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(71) Applicant: **KAYABA KOGYO KABUSHIKI KAISHA**
**Tokyo (JP)**

(72) Inventor: **Sugihara, Katsumichi,**
**c/o Kayaba Kogyo K.K.**
**2-chome, Minato-ku, Tokyo (JP)**

(74) Representative: **Grünecker, Kinkeldey,**
**Stockmair & Schwanhäusser**
**Anwaltssozietät**
**Maximilianstrasse 58**
**80538 München (DE)**

## (54) Weaving machine thread selector

(57) A thread used by a weaving machine is selected according the energization of a corresponding solenoid. A mechanism for supplying energizing current to the solenoid, and a mechanism for causing the energizing current to oscillate when the energizing current has been continuously supplied for a predetermined time, are provided. By causing the energizing current to oscillate, temperature rise of the solenoid is prevented.

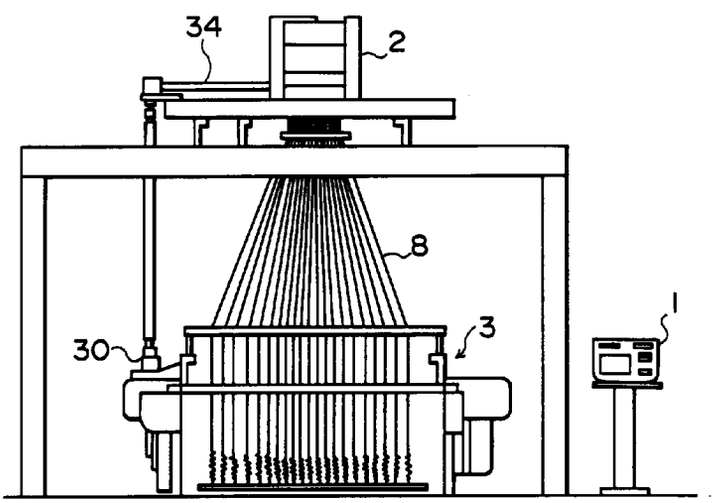


FIG. 1

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## Description

### FIELD OF THE INVENTION

This invention relates to a thread selector used to enable a weaving machine to select a thread according to a pattern or design of a woven fabric, and more specifically, to a thread selector that selects a thread using a solenoid.

### BACKGROUND OF THE INVENTION

In weaving machines, a thread selector such as a Jacquard mechanism is used to select a thread according to a pattern or a design.

As an example of such a thread selecting machine, Tokkai Hei 3-90606 published by the Japanese Patent Office in 1991 discloses a device using an electromagnetic solenoid type actuator.

This device comprises a large number of thread selecting units each comprising a knife disposed above the weaving machine which moves up and down in synchronism with the operating cycles of the machine, a needle driven upwards by the knife, a hook for retaining the needle in a raised position, and an electromagnetic solenoid which causes the hook to oscillate between the needle retention position and a needle release position. When the solenoid is energized as the needle is rising so that the hook engages with the needle, the needle is retained in its raised position even after the knife has moved down. When energization of the solenoid is stopped, the hook swings into the non-engaging position, so the needle moves down together with the knife. The needle is connected to a thread via a connecting mechanism, the weaving machine using only those threads connected to needles retained in their raised positions.

Therefore, by selectively supplying energizing currents to the solenoids of the thread selecting units, only those threads which are required may be selected from a large number of candidate threads.

As long as selection of threads corresponding to solenoids continues, these solenoids remain energized, however as this energization generates heat, the solenoids become hot if the energization continues over a long period of time.

As the thread selecting mechanism comprises a large number of thread selecting units, the solenoids are packed closely together. It is therefore difficult to cool any specific solenoid which has become hot, and if such a solenoid is allowed to remain hot, there is a risk that it may be damaged by the heat.

Continuous energization of specific solenoids occurs during the normal running of the weaving machine, but it may occur also for example when a transverse or longitudinal thread breaks so that the operation of the machine is interrupted. In this case, the knife which moves in synchronism with the machine stops moving up and down, however the solenoid corresponding to the needle which was selected when the interruption occurred, remains energized.

To prevent overheating of solenoids in such an event, this type of thread selecting mechanism is provided with a mechanism for cutting off power to all solenoids in synchronism with the shutdown of the machine. The thread selecting units then return to their initial state when operation of the machine is interrupted.

However, if the thread selecting units are initialized in this way, a delay tends to occur in the action of the hooks when the solenoids are first energized after operation is resumed. As a result, the upward moving needles are not retained by the hooks with the correct timing, and there is a risk that inconsistencies might be introduced in the woven pattern immediately after recommencing the operation.

Further, according to this mechanism, temperature rise of the solenoids while the weaving machine is operating cannot be prevented.

### SUMMARY OF THE INVENTION

It is therefore an object of this invention to prevent the temperature of a solenoid of a thread selecting unit from rising regardless of whether a weaving machine is operating or not operating.

In order to achieve the above object, this invention provides a thread selecting unit for such a weaving machine that comprises an electromagnetic actuator for selecting a thread used by the weaving machine according to energizing of a solenoid, and a mechanism for supplying an energizing current to the solenoid, the unit comprising. The selecting unit comprises a mechanism for measuring an energizing time of the solenoid and a mechanism for periodically interrupting the energizing current when the energizing time exceeds a predetermined value.

According to an aspect of the invention, the unit further comprises a mechanism for detecting an operating cycle of the machine, needles respectively connected to a plurality of the threads, a mechanism for causing the needles to move up and down in synchronism with the operating cycle of the machine, a first mechanism for outputting an energizing signal in synchronism with the operating cycle, a second mechanism for outputting a signal which switches the energizing current on and off based on preset data so as to select a required thread, and a mechanism for controlling the energizing current based on the signals output by the first mechanism and second mechanism, wherein the interrupting mechanism further comprises an oscillating mechanism for outputting an oscillating signal having a predetermined amplitude when the energizing time exceeds a predetermined value and a mechanism for supplying current to the solenoid corresponding to a product of the energizing current and the oscillating signal.

The details as well as other features and advantages of this invention are set forth in the remainder of the specification and are shown in the accompanying

drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic front view of a weaving machine and thread selecting unit according to this invention.

Fig. 2 is a side view of the thread selecting unit.

Figs. 3(a) - 3(c) are vertical sectional views of the thread selecting unit showing different stages in its operation.

Figs. 4(a) and 4(b) are vertical sectional views of the thread selecting unit in a direction perpendicular to that of Fig. 3 showing different stages in its operation.

Fig. 5 is a block diagram showing a circuit controlling solenoid energizing current according to this invention.

Fig. 6 is a timing chart showing an energized state of a solenoid according to this invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Fig. 1 of the drawings, a thread selecting unit 2 is disposed above a weaving machine 3. The thread selecting unit 2 is driven via a shaft 34 connected to a shaft 30 which rotates in synchronism with the machine 3.

An eccentric wheel 31 is fixed to the shaft 34 as shown in Fig. 2. The rotation of the shaft 34 is converted to an up-and-down motion via an arm 32 whereof one end is connected to the outer circumference of the wheel 31 and a link mechanism 33, and this motion is transmitted to sets of knives 7A, 7B. The knives 7A, 7B therefore move up and down alternately in synchronism with the weaving cycles of the machine 3.

As shown in Fig. 3, the upward moving knives 7A, 7B respectively drive needles 4A, 4B upwards. Engaging holes 40 are formed at the upper ends of the needles 4A, 4B. An operating thread 42 by which a common pulley 41 is suspended, are connected to the lower ends of the needles 4A, 4B. A thread 8 is connected to the pulley 41. When the needles 4A, 4B are both in their raised positions, the thread 8 is pulled upward via the pulley 41 so that the thread 8 is selected.

When either the needle 4A or 4B is in its lowered position, the thread 8 is not pulled up so that the thread 8 is deselected. Since the knives 7A, 7B move up and down alternately, the needles 4A, 4B are never both in their lowered positions.

A hook 6A is supported free to swing on a hinge 43 above the knife 7A, and a hook 6B is likewise supported above the knife 7B on the hinge 43. The hooks 6A, 6B swing independently of one another. Solenoids 5 are respectively disposed above the hooks 6A, 6B to drive the hooks 6A, 6B.

The hooks 6A, 6B are driven by the solenoids 5 via the mechanism shown in Fig. 4. i.e., an energized solenoid 5 draws an armature 9 toward a yoke 10. The upper end of the hook 6A(6B) is pushed by a spring 12 so that it comes in contact with the armature 9. When the armature 9 is pulled toward the yoke 10, the hook 6A(6B) swings against the force of the spring 12, and a claw 60 provided at its lower end moves into a forward position. On the other hand, when the energizing current of the solenoid 5 is cut off, the hook 6A(6B) swings into such a direction as to push the armature 9 back due to the force of the spring 12, and the claw 60 moves into a retracted position.

When the solenoid 5 is energized with the needle 4A in its raised position, the hook 6A swings, and the claw 60 enters the engaging hole 40 of the needle 4A as shown in Fig. 4(a). The needle 4A is therefore retained in its raised position even after the knife 7A has moved down. The same can be said for the hook 6B and needle 4B.

When either of the needles 4A or 4B is retained in its raised position, the thread 8 is pulled up when the other needle has moved into Its raised position so that the thread 8 is selected.

When the hooks 6A, 6B are both in their retracted positions and either of the needles 4A, 4B has moved into its raised position, the other needle moves down, hence the thread 8 is not pulled up and is thus deselected.

On account of this construction, it is sufficient to provide a single solenoid 5 for the two hooks 6A, 6B. When a solenoid 5 is provided for each hook, the thread 8 is always selected by energizing both of the solenoids 5 regardless of whether the knives 7A, 7B are moving up or down.

Supply of energizing current to the solenoid 5 is controlled by a circuit shown in Fig. 5.

A rotary encoder 11 which outputs a pulse signal corresponding to a predetermined rotation position of the shaft 34 is provided, and this pulse signal is input to a control unit 1. The control unit 1 is provided with a memory for storing data as to which thread should be selected at which time. Each time the pulse signal is input, the control unit 1 reads data so as to select a thread from the data stored in the memory and outputs energizing signals S1 to switch on and off the energizing current to the corresponding solenoids 5. This signal S1 comprises a high level and a low level. Control units having such functions are known in the prior art.

The thread selecting unit 2 further comprises a timer circuit 13, oscillating circuit 14, AND circuit 15 and amplifying circuit 16. All the signals output by these circuits also comprise a high level and a low level.

The output signal S1 from the control unit 1 is input to the AND circuit 15.

A signal S2 output by the timer circuit 13 is normally low level. When a pulse signal is input from the rotary encoder it simultaneously changes to high level, and returns to low level after a predetermined time $t$ has elapsed.

The oscillating circuit 14 varies an output signal S3 according to the signal S2. In other words, when the sig-

nal S2 is low level, the signal S3 oscillates. i.e. it switches between high level and low level in a short period, and when the signal S2 is high level, the output signal S3 is caused to be high level.

The signal S3 is input to the AND circuit 15 together with the aforesaid signal S1. A signal S4 output by the AND circuit 15 is high level only when both these input signals are high level, otherwise it is low level.

In the amplifying circuit 16, the signal S4 is amplified to a level required to energize the solenoid 5, and is then output to the solenoid 5.

The action of this mechanism will now be described with reference to Fig. 6.

In normal operation, energization of the solenoid 5 begins when the signal S1 output by the control unit 1 changes from low level to high level. When this changeover occurs, the timer circuit 13 starts to measure the elapsed time, however the signal S2 output by the timer circuit 13 is high level and the signal S4 output by the AND circuit 15 is also high level until the elapsed time reaches the predetermined time *t*. As a result, the solenoid 5 is energized by energizing current amplified in the amplifying circuit 16, the hook 6A(6B) engages with the needle 4A(4B) and the corresponding thread 8 is selected.

When the predetermined time *t* elapses from energization of the solenoid 5, the signal S2 output by the timer circuit 13 changes to low level, and the signal S3 output by the oscillating circuit 14 starts to oscillate. The signal S1 input to the AND circuit 15 remains at high level, and the signal S4 output by the AND circuit 15 also oscillates. The energizing current to the solenoid 5 amplified by the amplifying circuit 16 therefore switches on and off with a short period.

Due to the characteristics of the solenoid, the solenoid 5 does not immediately stop attracting the armature 9 even when energization momentarily stops, its magnetism merely decreasing according to an inherent time constant. Hence, due to the intermittent current which switches on and off with a short period, although the magnetism of the solenoid 5 decreases, the hook 6A(6B) remains engaged with the needle 4A(4B) when the predetermined time *t* has elapsed from energization, the solenoid 5 retaining a small magnetism sufficient to keep the hook 6A(6B) in the same position. The hook 6A(6B) is therefore retained in Its engaging position with the needle 4A(4B) even under this reduced magnetic force. The heat generated by the solenoid 5 increases with the time of passage of the energizing current, however by making the energizing current intermittent, the heat generated by the solenoid 5 is maintained effectively constant. The power required to energize the solenoid 5 is also maintained at a low level.

When the machine 3 stops operating due to a broken thread or the like, the rotary encoder 11 no longer detects rotation of the shaft 34, so the control unit 1 continues to output the signal S1. In this case also, alter the predetermined time *t* has elapsed, the energizing current to the solenoid 5 continues to switch on and off with a short period until operation restarts as shown in Fig. 6 due to oscillation of the signal S4 output by the AND circuit 15. All the needles 4A(4B) are therefore maintained in the positions in which they were when operation of the machine 3 was interrupted, it is unnecessary to provide a process for returning the needles to this state when operation is restarted, and weaving can be resumed speedily.

Further, by making the energizing current to the solenoid 5 intermittent, the heat generated by the solenoid 5 when operation of the machine 3 stops is maintained effectively constant. There is thus no risk that the solenoid 5 will overheat even if the shutdown time is long.

If the control unit 1 is a microprocessor comprising a CPU, memory and I/O interface, all or part of the timer 13, oscillating circuit 14 and AND circuit 15 may be implemented as internal functions of the control unit 1.

Accordingly, although this invention has been shown and described in terms of the preferred embodiment thereof, it is not to be considered as limited by any of the perhaps quite fortuitous details of said embodiment, or of the drawings, but only by the terms of the appended claims, which follow.

## Claims

1. A thread selecting unit (2) for use with a weaving machine (3) comprising an electromagnetic actuator (6A 6B) which selects a thread (8) used by said machine (3) according to energizing of a solenoid (5), and means (16) for supplying an energizing current to said solenoid (5), said unit (2) comprising:

   means (13) for measuring an energizing time of said solenoid (5), and

   means (14, 15) for periodically interrupting said energizing current when said energizing time exceeds a predetermined value.

2. A thread selecting unit (2) as defined in claim 1 wherein said unit (2) further comprises means (11) for detecting an operating cycle of said machine (3), needles (4A, 4B) respectively connected to a plurality of the threads (8), means (7A, 7B) for causing said needles (4A, 4B) to move up and down in synchronism with the operating cycle of said machine (3), first means (1) for outputting an energizing signal in synchronism with said operating cycle, second means (1) for outputting a signal which switches said energizing current on and off based on preset data so as to select a required thread, and means (1) for controlling said energizing current based on said signals output by said first means (1) and second means (1), said interrupting means (14, 15) further comprising oscillating means (14) for outputting an oscillating signal hav-

ing a predetermined amplitude when said energizing time exceeds a predetermined value, and means (15) for supplying current to said solenoid corresponding to a product of said energizing current and said oscillating signal.

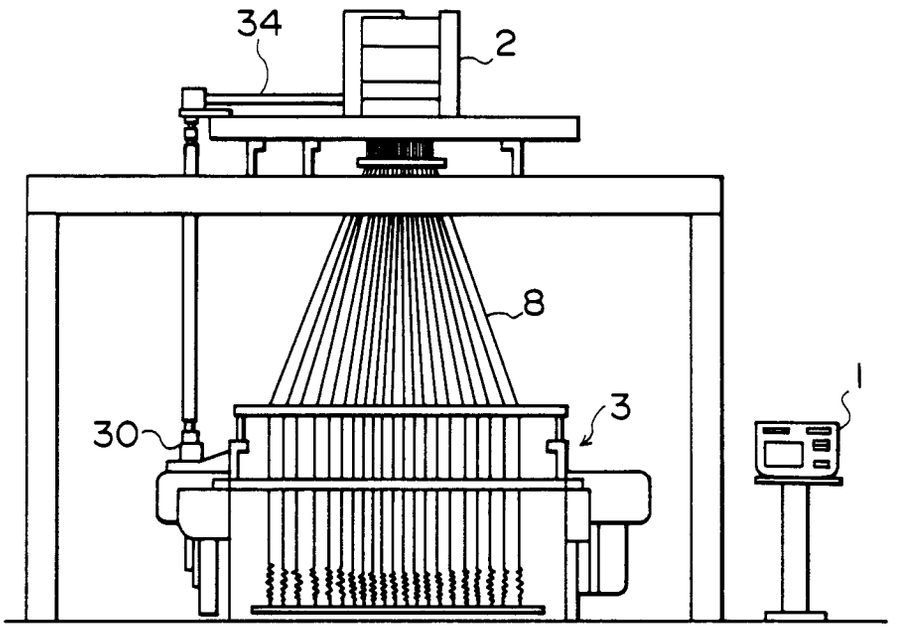



FIG. 1

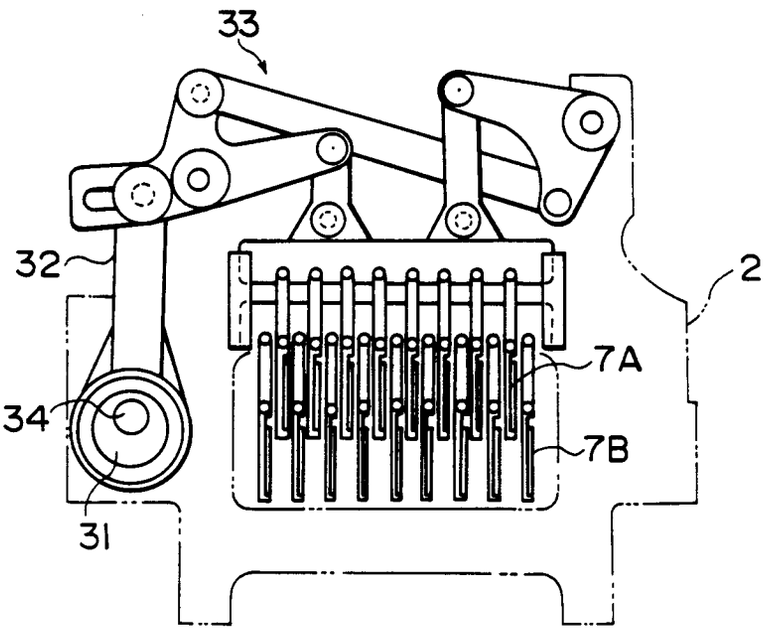



FIG. 2

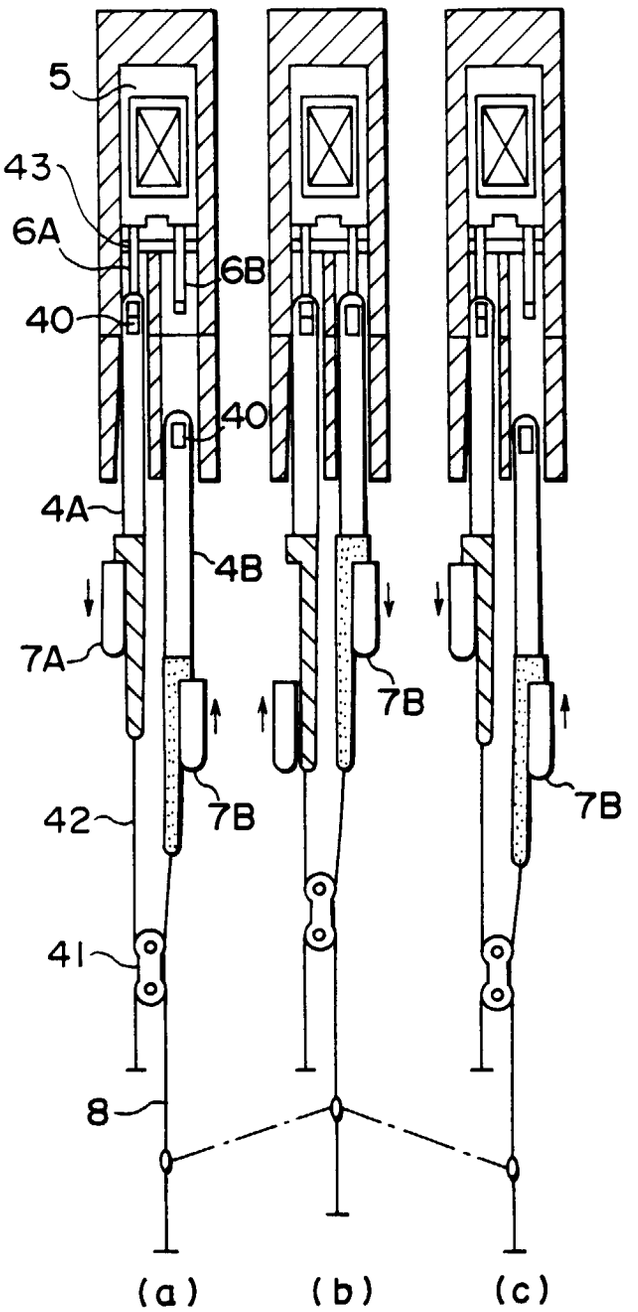



FIG. 3

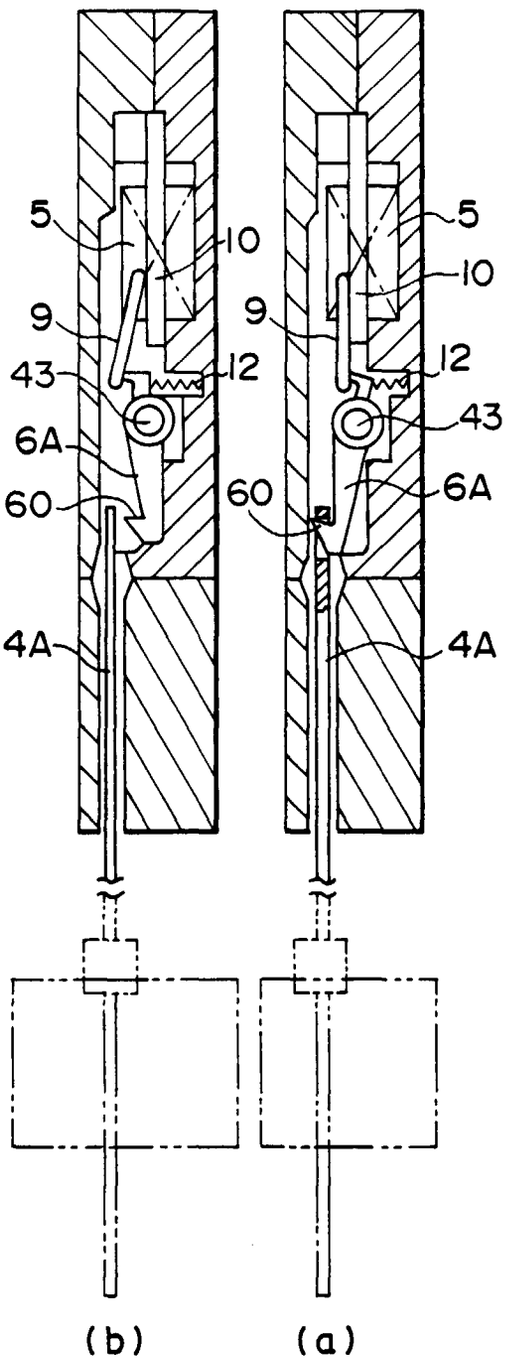



FIG. 4

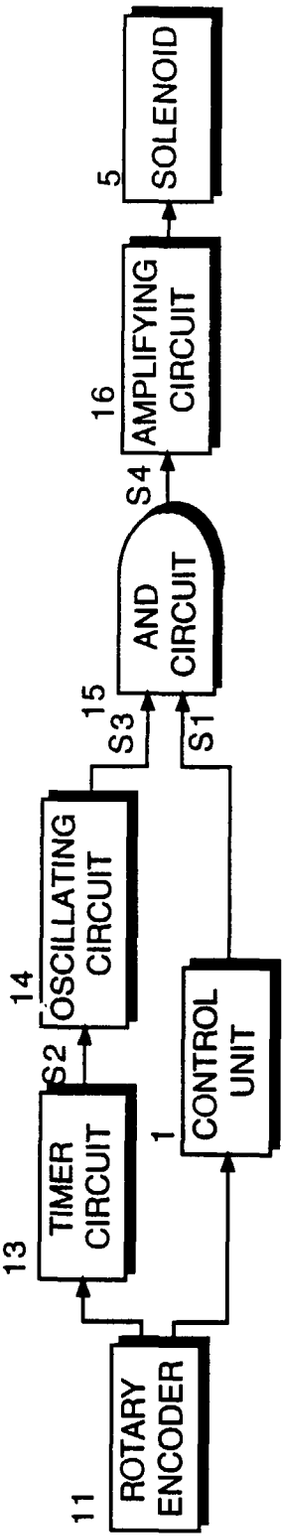
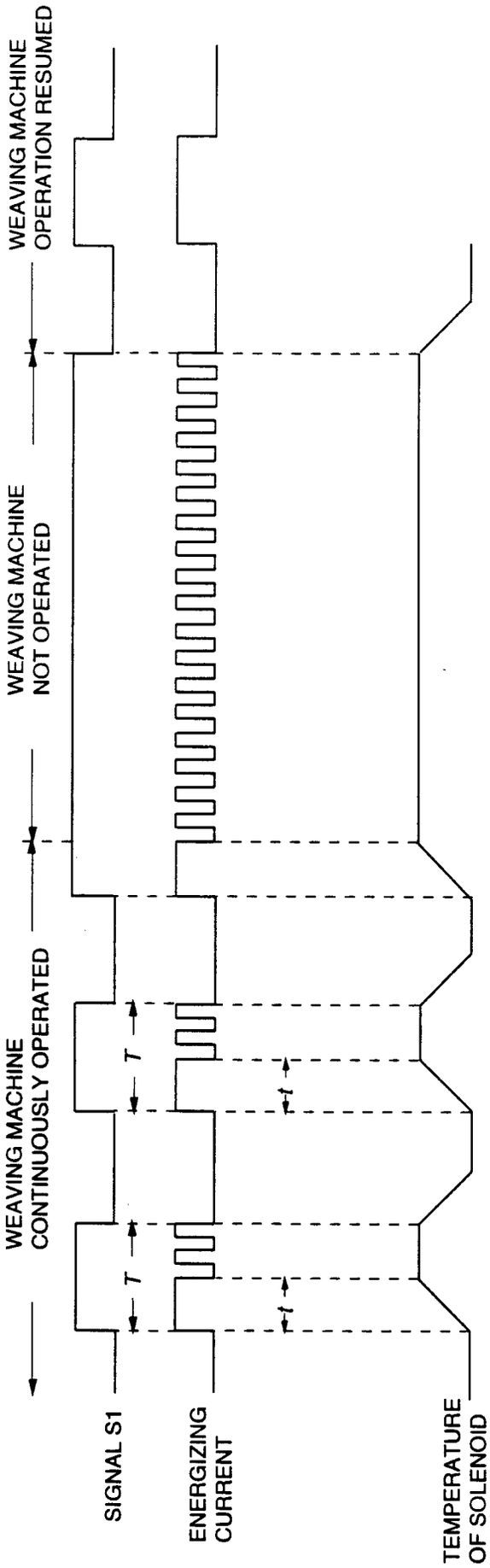

11
ROTARY ENCODER
13
TIMER CIRCUIT
S2
14
OSCILLATING CIRCUIT
1
CONTROL UNIT
S3
15
S1
AND CIRCUIT
S4
16
AMPLIFYING CIRCUIT
5
SOLENOID

FIG. 5


WEAVING MACHINE CONTINUOUSLY OPERATED
WEAVING MACHINE NOT OPERATED
WEAVING MACHINE OPERATION RESUMED
T
T
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SIGNAL S1
ENERGIZING CURRENT
TEMPERATURE OF SOLENOID

FIG. 6

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 96 10 5086

## 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.6) |
|---|---|---|---|
| P,X | EP 0 697 477 A (KAYABA KOGYO K.K.)<br>* the whole document *<br>----- | 1,2 | D03C3/20 |

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

D03C

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 2 April 1997 | Boutelegier, C |

CATEGORY OF CITED DOCUMENTS

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