving i.e. reducing air consumption.

The air injection pressure of the main weft inserting nozzle 4 is controlled by the computer control C_2 which then controls the pressure control valve 12 according to the arrival time detected by the weft sensor 9. The air injection pressure of the auxiliary weft inserting nozzles 5-8 is controlled by the computer control C_2 which then controls the pressure control valve 13 according to the difference between the above arrival time and the weft released time detected by the weft release detector 3.

DESIGNATION OF REFERENCE NUMERALS

4 ... Main weft inserting nozzle; 3 ... Weft release detector as the weft released time detecting means; 5-8 ... Auxiliary weft inserting nozzles; 9 ... Weft sensor as the arrival time detecting means; 12, 13 ... Electrically-operated air pressure control valves as the air injection pressure adjusting means; C_2 ... Computer control as the control means for controlling the air injection pressure adjustment.

Claims

1. Apparatus for controlling weft inserting air pressure in a jet loom wherein weft insertion is accomplished by air jets from main weft inserting nozzle (4) and auxiliary weft inserting nozzles (5, 6, 7, 8) and the weft inserting air pressure is controlled in accordance with the information representative of time at which the leading end of an inserted weft (Y) arrives at a predetermined position (9) in the loom, said apparatus comprising:

   weft released time detecting means (3) for detecting the time at which releasing of a weft from a weft winding and storage device (1) is completed;

   weft end arrival time detecting means (9) disposed at said predetermined position for detecting the time at which the leading end of an inserted weft arrives at said arrival time detecting means;

   first adjusting means (C_2, 12) for adjusting the air injection pressure of said main weft inserting nozzle (4);

   second adjusting means (C_2, 13) for adjusting the air injection pressure of said auxiliary weft inserting nozzles (5, 6, 7, 8); and

   control means (C_2) for controlling the air injection pressure adjustments by said first and second adjusting means (12, 13);

   said control means (C_2) having functions of controlling the air injection pressure of said main weft inserting nozzle (4) according to the detected weft end arrival time and of controlling the pressure difference between the air injection pressure of said main weft inserting nozzle (4) and that of said auxiliary weft inserting nozzles (5, 6, 7, 8) according to the time difference between the detected weft end arrival time and the detected weft released time.

2. Apparatus for controlling weft inserting air pressure in a jet loom wherein weft insertion is accomplished by air jets from main weft inserting nozzle (4) and auxiliary weft inserting nozzles (5, 6, 7, 8) and the weft inserting air pressure is controlled in accordance with the information representative of time at which the leading end of an inserted weft (Y) arrives at a predetermined position (9) in the loom and with control means (C_2) for controlling and maintaining the air pressure difference ($<TW-TBW>_n=\alpha$) between the air injection pressure of said main nozzle (4) and the air injection pressure of said auxiliary nozzles (5, 6, 7, 8) within an given range.

3. Apparatus as claimed in claim 1 or claim 2 comprising a main air tank (14), supplying air to a second air tank (10) for supplying air to said main nozzle (4) and to a third air tank (11) for supplying air to said auxiliary nozzles (5, 6, 7, 8) and pressure adjusting means (12, 13) for adjusting the pressure of the second air tank (10) and the third air tank (11) respectively.

4. Apparatus as claimed in any of claims 1 to 3, further comprising an imput device (18) for imputting values of the air pressure difference ($<TW-TBW>_n=\alpha$) between the air injection pressure of said main nozzle (4) and the air injection pressure of said auxiliary nozzles (5, 6, 7, 8) to a control device (C_2).

5. Apparatus as claimed in any of claims 1 to 4, wherein the control devices (C_1, C_2) are digital computer control devices.

6. Loom with air jet weft insertion comprising an apparatus as claimed in any of claims 1 to 5.

Fig. 1

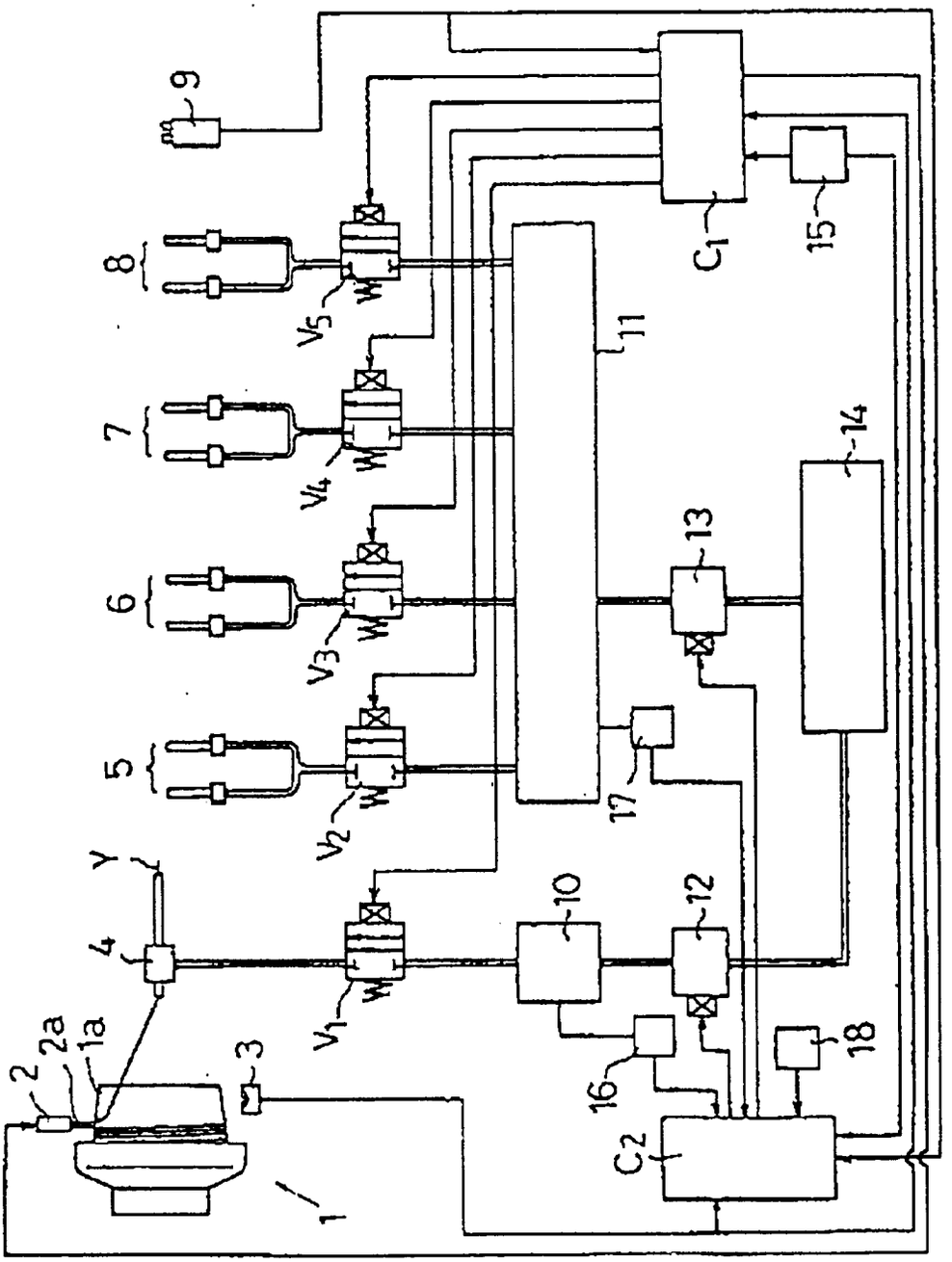


Fig. 2

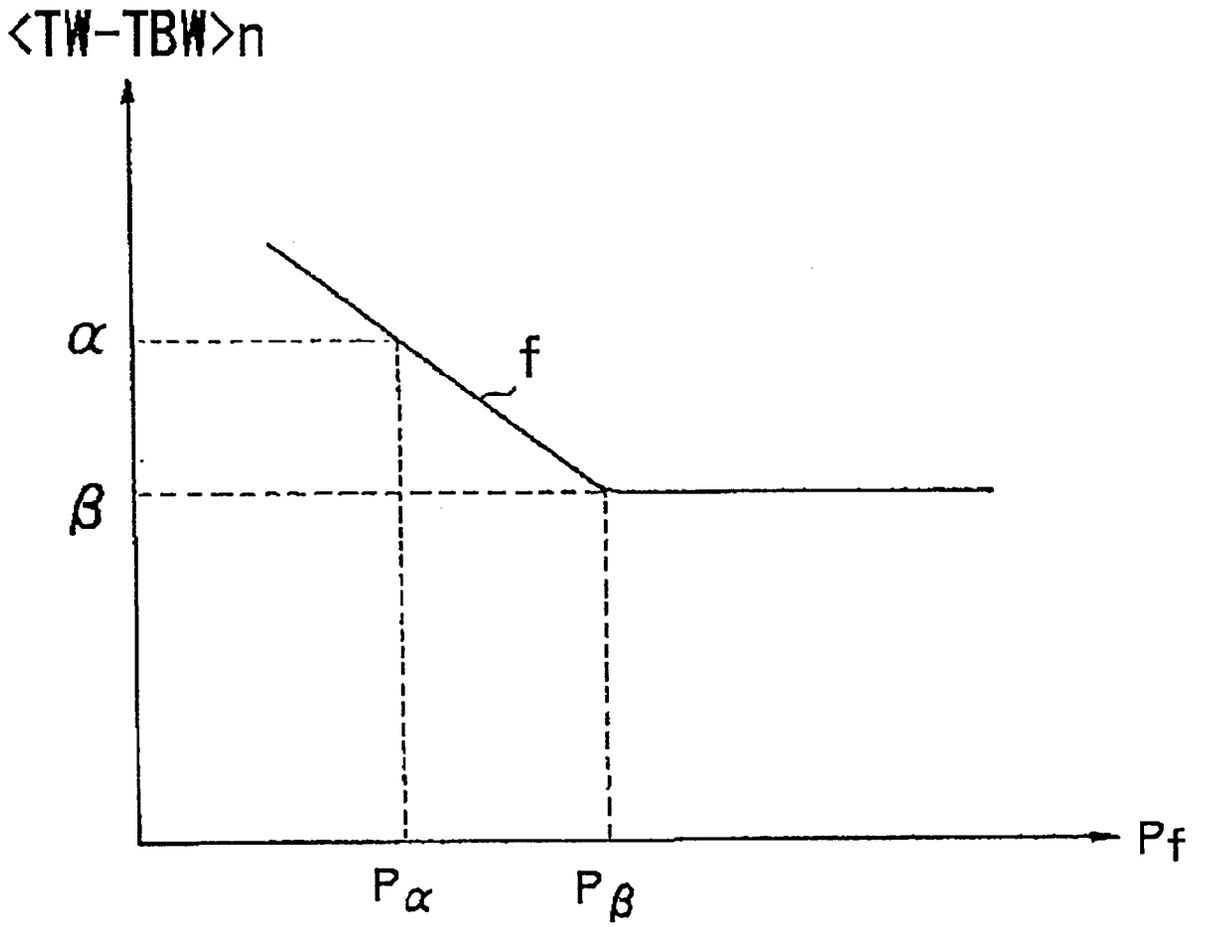
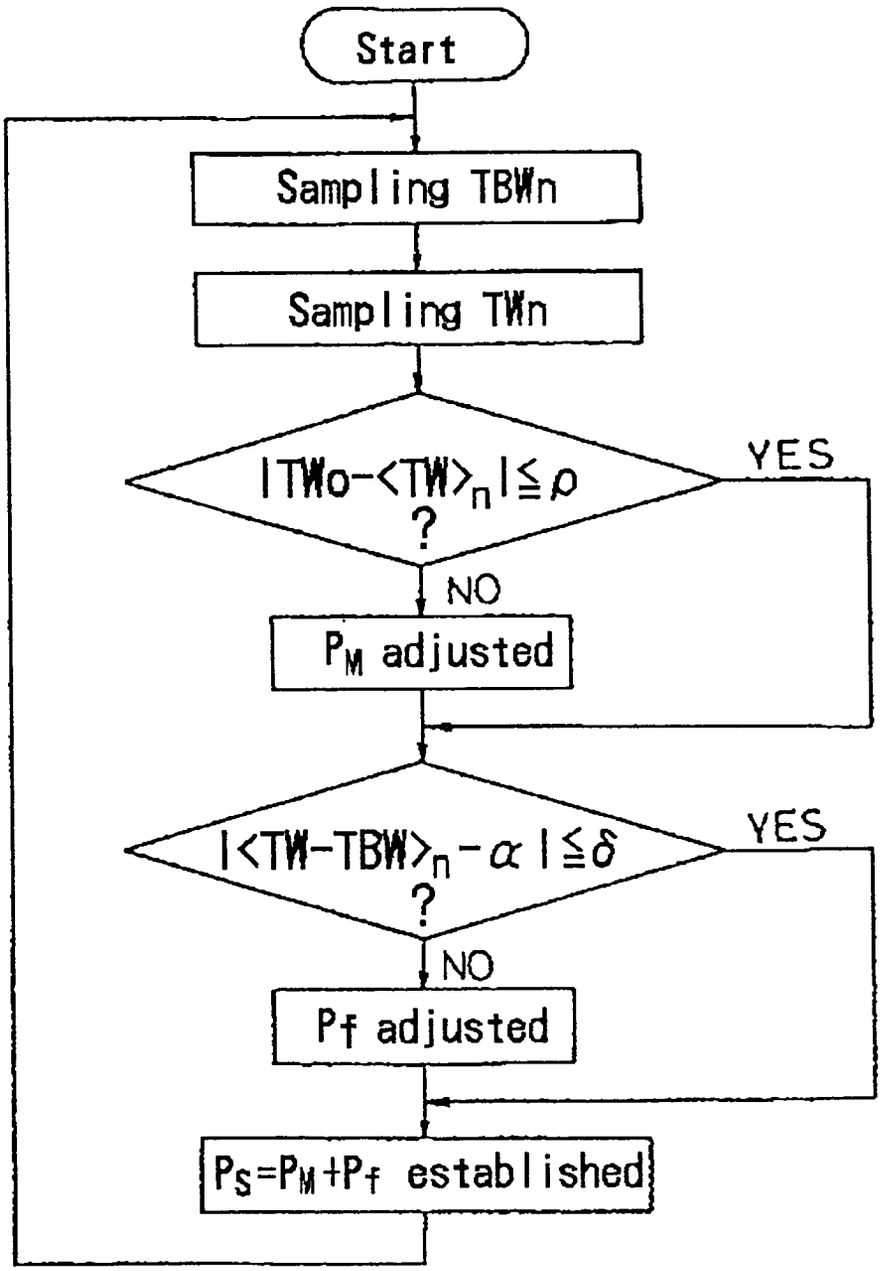


Fig. 3


Start
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Sampling TWn
|TWo-<TW>n| ≦ ρ ?
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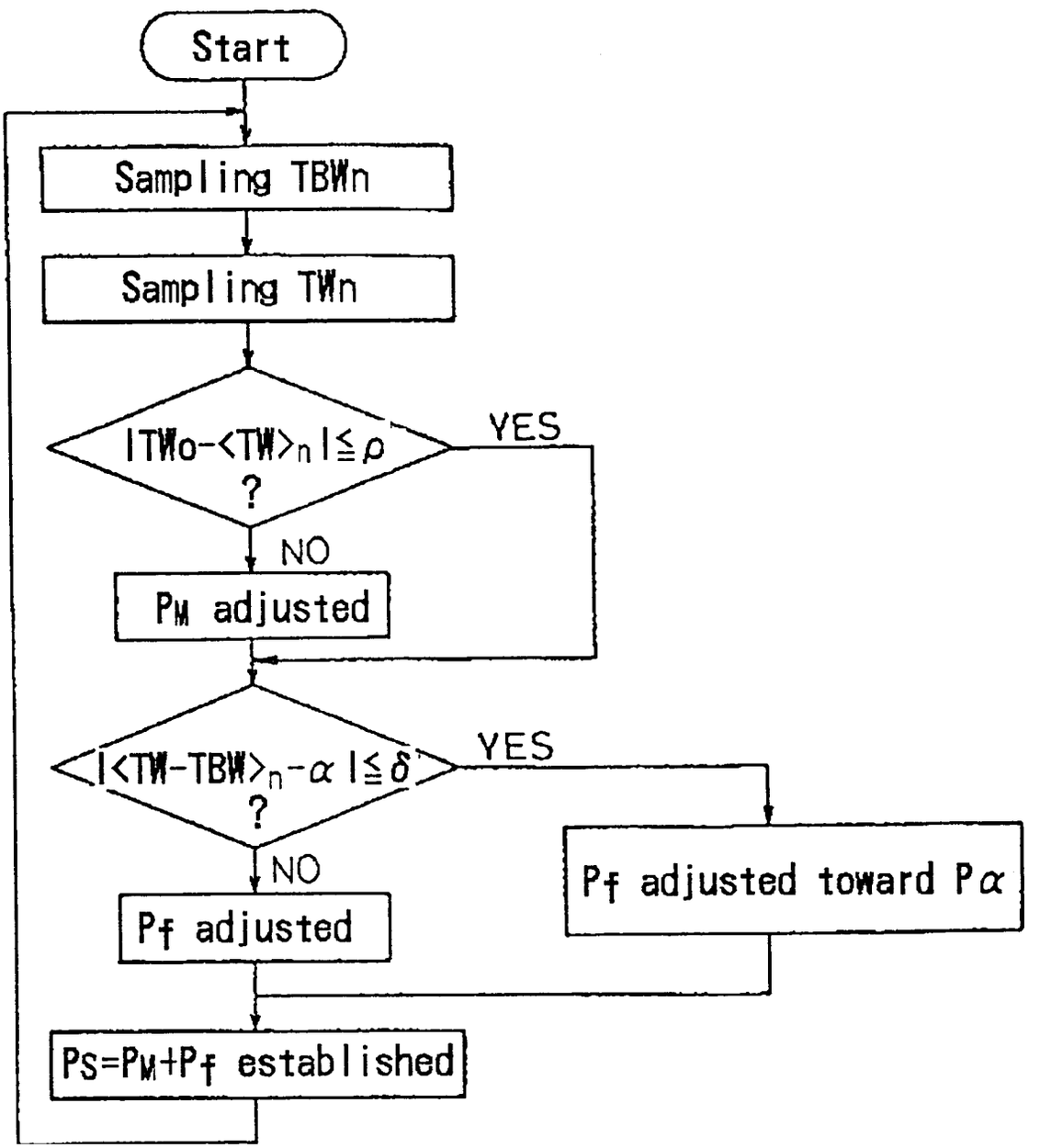
NO
PM adjusted
|<TW-TBW>n - α| ≦ δ ?
YES
NO
Pf adjusted
PS=PM+Pf established

Fig. 4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|TWo-<TW>n|≦ρ ?
YES
NO
PM adjusted
|<TW-TBW>n-α|≦δ ?
YES
NO
Pf adjusted
Pf adjusted toward Pα
PS=PM+Pf established

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 81 1001

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	EP-A-0 263 445 (TSUDAKOMA CORP.) * page 5, column 7, line 26 - page 7, column 11, line 10; figures 1-8 *	1,2	D03D47/30
A	EP-A-0 276 829 (TSUDACOMA CORP.) * page 3, column 3, line 46 - page 4, column 6, line 34; figures 1-3 *	1,2	
A	EP-A-0 344 104 (GEBRÜDER SULZER) * page 5, column 7, line 9 - column 8, line 17; figures 1-3 *	1,2	
A	US-A-4 915 142 (NISSA MOTOR CO LTD) * column 2, line 20 - column 4, line 38; figures 1-7 *	1,2	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			D03D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	06 APRIL 1992	HENNINGSEN O.

CATEGORY OF CITED DOCUMENTS

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