



(86) Date de dépôt PCT/PCT Filing Date: 2005/06/28

(87) Date publication PCT/PCT Publication Date: 2006/01/12

(45) Date de délivrance/Issue Date: 2014/12/09

(85) Entrée phase nationale/National Entry: 2006/12/28

(86) N° demande PCT/PCT Application No.: IB 2005/052141

(87) N° publication PCT/PCT Publication No.: 2006/003617

(30) Priorité/Priority: 2004/06/30 (US60/584,760)

(51) Cl.Int./Int.Cl. *A61C 17/32* (2006.01),
A61C 17/22 (2006.01), *H02P 7/00* (2006.01)

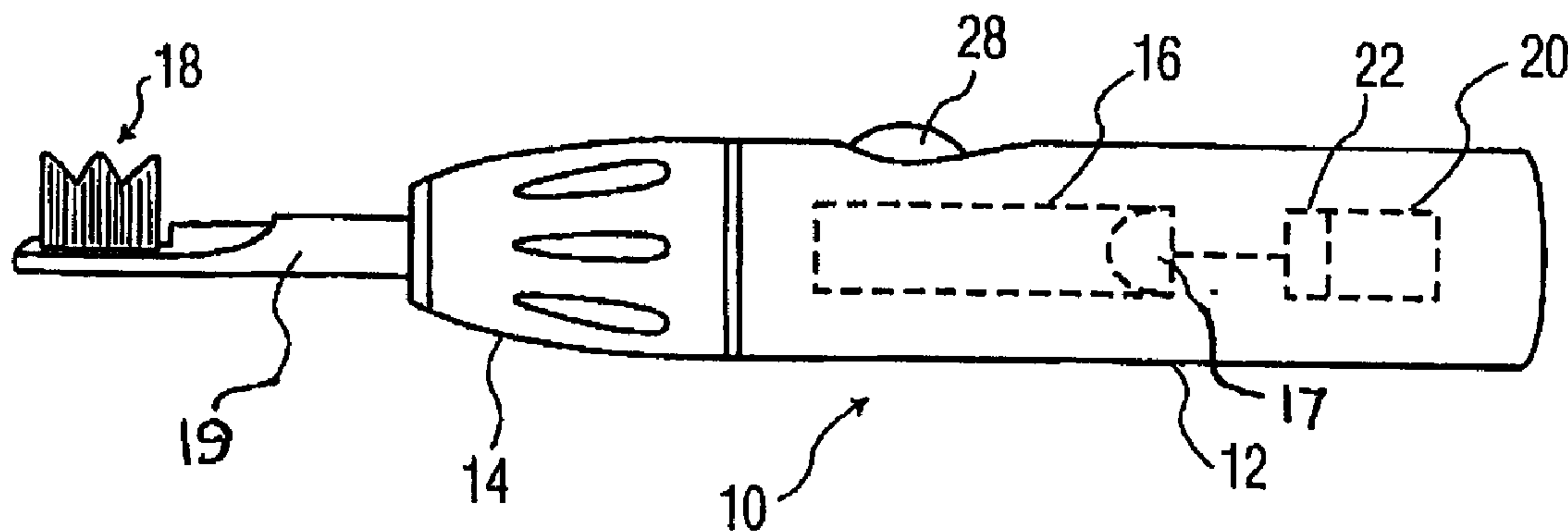
(72) Inventeurs/Inventors:
HALL, SCOTT E., US;
BAYEH, DANIEL, US;
LILLEY, RONALD C., US

(73) Propriétaire/Owner:
KONINKLIJKE PHILIPS ELECTRONICS, N.V., NL

(74) Agent: SMART & BIGGAR

(54) Titre : BROSSE A DENTS ELECTRIQUE A FONCTIONNEMENT REGLABLE

(54) Title: POWER TOOTHBRUSH WITH ADJUSTABLE OPERATION



(57) Abrégé/Abstract:

The system changes frequency of the toothbrush to adjust the amplitude of motion of the brush portion of the toothbrush. The change in frequency occurs either manually or automatically. In the manual embodiment, the user, via a switch and internal circuitry, can adjust the operating frequency of the toothbrush which results in a change of amplitude to a value which is most comfortable to the user. In the automatic mode, the resonant frequency of the toothbrush is determined upon initiation of the operation of the toothbrush. The resonant frequency value is then offset by a selected amount, usually higher than the resonant frequency; this offset frequency is the operating frequency of the toothbrush.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
12 January 2006 (12.01.2006)

PCT

(10) International Publication Number
WO 2006/003617 A1

(51) International Patent Classification⁷: **A61C 17/32**,
17/22, H02P 7/00

SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC,
VN, YU, ZA, ZM, ZW.

(21) International Application Number:
PCT/IB2005/052141

(22) International Filing Date: 28 June 2005 (28.06.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/584,760 30 June 2004 (30.06.2004) US

(71) Applicant (for all designated States except US): **KONINKLIJKE PHILIPS ELECTRONICS, N.V.** [NL/NL];
Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **HALL, Scott E.** [US/US]; P.O. Box 3001, Briarcliff Manor, NY 10510-8001 (US). **BAYEH, Daniel** [ET/US]; P.O. Box 3001, Briarcliff Manor, NY 10510-8001 (US). **LILLEY, Ronald C.** [US/US]; P.O. Box 3001, Briarcliff Manor, NY 10510-8001 (US).

(74) Common Representative: **KONINKLIJKE PHILIPS ELECTRONICS, N.V.**; c/o Russell Gross, P.O. Box 3001, Briarcliff Manor, NY 10510-8001 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL,

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

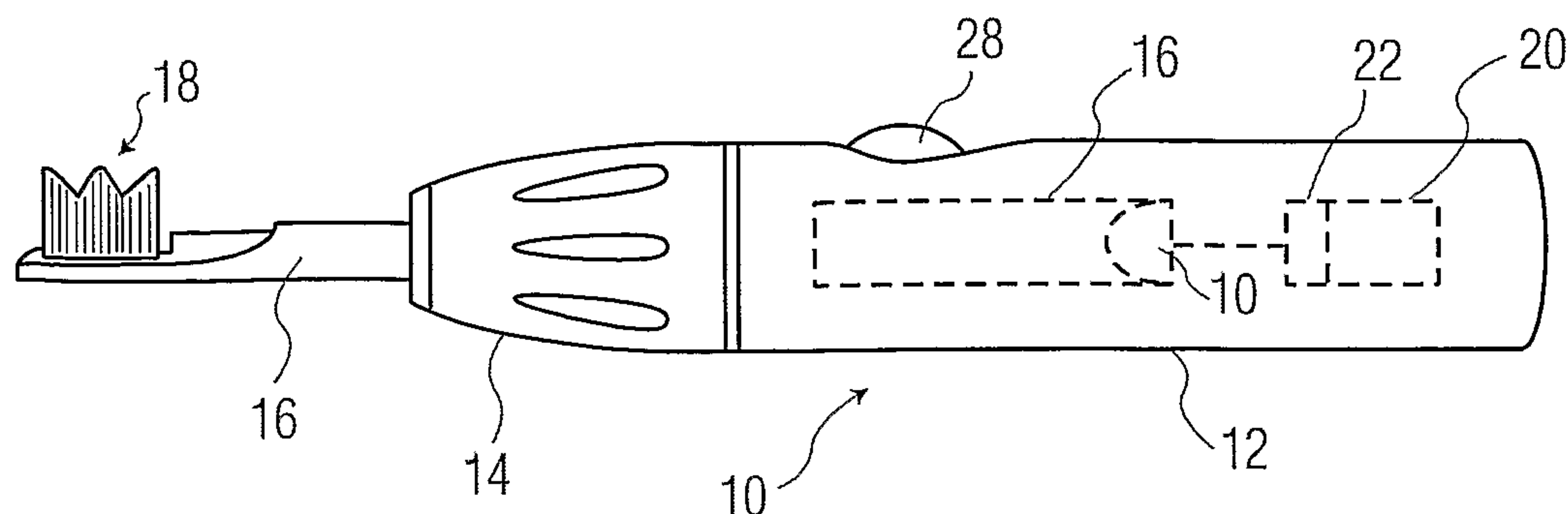
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations

Published:

- with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: POWER TOOTHBRUSH WITH ADJUSTABLE OPERATION



(57) Abstract: The system changes frequency of the toothbrush to adjust the amplitude of motion of the brush portion of the toothbrush. The change in frequency occurs either manually or automatically. In the manual embodiment, the user, via a switch and internal circuitry, can adjust the operating frequency of the toothbrush which results in a change of amplitude to a value which is most comfortable to the user. In the automatic mode, the resonant frequency of the toothbrush is determined upon initiation of the operation of the toothbrush. The resonant frequency value is then offset by a selected amount, usually higher than the resonant frequency; this offset frequency is the operating frequency of the toothbrush.

WO 2006/003617 A1

52375-12

POWER TOOTHBRUSH WITH ADJUSTABLE OPERATION

The invention generally relates to power toothbrushes and more specifically concerns a system for adjusting the operation of the toothbrush by adjusting the amplitude of the brush motion.

5 The operational parameters of a power toothbrush, in particular, the frequency of the reciprocal motion of the brush portion of the toothbrush and the amplitude of the motion are typically established and set by the manufacturer prior to sale of the toothbrush. In those toothbrushes which are resonant systems, the operating frequency of the toothbrush is typically set at or near the resonant frequency of the toothbrush.

10 The amplitude of a power toothbrush established by the manufacturer may, however, not be optimal for a particular toothbrush and/or a particular user. A somewhat different amplitude than that established by the manufacturer may often be desirable to provide a maximum response and a preferred sense/feel by a particular user. Actual results from use of the toothbrush may also vary depending upon the particular amplitude of
15 toothbrush motion. While amplitude may be adjusted by changing the power supplied to the motor, this approach has practical limitations, due to magnetic saturation in the motor and battery capacity.

 It is desirable to be able to change the amplitude of the brush after it leaves the manufacturer to optimize performance and/or the sense of cleansing, without directly
20 adjusting the power.

 Accordingly, the present invention in one embodiment is a manual system for changing the amplitude of motion of a brush portion of a power toothbrush, comprising: a drive system for a power toothbrush which operates at a selected frequency to move the toothbrush at a resulting amplitude; and a frequency adjustment system,
25 including a member operable by a user for changing the frequency of the drive system and hence the amplitude of motion of the brush portion.

52375-12

In one particular embodiment, the present invention provides a manual system for changing the amplitude of motion of a brush portion of a power toothbrush, comprising: a drive system for a power toothbrush which operates at a selected operating frequency to move the brush portion at a resulting amplitude; and a frequency adjustment system, including a member operable by a user, for changing the operating frequency of the drive system in user-determined, microprocessor controlled, two-way, successive frequency steps, wherein each operation of the frequency adjustment system increases or decreases the operating frequency by a preselected amount, wherein the operable member is a mechanical switch located on a handle of the toothbrush, and further wherein the frequency adjustment system includes a microprocessor which in turn includes a clock signal which provides an initial frequency of operation of the power toothbrush and an up-down counter/timer assembly responsive to the switch for changing the frequency provided by the clock signal by the selected amount.

Another embodiment is an automatic system for changing the amplitude of motion of a brush portion of a power toothbrush, comprising: a drive system for a power toothbrush for operating the toothbrush at a particular frequency to produce a resulting amplitude; a system for determining the resonant frequency of the toothbrush at a selected time following initiation of operation of the toothbrush by the user; and a frequency

52375-12

adjustment system, which controls the setting of the operating frequency of the toothbrush at a value which is offset from the determined resonant frequency by a preselected amount.

Figure 1 shows a power toothbrush with which the present invention can be used.

5 Figure 2 is a block diagram showing one embodiment of the tunable toothbrush of the present invention.

Figure 3 is a block diagram of another embodiment of the tunable toothbrush of the present invention.

Figure 4 is a flow chart for a software program used in the embodiment of 10 Figure 3.

Figure 1 shows a power toothbrush 10. As an example, power toothbrush 10 includes a handle portion 12 and a head portion 14 attached to the handle portion. The handle portion includes a stator 16 which is part of the motor for the toothbrush and includes a drive coil 17. The motor is driven by a drive signal produced by a signal source 15 20, which includes switching circuit 22.

Head portion 14 typically includes a stem portion 19 and a brush portion 18 which is driven by operation of the motor. Operating an on/off switch 28 results in the brush portion 18 moving at a selected frequency and amplitude.

In the present invention, the operation of the toothbrush 10 is adjusted by 20 changing the operating frequency of the toothbrush, which in the embodiments shown and described results in a change in amplitude of the brush motion, as described in more detail below. Figure 2 shows a manual embodiment of the frequency adjusting system. In the manual embodiment, the user operates a rocker switch 36 to change the operating frequency of the toothbrush through the action of a microprocessor 39. The action of 25 rocker switch 36 is sensed by an up/down counter 38 to determine the amount of increase or decrease of the frequency of the signal to be provided by timer 40. The up/down counter 38 loads timer 40, to which is applied a clock signal 37 which provides the initial frequency of operation of the appliance. The output of timer 40 is sent to a divide-by-two circuit 42 which is used to produce a square wave, which is then applied to inverters 46 and 30 48. The output of inverters 46, 48 is applied to FETs 50 and 52 which control the application of current to stator coil 54 of motor 16. Other electrical switches, such as bipolar transistors, could be used in place of the FETs.

By operating rocker switch 36, a change of operating frequency of the toothbrush is produced which in turn affects the amplitude of the brush motion. The user operates the rocker switch until an optimal "feel" or other desired result, occurs. Each operation of the rocker switch will alter the frequency of operation by a selected amount.

5 The frequency selected by the user may be higher or lower than the preset frequency and may be higher or lower than the actual resonant frequency of the toothbrush. In the embodiment shown, the user can operate the frequency adjustment system at his/her convenience, even during brushing, to adjust the amplitude to a preferred optimal value. Typically, as indicated above, this value will be different than the frequency set by the

10 manufacturer.

It is possible, however, to limit the ability of the user to change the frequency, and hence the amplitude, to some extent, such as by providing a timer which must expire prior to the user being able to change the frequency again. The timer could be, for instance, set to limit the ability of the user to change the frequency to once or perhaps

15 twice during a normal brushing event, which is typically two minutes.

Figure 3 is a block diagram showing another embodiment, specifically, an automatic toothbrush frequency/amplitude adjustment system. In general in this embodiment, when the user turns the toothbrush on, a system is initiated which determines the resonant frequency of the toothbrush. This is done by sweeping through a series of

20 frequencies, the range of which includes the value of the resonant frequency of the toothbrush. Once the resonant frequency is determined by this sweeping of frequencies, the actual operating frequency for the toothbrush is produced by including an offset from the determined resonant frequency. This value of frequency offset is established by the manufacturer. This setting of the operating frequency occurs each time the user turns on

25 the toothbrush. Hence, changes in the resonant frequency of the toothbrush over time can be automatically accommodated.

Referring now to Figure 3, which shows the automatic adjustment system, including a microprocessor 58, a timing register 60 in the microprocessor is first initialized. The timing register 60 then preloads a timer 62 which is also responsive to a clock 63. The

30 first frequency value established by the timing register is typically the lowest frequency value in the "sweep" of frequencies, although the sweep could occur from highest frequency to the lowest frequency as well. The output of timer 62 (initially the lowest

frequency) is then applied to a divide-by-two circuit 64 which produces a square wave, which is applied to inverting circuits 66 and 68.

The output from the inverters is then applied to FETs 70, 76 which produce a current which is applied to the stator coil 77 for a short selected time, *e.g.* 1/10th second.

5 The current in the coil is sensed at 72 and the phase shift is measured at 74. As the frequency values move through the resonance frequency of the brushhead, the time necessary for the current to reverse will change. The term "phase shift" here refers to the relationship between the voltage drive (the square wave signal) and the zero crossing of the current waveform. This value of phase shift as defined above is applied to RAM 76 in the

10 microprocessor, providing a first value in a table of phase values. The timing register 60 is then changed by a specific frequency value and the process is repeated, until a table of phase shift values is established. When the last frequency in the preselected "sweep" of frequencies through a selected range is used, and the table is complete, the resonant frequency is determined. The resonant frequency is associated with the minimum value of

15 phase shift in the table. The operating frequency is then set, *i.e.* established, using the offset frequency value determined by the manufacturer. This resulting operating frequency value is then used to set the timing register 60 and the toothbrush is set to run for the specified amount of time (time for brushing).

Figure 4 is a flow chart of the software program in microprocessor 58 for

20 control of the automatic operation of the appliance. First, timing register 60 is initialized, as shown in block 90. The timing register 60 will initially be set at the first, *i.e.* lowest, frequency in the frequency sweeping range (although it could be the highest, as indicated above) to determine the resonant frequency of the toothbrush. This value is then used to preload the timer 62 as shown in block 92. The stator of the motor is then run for a

25 selected number (n) cycles using the first frequency value, as shown at block 94.

The phase shift value resulting from this first frequency of operation is then captured and stored in RAM 76 as shown at block 96. The frequency is then incremented by one step. This is indicated at block 98, where the loop index or value (i) has its value incremented by one, each time through the loop. This new loop value of (i) is compared

30 then to a value (m), which is the total number of frequency steps in the frequency sweep process. This is shown at block 100. If the new value of (i) is not greater than (m), then

52375-12

timing register 60 is decremented, establishing a new preload value for the timer 62, as shown in block 102.

This process is repeated, building a table of phase shift values in RAM, until (i) is greater than (m). At this point, the resonant frequency of the toothbrush system is determined by ascertaining from the table in RAM the lowest value of the phase shift and correlating it with the associated frequency of operation. The preselected offset frequency set by the manufacturer is then used to establish the run timing value for the toothbrush, as shown at block 104. That value is used to set the timing register at block 106. Once the timer is set from the timing register, the appliance is then run for the time of the event, i.e. the preset time for brushing, in accordance with the established frequency value as shown at block 108.

Accordingly, a system has been described for adjusting the operation of a power toothbrush, both manually and automatically, by changing the frequency of the toothbrush.

Although a preferred embodiment of the invention has been disclosed for purposes of illustration, it should be understood that various changes, modifications and substitutions may be incorporated without departing from the scope of the claim.

52375-12

CLAIMS:

1. A manual system for changing the amplitude of motion of a brush portion of a power toothbrush, comprising:

5 a drive system for a power toothbrush which operates at a selected operating frequency to move the brush portion at a resulting amplitude; and

a frequency adjustment system, including a member operable by a user, for changing the operating frequency of the drive system in user-determined, microprocessor controlled, two-way, successive frequency steps, wherein each operation of the frequency adjustment system increases or decreases the operating frequency by a preselected amount,

10 wherein the operable member is a mechanical switch located on a handle of the toothbrush, and

further wherein the frequency adjustment system includes a microprocessor which in turn includes a clock signal which provides an initial frequency of operation of the power toothbrush and an up-down counter/timer assembly responsive to the switch for
15 changing the frequency provided by the clock signal by the selected amount.

2. The system of claim 1, wherein the frequency adjustment system is operable any time that the toothbrush is on to turn the toothbrush off.

3. The system of claim 1, including a limiting timer, wherein the limiting timer limits the frequency changes to the operating frequency to a preselected number in a
20 predetermined time period.

4. The system of claim 3, wherein the number of changes is one or two in the predetermined time period.

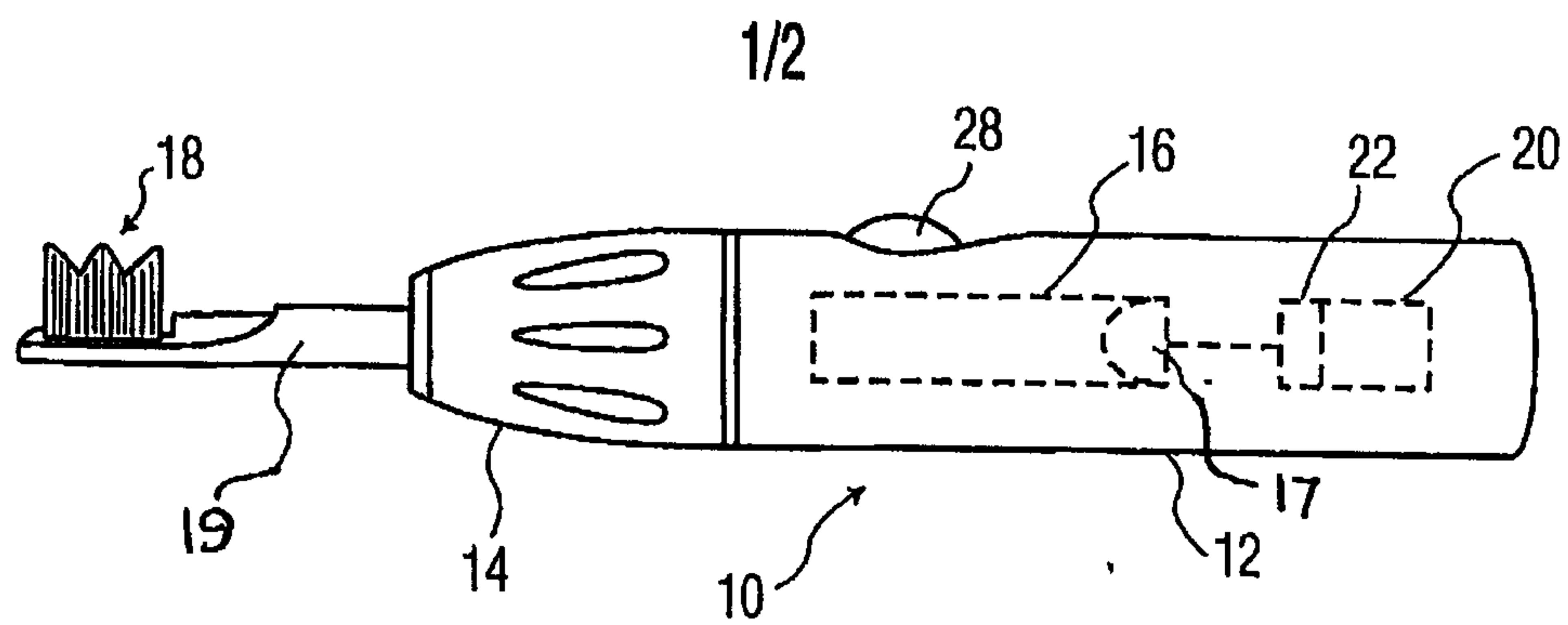


FIG. 1

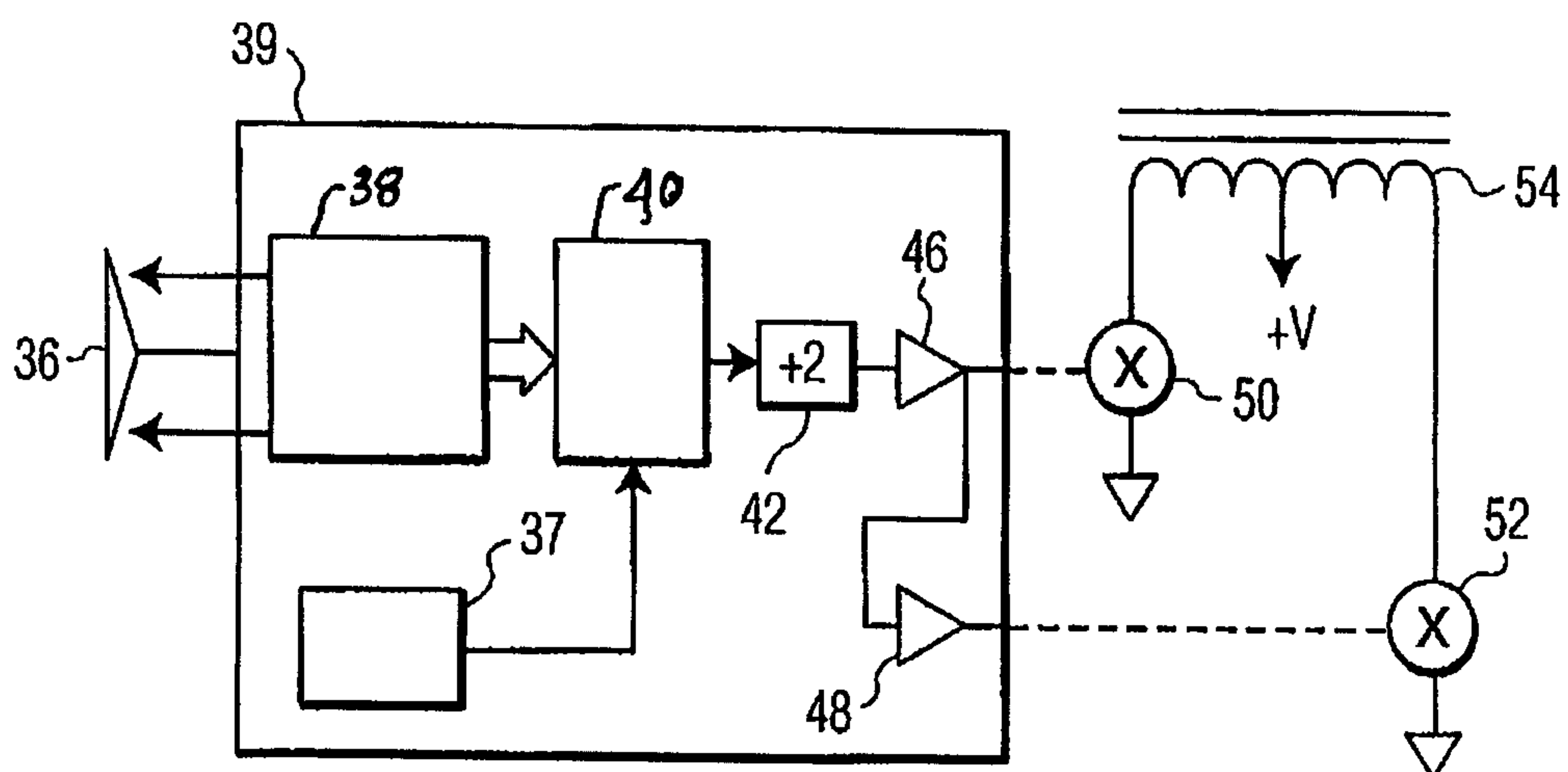


FIG. 2

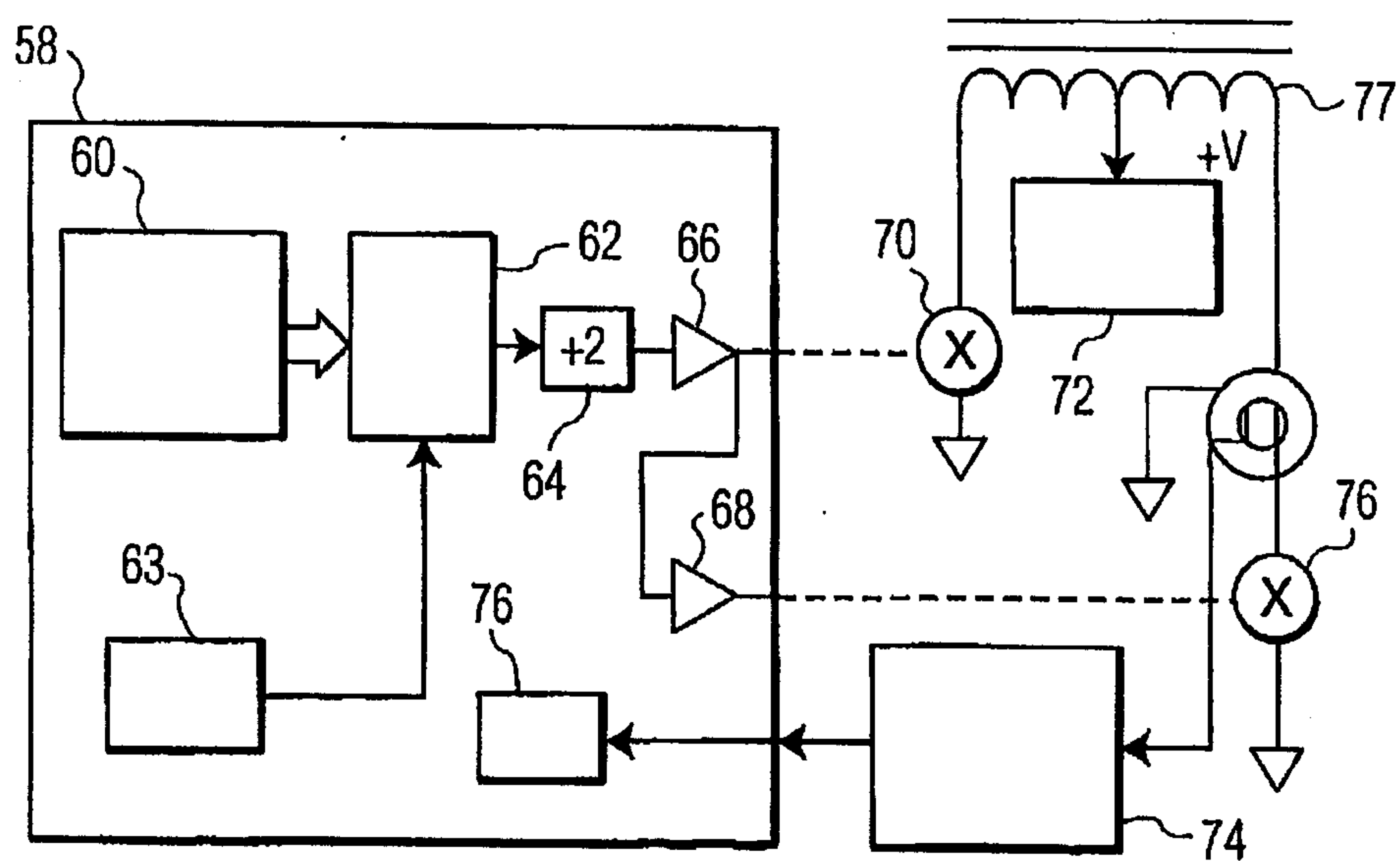


FIG. 3

2/2

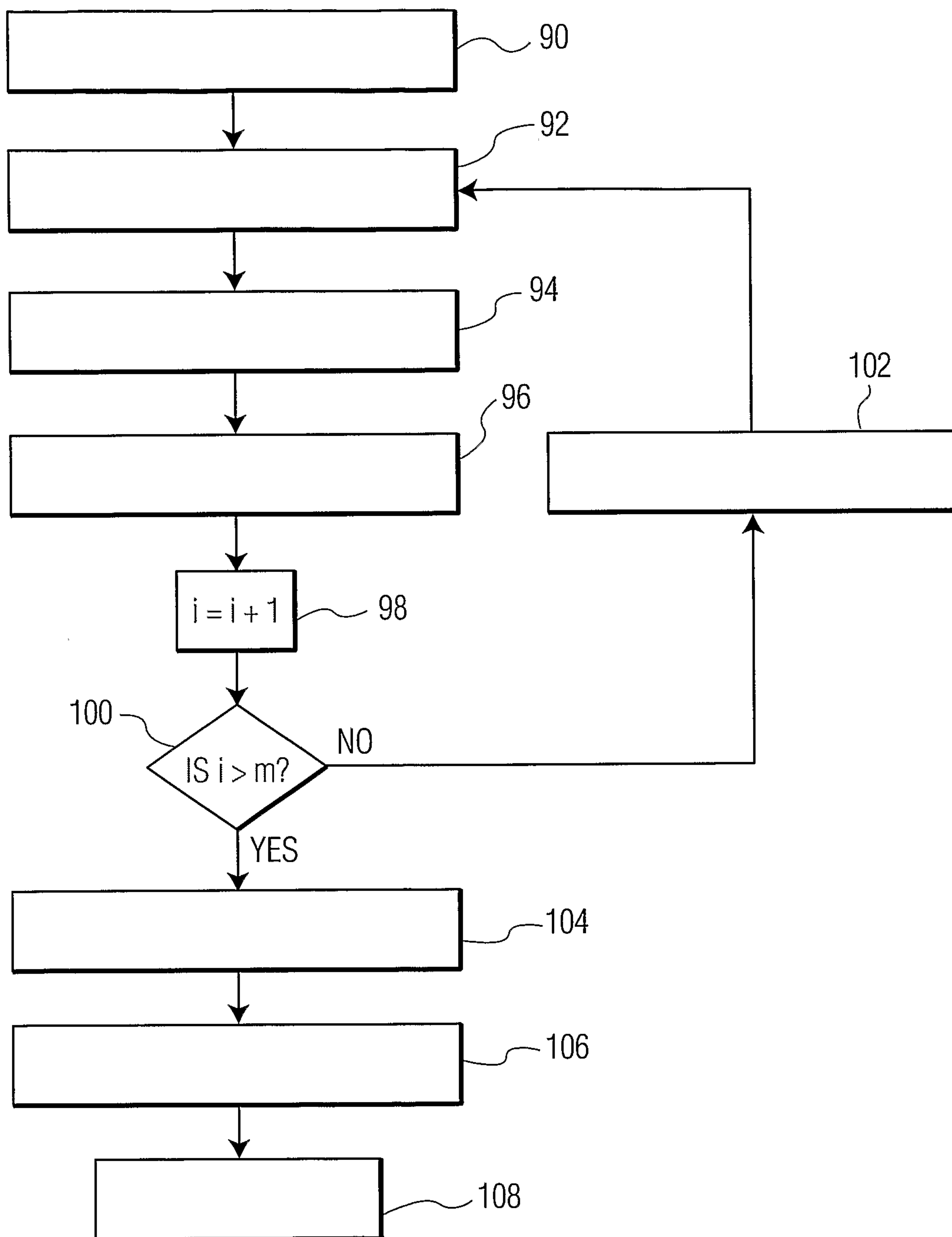


FIG. 4

