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ABSTRACT

A system for controlling a swimming pool solar heating arrangement. The system includes two or more temperature sensors and a controller. The sensors provide an indication of a temperature rise across a solar collector. The controller is configured to control a mechanism to move water at a flow rate about a fluid circuit, the fluid circuit including the pool and the solar collector; receive the indication of the temperature rise across the collector; and in response to the temperature rise across the collector control the mechanism to vary the flow rate to a non-zero value.

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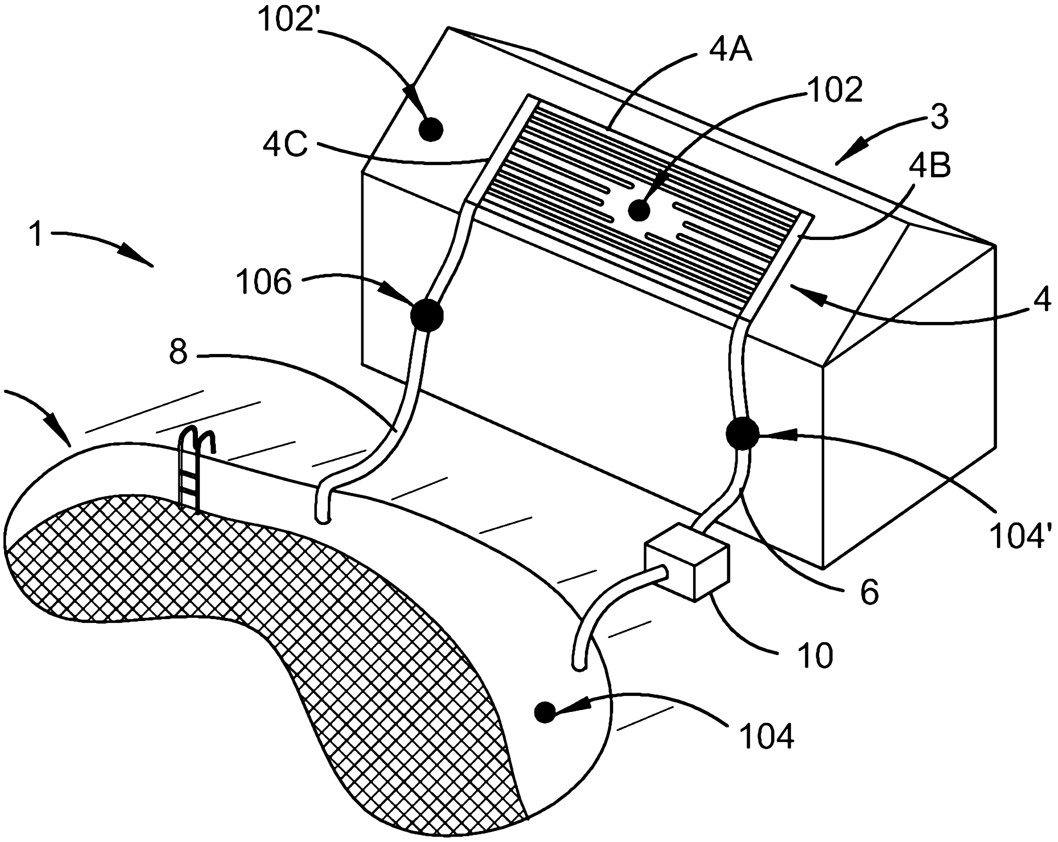

FIGURE 1

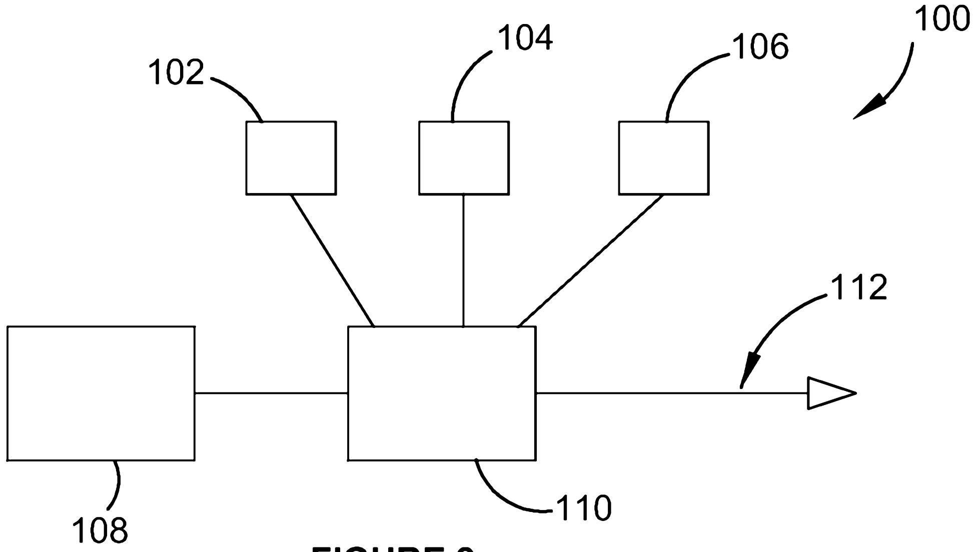

FIGURE 2

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COMPLETE SPECIFICATION

ASTRAL POOL AUSTRALIA PTY LTD and

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Invention title: SOLAR HEATING

The following statement is a full description of the invention, including the best method of performing known to us:

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SOLAR HEATING

FIELD OF THE INVENTION

The invention relates to solar heating swimming pools.

“Swimming pool” as used herein refers to a body of water in which a human may be immersed. In particular “swimming pool” as used herein takes in spas, Japanese hot tubs and like arrangements.

BACKGROUND OF THE INVENTION

An existing approach to heating a swimming pool includes a fluid circuit communicating a solar collector, typically in the form of a mat, with the swimming pool. The mat can take the form of a pair of manifolds connected by a large number of pipes typically arranged in parallel. The fluid circuit includes an inlet conduit for conveying water from the pool to one of the manifolds and a return conduit for returning water from the other manifold to the pool. A pump is activateable to drive fluid about the fluid circuit. The pipes are typically black to maximise heat absorption as the water is moved about the fluid circuit.

In some existing arrangements a first temperature sensor is positioned to provide an indication of the temperature of the water in the pool and a second temperature sensor is positioned to provide an indication of the solar intensity. The second temperature sensor can be positioned in any convenient sunny location but is often positioned within the mat itself in which case its output is also influenced by the temperature of the water flowing through the mat.

Typically the system will include a user interface in the form of a switch by which a user may turn the system on and off. A controller will activate the pump when:

1. the system is turned on; and

2. the pool water temperature (as indicated by the first temperature sensor) is below a target temperature; and

3. the sun is sufficiently intense (as indicated by the second temperature sensor).

The pump will continue running until one of these criteria is no longer satisfied.

It is an object of the invention to provide for more efficient solar heating of a swimming pool, or at least to provide an alternative for those concerned with swimming pools.

SUMMARY OF THE INVENTION

The inventors have identified that the above mode of operation is less than ideal because the pump is often delivering more water than is necessary or ideal to convey the heat collected in the solar collector to the pool or in other circumstances the amount of water delivered is less than ideal.

One aspect of the invention provides a system for controlling a swimming pool solar heating arrangement, the system including

two or more temperature sensors for providing an indication of a temperature rise across a solar collector; and

a controller configured to

> control a mechanism to move water at a flow rate about a fluid circuit, the fluid circuit including the pool and the solar collector;
>
> receive the indication of the temperature rise across the collector; and
>
> in response to the temperature rise across the collector control the mechanism to vary the flow rate to a non-zero value.

In preferred forms of the invention the controller is configured to control the mechanism to vary the flow rate to maintain the temperature rise across the collector at a target value. The system may further include an interface for receiving user input, in which case the controller may be configured to vary the target value at which the temperature rise across the collector is maintained in response to the user input. The target value at which the temperature rise across the collector is maintained is preferably in the range 2°C to 5°C, e.g. a temperature rise of about 4°C is thought to be ideal in tropical/sub-tropical regions. In temperate areas a higher temperature rise of about 8°C is preferred.

The controller may be configured to control the mechanism to stop the water in response to the temperature rise across the collector falling below a threshold. The threshold is preferably about 2°C.

Preferably the mechanism includes a pump and the controller is configured to operate the pump to move the water and alter the operation of the pump to vary the flow rate.

Another aspect of the invention provides a solar heating arrangement for heating a swimming pool including the system for controlling, the solar collector and the mechanism to move water.

Another aspect of the invention provides a system for controlling a swimming pool solar heating arrangement, the system including:

one or more temperature sensors for providing an indication of solar intensity; and a controller configured to

control a pump to move water at a flow rate about a fluid circuit, the fluid circuit including the pool and a solar collector in which the water absorbs heat;

receive the indication of solar intensity; and in response to the indication of solar intensity control the pump to vary the flow rate to a non-zero value.

In preferred forms of the invention the indication of solar intensity is or includes an indication of a temperature of water in or exiting the collector. The controller is preferably configured to control the pump to stop the water in response to the indication of solar intensity falling below a threshold. The pump may be a variable speed pump, and might include a brushless DC motor.

Another aspect of the invention provides a solar heating arrangement for heating a swimming pool including the system for controlling, the solar collector and the pump.

Another aspect of the invention provides a method of heating a swimming pool including:

moving water at a flow rate about a fluid circuit, the fluid circuit including the pool and a solar collector in which the water absorbs heat;

obtaining an indication of a temperature rise across the collector; and

in response to the temperature rise across the collector vary the flow rate to a non-zero value.

Preferably the flow rate is varied to maintain the temperature rise across the collector at a target value. The method may further include entering a user input to vary the target value at which the temperature rise across the collector is maintained. The target value at which the temperature rise across the collector is maintained is preferably in the range 2°C to 5°C.

The method may further include stopping the water in response to the temperature rise across the collector falling below a threshold. The threshold is preferably about 2°C

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In preferred forms of the invention the method includes operating a pump to move the water and altering the operation of the pump to vary the flow rate.

Another aspect of the invention provides a method of heating a swimming pool including:

operating a pump to move water at a flow rate about a fluid circuit, the fluid circuit including the pool and a solar collector in which the water absorbs heat;

obtaining an indication of solar intensity; and

in response to the indication of solar intensity controlling the pump to vary the flow rate to a non-zero value.

Preferably the indication of solar intensity is or includes an indication of a temperature of water in or exiting the collector. The method may further include stopping the water in response to the indication of solar intensity falling below a threshold.

The various aspects of the invention are complementary; each aspect may incorporate features described in respect of one or more other aspects.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a solar heating arrangement, in accordance with an embodiment of the invention, in situ; and

Figure 2 schematically illustrates a control system in accordance with an embodiment of the invention.

DESCRIPTION OF THE FIGURES

Figure 1 illustrates a solar heating arrangement 1 for heating a swimming pool 2. The arrangement 1 includes a solar collector 4 mounted atop a building 3, an inlet conduit 6, a return conduit 8 and a pump 10.

The solar collector 4 takes the form of a mat, including multiple pipes 4A connected in parallel between inlet manifold 4B and outlet manifold 4C. The inlet conduit 6 conveys water from the pool to the inlet manifold 4B. Return conduit 8 conveys water from the return manifold 4C to the pool 2. The pool 2, inlet conduit 6, collector 4 and return conduit 8 together define a fluid circuit. The pump 10 is positioned along the inlet conduit 6 to drive water about the fluid circuit.

The pump 10 is configured to deliver at least two non-zero flow rates, and preferably is capable of continuously varying its output over a wide range of potential flow rates. In this embodiment the pump is a centrifugal pump and includes a brushless DC motor. Other arrangements are possible. By way of example, a multi-speed pump such as a pump including a simple induction motor including multiple speed windings is possible. Indeed, the pump 10 might be replaced by a mechanism including a single speed pump and a variable valve to throttle the pump's output.

An air valve (not shown) is mounted within the collector 4. The valve opens automatically when the pressure within the mat falls below a predetermined level. This allows air to be drawn into the mat when the pump is inactive so that water can drain from the mat and so prevents water sitting in the matt for an extended period when the pump is inactive.

The solar heating arrangement 1 further includes a control system 100 (see Figure 2) for controlling the pump. The control system 100 includes three temperature sensors 102, 104, 106, a user interface 108, and a processor 110.

In this embodiment the temperature sensors 102, 104, 106 take the form of thermistors. The physical positions of the temperature sensors are illustrated in Figure 1. The sensor 102 is positioned in a convenient sunny location to provide an indication of solar intensity. In this embodiment the sensor 102 is positioned within the mat. Alternatively, the sensor 102 could be positioned remotely as per sensor 102'.

The sensor 104 is positioned within the pool to provide an indication of the temperature of the pool water before it passes through the collector. Alternatively, a temperature sensor may be positioned along the inlet conduit 6 as in sensor 104'. The sensor 106 is positioned along the return conduit 8 to provide an indication of the temperature of the water as it leaves the collector 4. Optionally the sensor 106 could be positioned anywhere along the conduit 108, or even within the manifold 4C. Subtracting the output of sensor 104 from the output of sensor 106 provides an indication of the temperature rise across the collector 4, i.e. the amount by which the water increases in temperature as it traverses the collector 4.

The processor 110 receives information from the sensors 102, 104, 106 and the user input 108, and applies logic thereto to generate a control signal 112 to control the pump 10. A wide variety of potential implementations of the invention are contemplated. By way of example, the sensors may be hard wired to the processor 110 or could be configured to communicate wirelessly. It is contemplated that a conventional PC might constitute the user interface 108 and the processor 110, but preferred that the processor 110 and user interface 108 be incorporated in a control panel dedicated to controlling the operation of the pool and spa area including its filtration and lighting. It is also possible that the user interface 108 might include or consist of a handheld remote control. Optionally the processor 110 could be wholly, or partly, integrated within the pump 10 and/or a valve unit for controlling the flow rate.

A preferred variant of the invention will now be described in which information is drawn from all three sensors 102, 104, 106 although there are other workable embodiments which omit one of the sensors 102, 106. In the described embodiment the pump output is varied as a function of the temperature rise across the collector 4. In other embodiments the output may vary as a function of the sensor 102.

In this embodiment the processor 110 receives from the user interface 108 an on-signal, and an indication of a desired pool temperature. The processor compares the desired temperature to the actual pool temperature 104. If the desired temperature is greater than the actual pool temperature by a predetermined margin, and there is sufficient solar intensity (i.e. the output from sensor 102 is above a predetermined threshold), the processor 110 sends a control signal 112 to activate the pump 10 to move water at a flow rate about the fluid circuit. The predetermined margin is included to prevent frequent cycling of the pump.

Initially the pump 10 is driven at a high output to purge the collector 4 of air. A purge time of about 2 minutes has been found to suit most domestic applications.

Preferred variants of the invention are configured to permit an installer to set and adjust the purge time. By way of example, a larger purge time may be required for “high head systems” (e.g. wherein the mat is atop a two storey house) or larger capacity collectors (e.g. larger capacity solar panels).

After this initial purge cycle the processor 110 controls the pump 10 to optimise the heating performance of the arrangement and/or the efficiency of the arrangement.

Varying the pump output in response to the temperature sensors leads to efficiencies over conventional systems. On the one hand, in low sunlight conditions the flow rate can be reduced to a low level so that mechanical work is not wasted pumping a large volume of water for very little temperature rise. On the other hand, when the pool is well below the desired temperature and the sun is intense, the flow rate can be increased to take full advantage of the intense sun.

There are two forms of efficiency at stake: thermal efficiency and the efficient use of electricity. Maximum thermal efficiency occurs at high flow rates and low temperature rises, whereas the most efficient use of electricity occurs at low flow rates and high temperature rises. Preferred forms of the controller have user-selectable preset modes whereby the user can choose “Maximum Temperature Gain” or “Minimum Electrical Usage” or somewhere in between both. In cases of less than ideal sun intensity, a typical existing system will not be able to run as the mat temperature will be insufficient, whereas in preferred forms of the described system, the pump can run at a low flow rate and hence achieve a useable temperature rise.

In an embodiment the pump output is controlled in proportion to the temperature rise across the mat. In other embodiments the pump output may be controlled to deliver a target temperature rise. By way of example, the user interface 108 might allow a user to select a high efficiency operating mode in which the target temperature rise is 5°C, or a maximum heating mode in which the target temperature rise is 2°C.

The processor 110 also includes logic to stop the pump (so that water is not moved at a flow rate about the fluid circuit, i.e. reduce the flow rate to a value of zero) when the pump is operating at a minimum efficient speed and the temperature rise across the mat falls below a predetermined threshold, e.g. 2°C.

This exemplary processor 110 is configured also to control the pump in response to the sensor 106 so as to limit the temperature of water returning to the pool to a safe value, e.g. to 45°C.

The inventors have recognised that in existing systems having only two sensors, the roof sensor is measuring a combination of the water outlet temperature and the roof temperature/solar intensity. When no water is flowing, the roof sensor will regularly see temperatures in excess of 60°C. When the water is flowing the temperature will stabilise to a temperature in between the roof temperature and the outlet water temperature. This is regularly over 45°C so the true outlet temperature cannot be controlled.

In the system 1 there is typically a significant difference between the output of sensor 102 and 104. When the pump 10 is running, sensor 102 is ignored and the pump controlled in response to the temperature rise between the outlet water and inlet water. The maximum outlet water temperature is set to, say, 45°C. If the set maximum temperature is exceeded, the flow rate is increased to maintain this temperature. Once the flow rate is at maximum, the pump could be deactivated if the outlet temperature remains above a or the set point so that scalding water is not returned to the pool.

Desirably the logic arrangements include allowances for transient conditions. By way of example, the outlet temperature may be ignored for a minute or so after the pump is first activated until the collector has been purged of water that has been sitting in the collector and may be in excess of 45°C.

According to preferred forms of the invention the above mechanical efficiencies are multiplied by electro mechanical efficiencies associated with having a variable speed motor, such as a brushless DC motor, relative to the simple induction motor of prior art systems.

In preferred forms of the invention the flow rate is varied on an ongoing basis, and most preferably is varied substantially continuously; e.g. the controller may be an analog device which continuously varies the flow rate or a digital device which varies the flow rate at closely spaced intervals.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A system for controlling a swimming pool solar heating arrangement, the system including

two or more temperature sensors for providing an indication of a temperature rise across a solar collector; and

a controller configured to

control a mechanism to move water at a flow rate about a fluid circuit, the fluid circuit including the pool and the solar collector;

receive the indication of the temperature rise across the collector; and

in response to the temperature rise across the collector control the mechanism to vary the flow rate to a non-zero value.

2. The system of claim 1 wherein the controller is configured to control the mechanism to vary the flow rate to maintain the temperature rise across the collector at a target value.

3. The system of claim 2 further including an interface for receiving user input, the controller being configured to vary the target value at which the temperature rise across the collector is maintained in response to the user input.

4. The system of claim 2 or 3 wherein the target value at which the temperature rise across the collector is maintained is in the range 2°C to 5°C.

5. The system of any one of claims 1 to 4 wherein the controller is configured to control the mechanism to stop the water in response to the temperature rise across the collector falling below a threshold.

6. The system of claim 5 wherein the threshold is about 2°C.

7. The system of any one of claims 1 to 6 wherein the mechanism includes a pump and the controller is configured to operate the pump to move the water and alter the operation of the pump to vary the flow rate.

8. A system for controlling a swimming pool solar heating arrangement, the system including:

one or more temperature sensors for providing an indication of solar intensity; and a controller configured to

control a pump to move water at a flow rate about a fluid circuit, the fluid circuit including the pool and a solar collector in which the water absorbs heat;

receive the indication of solar intensity; and

in response to the indication of solar intensity control the pump to vary the flow rate to a non-zero value.

9. The system of claim 8 wherein the indication of solar intensity is or includes an indication of a temperature of water in or exiting the collector.

10. The system of any one of claims 7 to 9 wherein the pump is a variable speed pump.

11. The system of claim 10 wherein the pump includes a brushless DC motor.

12. A solar heating arrangement for heating a swimming pool including: the system of any one of claims 8 to 11;

the solar collector; and

the pump.

13. A solar heating arrangement for heating a swimming pool including: the system of any one of claims 1 to 7;

the solar collector; and

the mechanism to move water.

14. A method of heating a swimming pool including:

moving water at a flow rate about a fluid circuit, the fluid circuit including the pool and a solar collector in which the water absorbs heat;

obtaining an indication of a temperature rise across the collector; and

in response to the temperature rise across the collector varying the flow rate to a non-zero value.

15. The method of claim 14 wherein the water flow rate is varied to maintain the temperature rise across the collector at a target value.

16. The method of claim 15 further including entering a user input to vary the target value at which the temperature rise across the collector is maintained.

17. The method of claim 15 wherein the target value at which the temperature rise across the collector is maintained is in the range 2°C to 5°C.

18. The method of any one of claims 14 to 17 further including stopping the water in response to the temperature rise across the collector falling below a threshold.

19. The method of claim 18 wherein the threshold is about 2°C

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20. The method of any one of claims 14 to 19 including operating a pump to move the water and altering the operation of the pump to vary the flow rate.

21. A method of heating a swimming pool including:

operating a pump to move water at a flow rate about a fluid circuit, the fluid circuit including the pool and a solar collector in which the water absorbs heat;

obtaining an indication of solar intensity; and

in response to the indication of solar intensity controlling the pump to vary the flow rate to a non-zero value.

22. The method of claim 21 wherein the indication of solar intensity is or includes an indication of a temperature of water in or exiting the collector.

23. The method of claim 21 or 22 wherein the pump is a variable speed pump.

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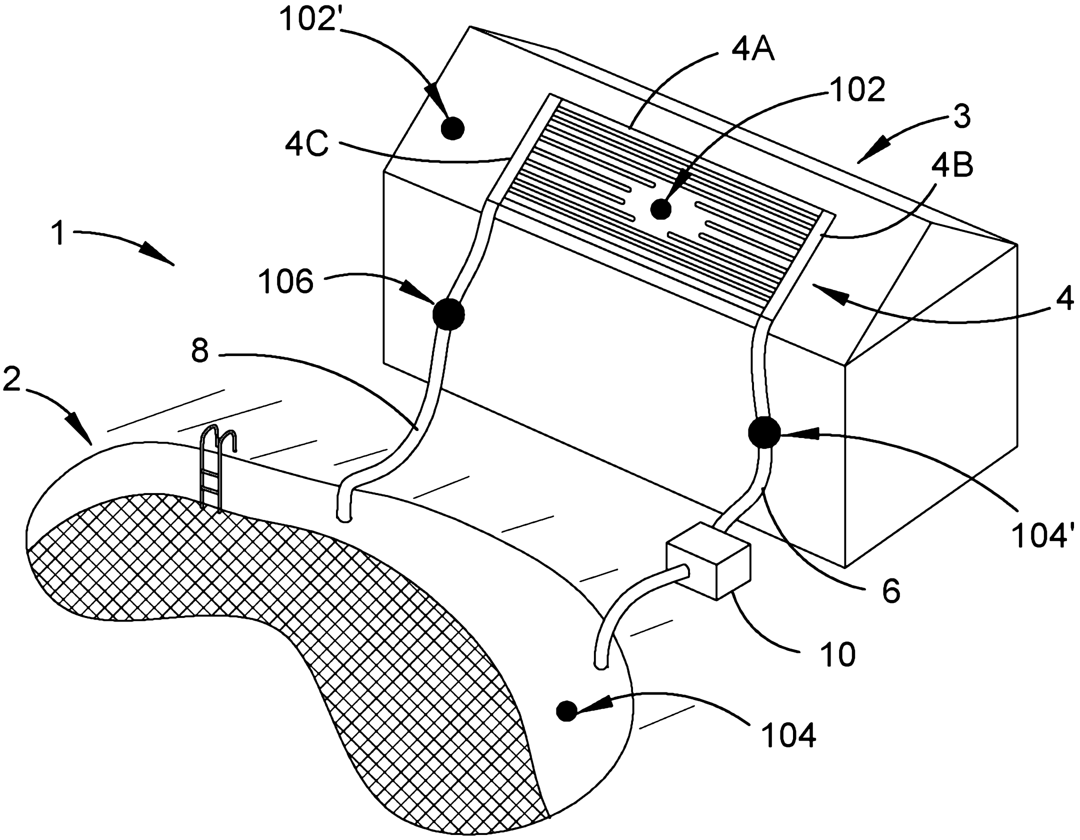

FIGURE 1

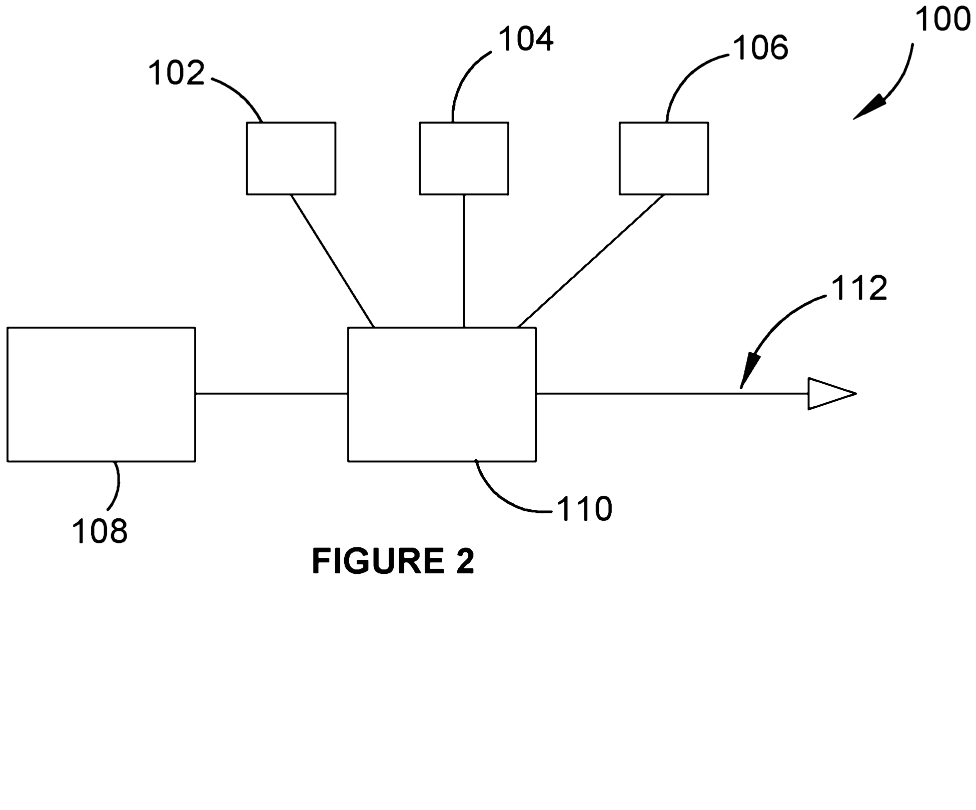

FIGURE 2