Europäisches Patentamt
European Patent Office
Office européen des brevets

(19) (11) Publication number: **0 211 488 A2**

EUROPEAN PATENT APPLICATION

(12)

(21) Application number: 86304534.0

(22) Date of filing: 12.06.86

(51) Int. Cl.4: G10H 1/44

(30) Priority: 18.06.85 JP 132163/85

(43) Date of publication of application: 25.02.87 Bulletin 87/09

(84) Designated Contracting States: DE FR GB

(71) Applicant: SEIKO INSTRUMENTS & ELECTRONICS LTD.
31-1, Kameido 6-chome
Koto-ku Tokyo 136(JP)

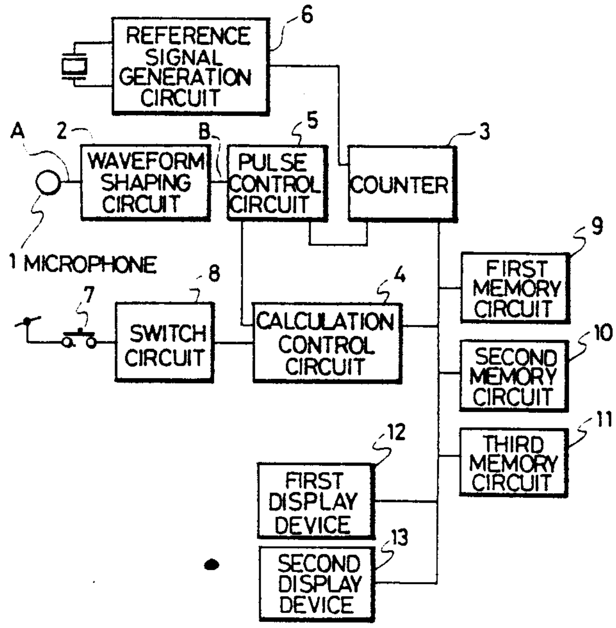
(72) Inventor: Kaneko, Noboru c/o SEIKO INSTRUMENTS
& ELECTRONICS LTD 6-31-1, Kameido
Koto-ku
Tokyo(JP)

(74) Representative: Caro, William Egerton et al
J. MILLER & CO. Lincoln House 296-302 High Holborn
London WC1V 7JH(GB)

(54) Tuning apparatus.

(57) A tuning apparatus for extracting the pitch of sound to be tuned and displaying deviation of the extracted pitch,from a reference frequency, comprises an external switch (7) for determining a calibration mode; first memory circuit (9) for storing the deviation of the sound to be tuned from the fixed reference frequency, a second memory circuit (10) to which the stored deviation data is transferred from the first memory circuit upon operation of the external switch, a calculation control circuit (4) for subtracting the data stored in the second memory circuit (10) from the measured data in the first memory circuit (9) after operation of the external switch, and a display (12,13) for displaying the result of calculation of the calculation control circuit.

FIG.1



EP 0 211 488 A2

"TUNING APPARATUS"

This invention relates to tuning apparatus and more particularly, although not so restricted, to tuning apparatus, for tuning voice and musical instruments, equipped with a calibration function by means of which an arbitrary tuning reference can be set.

In conventional tuning apparatus such as disclosed in U.S. Patent Specification No. 4,324,166, a reference pitch for measuring a sound to be tuned is a fixed frequency inherent to that tuning apparatus and is generally A_4 = 440 Hz. Although the reference pitch is not limited to A_4 = 440 Hz but includes A_4 = 441 Hz, 442 Hz,..., 445 Hz, only one of them is selected for tuning.

Since the reference pitch for measuring the sound to be tuned is fixed in the conventional tuning apparatus, it has been difficult to effect tuning in a pitch which deviates from the fixed pitch. For instance, in an ensemble of a piano - which is difficult to tune within a short period of time even for those who are skilled in tuning -and another instrument, that other instrument must be tuned using the pitch of the piano as the reference. In accordance with the conventional tuning apparatus, the deviation of the piano sound from the fixed pitch of the tuning apparatus is first measured, and a tuner who tunes the other instrument memorizes this deviation and tunes the other instrument so that their deviations are substantially equal. Therefore, unless the tuner correctly memorizes the deviation of the piano sound from the fixed pitch of the tuning apparatus, the other instrument will be tuned incorrectly. In addition, the mode of use of the tuning apparatus in this case is different from the mode of use for tuning a musical instrument alone, and the tuner will sometimes abuse the tuning apparatus.

In order to eliminate these problems the present invention seeks to provide a tuning apparatus which measures a sound to be tuned by using the pitch of a frequency predetermined by a player of a musical instrument as the reference pitch for tuning. The present invention also seeks to provide a a tuning apparatus which prevents erroneous tuning by displaying whether or not the measurement of the sound to be tuned is made in the pitch of an arbitrary sound as a tuning reference.

According to the present invention there is provided a tuning apparatus for extracting the pitch of sound to be tuned and displaying deviation of the extracted pitch from a reference frequency, the apparatus being characterised by comprising: external switch means for determining a calibration mode; first memory means for storing the deviation of said sound to be tuned from said fixed reference frequency; second memory means to which said stored deviation data is transferred from said first memory means upon operation of said external switch means; calculation control means for subtracting the data stored in said second memory means from the measured data in said first memory means after operation of said external switch means; and display means for displaying the result of calculation of said calculation control means.

Preferably the calculation control circuit adds 100% to the result of calculation and outputs data which is a half tone lower than the note to said display means when the result of calculation is smaller than -50%, and subtracts 100% from the result of calculation and outputs data which is a half tone higher than the note to said display means when the result of calculation is greater than +50%.

In a preferred embodiment the display means comprises first display means for displaying the result of calculation of said calculation control means, and second display means for indicating that the calibration function is operative.

The tuning apparatus may include third memory means for storing a reference table for determining the name of the note of the sound. The third memory means may be arranged to store the result of calculation of the calculation control means.

The tuning apparatus may include a counter for producing a signal representative of the timing of the sound.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

Figure 1 is a block circuit diagram of a tuning apparatus according to the present invention;

Figure 2 is a waveform diagram showing the waveforms of an input signal A and an output signal B of a waveform shaping circuit of the tuning apparatus of Figure 1;

Figure 3 is a schematic view showing an example of display before a calibration operation;

Figures 5 and 7 are schematic views similar to Figure 3 showing the display during the calibration operation; and

Figures 4 and 6 are flow charts for explaining the operation of a calculation control circuit during the calibration operation.

Referring first to Figure 1, a tuning apparatus according to the present invention includes: a waveform shaping circuit 2 which converts a measured input signal A, which is obtained by converting an audio signal to an electrical signal using, for example, a microphone 1, to a pulse signal B; a pulse control circuit 5 which receives the pulse signal B and applies signals to a counter 3 and a calculation control circuit 4; a reference signal generation circuit 6 which generates a clock signal for the counter 3; an external switch member 7; a switch circuit 8 which generates a switch signal upon operation of the external switch member 7; a first memory circuit 9 which stores a deviation value by a fixed pitch calculated from the count value output from the counter 3 and and the name of a note; a second memory circuit 10 which stores a correction value; a third memory circuit 11 which stores a reference table for calculating the name of a note as well as the deviation value by the fixed pitch in the calculation control circuit 4 described above; a first display device 12 which displays the result of measurement; and a second display device 13 which displays whether or not a calibration function is operative.

The waveform shaping circuit 2 converts the input signal A (Figure 2) to a pulse signal B. The pulse control circuit 5 controls the counter 3 to count each rise of the pulses of the pulse signal B, and outputs the rise timing t_1, t_2, t_3, t_4...to the calculation control circuit 4. The calculation control circuit 4 extracts the pitch of the pulse signal B from the counter values in the counter 3 corresponding to timing t_1, t_2, t_3, t_4. In other words, it compares

$$\sum_{i=1}^{n} t_i \text{ with } \sum_{i=2}^{n+1} t_i \quad \text{and}$$

$$\sum_{i=1}^{n} t_i \text{ with } \sum_{i=3}^{n+2} t_i \ ,$$

and extracts the pitch when all three are in agreement. Since

$$\sum_{i=1}^{2} t_i = \sum_{i=2}^{3} t_i = \sum_{i=3}^{4} t_i$$

$= t_1 + t_2$ in the case of the waveforms shown in Figure 2, it extracts $t_1 + t_2$ as the pitch. Table 1 shows the count value corresponding to each octave when the fixed reference pitch is A_4 = 440 Hz, for example. This table illustrates the data stored in the third memory circuit 11. If the extracted pitch of the pulse signal shown in Figure 2 is assumed to be $t_1 + t_2$ = 2308 counts, the calculation control circuit 4 calculates from the data shown in Table 1 that the measured signal has an octave n = 3. Furthermore, the third memory circuit 11 stores the count value of each note corresponding to octave 1 and the count value percentage deviation. Since the calculated octave value is n = 3, the count value corresponding to octave 1 is

$(t_1 + t_2) \times 2^{(n-1)} = 2{,}308 \times 2^2$

$= 9{,}232$

Thus the note is found to be F from Table 2 which is stored data of the third memory circuit 11, and the deviation is found to be

$(Fo - f)/5.25 = (9{,}172 - 9{,}232)/ 5.25$

= 11%

wherein

Fo is the count value at O%F;

f is the count value of the extracted pitch;

The value of 5.25 is the count deviation corresponding to percentage deviation at O% of F.

The name of the note and the value of the deviation are stored in the first memory circuit 9 and are displayed as shown in Figure 3 by the first display device 12.

If the external switch member 7 is closed, the switch circuit 8 outputs a high level signal to the calculation control circuit 4. Then, the calculation control circuit 4 executes calculations in accordance with the flowchart (I) shown in Figure 4. In other words, when receiving a high level signal from the switch circuit 8, the calculation control circuit 5 judges whether or not the first display device 12 displays the name of the note and the deviation value, and if it does, the calculation control circuit 4 transfers the deviation value of the data stored in the first memory circuit 9 to the second memory circuit 10.

In other words, since the deviation value stored in the first memory circuit 9 is -11% in this case, the value -11% is stored in the second memory circuit 10. Then, the deviation value of the input signal A that is inputted to the tuning apparatus. calculated as

-11 -(-11) = 0%,

and the first display device 12 displays the value 0% such as shown in Figure 5. Furthermore, the calculation control circuit 4 turns on the second display device 13 shown in Figure 5 clearly to represent that the mode is the calibration mode.

Table 1

OCTAVE n	frequency range (Hz)	count value range
1	31.772 - 63.544	12602 - 6302
2	63.544 - 127.089	6301 - 3151
3	127.089 - 254.177	3150 - 1576
4	254.177 - 508.354	1575 - 788
5	508.354 - 1016.709	787 - 394
6	1016.709 - 2033.416	393 - 197

Table 2

NOTE		frequency (Hz)	count value	±1 cent count number τ
C	-50 cent	31.772	12602	
	0 cent	32.703	12243	7.00
	50 cent	33.661	11895	
C"	-50	33.661	11894	
	0	34.648	11556	6.75
	50	35.663	11228	
D	-50	35.663	11227	
	0	36.708	10908	6.25
	50	37.784	10598	
D"	-50	37.784	10597	
	0	38.891	10295	6.00
	50	40.030	10003	
E	-50	40.030	10002	
	0	41.203	9718	5.75
	50	42.411	9441	
F	-50	42.411	9440	
	0	43.654	9172	5.25
	50	44.933	8912	

Table 2 (contd.)

F"	-50 cent	44.933	8911	5.00
	0 cent	46.249	8657	
	+50 cent	47.605	8411	
G	-50	47.605	8410	4.75
	0	48.999	8172	
	50	50.435	7939	
G"	-50	50.435	7938	4.50
	0	51.913	7713	
	50	53.434	7494	
A	-50	53.434	7493	4.25
	0	55.000	7280	
	50	56.612	7073	
A"	-50	56.612	7072	4.00
	0	58.270	6871	
	50	59.978	6676	
B	-50	59.978	6675	3.75
	0	61.735	6486	
	50	63.544	6302	

In the calibration operation, it will be assumed that the input signal A shown in Figure 2 has the note F and the deviation value + 45% as the measured value at a fixed pitch A_4 = 440 Hz. Then, the calculation control circuit 4 executes calculation in accordance with the flowchart shown in Figure 6 and calculates the name of the tone and the deviation value at the fixed pitch A = 440 Hz. Here, the name of the tone and the deviation value are calculated as F and +45, for example. Next, a correction value CAL = -11% stored in the second memory circuit 10 is subtracted, thereby obtaining

CENT' = +45% -(-11) = +56

Next, judgement is made whether CENT' is smaller than -50 or greater than +50. In this example, +55 > +50. Then, the name of the tone is one that is a half tone higher and the deviation value is calculated as +56 -100 = -44%. If CENT' is greater than -50 but smaller than +50, on the other hand, the name of the tone and the deviation value are not corrected. If CENT' is smaller than -50, the name of the tone is corrected as a tone which is a half tone lower, and the deviation is corrected as (CENT' + 100). Accordingly, it becomes possible to make display within the deviation range of one half tone ±50% and to display the effective value by calibration.

In the embodiment of the present invention disclosed above, the external switch member, the second memory circuit for storing the correction value and the calculation control circuit are provided for executing correction. Therefore, there is provided the effect that the measured value can be tuned at an arbitrary reference pitch. Furthermore, since the second display device is provided, it is possible to display the state where tuning can be made in an arbitrary reference pitch.

Claims

1. A tuning apparatus for extracting the pitch of sound to be tuned and displaying deviation of the extracted pitch from a reference frequency, the apparatus being characterised by comprising: external switch means (7,8) for determining a calibration mode; first memory means (9) for storing the deviation of said sound to be tuned from said fixed reference frequency; second memory means (10) to which said stored deviation data is transferred from said first memory means (9) upon operation of said external switch means (7); calculation control means (4) for subtracting the data stored in said second memory means (10) from the measured data in said first memory means (9) after operation of said external switch means; and display means (12,13) for displaying the result of calculation of said calculation control means (4).

2. A tuning apparatus as claimed in claim 1 characterised in that, in operation, the calculation control circuit (4) adds 100% to the result of calculation and outputs data which is a half tone lower than the note to said display means when the result of calculation is smaller than -50%, and subtracts 100% from the result of calculation and outputs data which is a half tone higher than the note to said display means when the result of calculation is greater than +50%.

3. A tuning apparatus as claimed in claim 1 or 2characterised in that the display means comprises first display means (12) for displaying the result of calculation of said calculation control means, and second display means (13) for indicating that the calibration function is operative.

4. A tuning apparatus as claimed in any preceding claim characterised by third memory means (11) for storing a reference table for determining the name of the note of the sound.

5. A tuning apparatus as claimed in claim 4 characterised in that the third memory means (11) is arranged to store the result of calculation of the calculation control means.

6. A tuning apparatus as claimed in any preceding claim characterised by including a counter - (3) for producing a signal representative of the timing of the sound.

FIG.1

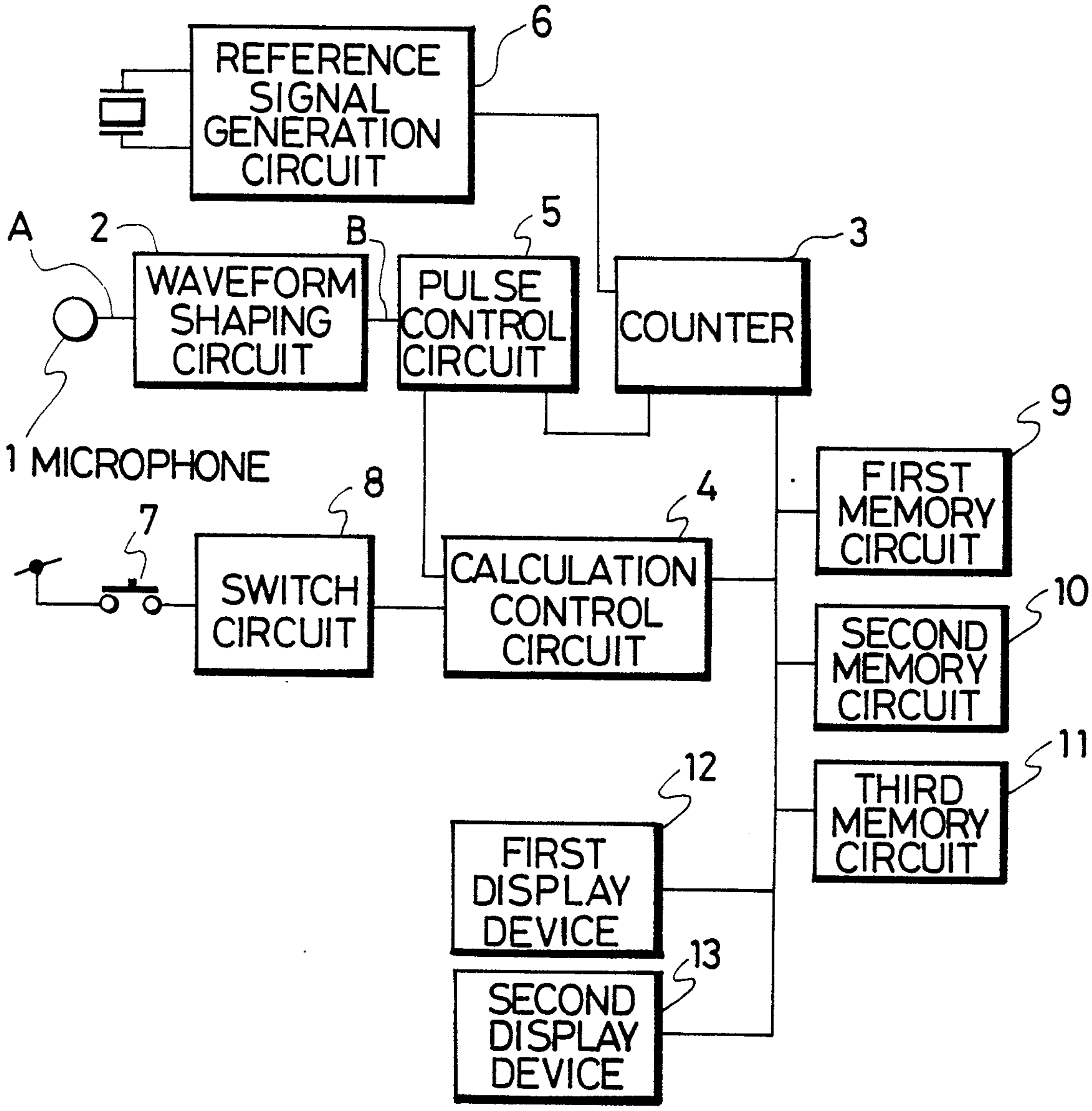

REFERENCE SIGNAL GENERATION CIRCUIT
6
A
2
WAVEFORM SHAPING CIRCUIT
B
5
PULSE CONTROL CIRCUIT
3
COUNTER
1 MICROPHONE
9
FIRST MEMORY CIRCUIT
8
7
4
SWITCH CIRCUIT
CALCULATION CONTROL CIRCUIT
10
SECOND MEMORY CIRCUIT
11
THIRD MEMORY CIRCUIT
12
FIRST DISPLAY DEVICE
13
SECOND DISPLAY DEVICE

FIG.2

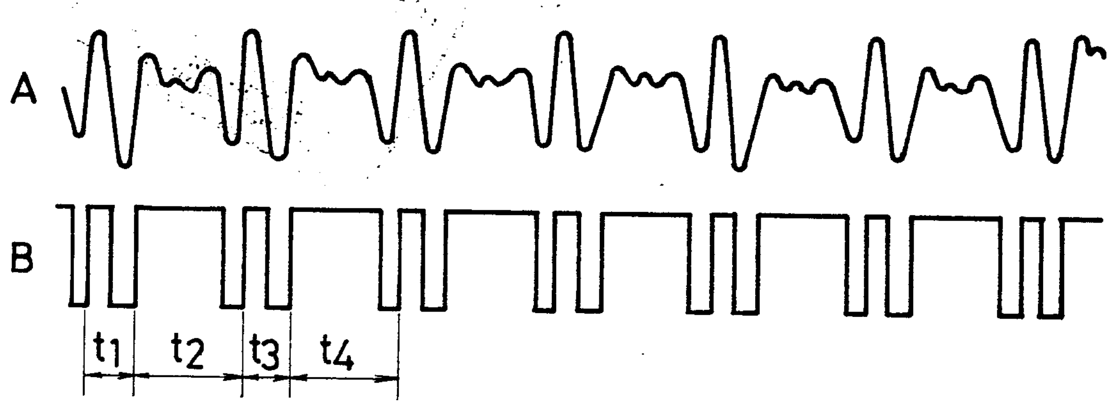

A
B
t1
t2
t3
t4

FIG. 3

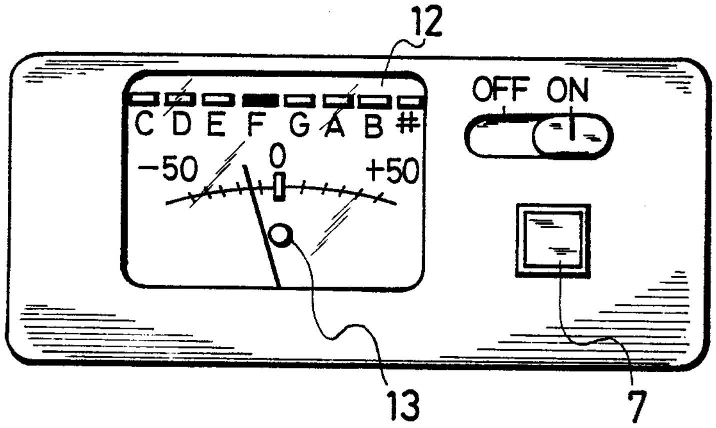

12
OFF ON
C D E F G A B #
−50 0 +50
13
7

FIG. 4

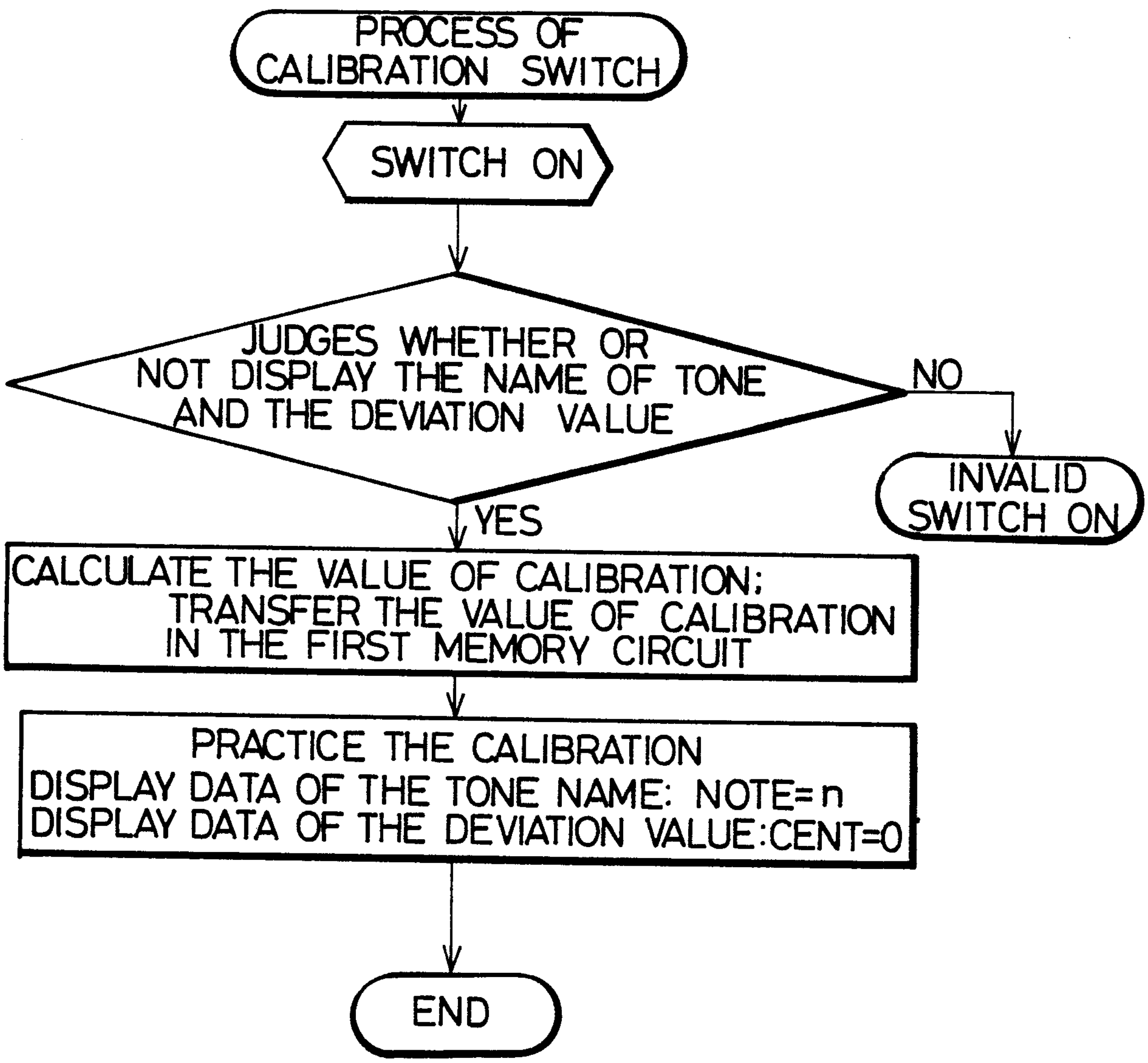

PROCESS OF CALIBRATION SWITCH
SWITCH ON
JUDGES WHETHER OR NOT DISPLAY THE NAME OF TONE AND THE DEVIATION VALUE
NO
INVALID SWITCH ON
YES
CALCULATE THE VALUE OF CALIBRATION; TRANSFER THE VALUE OF CALIBRATION IN THE FIRST MEMORY CIRCUIT
PRACTICE THE CALIBRATION
DISPLAY DATA OF THE TONE NAME: NOTE=n
DISPLAY DATA OF THE DEVIATION VALUE:CENT=0
END

FIG. 5

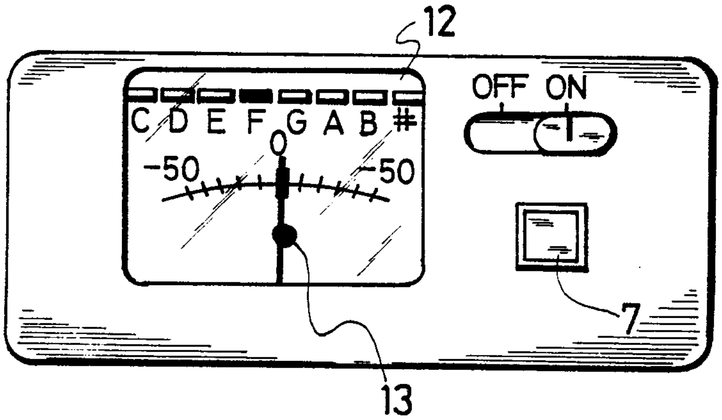

12
OFF ON
C D E F G A B #
0
-50
50
7
13

FIG. 6

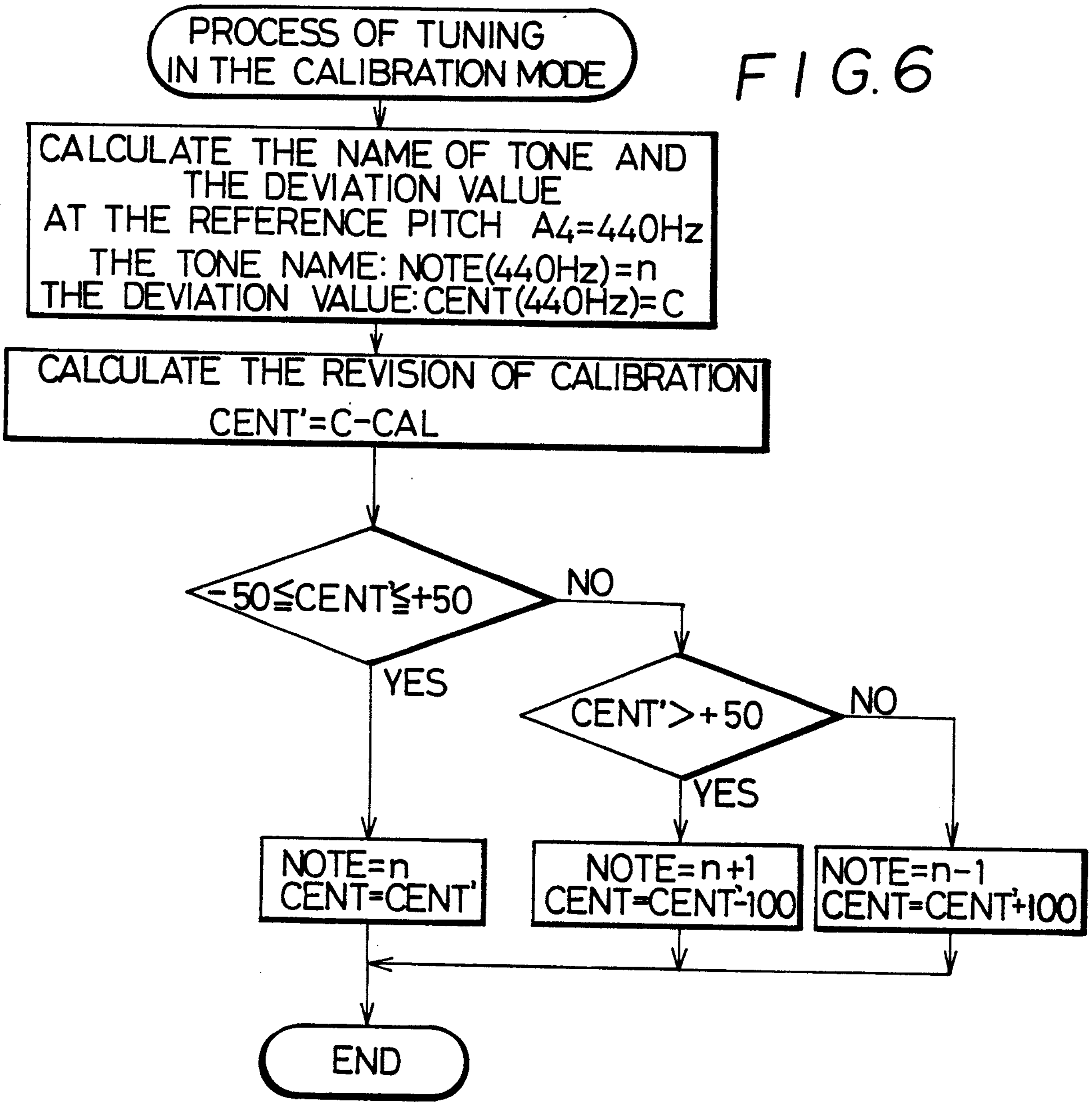

PROCESS OF TUNING IN THE CALIBRATION MODE
CALCULATE THE NAME OF TONE AND THE DEVIATION VALUE AT THE REFERENCE PITCH A4=440Hz
THE TONE NAME: NOTE(440Hz)=n
THE DEVIATION VALUE: CENT(440Hz)=C
CALCULATE THE REVISION OF CALIBRATION
CENT'=C-CAL
-50≦CENT'≦+50
NO
YES
CENT'>+50
NO
YES
NOTE=n
CENT=CENT'
NOTE=n+1
CENT=CENT'-100
NOTE=n-1
CENT=CENT'+100
END

FIG. 7