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Published:

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(54) **Title**: POOL DATA COLLECTION AND CONTROL SYSTEM

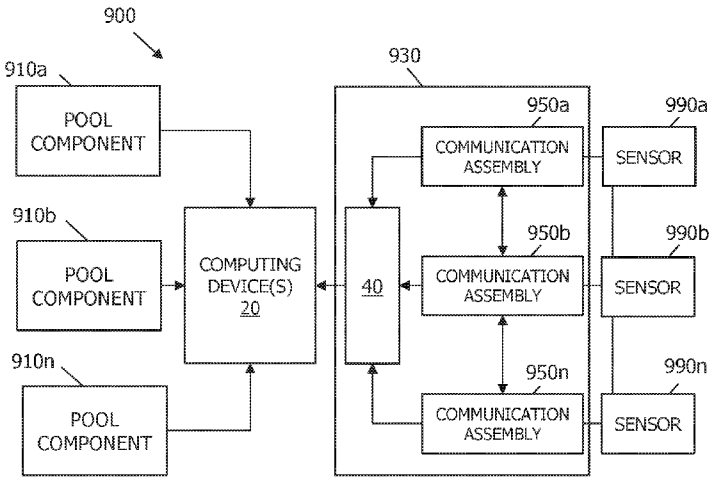

Figure 2

(57) **Abstract**: A system includes at least one sensor configured to obtain data concerning one or more pool system components. The system includes a communication assembly configured to transmit the obtained data concerning the pool component. The system includes a processor configured to, in response to receiving the obtained data, cause a response in one or more of the pool system components based on the obtained data.

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POOL DATA COLLECTION AND CONTROL SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of and priority to U.S. Provisional Application No. 62/256,491, filed November 17, 2015, U.S. Provisional Application No. 62/256,466, filed November 17, 2015, U.S. Provisional Application No. 62/256,458, filed November 17, 2015, and U.S. Provisional Application No. 62/328,956, filed April 28, 2016, the entire disclosures of which are incorporated by reference into the present application.

TECHNICAL FIELD

[0002] The present disclosure relates to pool data collection and control system and related methods.

BACKGROUND

[0003] Available power and data transmissions open up the potential for the development of a wide range of devices that record, display, and command numerous pool system states. An opportunity to demonstrate and build upon the previous projects involves chemical and physical pool system data and actions in response to certain thresholds. One area involves learning the condition of pool water or other pool system components.

SUMMARY

[0004] An embodiment of the disclosure is a system includes at least one sensor configured to obtain data concerning one or more pool system components. The system includes a communication assembly configured to transmit the obtained data concerning the pool component. The system includes a processor configured to, in response to receiving the obtained data, cause a response in one or more of the pool system components based on the obtained data.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The foregoing summary, as well as the following detailed description of illustrative embodiments of the present application, will be better understood when read in conjunction with the appended drawings. For the purposes of illustrating the present application, there is shown in the drawings illustrative embodiments of the disclosure. It should be understood, however, that the application is not limited to the precise arrangements and instrumentalities shown. In the drawings:

[0006] Figure 1 is a schematic of a pool system according to an embodiment of the present disclosure;

[0007] Figure 2 is a schematic diagram of a system for control and monitoring of the pool system shown in Figure 1;

[0008] Figure 3 is a schematic diagram of pool component of the pool system shown in Figures 1 and 2;

[0009] Figure 4 is a schematic diagram of a communication assembly in an embodiment of the present disclosure;

[0010] Figure 5A is a schematic diagram of part of a system of an embodiment of the present disclosure;

[0011] Figure 5B illustrates a plurality of computing devices networked to communication with the system shown in Figures 1 and 2;

[0012] Figure 6 is a schematic of illustrating collection of pool data and control of the pool using the system illustrated in Figure 2; and

[0013] Figure 7 is a process flow diagram for data collection and control of pool system.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0014] Figure 1 illustrates a pool system 400 that includes a pump 402, a filter 404, and a valve 406 where conduits from the drain 408 and heater 410 meet. The pool system 400 includes skimmers 412 and 414, a main drain 416, and a plurality of return lines 418 that terminate at returns 420 or return jets. The pump 402 will pull water from the pool 422 through a skimmer 412, 414 or main drain 416. The water is passed through a filter 404, and then filtered water is returned to the pool 422 under pressure through returns 420 and 430 that control flow direction and flow rate. Returns are also referred to as pool jets and are generally mounted on the pool wall below the surface. The return can include pop-up cleaning heads 430 as needed. The water is returned to the pool 422 through the pool jets 420 to create circulation and mixing of the pool water.

[0015] Referring to Figure 2, a pool data collection and control system 900 includes a plurality of pool components 910a, 910b,…,910n, a computing device 20, a communications system 930 that is electronic communication with the computing device 20, and a plurality of sensors 990a, 990b,…990n coupled to the communications system 930.

[0016] The pool components 910a-910n represent any pool component of pool system as described above and illustrated in Figure 1. A pool component may be a pump, valves, heater, drain, return lines, pool water, filters, skimmers, pop-up cleaning heads, pool jets, metering device, etc. Each pool component 910a, 910b,…,910n may be in electronic communication with the computing device 20.

[0017] Figure 3 shows schematic diagram of an exemplary pool component 910a. Pool component 910a may include a component sensor 912a, a controller 914a electronically coupled to the sensor 912a, and a send-receive unit 918a electronically coupled to the controller 914. The component sensor 912a may monitor the pool component and/or obtain pool data from proximate the pool component. The component sensor 912a may communicate with the controller 914a. The communication may be through a physical connection or through a visual light communication, wireless connection, or optionally a wired connection when appropriate. In some embodiments, pool component 910a may include a plurality of component sensors 912a, controllers 914a, and/or send-receive units 918a. In some embodiments, a component sensor 912a may communicate with only one controller 914a, while in alternate embodiments, a component sensor 912a may communicate with a plurality of controllers 914a. Similarly, in some embodiments controller 914a may communicate with only one component sensor 912a, while in other embodiments, controller 914a may communicate with a plurality of component sensors 912a.

[0018] The communications system 930 may include a communication hub 40 and a plurality of communication assemblies 950a-950n. Each communication assembly 950a-950n is electronically connected to the communication hub 40. The communication hub 40 may be electronically connected to the computing device 20 (or multiple computing devices 20). The electronic connection may be a physical connection (e.g. a wire) or it may be a wireless connection (e.g. Wi-Fi, Bluetooth, near field communication, optical, sound, ultrasound, or another wireless connection). The communication hub 40 may be a send-receive device that transmits data received from each communication assembly 950a-950n to computing device 20. In some instances, the communication hub 40 may be a component of the computing device 20 such that the computing device 20 receives the pool data from the communication assemblies 950a-950n. The communication assemblies 950a-950n may be partially submerged in water. The plurality of sensors 990a-990n may connect to the plurality communication assemblies 950a-950n. In some embodiments, multiple sensors 990a-990n may connect to the one

communication assembly 950a-950n. Alternatively and/or additionally, multiple communication assemblies 950a-950n may connect to the one sensor 990a-990n.

[0019] Turning to Figure 4, an exemplary communication assembly 950a includes a transmitter 952a, a receiver 954a, a communication assembly controller 956a, and a power source 958a. The transmitter 952a may communicate with a receiver 954a and with a receiver of another communications assembly. The controller 956a is electronically coupled to the transmitter 952a and the receiver 956a. The power source 958a supplies power the controller 956a, the transmitter 952a, and the receiver 954a. The controller 956a may include signal processing instructions, firmware, communication protocols, and/or other applications that operate signal transmission between the transmitter 952a and the receiver 954a and between different communication assemblies. The communication assembly 950a may include a plurality of transmitters 952a, receivers 954a, power sources 958a, and/or communication assembly controllers 956a. Furthermore, the transmitter 952a and receiver 954a can be configured as a transceiver, a transmitter-receiver, or any other device for processing input and output signals. In one example, the communication assembly is a visual light communication assembly. A visual light communication assembly includes at least one light emitting diode (LED) transmitter and at least one photodiode receiver. In such an example, the transmitter is configured to switch the light source on and off in order to generate a signal having encoding therein data.

[0020] A number of different power sources 958a may be used. For instance, the power source 958a can be batteries or power generators. For example, the power generators can be a flutter type that include a body configured to oscillate or move in response to fluid flow and generate a voltage based on said oscillations. In another example, the power generator can be a body with an inner surface, an outer surface, a winding at least partially disposed along the outer surface, a passage, and a moveable element disposed in the passage and moveable relative to the body so as to generate a voltage in response to fluid flow through the body.

[0021] Referring to Figure 5A, the system 1 may include one computing device 20 and a communications system 30. Figures 5A and 5B illustrate one computing device 20. However, multiple computing devices 20a, 20b, 20c...20n may linked to the communications system 30, as illustrated in Figure 5B. For purposes of clarifying how the software application is implemented across the various computing devices, reference number 20 is used interchangeably with reference numbers 20a, 20b, 20c…, 20n unless noted otherwise. In addition, the present disclosure describes software applications implemented over system components and configured to execute various steps in the methods and techniques described below. It should be appreciated

that a software application can implement steps in the methods utilizing all of the system components or just portions of the system components. Furthermore, the software applications are described below in singular form. It should be appreciated that multiple software applications may interface to perform the described functions, and multiple applications can run on more than one computing device to implement the methodologies described herein.

[0022] Turning to Figure 5A, the computing device 20 is configured to receive, process, and store various information used to implement one or more software applications, such as software application 29. The software application 29 may include native instructions for operation of the computing device 20 and instructions for implementing one or more of the methods described below. The hardware components of computing device 20 can include any appropriate device, examples of which include a portable computing device, such as a laptop, tablet or smart phone, or other computing devices, such as a desktop computing device or a server-computing device.

[0023] As illustrated in Figure 5A, the computing device 20 includes one or more processor 22, a memory 24, input/output elements 26, and a user interface (UI) 28. It is emphasized that the operation diagram depiction of the computing device 20 is exemplary and is not intended to imply a specific implementation and/or configuration. The processor 22, memory 24, input/output portion 26 and user interface 28 can be coupled together to allow communications therebetween, and can interface with the software application 29. The software application 29 may include an application programmatic interface (API).

[0024] Continuing with Figure 5A, the memory 24 can be volatile (such as some types of RAM), non-volatile (such as ROM, flash memory, etc.), or a combination thereof, depending upon the exact configuration and type of processor 22. The computing device 20 can include additional storage (e.g., removable storage and/or non-removable storage) including, but not limited to, tape, flash memory, smart cards, CD-ROM, digital versatile disks (DVD) or other optical storage, magnetic cassettes, magnetic tape, magnetic storage or other magnetic storage devices, universal serial bus (USB) compatible memory, or any other medium which can be used to store information and which can be accessed by the computing device 20.

[0025] Continuing with Figure 5A, in various embodiments, the input/output portion 26 includes an antenna, lead or trace, electronic connector for wired connection, or a combination thereof. In some implementations, input/output portion 26 can include a receiver and transmitter, a transceiver, or a transmitter-receiver. The input/output portion 26 is capable of receiving

and/or providing information concerning components of a pool system. Furthermore, the input/output portion 26 is capable of receiving and/or providing information pertaining to communication with a network such as, for example, the Internet. As should be appreciated, transmit and receive functionality may also be provided by one or more devices external to computing device 20.

[0026] Referring to Figure 5A, the user interface 28, which can include an input device and/or display (input device and display not shown) that allows a user to communicate with or provide input instructions for the computing device 20. The user interface 28 can include inputs that provide the ability to control components via, for example, buttons, soft keys, a mouse, voice actuated controls, a touch screen, visual cues (e.g., moving a hand in front of a camera on a component), or the like. The user interface 28 can provide outputs, including visual displays of the data obtained with the detection unit 18. Other outputs can include audio information (e.g., via speaker), mechanically (e.g., via a vibrating mechanism), or a combination thereof. In various configurations, the user interface 28 can include a display, a touch screen, a keyboard, a mouse, an accelerometer, a motion detector, a speaker, a microphone, a camera, or any combination thereof. The user interface 28 can further include any suitable device for inputting biometric information, such as, for example, fingerprint information, retinal information, voice information, and/or facial characteristic information, for instance, so as to require specific biometric information for access to the computing device 20. It should be appreciated that the computer devices can operate via any suitable operating system, such as Android, BSD, iOS, Linux, OS X, QNX, Microsoft Windows, Windows Phone, and IBM z/OS. Furthermore, the software application can operate with any of the aforementioned operation systems.

[0027] Continuing with reference to Figure 5B, the system is implemented via exemplary architecture that includes computing devices 20a, 20b, 20c...,20n in electronic communication with each other via a common communications network, such as, for example the Internet. The computing devices 20a-20n may be connected to a communications hub 40 as further explained below. The computing devices 20a, 20b, 20c... 20n may be arranged in a client-server architecture. The computing device 20a can receive and transmit data to other computing devices 20b, 20c,... 20n. In addition, one up to all the computing devices can receive information from the other computing devices. Furthermore, one or all of the computing devices can access information on the other computing devices. "Access" or "accessing" as used herein can include retrieving information stored in memory on a computing device. For instance, "access" or "accessing" includes sending instructions via the network to computing device 20a

so as to cause information to be transmitted to the memory of the computing device 20b for access locally by the computing device 20b. In addition or alternatively, "access" or "accessing" can include the sending an instruction to from one computing device to access information stored in the memory on another computing device.

[0028] Figure 5B illustrates a client-server network. However, the software application (s) can be implemented over any number of network configurations. For example, in alternate embodiments, the computing devices 20a, 20b, 20c... 20n are configured as a peer-to-peer network architecture. In still other alternative embodiments, the computing devices 20a, 20b, 20c...20n can be arranged in a ring-type network architecture. Further, the software applications can be implemented across computing devices arranged on a network that includes aspects of a client-server network, peer-to-peer network, ring-type network, and/or other network architectures known to a person of ordinary skill in the art. Accordingly, it should be appreciated that numerous suitable alternative communication architectures are envisioned.

[0029] Figure 6 illustrates how the system 900 may be used to collect and monitor pool data for a pool 422. As shown in Figure 6, a first sensor 990a, a second sensor 990b, and a third sensor 990c obtain pool data or pool component data under water. The sensors 990a, 990b and 990c are adapted to transmit obtained pool data to a submerged communication assembly 950a through the pool water. In response, the communication assembly 950a transmits the pool data from the submerged communication assembly 950a to the communications hub 40. The communications hub may include a receiver to obtain the transmitted pool data. The receiver may be partially submerged. The communications hub 40 transmits the pool data to the computing device 20. In response, the computing device 20 can initiate a responsive action and transmit a command instruction to one or more pool system components 910a (not shown in Figure 6).

[0030] Figure 7 illustrates a method 1000 for the collection of data and control of a pool system in accordance with an embodiment of the present disclosure. In step 1002, sensors 910a-910n obtain data concerning one or more pool system components 910a. In step 1006, the communications assembly 950a transmits the obtained data concerning the pool component to the computing device 20.

[0031] Step 1006 may include transmitting the pool data from the submerged communication assembly 950a to the communications hub 40. The communications hub 40 transmits the pool data to the computing device 20. In step 1008, the pool data concerning the

pool component is analyzed with the computer processor. In step 1012, the computing device 20 can transmit a command instruction to one or more pool system components 910a (not shown in Figure 6) to adjust operation of the one or more pool components.

[0032] In one example, in steps 1008 and 1012, the computer processor is configured to analyze chemical components in the pool water. In this example, the pool data is a chemical composition of the pool water. The processor determines a level of the chemical components in the water. Based on level of the chemical components, the computer processor adjusts operation of a metering device by metering one or more of the chemical components into the pool water from a chemical component source.

[0033] In another example of steps 1008 and 1012, the computer processor operates a pool system component. In this example, the computer processor analyzes energy usage of the pool circulation system. If the energy usage is above a threshold, the computer processor modifies operation of the pool circulation system, and one or more pool system components, to reduce energy usage. The computer process transmits a command signal to an actuator to either activate or deactivate a pool system component in response to the obtained data from the sensors.

[0034] The system may include a pool system and one or more pool system components. In one embodiment, data is collected by compiling or acquiring sensor data for properties including, but not limited to, chlorine, organic loading, and turbidity, or even the state of physical pool components, such as the pump. This data may then be displayed or configured to relay a command to mitigate a condition based on such data. With an included inline power generator and through-water communications, such as a visual light communication system, it becomes possible to acquire both pool component data and pool water data. The obtained data can be analyzed and displayed. By integrating sensors and defining certain thresholds for specifically-obtained data sets, control of pool components (including water condition) is possible using remote computing devices, such as smartphones, tablets, or other computing devices. The control system may run both a circulation system and pool water condition sensing. The system may integrate with sensor data and lighting, as well as other features of a pool system. Such a system may be configured to interact with a series of plug-and-play computing devices to increase pool maintenance and improve automation.

[0035] It will be appreciated that the foregoing description provides examples of the disclosed system and technique. However, it is contemplated that other implementations of the disclosure may differ in detail from the foregoing examples. All references to the disclosure or

examples thereof are intended to reference the particular example being discussed at that point and are not intended to imply any limitation as to the scope of the disclosure more generally. All language of distinction and disparagement with respect to certain features is intended to indicate a lack of preference for those features, but not to exclude such from the scope of the disclosure entirely unless otherwise indicated.

CLAIMS

1. A system for the collection of data and control of a pool system comprising:

at least one sensor configured to obtain data concerning one or more pool system components;

a communication assembly configured to transmit the obtained data concerning the pool component; and

a processor configured to, in response to receiving the obtained data, cause a response in one or more of the pool system components based on the obtained data.

2. The system according to claim 1, wherein the communication assembly includes a receiver capable of receiving the obtained data obtained by at least one sensor.

3. The system according to claim 1, wherein the communication assembly includes a transmitter capable of transmitting the obtained data obtained by at least one sensor.

4. The system according to claim 1, wherein the communication assembly is a visual light communication assembly.

5. The system according to claim 1, wherein the communication assembly includes at least one of A) a light-emitting diode (LED) transmitter and B) a photo diode receiver.

6. The system according to claim 1, wherein the communication assembly is further configured to transmit obtained data to a computing device via a wire or wireless communications channel.

7. The system according to claim 1, the one or more pool components is water in a pool, and wherein the at least one processor is configured to analyze water in a pool based on the obtained data.

8. The system according to claim 1, where the at least one processor is configured to analyze chemical components in the water.

9. The system according to claim 8, where the at least one processor is configured to determine a level of the chemical components in the water.

10. The system according to claim 9, where the at least one processor is configured to adjust the level of the chemical components in the water by metering one or more of the chemical components into the pool water from a chemical component source.

11. The system according to claim 7, where the at least one sensor is configured to determine a pH of the water.

12. The system according to claim 1, wherein the one or more pool components are pool circulation components, and wherein the at least one sensor is configured to analyze the state of the pool circulation system components.

13. The system according to claim 1, wherein the at least one processor is configured to analyze energy usage of the pool circulation system.

14. The system according to claim 1, wherein the at least one processor is configured to operate the pool circulation system components based on the energy usage in the pool.

15. The system according to claim 1, further comprising at least one actuator that is configured to react in response to the transmitted information from the at least one sensor.

16. A method of using the system according to any one of the claim 1 to 15.

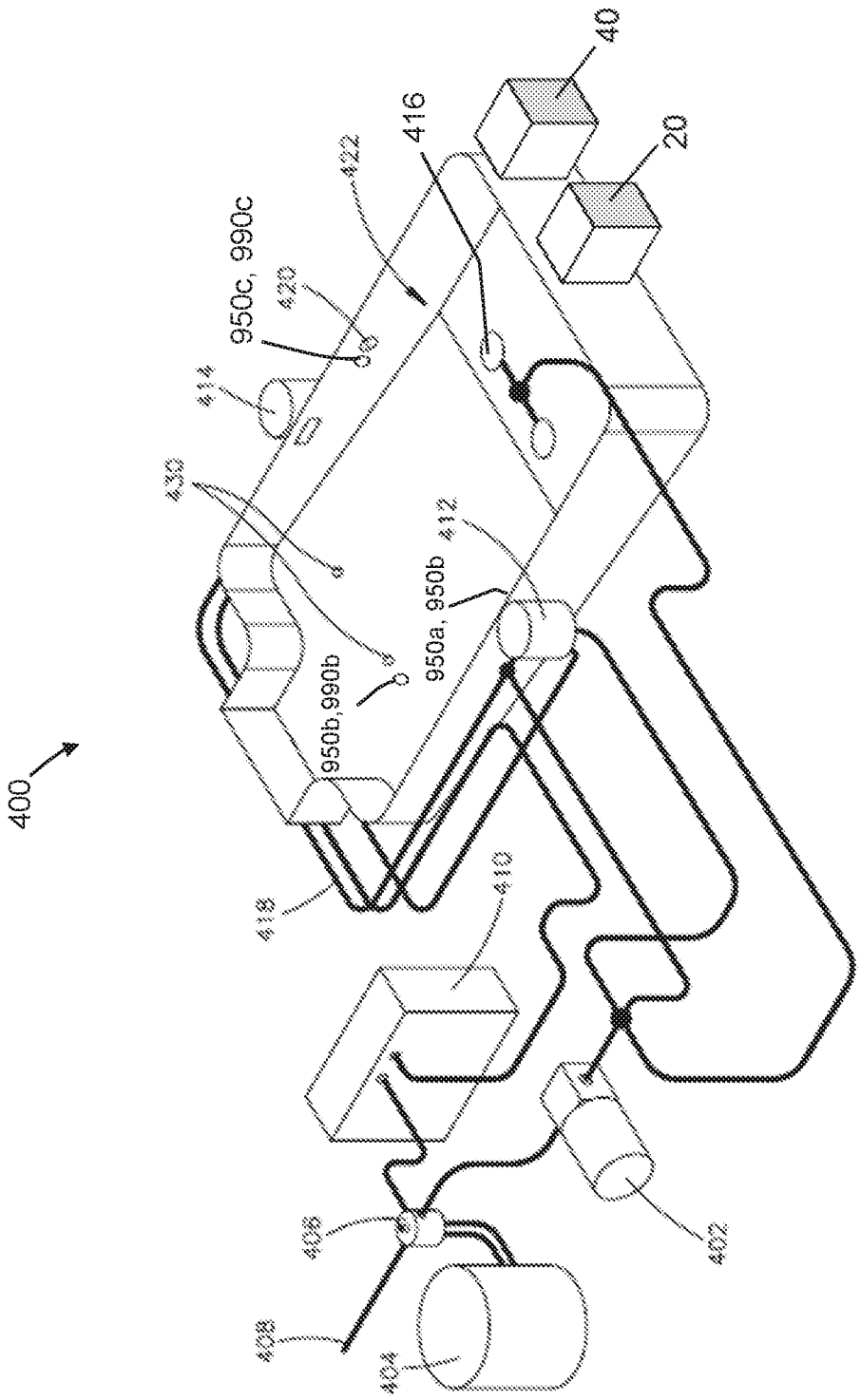
400
40
20
416
422
950c, 990c
420
414
430
412
950a, 950b
950b,990b
418
410
408
406
404
402

Figure 1

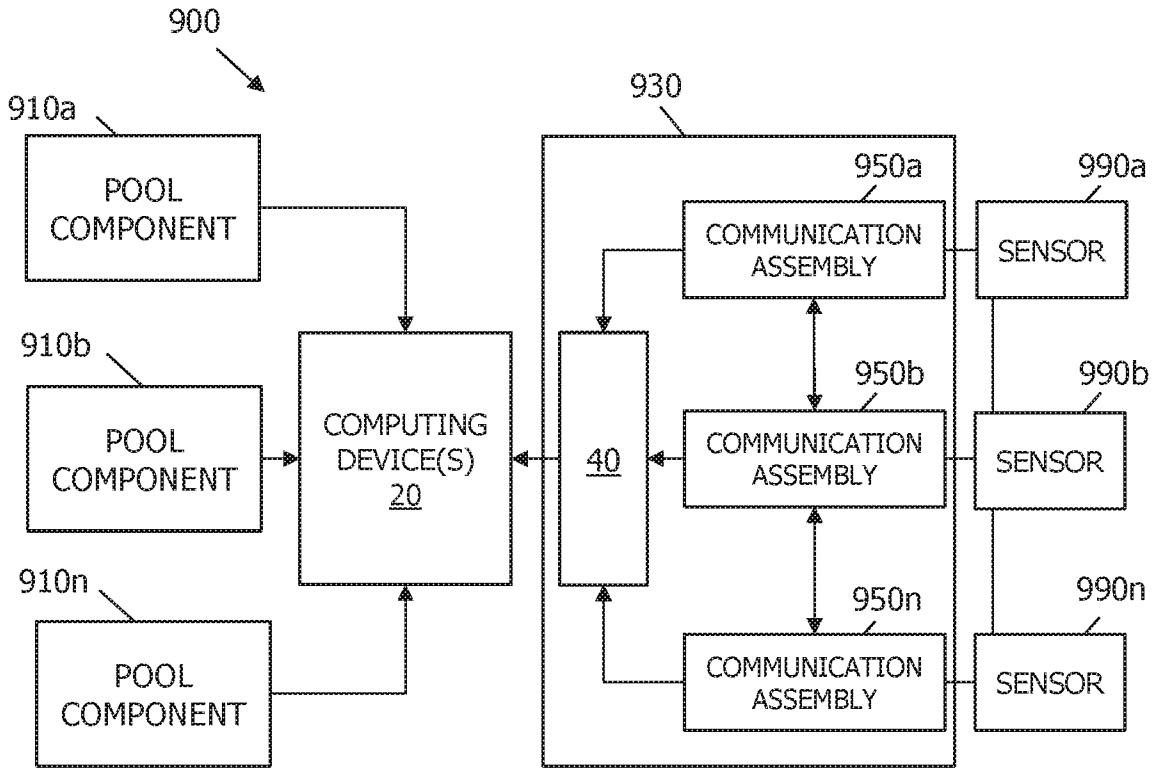
900
910a
POOL COMPONENT
910b
POOL COMPONENT
910n
POOL COMPONENT
COMPUTING DEVICE(S) 20
930
40
950a
COMMUNICATION ASSEMBLY
950b
COMMUNICATION ASSEMBLY
950n
COMMUNICATION ASSEMBLY
990a
SENSOR
990b
SENSOR
990n
SENSOR

Figure 2

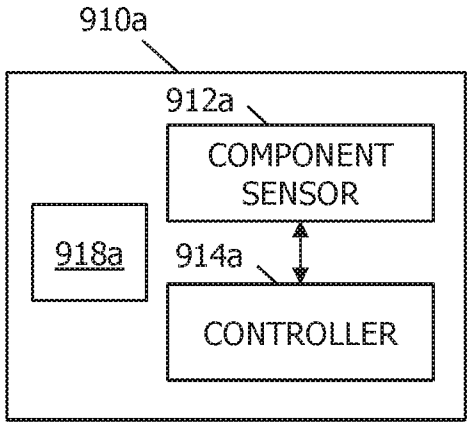

Figure 3

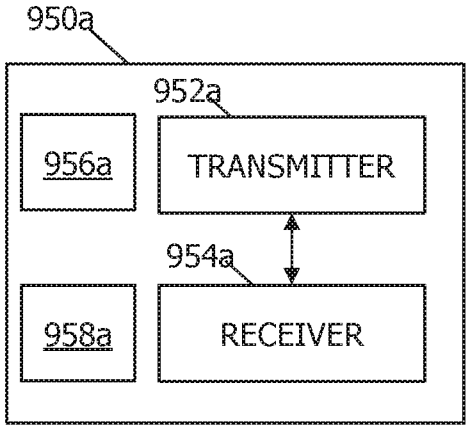

Figure 4

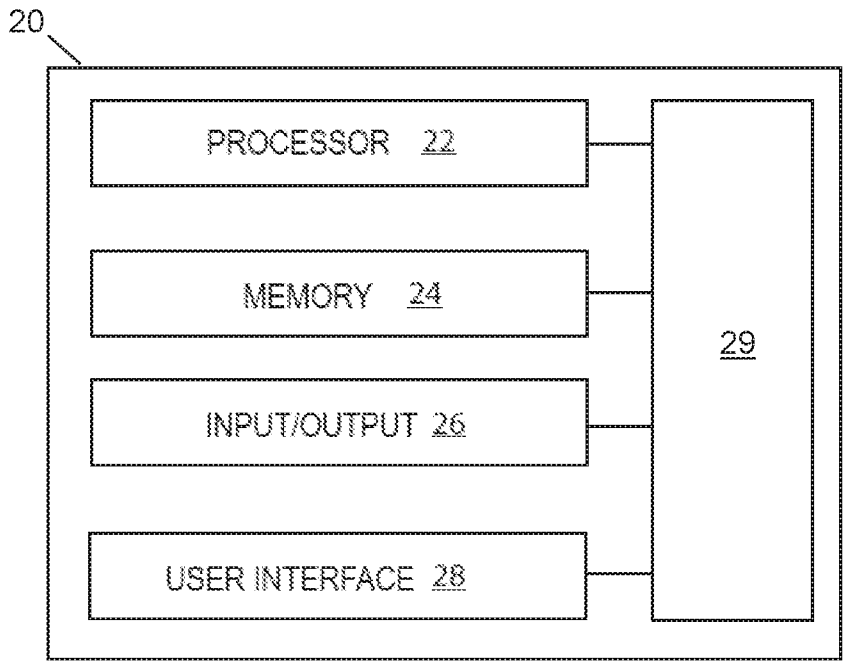

Figure 5A

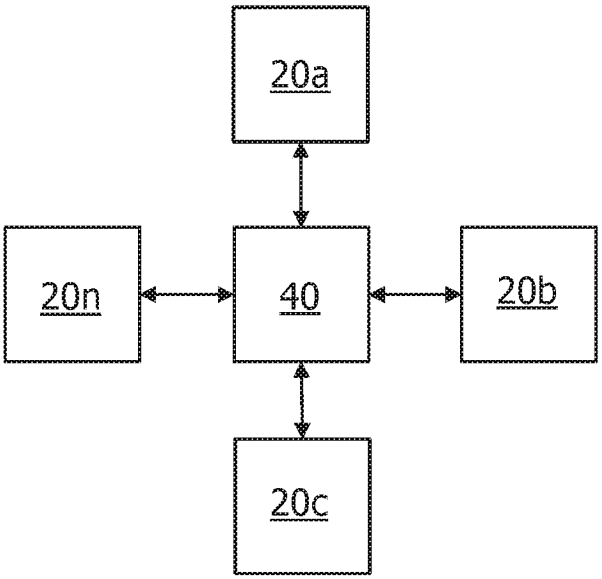

Figure 5B

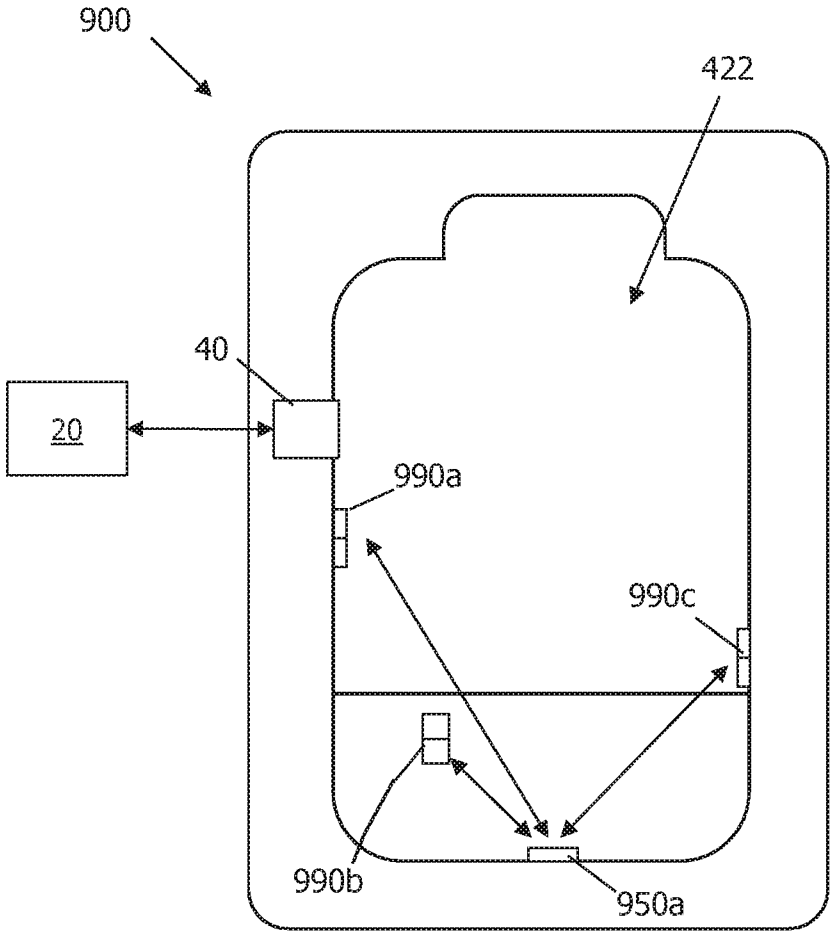

Figure 6

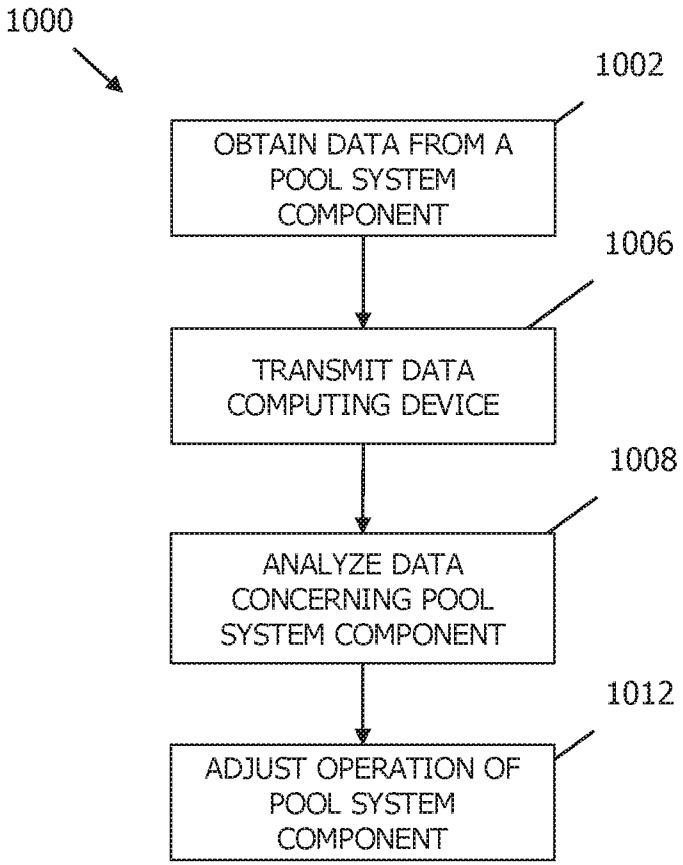
1000
1002
OBTAIN DATA FROM A POOL SYSTEM COMPONENT
1006
TRANSMIT DATA COMPUTING DEVICE
1008
ANALYZE DATA CONCERNING POOL SYSTEM COMPONENT
1012
ADJUST OPERATION OF POOL SYSTEM COMPONENT

Figure 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/062558

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04B10/116 E04H4/14 H04B13/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04B E04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2014/127742 A1 (FIELD CHRISTOPHER DAVID [AU]) 8 May 2014 (2014-05-08) abstract paragraphs [0004], [0005] paragraphs [0018] - [0032] paragraphs [0037] - [0042] paragraph [0056] figures 1A-1C, 2-4	1-16
X	US 2005/044617 A1 (MUELLER GEORGE G [US] ET AL) 3 March 2005 (2005-03-03) abstract paragraph [0076] paragraph [0093] paragraph [0104] paragraphs [0114] - [0120] paragraphs [0142] - [0148] figures 1, 2, 4, 8, 9	1-16

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

International application No
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