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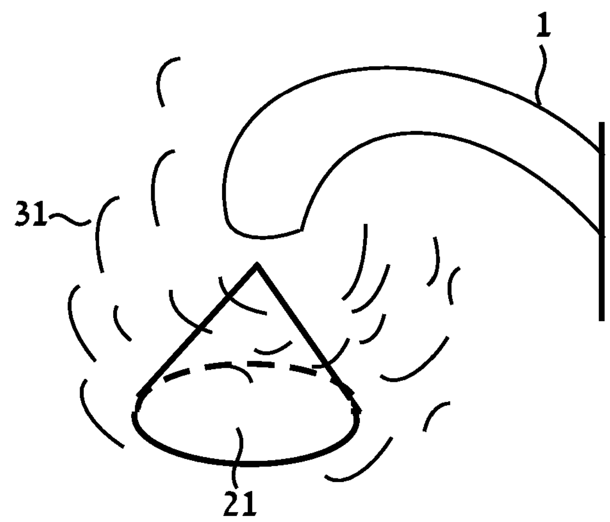

FIG. 1

(57) Abstract: An automatic faucet device comprises a water flow control valve and valve control means. In the control means, a decision regarding closing or opening the valve is based on readings from dual sensor means. The dual sensor means include infrared sensors and capacitive sensors. A decision re closing or opening the valve is based on readings from dual sensor means, an automatic faucet activation method comprising: read sensors input, wherein signals from the two sensors (IR and capacitive) are being read continuously; compute OPEN evaluation with criterion A: The sensors readings will be evaluated; to open valve? If Yes, then commands to an electro-mechanical device are issued, to open the water flow.

WO 2009/095879 A2

Automatic Faucet and Shower

Technical Field

The present invention relates to an automatic faucet or shower device and method with improved activation reliability.

WOD(TM) and Water On Demand(TM) are claimed as trademarks by the present applicants.

Cross-reference to related applications

The present application claims priority from patent application No. GB0801863.2 filed in U.K. on 01 February 2008 and patent application No. GB0814708.4 filed in U.K. on 12 August 2008.

Background Art

Automatic operation of a faucet is known in the art - the faucet is automatically opened or closed, without a human hand having to touch it.

An automatically operated faucet may save water, by automatically closing a faucet which was left open by a user. There is a hygienic benefit in users being spared the need to touch the faucet. Various other benefits may also be achieved.

For example Carmel, US Patent 5,549,273, Electrically operated faucet including sensing means.

Prior art faucets may use a capacitive sensor or an infrared sensor (IR), using active or passive IR. The active IR may use an illuminated cone; there may be reflections used to detect a user hand's presence.

There are various advantages to automatic operation of a faucet - it remains clean despite a user having dirty hands, is more easy and convenient to use, and it is saving on water usage.

And indeed, automatic faucets have found use in public places, and are now available commercially at reasonable prices.

A problem with such prior art automatic faucets is their false alarm rate - sometimes the faucet will open when not required to do so, or refuse to open when required to.
Sometimes it will close prematurely, when the user still needs more water.
Sometimes it will remain open when required to close.
Thus, the automatic system may have a reliability problem.

It is desirable to reduce the false activations in faucets, to save on water and to refrain from annoying the users.
The domestic market is less tolerant of such false activations than the public places market.

Thus, the automatic faucets did not find domestic use until now, since it was not reliable enough.
A possible problem - false activation, or no activation where required.

Therefore, it is a goal of the present invention to achieve an automatic faucet with a more reliable activation - the chance of its misinterpreting a user's desires is considerably reduced.
The improvements relate to both reliably opening and closing the faucet as desired by the user.

Disclosure of Invention

According to one aspect of the present invention, a new faucet or shower uses a dual sensor technology to reduce the false alarm rate and increase reliability of true activation - probability of true recognition of activation.

Preferably the IR sensor or transmitter/receiver (T/R) sensor pair is located under the faucet outlet, to form a cone of detection.

In a preferred embodiment, the IR sensor is located in the center of the faucet. In another preferred embodiment, a sensors array is located around the openings for water.

The new technology may be used, for example, in regular, pull-out or pull-down faucets. Various applications of the technology are optional.

According to another aspect of the invention, the faucet further includes a manual override mechanism, to activate or stop the water flow, in case the automatic detection means are in error.
The manual mechanism may further be used to adjust the water temperature to a desired value, and/or for manual operation when desired, irrespective of the sensor's activation.

This feature may be especially important in domestic use, where a user will not tolerate in his/her home a faucet not operating, or supplying water uncontrollably.

Preferably, the faucet controller will use different criteria or thresholds for ON (opening the water) and for OFF (closing it), since the flowing water may change the environment for the sensors.

Other factors may also affect the readings of sensors during the ON and/or OFF transitions.

Furthermore, the system may use an adaptive system and method, capable of learning a user's habits.

Further activation means adapted for a shower device are included.

The novel technology may be used to activate the water in a toilet as well as other applications.

Preferably, the learning capability will also include the manual override activations, which may be used to correct the presently used parameters.

Brief Description of Drawings

Fig. 1 illustrates a faucet with dual sensor means including capacitive and IR cone sensors

Fig. 2 illustrates a faucet with dual sensor means including capacitive and IR hollow cone sensors

Fig. 3 details a pull-out faucet with a central IR sensor

Fig. 4 details a pull-out faucet with a peripheral IR sensors array

Fig. 5 details a regular faucet with a peripheral IR sensors array

Fig. 6 details a block diagram of a dual sensor automatic faucet

Fig. 7 details a block diagram of a dual sensor automatic faucet with manual override

Fig. 8 details a block diagram of another embodiment of a dual sensor automatic faucet with manual override

Fig. 9 details a flow chart of a dual sensor automatic faucet with separate ON/OFF criteria

Fig. 10 details a flow chart of an adaptive automatic faucet with manual override

Fig. 11 details a data flow diagram of an adaptive automatic faucet with manual override

Fig. 12 details a shower device with dual sensor means including capacitive and IR cone sensors

Fig. 13 illustrates a shower device with dual sensor means including capacitive and IR hollow cone sensors

Fig. 14 illustrates a shower system with multiple sensor means including capacitive and IR cone sensors

Fig. 15 details a flow chart of a dual/multiple sensor automatic faucet with separate ON/OFF criteria and manual override

Modes for Carrying out the Invention

Referring to Fig. 1, which illustrates a faucet 1 with dual sensor means including capacitive and IR cone sensors, an IR sensor cone 21 is formed under the faucet 1.
Additionally, a capacitive sensor field 31 is formed around the faucet 1.
The capacitive sensor may use any of the presently commercially available such sensors.

The readings from both sensors are correlated to enhance the reliability of the automatic activation of the faucet.

The IR sensor beam in this embodiment may be easier to implement, such as illustrated in Fig. 3. It may be effective in detecting a request to activate the faucet (turn water ON). However, flowing water may interfere with its operation, and the turn off may also relay on a time delay means.

Fig. 2 illustrates a faucet 1 with dual sensor means including a capacitive sensor field 31 around the faucet 1 and an IR sensor hollow cone 22 under the faucet 1.

The IR sensor beam in this embodiment may be somewhat more difficult to implement, such as illustrated in Figs. 4 and 5. It may be more effective in detecting a request to activate the faucet (turn water ON or OFF).
Flowing water may interfere to a lesser extent with its operation.

Fig. 3 details a pull-out faucet 1 with a central IR sensor 23.
The faucet 1 may have water outlet holes 12 around the sensor 23, as illustrated.

Fig. 4 details a pull-out faucet 1 with a peripheral IR sensors array 24, surrounding the water outlet opening 13 in the faucet 1.

Fig. 5 details a regular faucet 1 with a peripheral IR sensors array. In one embodiment, the IR sensors array may be implemented with an IR sensor array ring 25 as illustrated. The ring 25 may be mounted around the faucet 1 with the outlet opening 13 therein.

Fig. 6 details a block diagram of a dual sensor automatic faucet.
The system includes an IR sensor 23 and a capacitive sensor 33 for detecting a user nearby requesting to open the faucet (turn water ON) or closing it.

The controller 41 processes the sensors signals to decide whether to open the faucet or close it. If an activation decision is reached, the controller 41 will activate electro-mechanical means 42 to implement the decision.

The electro-mechanical means 42 may include an electrical motor or a solenoid (not shown), for example. Either a DC motor, an AC motor or a stepper motor may be used.

The electro-mechanical means 42 will open or close a valve 43 in the faucet 1, to open or close the faucet for water flow.

The valve 43 may either have two positions ON/OFF, or allow for a variable degree of opening, for a desired flow rate.

For a variable flow rate, the controller 41 may store a programmable parameter indicating the desired flow rate. The user may change the flow rate using programming means as known in the art, for example using an IR communication channel with non-volatile memory means in the controller 41.

Alternatively, separate sensor means may be used to turn the water ON or OFF, and for controlling the flow rate.

Fig. 7 details a block diagram of a dual sensor automatic faucet with manual override means.

The system is similar to that disclosed in Fig. 6 and the related description, with the addition of a manual override input means 441.

The manual override input means 441 may include (not shown) a pair of electrical pushbuttons ON and OFF, connected to the controller 41. Pushing one of the buttons will indicate a corresponding override command, and the controller 41 will act accordingly to cancel the previous automatic activation. That is, the valve 43 will be turned ON or OFF responsive to the manual pushbutton being pressed.
Other embodiments of a manual override may be used.

Thus, the manual override feature may be used to cancel an automatic opening or closing of the water at the faucet, in any given situation.

The advantage of this embodiment is its simple and low cost implementation. A possible disadvantage is that, in case of a failure of the controller 41 or the power supply 49, the manual override will not have effect.

A possible solution is to use manual override means, such as a manual valve, to close the water if necessary and/or for automatic adjustments. A manual valve may be installed before the mixer.

Fig. 8 details a block diagram of another embodiment of a dual sensor automatic faucet 1 with manual override means.

Data from the IR sensor 23 and the capacitive sensor 33 are transferred to the controller 41. According to activation decisions, the controller 41 will activate electro-mechanical means 42 such as an electrical motor.

The system includes a dual activation valve 44, which may be opened or closed by the electro-mechanical means 42 or by the manual override input 442. In this case, the manual override input 442 will act directly on the valve 44 to open or close it.

The advantage of this embodiment is its enhanced reliability - it will operate as required, even in case of a failure of the controller 41 or the power supply 49.
A possible disadvantage is the more complex structure of the dual valve 44.

Preferably, the system will also include a manual override indication 443 connected from the valve 44 to the controller 41, so the controller 41 will be notified of a manual override. This information may be advantageously used to update the decision parameters and the activation history, as detailed elsewhere in the present disclosure.
The signal 443 may be generated for example with a microswitch installed in the valve 44, which is activated by the manual override input 442.

Fig. 9 details a flow chart of a dual sensor automatic faucet with separate ON/OFF criteria, and as detailed below.

Automatic faucet activation method

The method includes:

a. read sensors input 51
(dual sensor)
The signals from the two sensors (IR and capacitive) are being read

continuously.

b. compute OPEN evaluation with criterion A 52
The sensors readings will be evaluated according to a predefined algorithm, and using a first criterion A with related parameters.

c. to open valve? 53
if Yes, goto 54, else goto 55

d. open valve 54
commands to the electro-mechanical device 42 are issued, to open the water flow.

e. read sensors input 55
(dual sensor)
The signals from the two sensors (IR and capacitive) are being read continuously.

f. compute CLOSE evaluation with criterion B 56
The sensors readings will be evaluated according to a predefined algorithm, and using a second criterion B with different, related parameters.

g. to close valve? 57
if Yes, goto 58, else goto 59

h. close valve 58
commands to the electro-mechanical device 42 are issued, to close the water flow; goto 51.

i. timeout? 59
if Yes, goto 58, else goto 51

The optional Timeout feature measures the time since the last activation of water flow (entering ON state) and will close the water after a predetermined time delay. For example, the user may set this parameter for 2 minutes or 5 minutes. The benefit of this feature is to save water - a failure to turn the faucet OFF will not cause water to flow indefinitely.
** End of method **

Fig. 10 details a flow chart of an adaptive automatic faucet with manual override, and as detailed below.

Automatic adaptive faucet activation method

The method includes:

a. read sensors input 61
(dual sensor)
The signals from the two sensors (IR and capacitive) are being read continuously.

b. compute OPEN/CLOSE evaluation with criteria A/B 62
and programmable parameters
The sensors readings will be evaluated according to a predefined algorithm, and using separate criteria A or B with different, related parameters.

c. to open/close valve? 63
if Yes, goto 64, else goto 65 (in another embodiment: goto 62)

d. open/close valve 64

e. manual override? 65
if Yes, goto 66, else goto 61

Note: the manual override may be activated asynchronously, anytime during the execution of this method.

f. change valve activation 66
update OPEN/CLOSE parameters;
goto 61.
** End of method **

Notes on the Faucet Activation Method

1. Opening and closing the valve may use either symmetric or asymmetric criteria and parameters.

2. Different parameters may be used for opening and closing the valve. The flow of water itself may change the environment and/or the sensors readings, and this effect may be accounted for. It is possible measure, evaluate and/or estimate such effects and take them into account when implementing the above method.

3. Different criteria may be used for opening and closing the valve. For example, opening the valve may require the activation of both the infrared and capacitive sensors; closing the valve may be triggered by only one of the sensors.

Parameters update method

a. A mathematical algorithm may operate on sensors readings for a plurality of occurrences/events. For each event, the correct result (activation to ON or OFF, or no activation) is also stored. The Correct Result (CR) is the output after step 65 (Fig. 10) or the output of module 78 (Fig. 11), which also includes the user's override command.

b. A best fit algorithm is implemented, to change the activation parameters or thresholds, to best fit the decision for the whole set of events, to the Correct Results there.

c. The decision parameters are updated to include the best fit parameters found in step (b).

d. Steps a-c are repeated to improve the decision parameters of the automatic faucet, as the system gathers experience in that specific environment (each home, and each location therein, may result in a different set of decision parameters for the automatic faucet there).
** End of method **

Method of operation of automatic faucet with override

Fig. 11 details a data flow diagram of an adaptive automatic faucet with manual override:

a. Data from the capacitive sensor input 70 and the IR sensor input 71 are transferred to the decision to open/close faucet 73.

b. The decision module 73 also takes into account the sensors evaluation parameters table 72.

c. The output from decision module 73, together with data from the faucet activation history table 74, are transferred to the update decision to open/close faucet module 75.

d. The result from module 75 is used in the activate faucet (open/close) 76 module.

e. The output from module 76, together with the manual override 77 command, are processed in the parameters update 78 module.
The parameters update 78 activates, if required, updates in the parameters table 72 and the history table 74.

f. Thus, if there was a manual override, this is an indication to the system that the present activation parameters are not adequate and should be corrected. For example, the decision threshold of one of the sensors (or both) should be increased or reduced. Or maybe more importance (an increased relative weight) should be accorded to one sensor vs. the other.

g. The history table 74 may also include data from a time/date module 79. This may be used to detect patterns of use of the faucet - the system learns the user's habits, and relies on these learned habits to improve the activation decision.

For example, a user brushes her teeth every night at 22.00 . This information is stored in the history table 74 as a reliable habit, which occurred several times.
The system will then activate the faucet at about that time every night, even if the sensors data is not so reliable, or below the usual decision threshold.
** End of method **

Optionally, the above system and method may be used to also control the temperature of the water. The user can then use the automatic control means to both open and close the valve, and to determine the temperature of the water supplied. For example, two outlets may be available, one for cold water and the other for warm water; the user may choose to activate either one of the outlets. In another embodiment, separate control means may be used to control the opening/closing of the water supply, and the temperature of the water.

Fig. 12 details a shower device 18 with dual sensor means including capacitive (with electric field 31) and IR cone (IR sensor cone 21) sensors.

The direction of the IR sensor and the capacitive sensors may be adjusted so as to best detect the presence of a person taking a shower there.

Fig. 13 illustrates a shower device 18 with dual sensor means including a capacitive sensor field 31 around the shower device 18 and an IR sensor hollow cone 22 under the shower 18.

The IR sensor beam in this embodiment may be somewhat more difficult to implement, such as illustrated in Figs. 4 and 5. It may be more effective in detecting a request to activate the faucet (turn water ON or OFF). Flowing water may interfere to a lesser extent with its operation.

Fig. 14 illustrates a shower system with multiple sensor means including capacitive sensors 331, 332 and IR cone sensors 231, 232. These sensors may be installed in various locations to detect the presence of adults and children reliably.

A manual override control 441 may be used to turn the water on and off while the person is taking a shower, as the need be.

Fig. 15 details a flow chart of a dual/multiple sensor automatic faucet with separate ON/OFF criteria and manual override.

Automatic shower activation method

The method includes:

a. read sensors input 511
(dual or multiple sensor)
The signals from the two sensors (IR and capacitive) are being read continuously.

b. compute OPEN evaluation with criterion A 521
The sensors readings will be evaluated according to a predefined algorithm, and using a first criterion A with related parameters.

c. to open valve? 53
if Yes, goto 54, else goto c2

c2. to open valve (manual command)? 532
if Yes, goto 54, else goto 55

d. open valve 54
commands to the electro-mechanical device 42 are issued, to open the water flow.

e. read sensors input 55
(dual sensor)
The signals from the two sensors (IR and capacitive) are being read continuously.

f. compute CLOSE evaluation with criterion B 56
The sensors readings will be evaluated according to a predefined algorithm, and using a second criterion B with different, related parameters.

g. to close valve? 57
if Yes, goto 58, else goto h

h. close valve 58
commands to the electro-mechanical device 42 are issued, to close the water flow; goto 51.

i. timeout? 59
if Yes, goto 58, else goto i2
The optional Timeout feature measures the time since activation of water flow (entering ON state) and will close the water after a predetermined time delay. For example, the user may set this parameter for 2 minutes or 5 minutes.

i2. to close valve (manual command)? 592
if Yes, goto 58, else goto 59
** End of method **

In other possible embodiments, more sensors may be used and processed to further enhance a decision to turn the faucet ON or OFF.

It will be recognized that the foregoing is but one example of an apparatus and method within the scope of the present invention and that various modifications will occur to those skilled in the art upon reading the disclosure set forth hereinbefore.

Industrial Applicability

The present invention relates to a device and method for saving water and improving the performance of an automated faucet or shower.
The device uses a dual sensor technology to reduce the false alarm rate and increase reliability of true activation - probability of true recognition of activation.
Preferably the IR sensor or transmitter/receiver (T/R) sensor pair is located under the faucet outlet, to form a cone of detection.
In a preferred embodiment, the IR sensor is located in the center of the faucet. In another preferred embodiment, a sensors array is located around the openings for water.
The new technology may be used, for example, in regular, pull-out or pull-down faucets. Various applications of the technology are optional.

According to another aspect of the invention, the faucet further includes a manual override mechanism, to activate or stop the water flow, in case the automatic detection means are in error.
The manual mechanism may further be used to adjust the water temperature to a desired value, and/or for manual operation when desired, irrespective of the sensor's activation.

This feature may be especially important in domestic use, where a user will not tolerate in his/her home a faucet not operating, or supplying water uncontrollably.

Preferably, the faucet controller will use different criteria or thresholds for ON (opening the water) and for OFF (closing it), since the flowing water may change the environment for the sensors.
Other factors may also affect the readings of sensors during the ON and/or OFF transitions.

Claims

1. An automatic faucet device comprising a water flow control valve and valve control means, wherein in the control means a decision re closing or opening the valve is based on readings from dual sensor means, to reduce a false alarm rate and increase a reliability of true activation (a probability of true recognition of valve activation).

2. The automatic faucet device according to claim 1, wherein the dual sensor means include infrared (IR) sensor means and capacitive sensor means.

3. The automatic faucet device according to claim 1 or 2, wherein the IR sensor or transmitter/receiver (T/R) sensor pair is located under the faucet outlet, to form a cone of detection.

4. The automatic faucet device according to claim 1 or 2, wherein the IR sensor is located in the center of the faucet.

5. The automatic faucet device according to claim 1 or 2, wherein an IR sensors array is located around the openings for water.

6. The automatic faucet device according to claim 1 or 2, wherein the faucet is either a regular or a pull-out faucet.

7. The automatic faucet device according to claim 1 or 2, further including manual override means, to activate or stop the water flow, in case the automatic detection means are in error.

8. The automatic faucet device according to claim 7, wherein the manual override means further include means for adjusting the water temperature to

a desired value.

9. In an automatic faucet device comprising a water flow control valve and valve control means, wherein in the control means a decision re closing or opening the valve is based on readings from dual sensor means, an automatic faucet activation method comprising:

a. read sensors input (dual sensor), wherein signals from the two sensors (IR and capacitive) are being read continuously;

b. compute OPEN evaluation with criterion A: The sensors readings will be evaluated according to a predefined algorithm, and using a first criterion A with related parameters;

c. to open valve? if Yes, goto (d), else goto (e);

d. open valve: commands to an electro-mechanical device are issued, to open the water flow;

e. read sensors input (dual sensor): The signals from the two sensors (IR and capacitive) are being read continuously;

f. compute CLOSE evaluation with criterion B:
The sensors readings will be evaluated according to a predefined algorithm, and using a second criterion B with different, related parameters;

g. to close valve? if Yes, goto (h), else goto (i);

h. close valve: commands to the electro-mechanical device are issued, to close the water flow; goto (a)

i. timeout? if Yes, goto (h), else goto (a).

10. The automatic faucet activation method according to claim 9, wherein the Timeout step measures the time since activation of water flow (entering ON state) and will close the water after a predetermined time delay.

11. An automatic faucet device according to the present description and the attached drawings.

FIG. 1

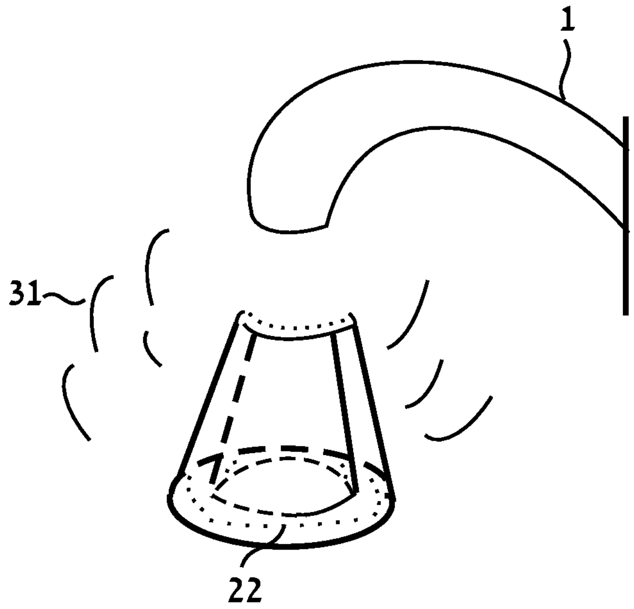

FIG. 2

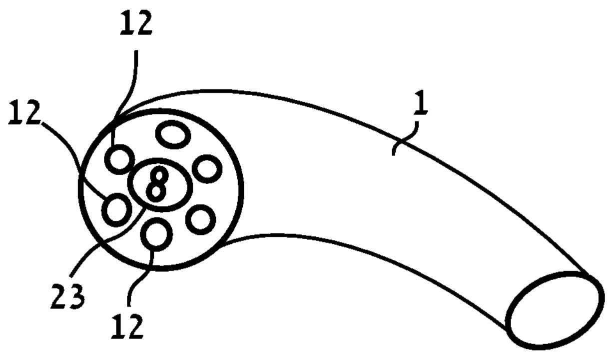

FIG. 3

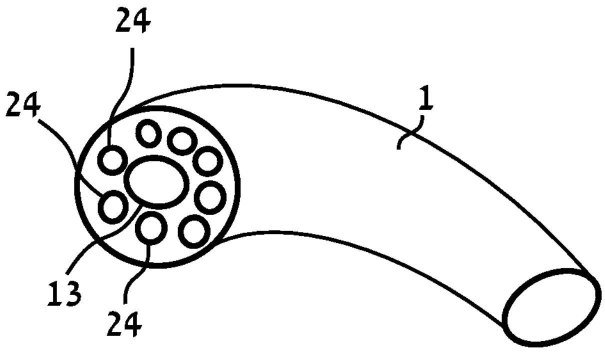

FIG. 4

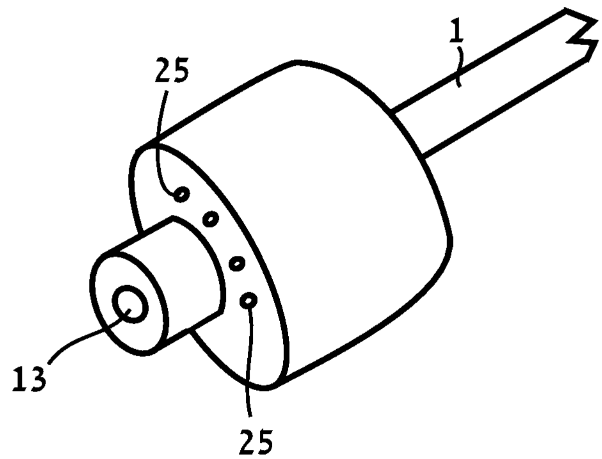

FIG. 5

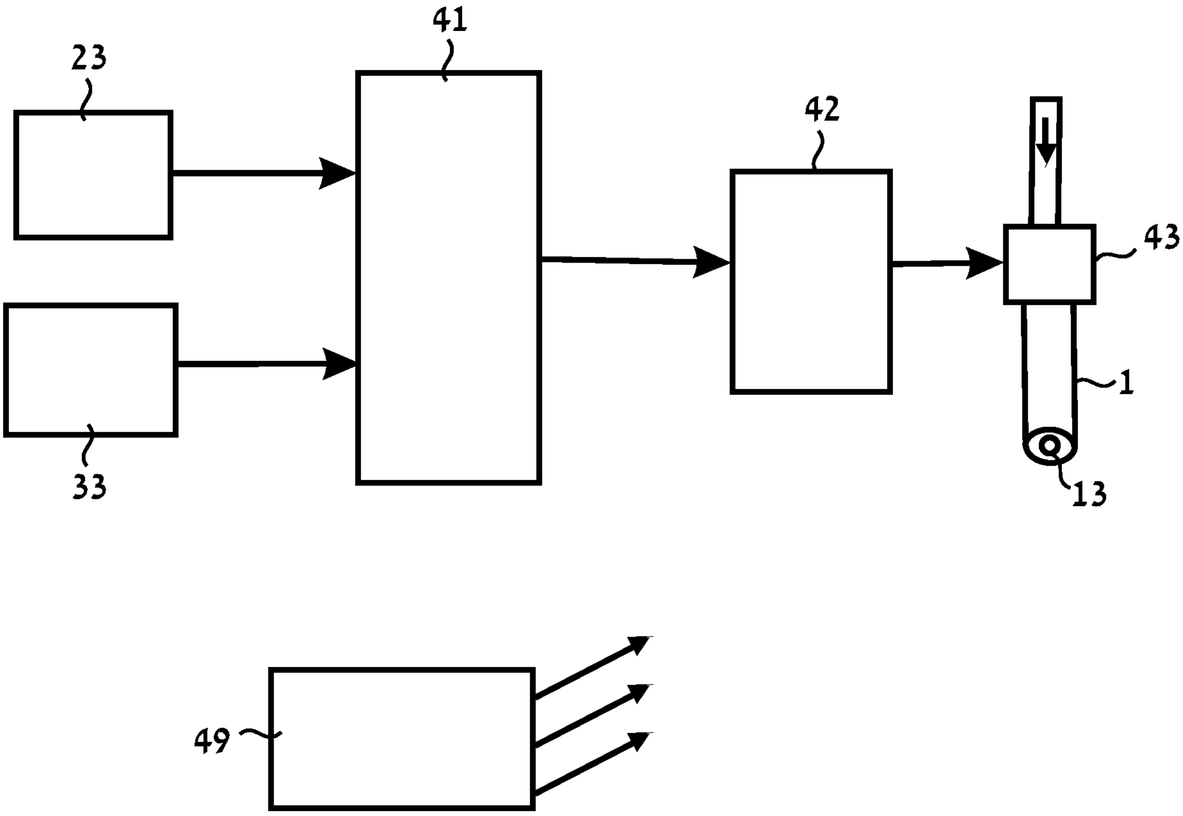

FIG. 6

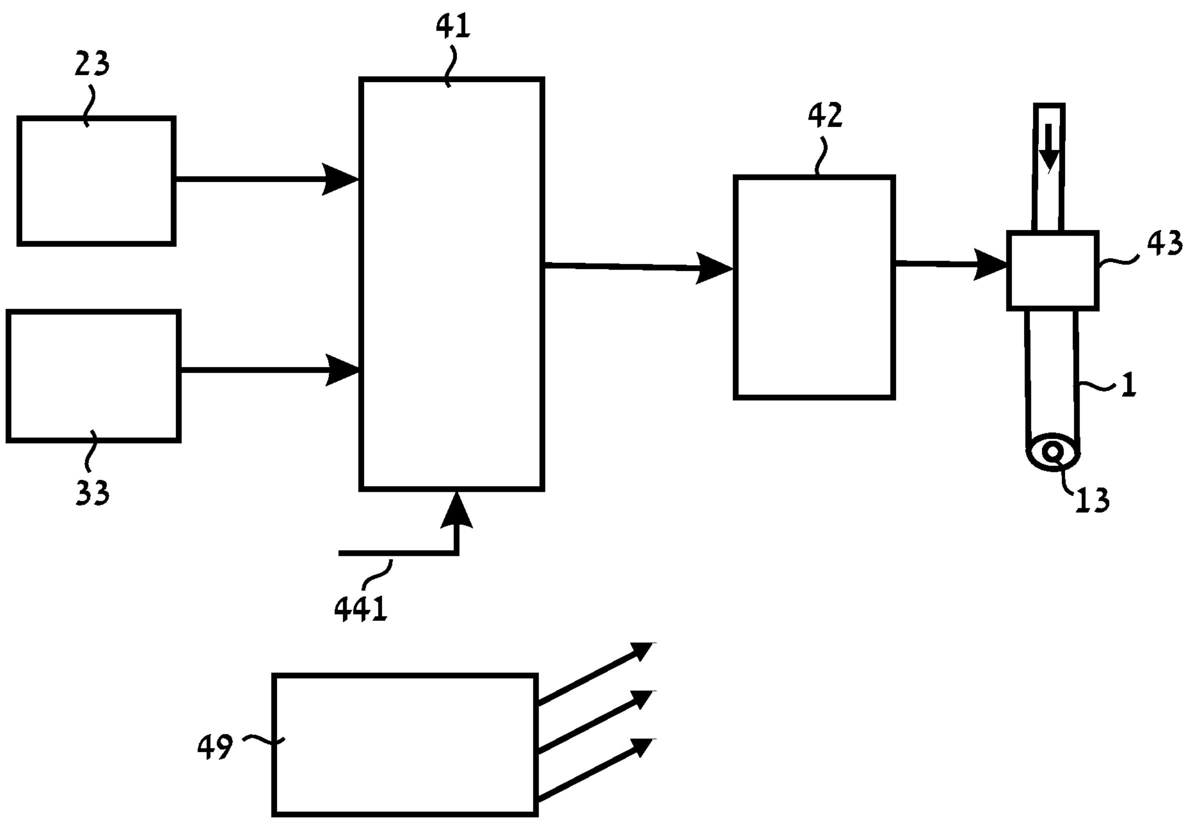

FIG. 7

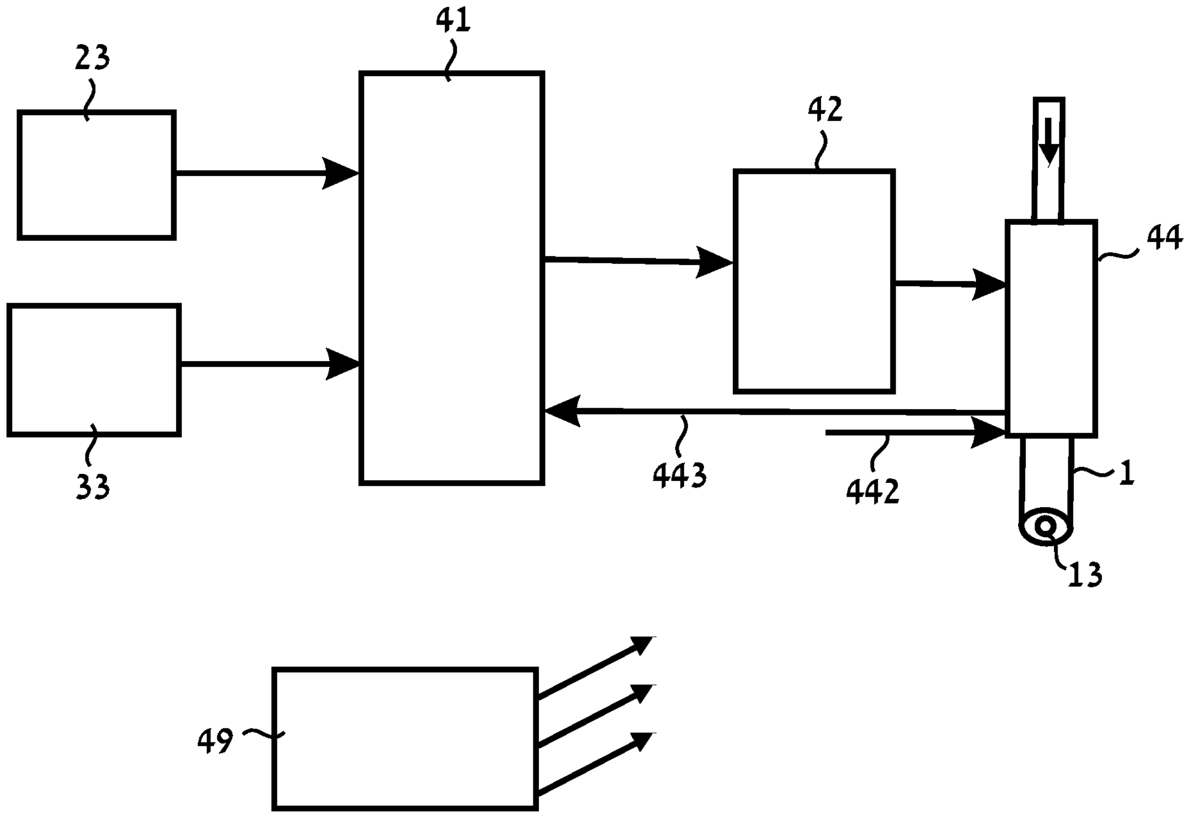

FIG. 8

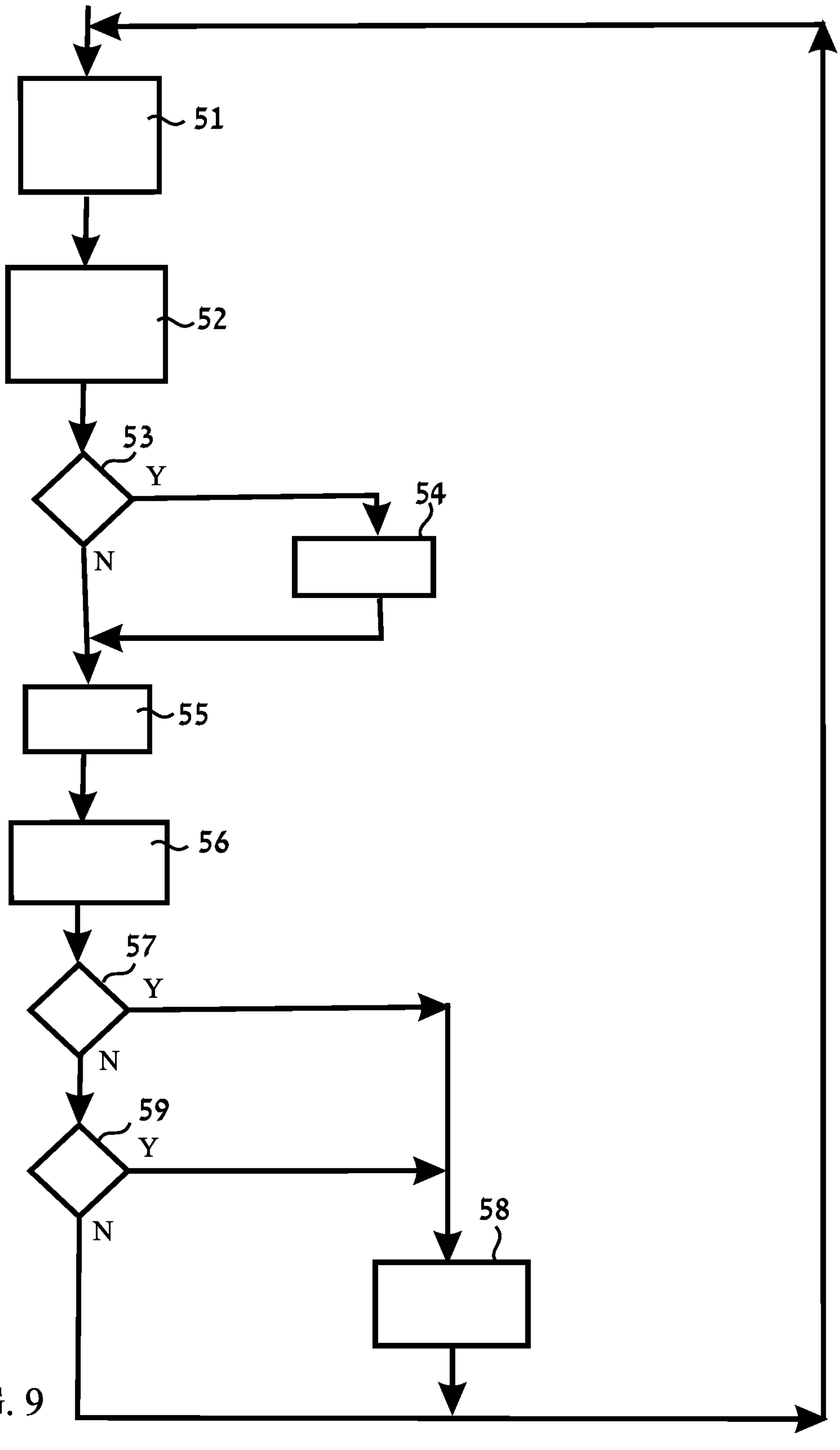

FIG. 9

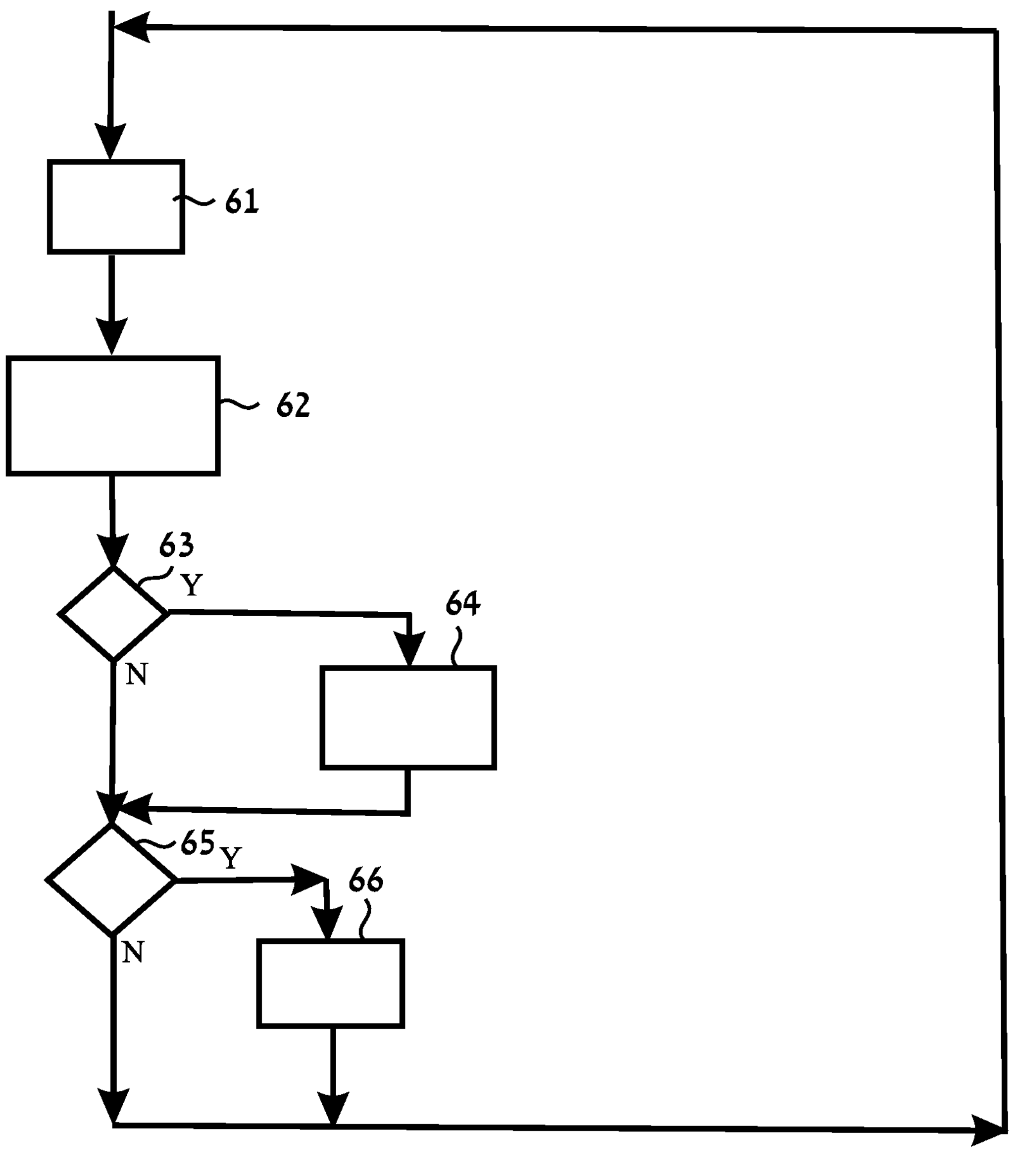

FIG. 10

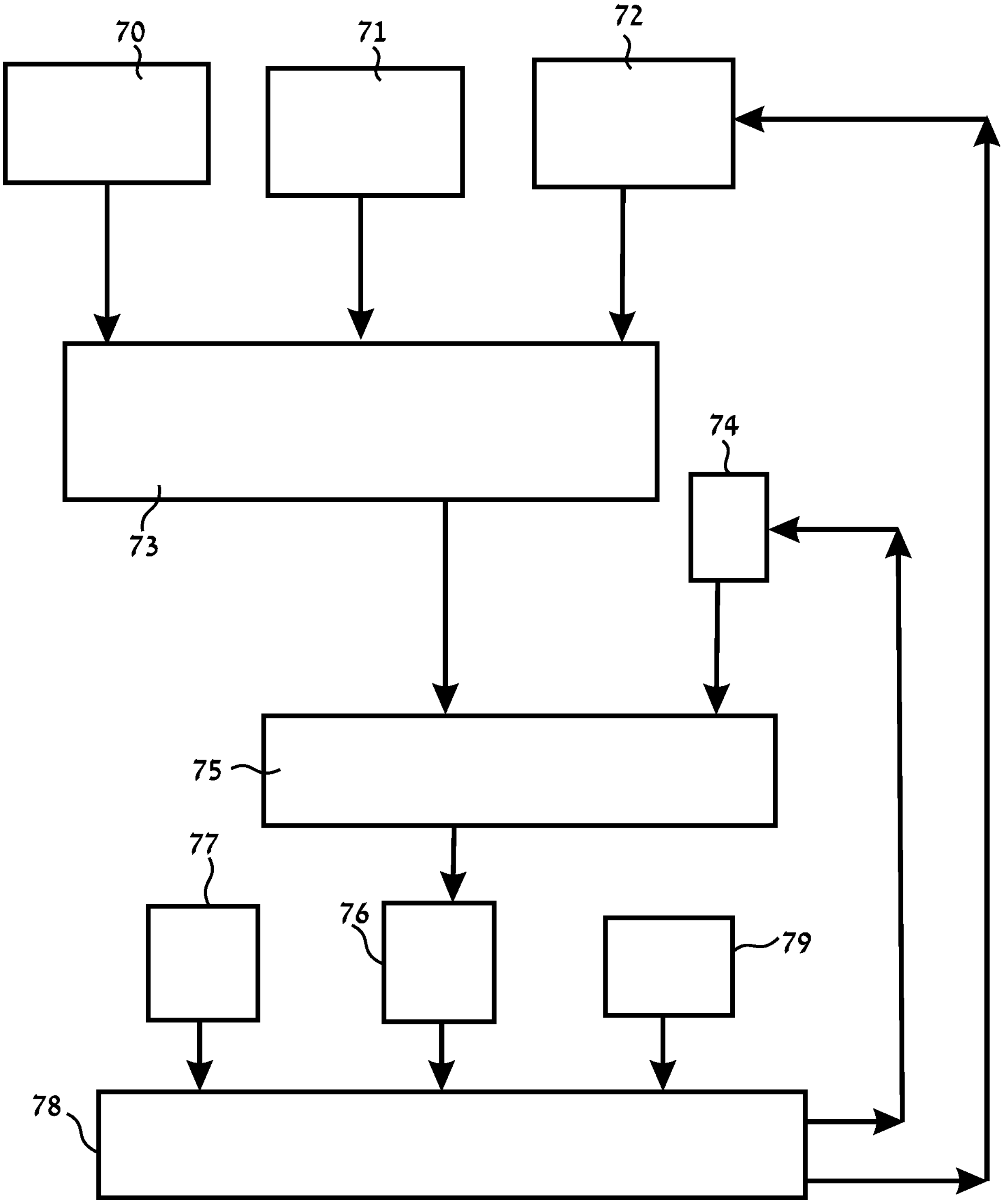

FIG. 11

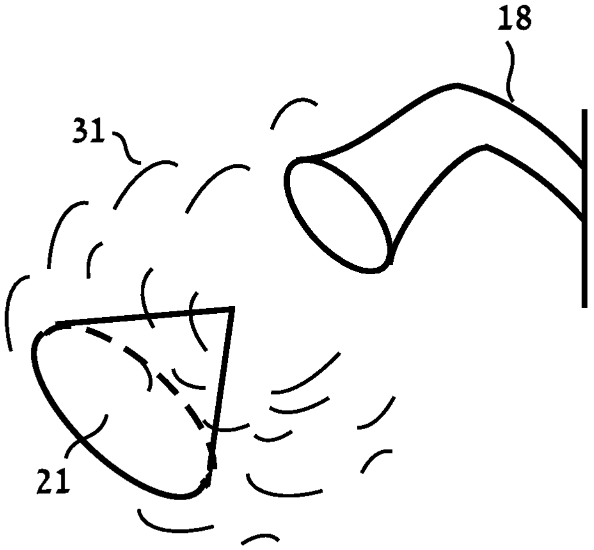

FIG. 12

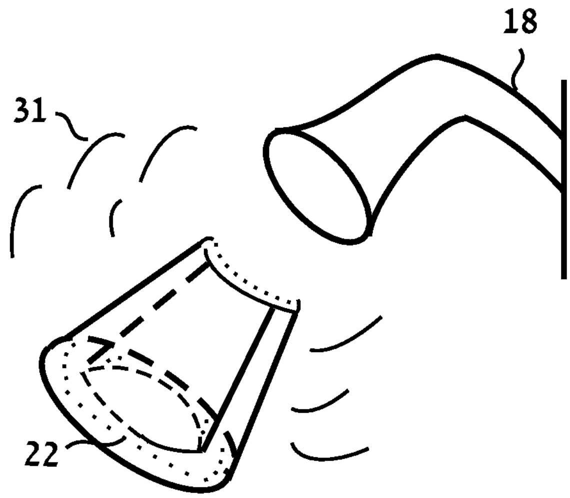

FIG. 13

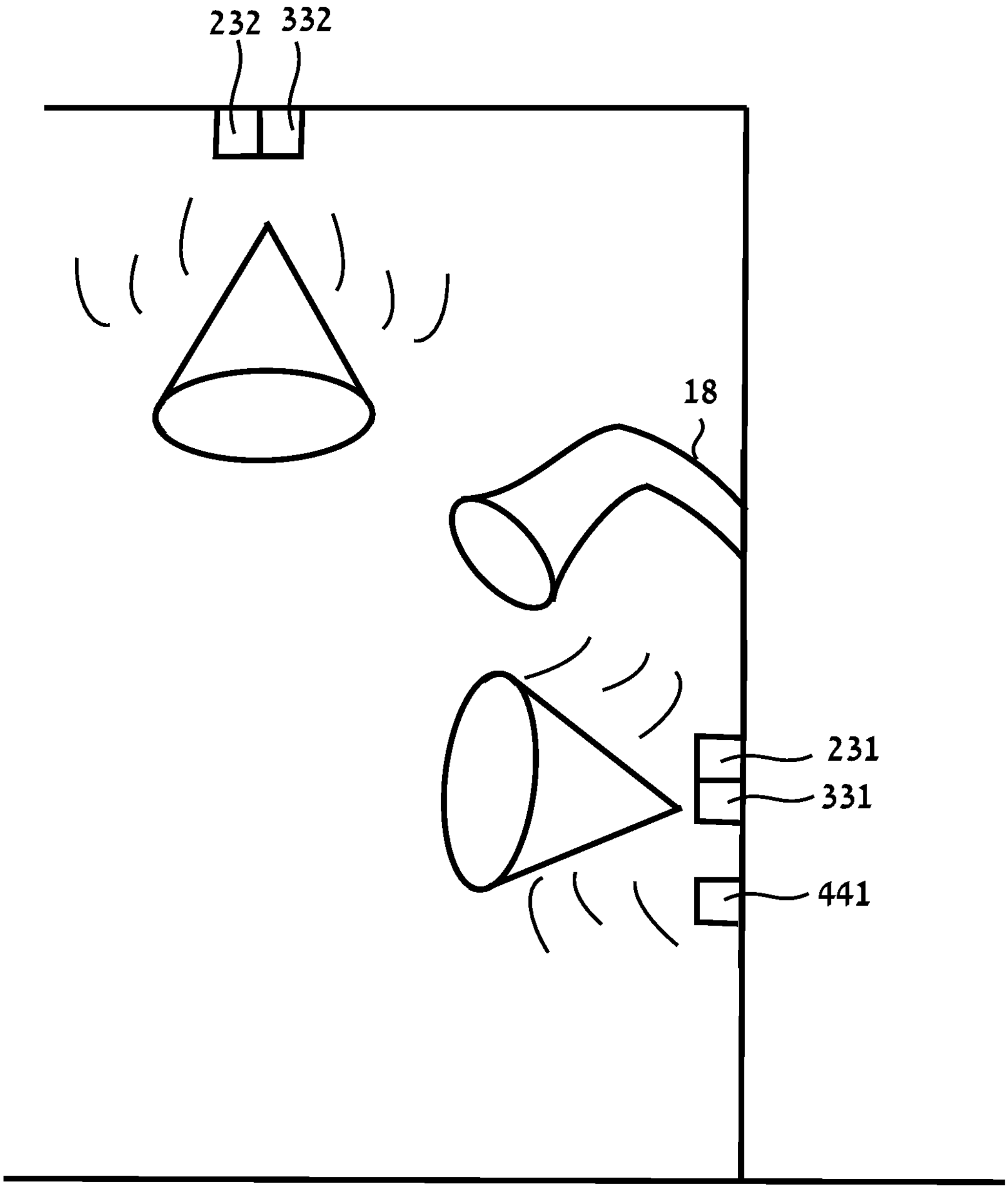

FIG. 14

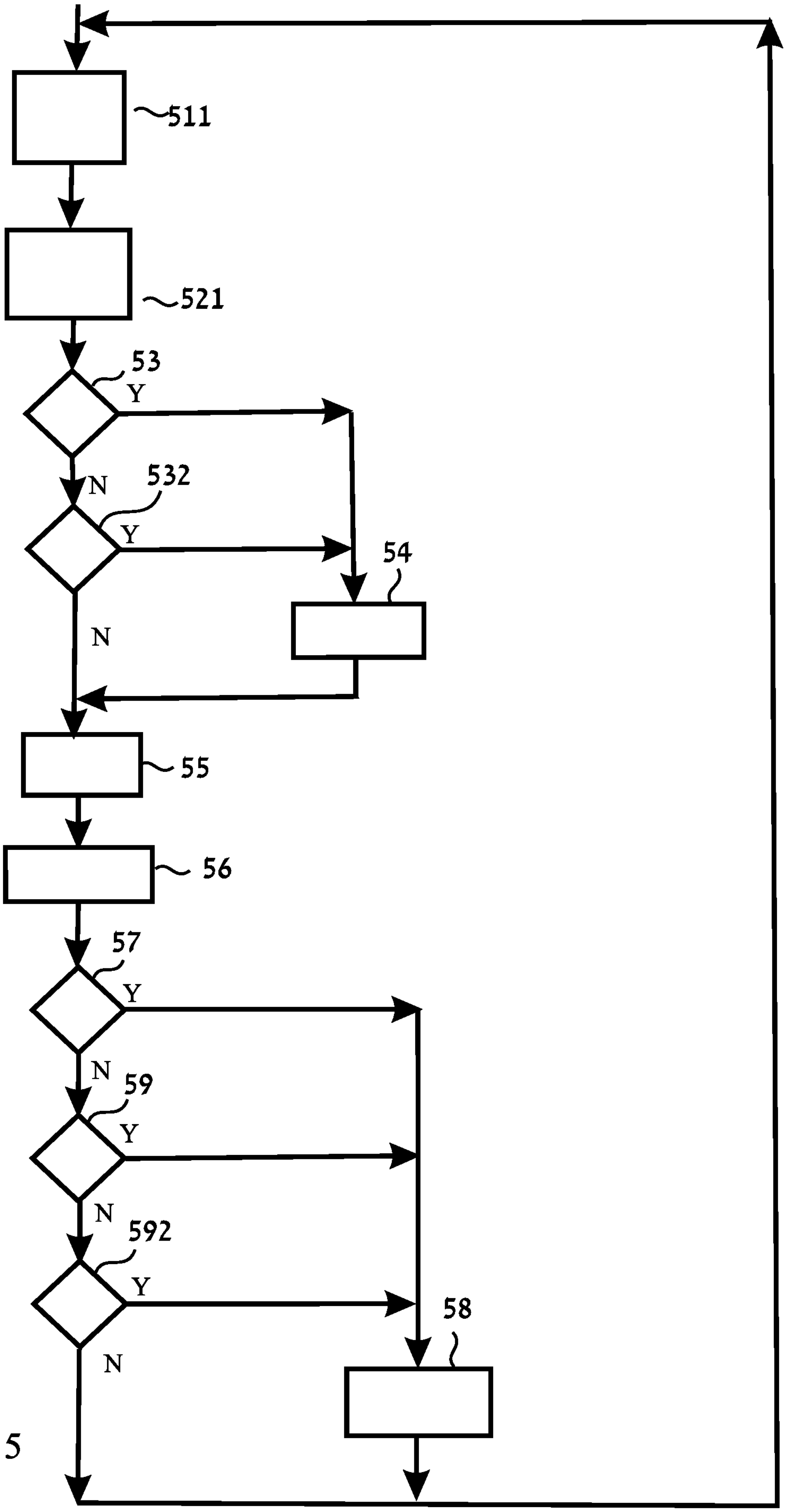

FIG. 15