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

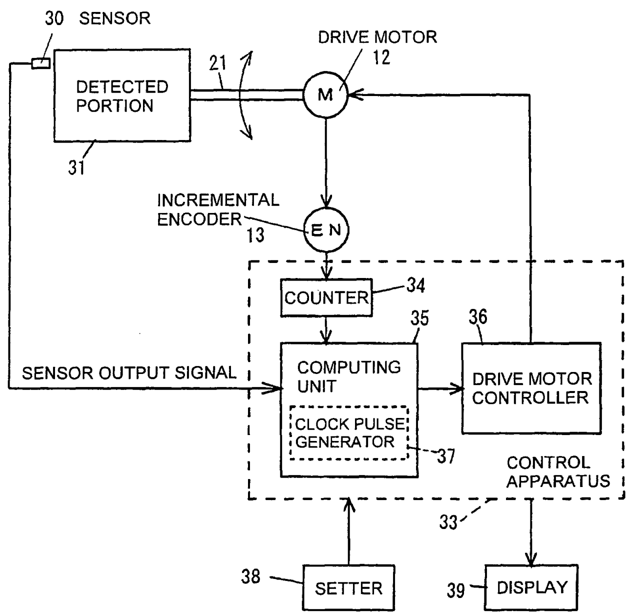
(72) Inventors:
- **Hirai, Jun**
Kanazawa-shi
Ishikawa-ken 921-8650 (JP)
- **Araki, Nobuhiro**
Kanazawa-shi
Ishikawa-ken 921-8650 (JP)

(74) Representative: **Samson & Partner**
Widenmayerstraße 5
D-80538 München (DE)

(54) **Control apparatus for moving member of loom**

(57) A control apparatus (33) for a heald frame (11) that functions as a moving member of a loom and a sensor (30) that detects the presence of the heald frame (11) at a predetermined position are included in the loom. The heald frame (11) is driven by a dedicated motor (12) that is provided separately from a main motor of the loom. The control apparatus (33) performs an origin search operation in which the control apparatus (33) receives a signal from the sensor (30) while driving the dedicated motor (12) and determines a rotational position of the dedicated motor (12) that corresponds to a mechanical origin of the heald frame (11) on the basis of the received signal. The control apparatus (33) determines the validity of the origin search operation by comparing one of an output period and a no-output period of the signal from the sensor (30) with a predetermined allowance in the origin search operation.

FIG.2



EP 1 715 090 A2

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an apparatus for determining the validity of an origin search operation in which the apparatus receives a signal from a sensor while driving a motor dedicated to a moving member and determines a rotational position of the dedicated motor that corresponds to a mechanical origin of the moving member on the basis of the received signal. The validity of the origin search operation is determined by comparing one of an output period and a no-output period of the sensor signal received in the origin search operation with a predetermined allowance.

2. Description of the Related Art

[0002] As described in Japanese Unexamined Patent Application Publication No. 2004-324033 and Japanese Unexamined Patent Application Publication No. 9-111576, in a typical electric shedding device, an origin search operation is performed to synchronize a drive motor of the electric shedding device and a main shaft of a loom before the operation of the loom is started. In the origin search operation, the position of a swing lever or a heald frame is detected by, for example, a proximity sensor for each frame and the phases of the drive motor and the main shaft of the loom are synchronized with each other.

[0003] According to the above-described publications, in the origin search operation, the proximity sensor may output an incorrect signal due to noise or dust or an intermittent signal due to vibration of the proximity sensor itself or vibration of the detected object, such as the swing lever and heald frame, relative to the proximity sensor. If the mechanical origin is determined on the basis of such an abnormal signal, the motor dedicated to the heald frame is driven with a phase shifted from the phase of the main shaft of the loom when the operation of the loom is started. This leads to malfunction of the loom or defects in woven cloth.

SUMMARY OF THE INVENTION

[0004] Accordingly, an object of the present invention is to provide a control apparatus for a moving member that is included in a loom and driven by a dedicated motor in synchronization with a main shaft of the loom, the control apparatus determining whether or not an origin search operation has been normally performed.

[0005] A control apparatus for a moving member of a loom and a sensor that detects the presence of the moving member at a predetermined position are included in the loom. The moving member is driven by a dedicated motor that is provided separately from a main motor of the loom. The control apparatus performs an origin search operation in which the control apparatus receives a signal from the sensor while driving the dedicated motor and determines a rotational position of the dedicated motor that corresponds to a mechanical origin of the moving member on the basis of the received signal. The control apparatus determines the validity of the origin search operation by comparing one of an output period and a no-output period of the signal from the sensor with a predetermined allowance in the origin search operation.

[0006] The above-described period may be determined in terms of rotational angle that represents a rotational position of the dedicated motor or in terms of time.

[0007] According to the present invention, if an abnormal signal is output from the sensor in the origin search operation, the output period or the no-output period will be out of an allowable range defined by the allowance and the operator can be informed of the origin search error. Accordingly, the loom is prevented from being operated under the condition that the phase of the dedicated motor and the phase of the main shaft are shifted from each other.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 is a side view illustrating the main part of an electric shedding device;
Fig. 2 is a block diagram of a control apparatus included in the electric shedding device;
Fig. 3 is a diagram illustrating amplitudes of a swing lever, which functions as a moving member, and the relationship between a sensor and a detected portion;
Fig. 4 is a diagram illustrating a sensor signal;
Fig. 5 is a diagram illustrating sensor signals and the relationship between the rotational angle of a drive motor and the vertical displacement of a heald frame;
Fig. 6 is a flowchart of an origin search operation and determination of its validity performed by the control apparatus; and
Fig. 7 is another flowchart of an origin search operation and determination of its validity performed by the control apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0009] The present invention may be applied to devices included in a loom and having moving members driven by dedicated motors that are provided separately from a main motor of the loom. In a typical loom, an electric shedding device and an electric selvage device are examples of such devices. In a first embodiment described below, the present invention is applied to an electric shedding device according to the above-mentioned Japanese Unexamined Patent Application Publication No. 2004-324033. In a second embodiment described below, the present invention is applied to an electric shedding device according to the above-mentioned Japanese Unexamined Patent Application Publication No. 9-111576.

First Embodiment

[0010] As described above, in the first embodiment, the present invention is applied to an electric shedding device 10 according to Japanese Unexamined Patent Application Publication No. 2004-324033. In the present embodiment, a drive motor 12 compatible with an incremental encoder is used.

Device Structure

[0011] Fig. 1 illustrates the main part of the electric shedding device 10 included in a loom. The electric shedding device 10 includes a plurality of heald frames 11 that function as moving members of the loom. A drive motor 12 is provided separately from a main motor (not shown) for driving a main shaft of the loom as a motor dedicated to each heald frame 11. Although the electric shedding device 10 includes a plurality of drive motors 12 for a plurality of heald frames 11 in practice, only one heald frame 11 and one drive motor 12 are shown in Fig. 1.

[0012] An output shaft of the drive motor 12 is connected to an incremental encoder 13, and the rotation of the output shaft of the drive motor 12 is reduced in speed by a speed reduction device 14 and is transmitted to a disc shaft 16 of a crank disc 15 to drive the corresponding heald frame 11. According to the present embodiment, the reduction ratio of the speed reduction device 14 is determined such that the heald frame 11 moves up and down once when the drive motor 12 rotates five turns.

[0013] The rotation of the crank disc 15 is converted into a swinging movement of a swing lever 21 by an eccentric shaft 17 of the crank disc 15, a crank rod 18 connected to the eccentric shaft 17, and a connection shaft 20 of a connecting member 19. The swing lever 21 has a triangular shape and is rotatably supported on a loom frame 23 by a lever shaft 22 at a substantially central position thereof. An arm portion 24 of the swing lever 21 is connected to the connecting member 19 such that the connecting position thereof can be adjusted.

[0014] The swing lever 21 has a projecting portion that is connected to one end of the heald frame 11 with two pins 25 and a connecting rod 26 having an adjustable length. In addition, the swing lever 21 also has another projecting portion that is connected to the other end of the heald frame 11 with a pin 27, a connecting bar 28, and a unit of a swing lever, two pins, and a connecting rod (not shown) disposed at the other end. Accordingly, the heald frame 11 and the other heald frames that are not shown in the figure are moved vertically by the rotating force of the respective drive motors 12, thereby performing a shedding motion corresponding to a weave structure in synchronization with the rotation of the loom main shaft (not shown) that is driven independently of the heald frames.

[0015] The shed size of the heald frame 11 can be changed by adjusting the position at which the connecting member 19 is attached to the arm portion 24 of the swing lever 21. More specifically, the shed size of the heald frame 11 is increased as the arm length is reduced by moving the position at which the connecting member 19 is attached toward the lever shaft 22, and is reduced as the arm length is increased by moving the position at which the connecting member 19 is attached away from the lever shaft 22.

[0016] The swing lever 21 has an arc-shaped detected portion 31 that extends along the reciprocating direction of the swing lever 21. The swinging movement of the detected portion 31 is detected by a proximity sensor 30 as a vertical position of the heald frame 11. The sensor 30 is attached to a shaft support 29 provided on the loom frame 23 with a bracket 32 and faces the detected portion 31 with a predetermined gap therebetween.

[0017] Fig. 2 illustrates the structure of a control apparatus 33 of the electric shedding device 10. An output signal from the encoder 13 is input to a counter 34, and a count output signal from the counter 34 and a signal from the sensor 30 are input to a computing unit 35 included in the control apparatus 33. The computing unit 35 includes a clock pulse generator 37 as necessary. An output from the computing unit 35 is transmitted to a drive motor controller 36 in synchronization with the operation of the loom. The drive motor controller 36 receives the output from the computing unit 35 and controls the rotation of the drive motor 12. The control apparatus 33 is connected to a setter 38 and a display 39. The setter 38 is used to set input data and the display 39 displays the input data and control data so that the input data and the control data can be checked visually.

[0018] Fig. 3 shows the relationship between the sensor 30 and the movement of the detected portion 31. Referring to Fig. 3, although the detected portion 31 moves along the same arc irrespective of whether the amplitude is set to a minimum value (small shedding motion) or to a maximum value (large shedding motion) in practice, two arcs having different radii are displayed for convenience of explanation. The detected portion 31 has a relatively long arc shape that extends along the reciprocating direction so that the detected portion 31 can move close to the sensor 30 and be detected by the sensor 30 irrespective of whether the amplitude of the swing lever 21 is set to a minimum value (small shedding motion) or to a maximum value (large shedding motion).

[0019] As shown in Fig. 3, the detected portion 31 has a relatively long arc shape that extends along the reciprocating direction of the swing lever 21. Accordingly, both when the heald frame 11 performs a small shedding motion and a large shedding motion, the sensor 30 is turned on and continuously outputs a signal while the heald frame 11 is at one of the maximum opening positions (limit positions) and is turned off otherwise.

[0020] Fig. 4 shows the manner in which the signal from the sensor 30 is turned on and off with time t. The signal is turned on during an output period in which the detected portion 31 is being detected and is turned off otherwise.

[0021] The shed size of the heald frame 11 can be changed by adjusting the position at which the connecting member 19 is attached to the arm portion 24 of the swing lever 21. However, even when the shed size is changed, the output period (ON period) of the sensor 30 can be determined with respect to one of the maximum opening positions.

[0022] Thus, the amount of movement of the swing lever 21 and the maximum opening positions vary depending on the shed size. However, when the sensor 30 is placed at a position with enough allowance, for example, at the midpoint between the top and bottom maximum opening positions (so-called cross position), the signal from the sensor 30 can be turned on at one of the maximum opening positions and off at the other irrespective of the setting of the shed size between maximum and minimum values.

Movement of Heald Frame 11 and Sensor 30 in Origin Search Operation

[0023] Fig. 5 shows the relationship between the rotation of the drive motor 12, the shedding motion (vertical displacement) of the heald frame 11, and the signal from the sensor 30 in a weaving process. In Fig. 5, the horizontal axis shows the rotational angle of the drive motor 12 that represents time and the vertical axis shows the displacement of the heald frame 11. The rotation of the drive motor 12 is expressed as a sine curve for convenience and the vertical displacement of the heald frame 11 is determined on the basis of the swinging movement of the swing lever 21 in practice. In the sine curve showing the rotation of the drive motor 12, one period corresponds to one turn of the drive motor 12. Although the horizontal axis shows the rotational angle in Fig. 5, it may also show time, similar to Fig. 4.

[0024] As described above, since the speed reduction device 14 is provided, the heald frame 11 moves up and down once while the drive motor 12 rotates five turns. More specifically, the heald frame 11 leaves a bottom dead center (the bottom maximum opening position), reaches a top dead center (the top maximum opening position that corresponds to a rotation amount P0), and returns to the bottom dead center. When the heald frame 11 moves upward and reaches an approximate midpoint of the moving range of the heald frame 11 at a rotation amount P1, the detected portion 31 enters a detecting area of the sensor 30. Accordingly, the signal from the sensor 30 is turned on and is continuously output. Then, when the heald frame 11 moves downward and reaches the approximate midpoint of the moving range at a rotation amount P2, the detected portion 31 leaves the detecting area of the sensor 30 and the signal from the sensor 30 is turned off. The rotation amounts P0, P1, and P2 are detected as the numbers of counts of the counter 34, as described below.

[0025] As indicated by circled numbers 1 and 2 in Fig. 5, the ON signal output from the sensor 30 is approximately symmetric about the rotation amount P0 along the horizontal axis representing the rotational angle. When the rotation amount is P0, the heald frame 11, which functions as a moving member of the loom, is at the maximum opening position. The circled number 1 shows the ON signal obtained from the sensor 30 when a large shedding motion is performed and the circled number 2 shows the ON signal obtained from the sensor 30 when a small shedding motion is performed.

Calculation of Rotation Angle Corresponding to Maximum Opening

[0026] Fig. 6 is a flowchart of an origin search operation according to the first embodiment. In the first embodiment, the top dead center of the heald frame 11, that is, the rotation amount P0 corresponding to the maximum opening, is determined as the mechanical origin. In this case, the origin search operation (calculation of the rotation angle corresponding to the maximum opening) is performed as described below.

[0027] When an operator turns on a power switch (not shown) of the loom and presses a synchronization operation button (not shown) for the origin search operation, the control apparatus 33 starts the origin search operation. First, the number of counts of the counter 34 is cleared to 0 and the counter 34 is enabled. Then, the drive motor controller 36 starts the rotation of the drive motor 12 at a low speed (inching operation) to move the heald frame 11 in the vertical direction (step 1).

[0028] While the drive motor 12 continues to rotate, the counter 34 counts each pulse of the pulse signal output from the incremental encoder 13 connected to the drive motor 12 (step 2). When the number of pulses that corresponds to the number of turns of the drive motor 12 reaches five, the counter 34 resets the number of counts to 0.

[0029] When the signal from the sensor 30 is switched from OFF to ON (step 3), the computing unit 35 receives the number of counts, i.e., the rotation amount P1 from the counter 34 (step 4). In Fig. 6, the parenthesized expressions in steps 3 and 6 correspond to the case in which allowances are set for a no-output period, as will be described in more detail below.

[0030] The counter 34 continuous to count the pulse signal from the encoder 13 (step 5). Then, when the signal from the sensor 30 is switched from ON to OFF for the first time since it has been turned from OFF to ON (step 6), the computing unit 35 receives the number of counts, i.e., the rotation amount P2 from the counter 34 (step 7).

[0031] The computing unit 35 confirms the validity of the origin search operation (steps 8 and 9), and then calculates the middle rotation amount P0 between the rotation amounts P1 and P2 as P0 = (P1 + P2)/2. Thus, the rotation amount P0 of the drive motor 12 corresponding to the maximum opening is determined, and this rotation amount P0 is used as the mechanical origin for achieving synchronization with the loom main shaft (step 10). When the origin search is normally performed, the display 39 displays that normal origin search has been performed (step 11) and the origin search operation is normally finished. Thus, the electric shedding device 10 and the loom main shaft can be synchronized with each other by determining the rotation amount (rotational position) of the drive motor 12 that corresponds to the mechanical origin of the heald frame 11 that functions as a moving member.

Determination of Validity of Origin Search Operation

[0032] The determination of validity of the origin search operation is performed in steps 8 and 9 in the above-described process of calculating the rotation angle corresponding to the maximum opening and in steps 13 and 14.

[0033] When the top dead center of the heald frame 11 is determined as the origin in the origin search operation, allowances defining an allowable range for the output period (ON period) of the signal from the sensor 30 are input by the setter 38 and set in the control apparatus 33 (computing unit 35) in advance. The allowances serve to limit a range of the rotation amount during the output period (ON period) and are set in accordance with the shed size that is set mechanically. As is clear from the above, the allowances may also be set for the no-output period (OFF period).

[0034] If, for example, one pulse is output each time the drive motor 12 is rotated by 1° and the shed size of the heald frame 11 is 142 mm, an allowable range for the output period (ON period) is set to 785 $\pm$ 50 pulses (see circled number 1 in Fig. 5). If the shed size of the heald frame 11 is 64 mm, the allowable range is set to 620 $\pm$ 50 pulses (see circled number 2 in Fig. 5).

[0035] After step 7 in Fig. 6, the computing unit 35 calculates an increase in the rotation amount as P3 = |P1 - P2| in step 8. Then, the computing unit 35 determines whether or not the increase P3 in the rotation amount is within the allowable range, that is, whether or not $570 \leq P3 \leq 670$ is satisfied if the shed size of the heald frame 11 is 64 mm (step 9). If the result of determination is Y (Yes), that is, if the increase P3 in the rotation amount is within the allowable range, it is determined that the detection result of the sensor 30 has no errors and the origin search operation has been normally performed. Then, the process proceeds to step 10.

[0036] When the result of determination is N (No) in step 9, that is, when the increase P3 in the rotation amount is out of the allowable range, it is determined that the origin search operation is abnormal. The abnormal state of the origin search operation is displayed on the display 39 as a result of the operation. The normal state of the origin search operation may also be displayed on the display 39 if the origin search operation is normal.

[0037] Although two allowances are set for each shed size in the first embodiment, only one allowance may be set for each shed size. In such a case, the validity of the origin search operation is determined on the basis of the relationship between the increase P3 in the rotation amount and the allowance.

[0038] In the above-described operation, it may be difficult for a typical operator to set the allowances in terms of the number of pulses of the encoder 13. Accordingly, a maintenance staff, for example, may input the allowances with the setter 38. Alternatively, the maintenance staff may input reference allowances in advance and the computing unit 35 may automatically set the allowances in accordance with the shed size set by the operator.

First Modification of First Embodiment

[0039] In the first embodiment, when the validity of the origin search operation is determined, the number of pulses of the encoder 13 is counted. However, if the clock pulse generator 37 is installed in or attached to the computing unit 35 as shown in Fig. 2, the number of clock pulses may also be counted. In such a case, as shown in Fig. 7, counting of the number of clock pulses is started from 0 when the signal from the sensor 30 is switched from OFF to ON. Then, the time C1 elapsed until the signal is switched from ON to OFF for the first time since it has been switched from OFF to ON is determined and the validity of the origin search operation is determined on the basis of the time C1. In this case, the allowances are set in accordance with the rotational speed of the drive motor 12 in the origin search operation since the above-described time C1 varies depending on the rotational speed of the drive motor 12. The allowances may be changed automatically when the setting of the rotational speed of the drive motor 12 is changed. Fig. 7 shows only the steps regarding the determination of validity of the origin search operation. In this modification, the steps of the calculation of rotational angle corresponding to the maximum opening are similar to those in the first embodiment.

Second Modification of First Embodiment

[0040] In the determination of validity of the origin search operation according to the first embodiment, the output signal from the encoder 13 that is connected to the drive motor 12 may be directly input to the computing unit 35 as a count signal of the rotational angle. The rotation amount is counted from 0 using the count signal after the signal from the sensor 30 is switched from OFF to ON, and the rotation amount obtained at the time when the signal is switched from ON to OFF for the first time since it has been switched from OFF to ON is determined as the rotation amount P3.

[0041] In the first embodiment, if the bottom dead center of the heald frame 11 is determined as the origin in the origin search operation, allowances for the no-output period (OFF period) of the signal from the sensor 30 are set in advance. Then, the rotation amounts P1 and P2 of the drive motor 12 that are respectively obtained when the signal from the sensor 30 is switched from ON to OFF and when the signal is switched from OFF to ON for the first time since it has been switched from ON to OFF are determined. Then, the increase P3 in the rotation amount during the no-output period is calculated from the rotation amounts P1 and P2, and the validity of the origin search operation is determined on the basis of the increase P3 in the rotation amount. Then, the rotation amount (rotational position) P0 of the drive motor 12 that corresponds to the mechanical origin is calculated. The determination of validity of the origin search operation based on the no-output period (OFF period) and the calculation of the rotation amount (rotational position) P0 in the no-output period (OFF period) may also be applied to the above-described first and second modifications.

Second Embodiment

[0042] As described above, the present invention may also be applied to the electric shedding device according to Japanese Unexamined Patent Application Publication No. 9-111576. The electric shedding device according to this publication has mechanisms (crank mechanism and link mechanism) similar to those of the first embodiment. In this electric shedding device, a predetermined position (distance) of a swing lever 21, which is similar to the swing lever 21, in the swing area thereof is detected by a distance detection sensor (height detection sensor). Alternatively, a predetermined position (top dead center) of a heald frame is detected by a position detection sensor disposed at the top dead center of the heald frame. In either case, the output signal (ON signal) is obtained from the sensor while the heald frame is placed at the predetermined position, that is, at the top dead center. Therefore, in either case, an allowance for the output period (ON period) of the sensor is set in advance and is compared with the detected output period to determine the validity of the origin search operation. If the no-output period (OFF period) of the sensor is longer than the output period (ON period) due to the adjustment of the sensor or the like, an allowance may be set for the no-output period (OFF period).

[0043] The present invention may be applied not only to electric shedding devices of looms but also to other devices, such as electric selvage devices, included in looms. In an electric selvage device, rotating members through which selvage yarns are inserted function as moving members. The rotating members are driven in synchronization with a main motor of the loom by dedicated motors that are provided separately from the main motor. Accordingly, sensors are disposed near the rotating members that function as moving members, and rotational positions of the dedicated motors (output shafts) corresponding to the mechanical origins are determined on the basis of signals obtained from the sensors. The validity of the origin search operation is determined in the process of determining the rotational position (searching the origin).

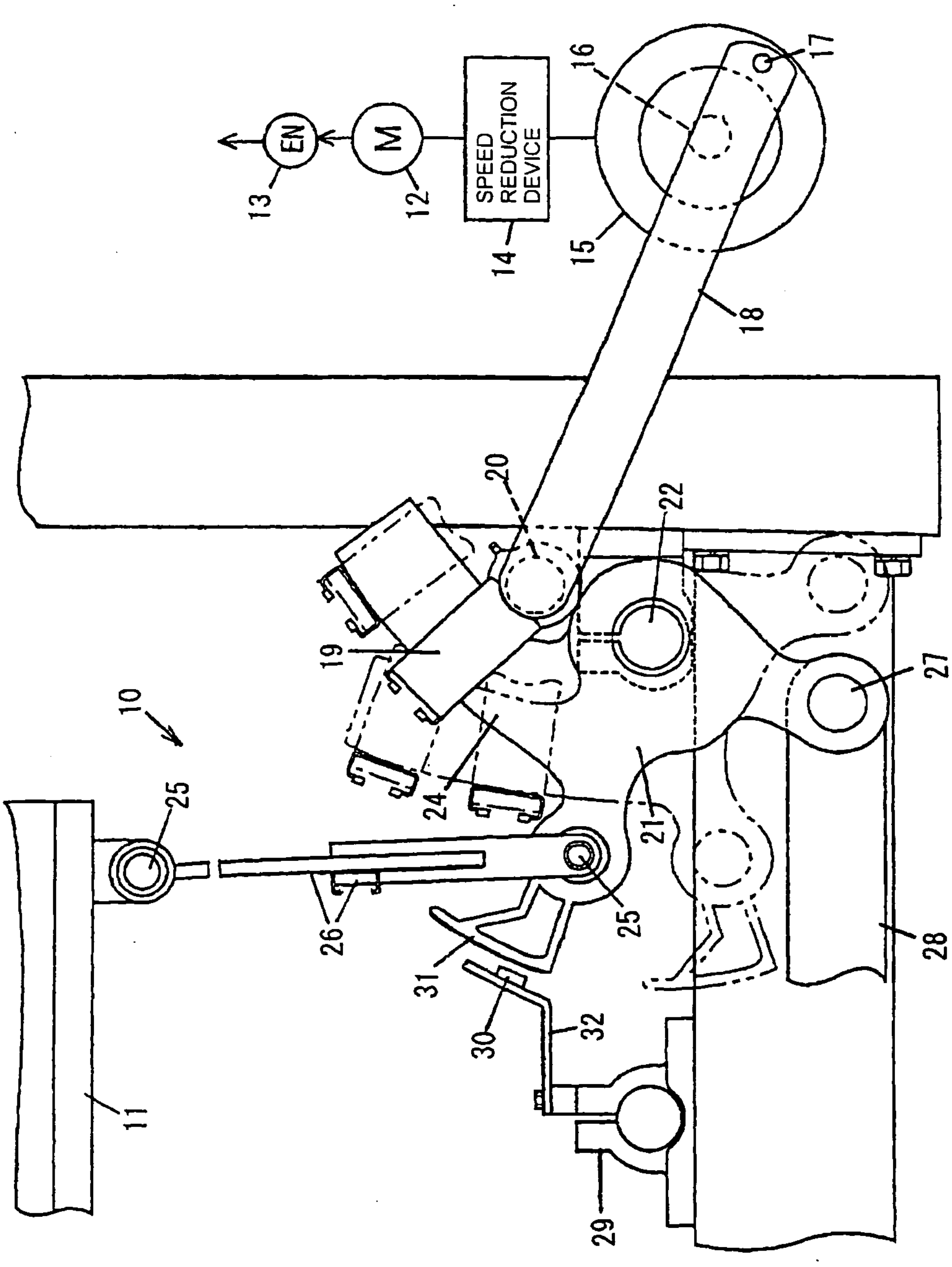
Claims

1. A control apparatus (33) for a moving member (11) of a loom that includes a sensor (30) for detecting the presence of the moving member (11) at a predetermined position and the control apparatus (33), the moving member (11) being driven by a dedicated motor (12) that is provided separately from a main motor of the loom and the control apparatus (33) performing an origin search operation in which the control apparatus (33) receives a signal from the sensor (30) while driving the dedicated motor (12) and determines a rotational position of the dedicated motor (12) that corresponds to a mechanical origin of the moving member (11) on the basis of the received signal,
   wherein the control apparatus (33) determines the validity of the origin search operation by comparing one of an output period and a no-output period of the signal from the sensor (30) with a predetermined allowance in the origin search operation.

2. The control apparatus (33) according to Claim 1, wherein said one of the output period and the no-output period is determined in terms of rotational angle that represents a rotational position of the dedicated motor (12).

3. The control apparatus (33) according to Claim 1, wherein said one of the output period and the no-output period is determined in terms of time.

FIG.1


SPEED
REDUCTION
DEVICE
EN
M
10
11
12
13
14
15
16
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22
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29
30
31
32

FIG.2

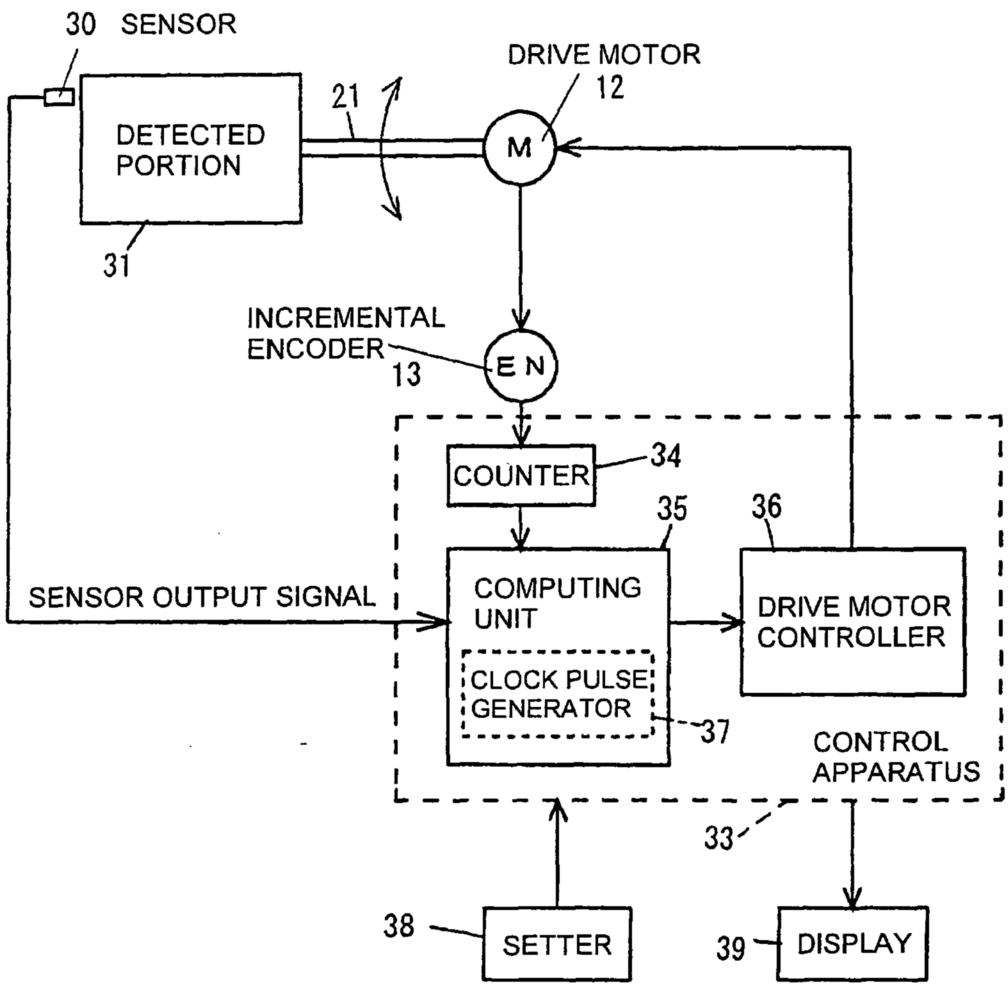

30 SENSOR
DETECTED PORTION
31
21
DRIVE MOTOR
12
M
INCREMENTAL ENCODER
13
E N
COUNTER
34
35
36
SENSOR OUTPUT SIGNAL
COMPUTING UNIT
CLOCK PULSE GENERATOR
37
DRIVE MOTOR CONTROLLER
CONTROL APPARATUS
33
38
SETTER
39
DISPLAY

FIG.3

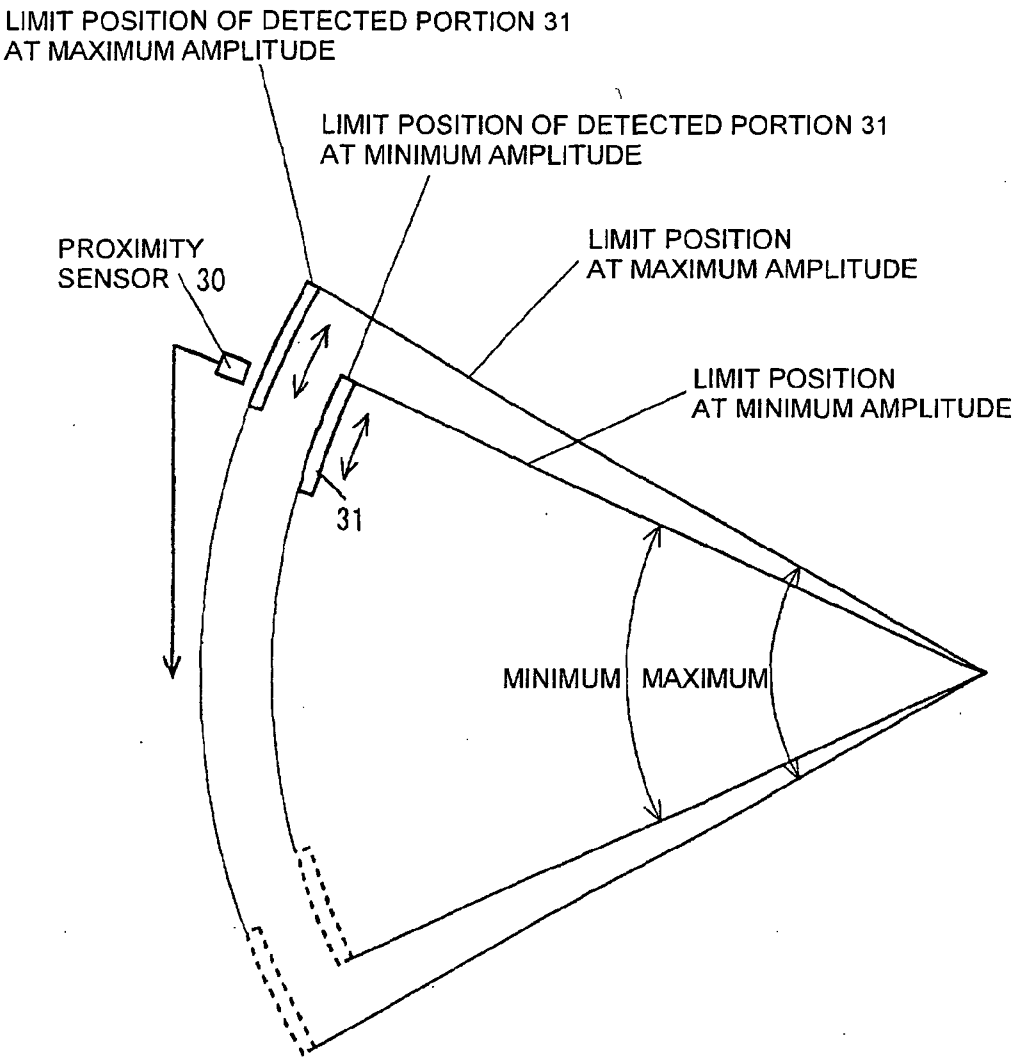

LIMIT POSITION OF DETECTED PORTION 31
AT MAXIMUM AMPLITUDE
LIMIT POSITION OF DETECTED PORTION 31
AT MINIMUM AMPLITUDE
PROXIMITY
SENSOR 30
LIMIT POSITION
AT MAXIMUM AMPLITUDE
LIMIT POSITION
AT MINIMUM AMPLITUDE
31
MINIMUM
MAXIMUM

FIG.4

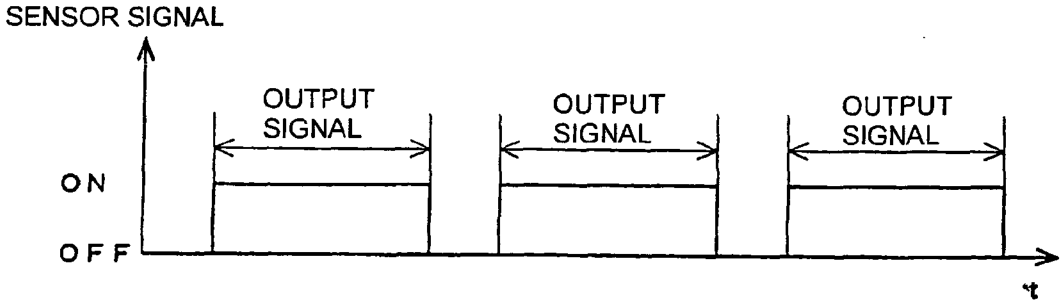

SENSOR SIGNAL
OUTPUT
SIGNAL
OUTPUT
SIGNAL
OUTPUT
SIGNAL
ON
OFF
t

FIG.5

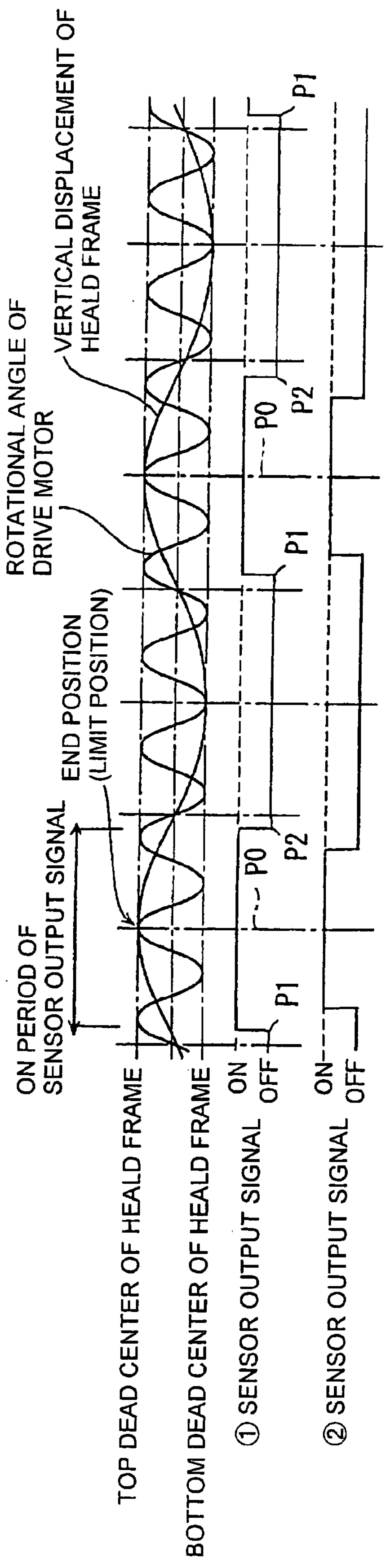

ON PERIOD OF SENSOR OUTPUT SIGNAL
END POSITION (LIMIT POSITION)
ROTATIONAL ANGLE OF DRIVE MOTOR
VERTICAL DISPLACEMENT OF HEALD FRAME
TOP DEAD CENTER OF HEALD FRAME
BOTTOM DEAD CENTER OF HEALD FRAME
① SENSOR OUTPUT SIGNAL
② SENSOR OUTPUT SIGNAL
ON
OFF
P0
P1
P2

FIG.6

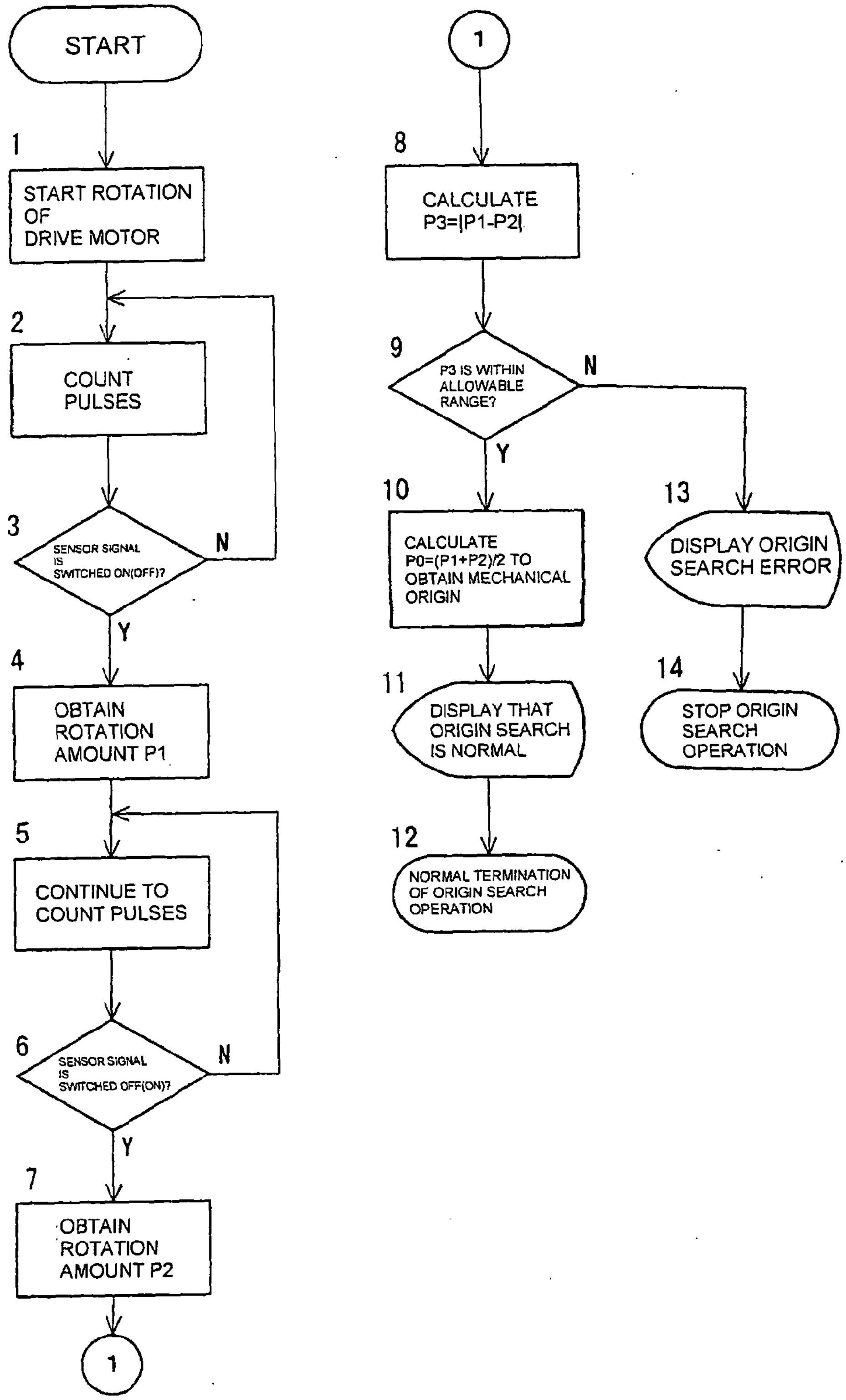
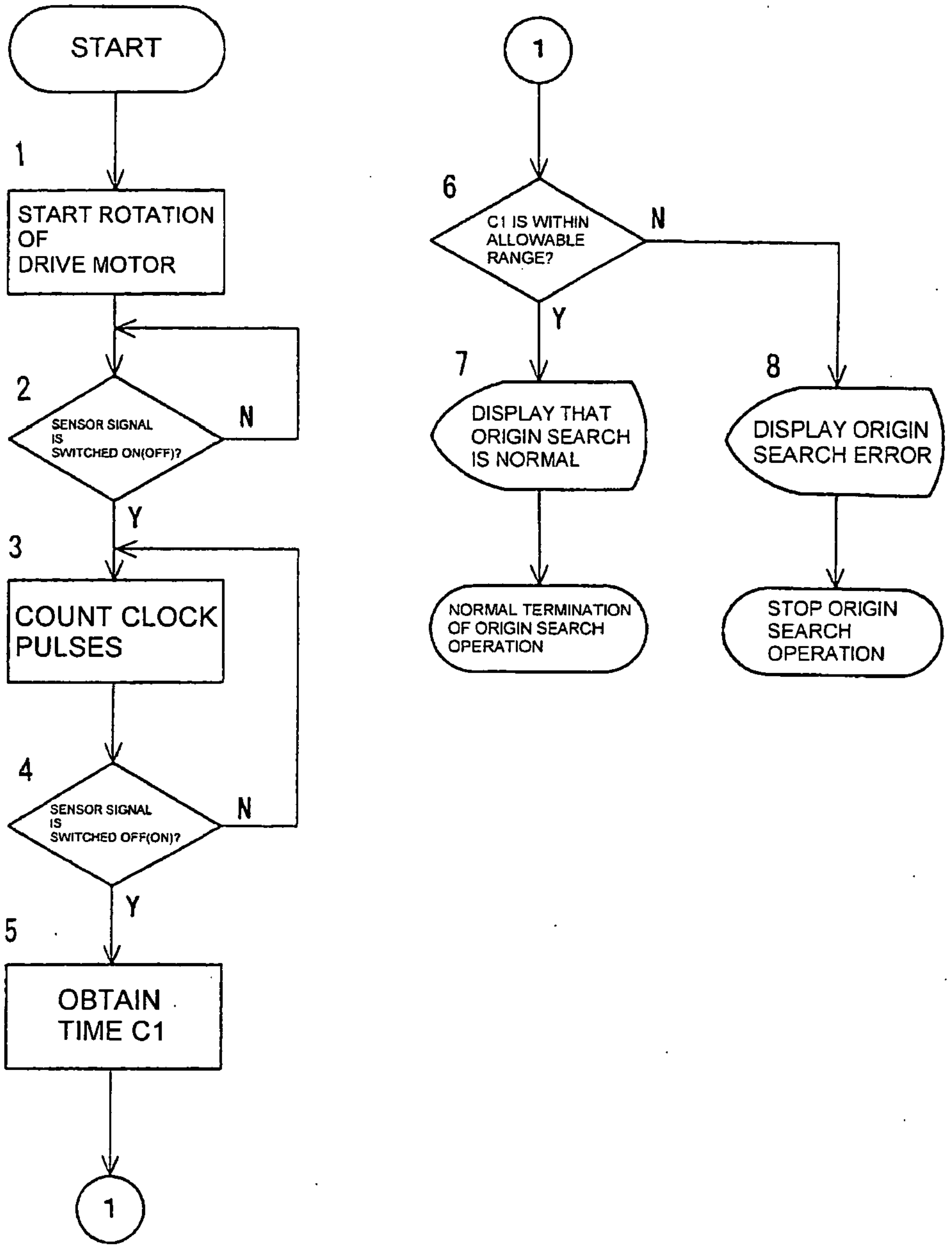

START
1
START ROTATION OF DRIVE MOTOR
2
COUNT PULSES
3
SENSOR SIGNAL IS SWITCHED ON(OFF)?
N
Y
4
OBTAIN ROTATION AMOUNT P1
5
CONTINUE TO COUNT PULSES
6
SENSOR SIGNAL IS SWITCHED OFF(ON)?
N
Y
7
OBTAIN ROTATION AMOUNT P2
1
1
8
CALCULATE P3=|P1-P2|
9
P3 IS WITHIN ALLOWABLE RANGE?
N
Y
10
CALCULATE P0=(P1+P2)/2 TO OBTAIN MECHANICAL ORIGIN
11
DISPLAY THAT ORIGIN SEARCH IS NORMAL
12
NORMAL TERMINATION OF ORIGIN SEARCH OPERATION
13
DISPLAY ORIGIN SEARCH ERROR
14
STOP ORIGIN SEARCH OPERATION

FIG.7


START
1
START ROTATION
OF
DRIVE MOTOR
2
SENSOR SIGNAL
IS
SWITCHED ON(OFF)?
N
Y
3
COUNT CLOCK
PULSES
4
SENSOR SIGNAL
IS
SWITCHED OFF(ON)?
N
Y
5
OBTAIN
TIME C1
1
1
6
C1 IS WITHIN
ALLOWABLE
RANGE?
N
Y
7
DISPLAY THAT
ORIGIN SEARCH
IS NORMAL
8
DISPLAY ORIGIN
SEARCH ERROR
NORMAL TERMINATION
OF ORIGIN SEARCH
OPERATION
STOP ORIGIN
SEARCH
OPERATION

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Patent documents cited in the description

- JP 2004324033 A **[0002] [0009] [0010]**
- JP 9111576 A **[0002] [0009] [0042]**