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(54) Title: PACING TOOTHBRUSH

(57) Abstract

A vibrating toothbrush, which includes a handle member, an elongated arm which has a brushhead at the distal end thereof, and a drive assembly for moving the brushhead at a selected velocity. Responsive to an on/off switch on the toothbrush is an on/off variable, which enables a master clock to produce a drive signal, the on/off variable being reset by a 120-second timer. A quadtimer variable, when in the enabled state, is responsive to the on/off switch to produce an audible signal and a difference in brush velocity at 30-second intervals within the 120-second period.
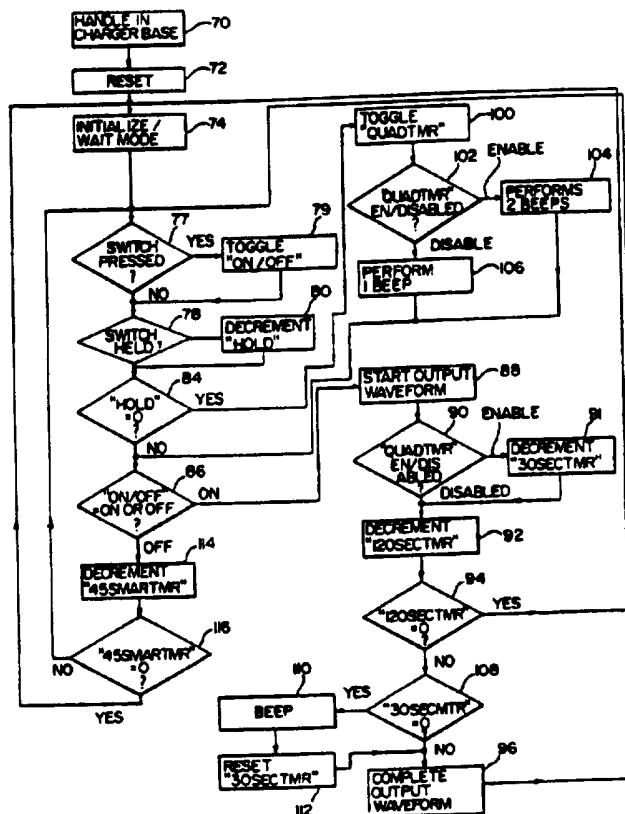
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Description

PACING TOOTHBRUSH

<u>Technical Field</u>

This invention relates generally to the art of
5 toothbrushes, and more specifically concerns a power
toothbrush which is capable of indicating the passage of
selected intervals of time within a longer set time
period.

10 <u>Background of the Invention</u>

Studies have shown that dental hygiene is
often uneven, i.e. some areas of the dentition (dental
areas) receive more hygiene attention than others. For
instance, the posterior (rear) teeth are typically less
15 well cleaned. This is often true even for those
patients who generally practice good dental hygiene.
While the reasons for an uneven dental condition in a
given person's mouth are not fully known, it is believed
that differences in the respective times of brushing for
20 the various dental areas is a significant factor. While
there has been some effort to provide an indication of
the passage of a desired total elapsed time of brushing,
which is now regarded to be approximately two minutes,
such as by providing a sound at the end of such a total
25 elapsed time, as shown in U.S. Patent No. 4,788,734,
such an approach does not solve the uneven dental
condition problem. Hence, it would be desirable to
provide further assistance to the user which would tend
to promote a good, even dental condition in all areas of
30 the mouth, i.e. uniform cleaning of all teeth.

<u>Summary of the Invention</u>

Accordingly, the present invention includes a
power toothbrush, which includes a support member having
35 a brushhead at a distal end thereof and means for
driving the brushhead, and further including a timing
means, responsive to the device being turned on, for

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producing successive indications of intervals of elapsed
time, wherein the intervals of elapsed time are related
to desired times for brushing portions of the dental
region.

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Brief Description of the Drawings

Figure 1 is a perspective view of the
toothbrush of the present invention.

Figure 2 is a circuit diagram showing a
10   hardware implementation of the present invention.

Figure 3 is a block diagram showing a software
implementation of the present invention.

Figure 4 is a flow chart for the software
implementation of Figure 3.

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Best Mode for Carrying Out the Invention

Figure 1 shows an exterior view of a power
toothbrush which incorporates the present invention.
Such a power toothbrush could be designed to produce any
20   one of various brushing actions, including back and
forth, side to side, rotational, and others.   The
toothbrush 10 includes a handle 12, an elongated arm 14
which is vibrated or otherwise activated by a driving
assembly (not shown) in handle 12, and a brushhead 16 at
25   the distal end of arm 14.   While the toothbrush shown in
Figure 1 and briefly described herein is driven
electromagnetically, it should be understood that other
means, including electromechanical and mechanical, can
be used to drive arm 14 and hence brushhead 16, since
30   the principles of the present invention are not
dependent upon an electromagnetic driver.

The toothbrush 10 is operated by a button
switch 18 which is pushed and released by the operator,
the switch thus having two operating positions.   When
35   not in use, the electromagnetic toothbrush sits in a
base unit 20, which is a charge unit for a rechargeable
battery present in handle 12.   Hence, there is no direct

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connection between the toothbrush and an exterior source of electrical energy (such as a cord to a wall plug) when the toothbrush is removed from the base and put into use.

5   U.S. Patent No. 5,189,751, entitled "Vibrating Toothbrush Using A Magnetic Driver", which is assigned to the same assignee as that of the present invention, discloses an electromagnetic toothbrush which drives a brushhead at a frequency in the range of 150-400 Hz,

10 although it should be understood that the principles of the present invention are not limited to a particular brushhead frequency. The contents of the '751 patent are hereby incorporated by reference.

        In the vibrating toothbrush shown in the '751

15 patent, switch 18 is used to enable a master clock, the signal from which is then divided down to a desired number, which divided signal is then applied to the electromagnetic circuit, which in turn drives a brushhead at the distal end of the arm. The toothbrush

20 of the present invention is similar to the toothbrush described in the '751 patent, but includes a particular timing capability, so that the user may conveniently "pace" his or her brushing time within a given set time. Specifically, the toothbrush is designed to provide a

25 signal at specified times within an overall set operating time, such as, for instance, two minutes.

        As stated above, it is known for a toothbrush to provide an indication of total desired elapsed time. In the commercial implementation of the toothbrush

30 disclosed in the '751 patent, for instance, a 120-second timer is used, and operation of the toothbrush hence stops after 120 seconds from the initiation of switch 18 by the user. Such a toothbrush thus provides a reliable indication of a total elapsed time which has been deemed

35 appropriate for brushing.

        In originating the present invention, and attempting to address the problem of uneven dental

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condition noted above, the inventors determined that
brushing time alone, even apart from the technique of
brushing, was a major factor in producing uniform
results for all the dental areas of the mouth. Hence,
5   it was determined that providing a pacing indication
within a total set time of two minutes, which would
permit a user to pace the use of the toothbrush area by
area within the mouth, would likely be helpful in
producing uniform dental hygiene results. The inventors
10 further determined, after some study and evaluation,
that the most productive time/area division was four
identical time intervals, hence in effect dividing
brushing time between four quadrants of the mouth. It
was believed that this would provide a reliable and
15 useful pace of brushing to provide the even brushing
effect desired.

Figure 2 shows a hardware circuit embodiment
designed to accomplish the desired time division.
Switch 22, as indicated previously, has two conditions.
20 When the switch is depressed by the user and maintained
in that position, the output from switch 22 is "low"
(logic 0), while when the switch is released, the output
is "high" (logic 1). When the output from switch 22 is
high, a one-shot multivibrator 26 with a two-second time
25 period is cleared by the signal at input 27. When the
switch is depressed, however, the resulting low signal
has two effects. First, multivibrator 26 is reset and
begins to count down for two seconds (if switch held
depressed). Second, "toggle" flip-flop 28 changes state
30 (from "off" to "on" or vice versa).

Flip-flop 28 thus controls the on/off
condition of the apparatus. When it is toggled to "on,"
it will enable master clock 30 to begin producing a
signal output of selected frequency. The frequency of
35 the output from master clock 30 is controlled by a
stable frequency source, such as a ceramic resonator 32,
which could alternatively be a crystal or other

oscillator circuit capable of providing the desired
stable frequency. In the present invention, the
frequency of the master clock signal is divided by
frequency divider 34 to produce a frequency of 522 Hz.
5   The 522 Hz signal is then applied to input 31 of AND
gate 56 and to another divider 36, which reduces the
frequency to 261 Hz. The out of divider 36 is applied
to input 29 of AND gate 38.

         The output from toggle flip-flop 28 is also
10   applied to a 120-second timer 40, which immediately
begins timing down. At the end of the 120-second
interval, an output is produced which is applied to a
reset pin 21 of flip-flop 28, which toggles it to an
"off" condition. Timer 40 thus provides the basic full
15   on time (set time interval) for the operation of the
toothbrush.

         The output from flip-flop 28 is also applied
as an input to both AND gate 38 (input 33) and AND gate
56 (input 35). A "false" or "low", i.e. "off",
20   condition of flip-flop 28 thus prevents divided clock
signals from being applied to OR gate 60 (and then to
the load) through either AND gate. Conversely, when
flip-flop 28 is "true", i.e. "on", and timer 40 is
counting down, a high signal is applied to input 33 of
25   AND gate 38 and input 35 of AND gate 56, while a 522 Hz
signal is applied to input 31 of AND gate 56 and a 261
Hz signal is applied to input 29 of AND gate 38.

         The one-shot two-second multivibrator 26 is
responsive to switch 22 as follows. If switch 22 is
30   held depressed for more than two seconds, one-shot 26
produces an output signal which is applied to a toggle
flip-flop 46, similar to toggle flip-flop 28, reversing
its previous state, from "enabled" to "disabled" or
vice versa. Once flip-flop 46 indicates quad timer
35   enable by a two-second hold of switch 22, it will remain
in the "enabled" state until the next successive
two-second hold of switch 22. The output from flip-flop

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46 is applied to the reset pin 45 of a 1/4-second one-
shot 50, and to the trigger input of a one-shot 24, the
output of which is a short duration high signal (usually
less than 1 msec) applied to OR gate 49, the output of
5 which triggers a 30-second timer 48 which, as can be
seen, is exactly one-fourth of the overall desired set
time (120 seconds) for brushing. When 30-second timer
48 runs out, a signal is applied to a 1/4-second one-
shot circuit 50. The Q output of one-shot 50 is applied
10 back as an input to OR gate 49, thereby triggering a
subsequent 30-second time period, 1/4 second after
termination of the immediately prior 30-second time
period, as clarified below. This provides the desired
repetitive time period.
15   When the output of toggle flip-flop 46
indicates quad timer disabled, the 1/4-second one-shot
50 is reset by a signal at input 45, which prevents the
1/4-second interrupts of the 261 Hz signal applied to OR
gate 60 through AND gate 38.
20   Output Q of one-shot 50 is "true", i.e. high,
during the entire time of toothbrush operation, other
than the 1/4- second period; output $\overline{Q}$ is "true", i.e.
high, when Q is not true, i.e. low. Outputs Q and $\overline{Q}$ are
applied, respectively, at inputs 37 and 39 to AND gates
25 38 and 56. Outputs Q and $\overline{Q}$ in effect thus determine
which of the two AND gates 38, 56 conducts clock signals
from the other input lines to those AND gates from the
frequency counters 36, 34, respectively, and then to OR
gate 60. Neither AND gate produces an output unless
30 toggle flip-flop 28 is "on". If it is, then either a
261 Hz signal from divider 36 or a 522 Hz signal from
divider 34 is conducted to OR gate 60 and then to the
load 62, depending on whether output Q or output $\overline{Q}$ is
true. In typical operation of the pacing toothbrush,
35 the load 62 thus will receive a 261 Hz signal for 30
seconds, followed by a 522 Hz signal for 1/4 second.
This sequence continues until the 120-second timer times

out.

During the periodic 1/4-second intervals, two significant effects occur. First, the 522 Hz signal is sufficiently fast to produce a "null" effect at the

5   brushhead (the load contact with the user), which is hence immediately distinguishable by the user. Also, the 522-Hz signal is used to produce a 1/4-second beep. The user hence knows both aurally and tactilely that a 30-second time interval has elapsed. Various methods of

10 producing the desired beeps can be used. For instance, a piezoelectric buzzer 23 could be connected to the output of AND gate 56, so that an alternating pulse is applied during the 1/4-second interval, creating an audible beep. An alternative is to interrupt the driver

15 with a silence "burst". Each 30-second interval represents the time the user should be taking for each quadrant of dentition (dental areas) in the mouth. Hence, the user will successively progress from, for instance, the upper left quadrant to the upper right

20 quadrant, then to the lower right and the lower left, both inner and outer sides of the teeth as well as the upper surfaces thereof. Other sequences, of course, can be used.

The user now, however, has information by

25 which the brushing can be paced to produce a uniform dental hygiene condition. It should be understood that other sets of intervals can be used, although four was experimentally determined to be a good compromise between an overly complex arrangement (i.e. eight time

30 intervals) and a very simple arrangement (i.e. two intervals), which is not likely to produce an even effect.

A software implementation of the present invention is shown in Figures 3 and 4. This embodiment

35 includes a microprocessor controller 63, a control switch 65, a ceramic resonator 67, and reset circuitry 69. The software embodiment operates into a load 71

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which comprises two driving transistors and a center tapped coil, which in turn results in brushhead movement in an electromagnetic driving system. Switch 65 is used to turn the apparatus on and off, while the ceramic

5   resonator 67 is used to determine the clock frequency of the microprocessor controller. The reset circuitry produces a reset signal to the software in the microprocessor when the unit is placed in the charger base.

10   The operation of the software embodiment is perhaps best understood by describing the four possible operating states of the toothbrush. In a first operating state, the toothbrush is positioned in charger base unit 20. This is represented by block 70 in Figure

15 4. In this state, a reset command is initiated, as shown by block 72, and the software is initialized, as shown at block 74, at the conclusion of which the software enters a wait mode. The software then in effect waits for switch 65 to be pressed by a user.

20   The remaining three operating states occur when the toothbrush has been removed from base unit 20. In these three states, the condition of the button switch 65 (18 in Figure 1) is monitored by the software, as shown by block 77. The monitoring function, which

25 results in a cycling through of the flow chart, occurs at a high rate, approximately 2 MHz. When the switch 65 is pressed, an on/off variable in the software indicating the operating condition of the unit is toggled (from off to on or vice versa), as shown at

30 block 79. Thus, when the toothbrush is off, and the switch is then pressed, the on/off variable is toggled to on. This is a second operating state. A determination is then made whether the switch 65 is held for 2 seconds, as shown by blocks 78, 80 and 84. If

35 yes, then a quadtimer variable is toggled, at block 100. If the quadtimer variable was previously in an enabled state, then it would change to disabled and vice versa.

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The quadtimer variable and following software functions control the pacing feature of the toothbrush.

A determination of the new state of the quadtimer variable is made after the quadtimer variable
5 has changed state, as shown at block 102. If the switch 65 has been pushed for 2 seconds, so that the state of the quadtimer variable changes, 2 beeps are produced if the quadtimer is now enabled (block 104), while 1 beep is produced if the quadtimer is now disabled (block
10 106). Beeps may be produced by changing the drive frequency applied to the load, e.g. from 261 Hz to 522 Hz, or by other techniques, such as interrupting the drive signal, or using a piezoelectric buzzer 68 connected to the microcontroller, or a combination
15 thereof. Hence, the user knows whether or not the pacing feature is enabled or disabled following the pressing of the switch for 2 seconds. The quadtimer variable will then remain in that state until the next 2-second pressing of the switch.

20   In each cycle through the software, regardless of the status of the quadtimer variable, the condition of the on/off variable is determined, as shown by block 86. In the "on" state (the second operating condition), the output signal is started, as shown at block 88, to
25 drive the load. If the quadtimer is enabled, a 30-second decrementing timing function is begun, as shown at block 91. A 120-second decrementing time function begins (block 92) as soon as the unit is turned on. When the 30-second timing function goes to zero, within
30 the 120-second timing period, as shown at blocks 94 and 108, a beep will be produced as shown at block 110, and the 30-second timing function will be reset, as shown at block 112. During this time, the output signal is applied to the load.

35   When the 120-second timing function is recognized to be at zero, as shown by block 94, the software is then initialized and returns to the wait

10

mode (block 74). The established set period for brushing is now over. When the switch 65 is again pushed, the output signal to drive the load begins again, with the quadtimer variable being in the same

5   status, unless the switch is held for longer than two seconds.

In a third operating state, button switch 65 is turned off by the user less than 120 seconds after it has been initially turned on. Block 86 now indicates

10   that the on/off toggle 79 is "off", so that no output signals are produced. When the on/off variable (block 79) is toggled to off, a 45-second timing function is initiated, shown at block 114. When this goes to zero, as shown at block 116, the software is initialized and

15   set to the wait mode, at block 74.

In a fourth state, which is a variation of the third state, the toothbrush is turned back on again within a 45-second period after it has been turned off. Since the software has not been initialized in that

20   time, the software (i.e. the 30-second and 120-second timing functions) picks up where it was when the unit was turned off. The on condition of the on/off variable 79 is recognized, at block 86, and the output driving waveforms begin again, until the 120-second function

25   goes to zero. Hence, when the toothbrush is turned on and then turned off within 120 seconds, the software in effect remains in a "halt" condition thereafter for 45 seconds, before the software is initialized and reset.

Hence, a vibrating toothbrush has been

30   disclosed which includes a capability of providing an indication to the user of certain elapsed periods of time within an overall set timer, which are related to optimal times for cleaning one portion of the dental region.

35   Although a preferred embodiment of the invention has been disclosed herein for illustration, it should be understood that various changes, modifications

and substitutions may be incorporated in such embodiment without departing from the spirit of the invention, which is defined by the claims which follow:

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Claims

1.   A dental hygiene device for cleaning teeth, comprising:

a power toothbrush, including a support member having a brushhead at a distal end thereof and means for driving the brushhead; and

timing means, responsive to the device being turned on, for producing successive indications of intervals of elapsed time, wherein the intervals of elapsed time are related to desired times for brushing portions of the dental region.

2.   An apparatus of claim 1, wherein the successive indications of time are provided within a preestablished set period of time during which the toothbrush is operating.

3.   An apparatus of claim 1, wherein the indications are a selected one of a) an audible signal and b) a detectable change in bristle movement.

4.   An apparatus of claim 3, wherein the indications comprise both an audible signal and a detectable change in bristle movement.

5.   An apparatus of claim 2, wherein the set period of time is approximately two minutes and wherein the selected intervals of time are approximately 30 seconds.

6.   An apparatus of claim 1, including means for changing the state of the timing means between enabled and disabled after the apparatus is turned on.

7.   An apparatus of claim 6, wherein the changing means is responsive to an on/off switch being
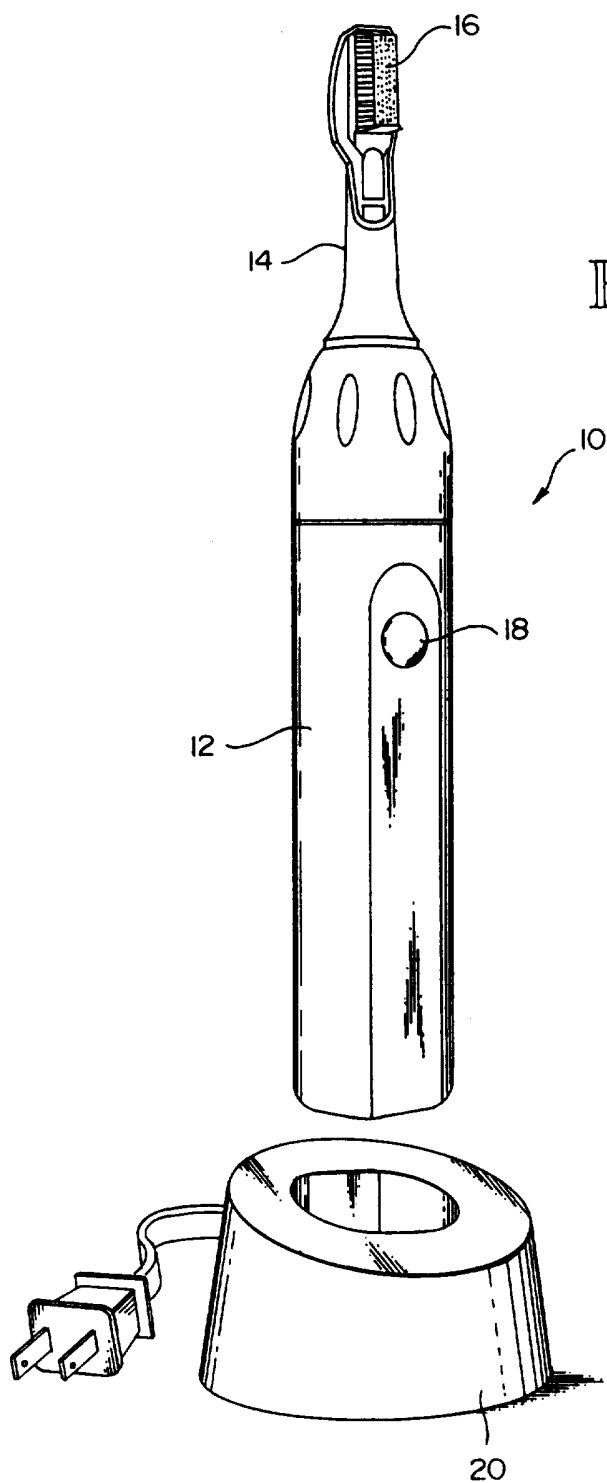
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pressed on for a selected period of time.

8.   An apparatus of claim 6, wherein a first audible signal indicates that the timing means has been enabled and a second audible signal different from the first audible signal indicates that the timing means has not been activated.

9.   An apparatus of claim 7, wherein the selected period of time is approximately two seconds.

10.   An apparatus of claim 2, including means for maintaining the status of the timing means for a selected period of time after the apparatus has been turned off during said preestablished period of time following the apparatus being turned on.

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FIG. 1

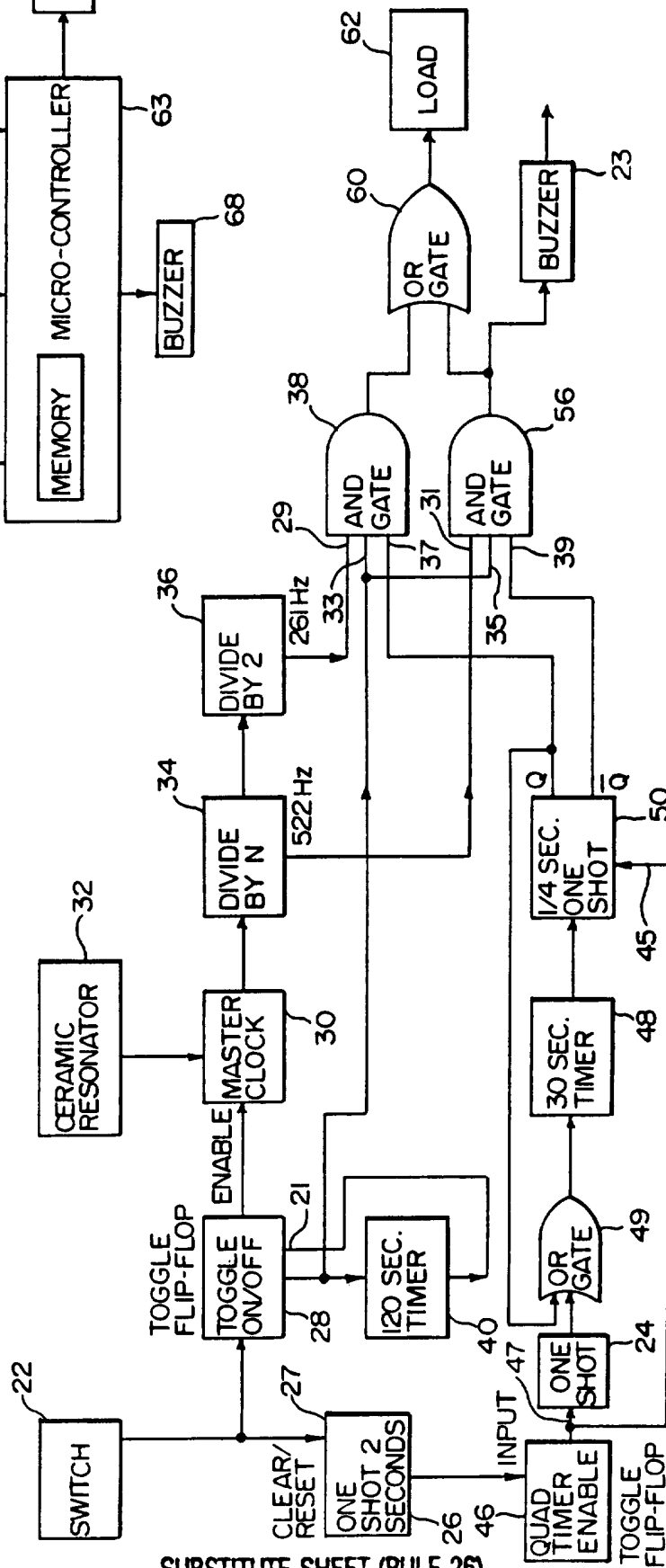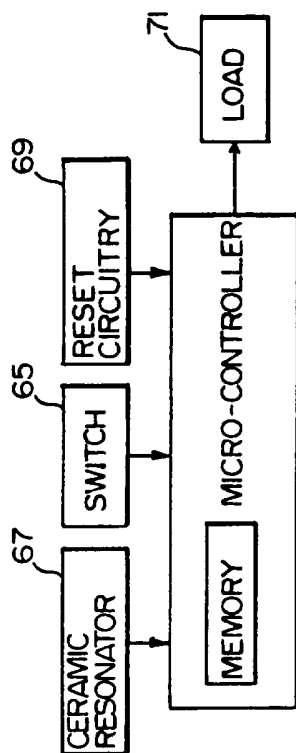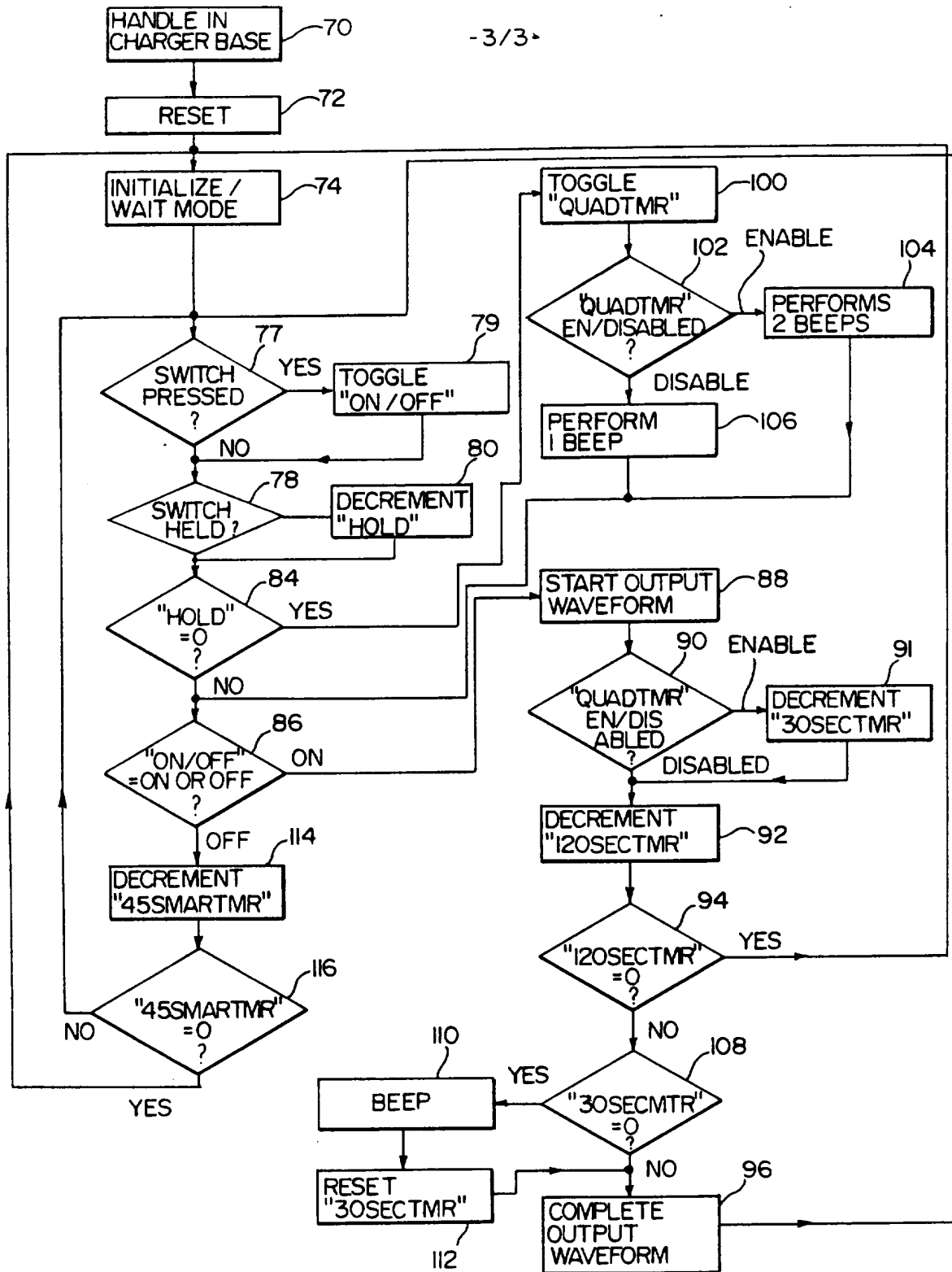FIG.3

FIG.2

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FIG. 4