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(54) **SYSTEMS AND METHODS FOR WIRELESSLY COMMUNICATING WITH AUTOMATIC SWIMMING POOL CLEANERS**

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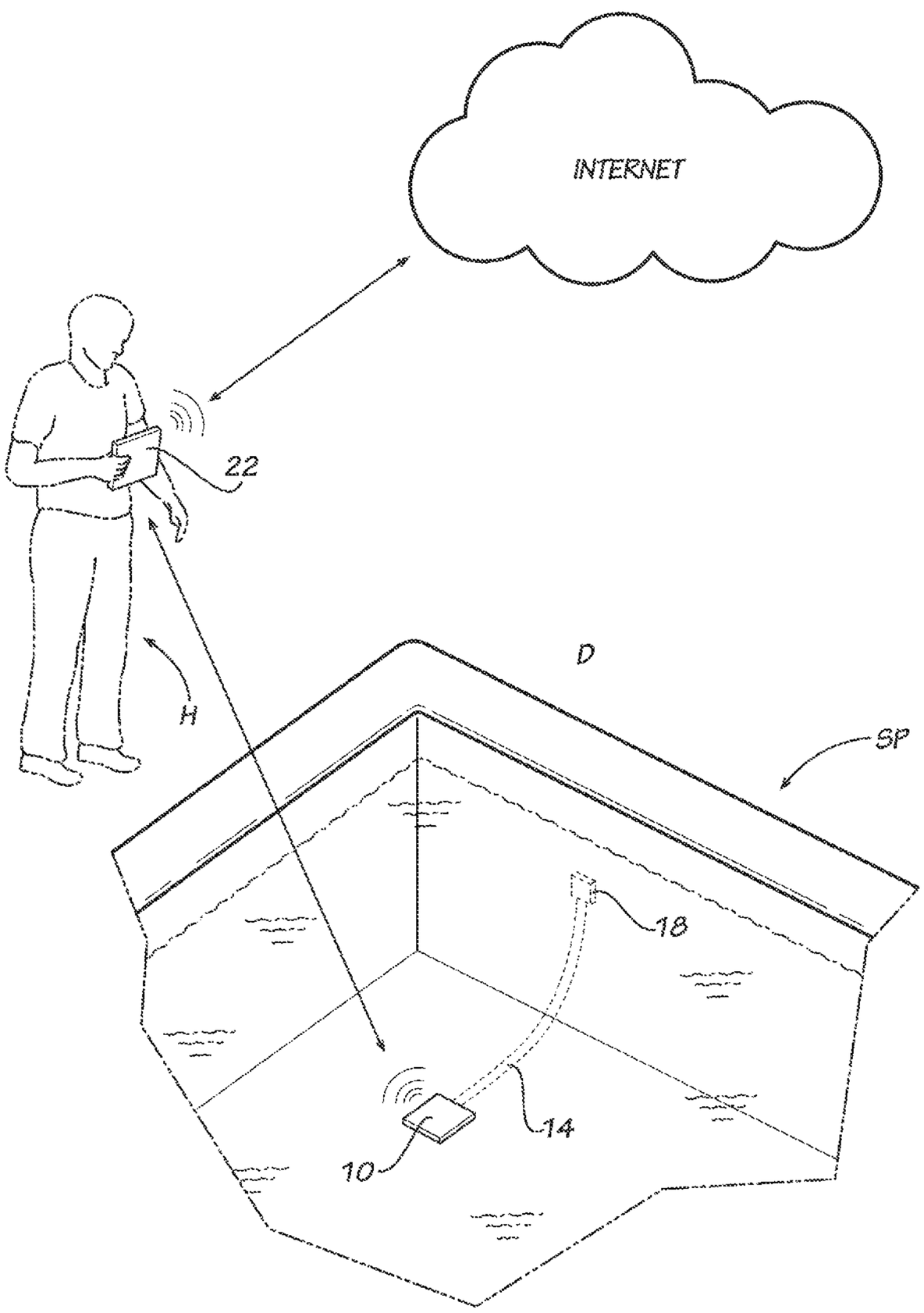
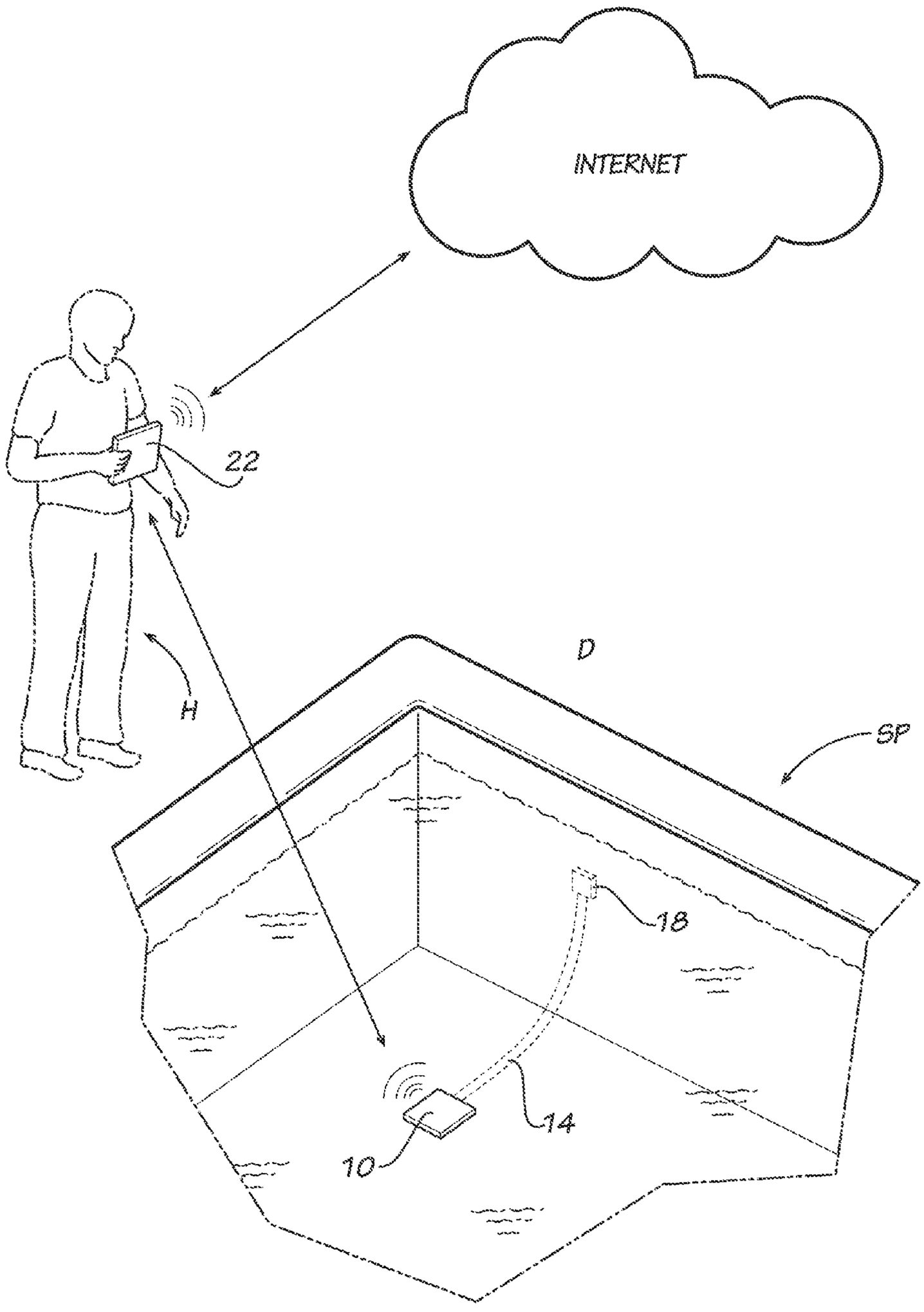
(57) **ABSTRACT**

Systems and methods for communicating wirelessly with automatic pool cleaners are addressed. Hydraulic cleaners, in particular, may be provided with on-board electricity-generating capabilities, processors, sensors, and transceivers for purposes of communication. Control of the cleaners may be accomplished using "smart" devices capable of downloading software via, for example, the Internet.





FIGURE

SYSTEMS AND METHODS FOR WIRELESSLY COMMUNICATING WITH AUTOMATIC SWIMMING POOL CLEANERS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of and priority to U.S. Provisional Patent Application No. 61/809449, filed Apr. 8, 2013, entitled "Smart Device Communication with Swimming Pool Cleaner," the entire contents of which are incorporated herein by this reference.

FIELD OF THE INVENTION

[0002] This invention relates to systems and methods for communicating with mobile cleaning equipment, such as automatic cleaners of swimming pools and spas, and more particularly, although not necessarily exclusively, to employing hand-held devices in the form of "smart" telephones, tablet computers, etc. to communicate with hydraulic-type automatic swimming pool cleaners (APCs), preferably with radio frequency (RF) signals employing protocols such as WiFi, Bluetooth, Zigbee, or Z-Wave (as examples).

BACKGROUND OF THE INVENTION

[0003] Conventionally, an APC may be considered either "hydraulic" or "electric" depending on the source of energy employed to effect its movement within a pool, spa, or other water-containing vessel. "Electric" cleaners, sometimes also called "robots," typically use electricity to power motors used to drive wheels or treads to allow the cleaners to move throughout the vessel. Although on-board batteries are sometimes considered to supply electricity to the robots, more likely electricity from mains outside the vessels is conveyed via electrical cords to the robots within the vessels.

[0004] "Hydraulic" cleaners, by contrast, connect to external pumps and utilize water flow caused by operation of the pumps to effect their movement within a pool or spa. Some hydraulic cleaners connect to pump outlets; these devices are called "pressure-side" APCs, as pressurized water from pump outlets typically drives the cleaners. Alternatively, hydraulic cleaners may connect to inlets of pumps. These "suction-side" cleaners often include valves and supporting structure designed periodically to interrupt water flow through their bodies to the pumps. Periodic flow interruption creates a "water-hammer" effect, with the resulting energy used to move the APCs within pools.

[0005] U.S. Pat. No. 5,569,371 to Perling discloses an electric cleaner, or robot, whose housing includes a microprocessor. An electrical cable attached to the housing conveys power and signals to the robot from a poolside "intercommunication box." See Perling, col. 2, 11. 60-64. The robot additionally may transmit ultrasonically or optically to receivers within the pool for purposes of determining its location. A wheeled caddy used to transport the robot outside of the pool contains a wireless receiver, although no corresponding wireless transmitter is identified.

[0006] Detailed in European Patent Application Publication No. 1122382 of Clementi is another robot capable of communicating with a "feeding source" floating within a pool. Such communication again occurs via cable, however. The floating source, by contrast, may receive wireless signals from "a radio control transmitter held by an operator on an edge of the swimming pool." See Clementi, col. 2, ¶ 0011 (numeral omitted).

[0007] International Patent Application Publication No. WO 2013/160628 of Michelon discloses another robot which as illustrated communicates, via a wired connection, to a "modification device" outside the pool. Like the feeding source of the Clementi application, the modification box of the Michelon application may receive "wireless request signals" from a transmitter outside the pool, with the request signals overriding control signals received at the modification box via a wired connection to a control unit.

[0008] Hydraulic APCs are typically manufactured to perform in pre-determined manners due to hydraulic and mechanical principles and geometries. Some variations to improve cleaning performance may be implemented by end-users or servicers of the cleaners by, for example, physically changing parts or making mechanical adjustments to existing parts. Rarely do hydraulic APCs—whether or not in operation—provide any diagnostic or other feedback to users, however, as presently unavailable commercially is any mechanism for communicating electronically with hydraulic cleaners.

[0009] Many reasons for this lack of availability exist including, for example, that hydraulic APCs conventionally have no on-board source of electrical power, no processor, and no transceiver. Equally problematic are difficulties in transmitting information wirelessly through water. Existing wired robotic systems further typically utilize proprietary software neither easy nor quick to update.

SUMMARY OF THE INVENTION

[0010] The present invention resolves these issues by creating systems and methods for communicating wirelessly with operating APCs. In particular, assemblies of the invention may include hydraulic APCs with on-board electricity-generating capabilities so as to power processors, sensors, and transceivers. Control of the APCs may be accomplished or facilitated, further, using conventional "smart" devices such as (but not limited to) Internet-compatible telephones, tablets, personal computers, etc. Preferably such control devices are hand-held, although this feature is not absolutely necessary. Consequently, relevant applications software ("apps") may be updated via the Internet as appropriate or desired. In some cases, control of a particular APC may occur via remote commands sent via the Internet.

[0011] Communicating with APCs, especially hydraulic ones, allows input and output data to be transferred for numerous purposes beyond controlling the cleaners within a pool or spa. As examples, signals may be sent to change (directly or indirectly) movement speed of an APC, to change navigation parameters (turning, stopping, reversing, etc.) of a cleaner, to set time schedules for various functions, and to request desired output information from a cleaner. Exemplary output signals from an APC may provide information such as (but not limited to) connectivity signal presence and strength, current cleaning mode engaged, water characteristics (e.g. flow through the cleaner, temperature, pressure, chemistry), electrical information (e.g. system voltage, amperage, charging information), cleaning cycles completed or remaining in a warranty period or expected life), and failure codes. Persons skilled in the relevant art will recognize additional potential purposes for communication.

[0012] Smart devices are ubiquitous in society. Prevalence of these devices allows for a wide audience to use them for communicating with APCs. Many of the devices already are configured for wireless, radio frequency (RF) communications via Bluetooth or WiFi protocols (or both or others) with sufficient signal strength to allow localized communication through pool water. They also often are configured to download software apps via the Internet upon demand, facilitating periodic updating of the apps. Moreover, software updates may also be downloaded to the devices and then transferred to the associated APCs for (as examples) any or all of added functionality, repairs, upgrades, or changing programmed settings of the APCs that the APCs then use autonomously thereafter. Pairing of a device and APC, for example using Bluetooth technology, additionally may occur if desired.

[0013] It thus is an optional, non-exclusive object of the present invention to provide systems and methods for communicating electronically with APCs.

[0014] It is another optional, non-exclusive object of the present invention to provide systems and methods for communicating electronically with hydraulic APCs.

[0015] It is also an optional, non-exclusive object of the present invention to provide systems and methods for communicating wirelessly, preferably through RF signals, to hydraulic or other APCs.

[0016] It is, moreover, an optional, non-exclusive object of the present invention to provide systems and methods for communicating with APCs using apps of smart devices.

[0017] It is a further optional, non-exclusive object of the present invention to provide systems and methods for communicating with APCs that conventionally have lacked any on-board electricity-generating mechanism.

[0018] Other objects, features, and advantages of the present invention will be apparent to those skilled in the relevant art with reference to the remaining text and the drawing of this application.

BRIEF DESCRIPTION OF THE DRAWING

[0019] The FIGURE is a schematicized representation of aspects of the present invention.

DETAILED DESCRIPTION

[0020] Illustrated in the FIGURE is a water-filled swimming pool SP in which APC **10** is operating. As noted above APC **10** preferably (but not necessarily) is of the hydraulic type. Accordingly, APC **10** may be in direct or indirect fluid communication with either an inlet or an outlet of a pump of a water-recirculation system using hose **14**. However, unlike conventional hydraulic cleaners, APC **10** includes an on-board power source and a transceiver as well as, optionally, one or more sensors or processors. An example of such an APC is described in U.S. patent application Ser. No. 14/205,408, filed Mar. 12, 2014, entitled "Hydraulic Swimming Pool Cleaners With Electricity Generators" (the "'408 Application").

[0021] Hose **14** itself typically terminates at a fitting **18**, a skimmer, or at some other terminus in or associated with pool SP. Moreover, if APC **10** is a hydraulic cleaner, it need not have any electrical cord, as electricity would not be required for its movement within pool SP. Hence, the invention may avoid need for any cord or hose to be positioned on deck D of pool SP while APC **10** is operating.

[0022] Also shown in the FIGURE is a human H holding device **22**. Human H may be an owner, user, or servicer of pool SP or any other person interested in controlling APC **10**. Device **22** preferably is a smart device configured to transmit and receive RF (or other) signals wirelessly with sufficient strength to communicate with APC **10** within pool SP and with the Internet in any appropriate manner. Device **22** also preferably is hand-held for easy use around pool SP.

[0023] Advantageously, control software for APC **10** created by its manufacturer or a third party may be downloaded to device **22** via the Internet. Such software, in an executable form commonly called an "app," may be used by human H such that device **22** transmits to and receives information from APC **10**. Alternatively or additionally, controlling APC **10** may occur remotely, with control information passed via the Internet to device **22** for relay to APC **10**. Similarly, information transmitted by APC **10** to device **22** may be relayed remotely for review, processing, storage, or consideration in any manner. As indicated earlier, signals may be transmitted to change (directly or indirectly) movement speed of APC **10**, to change navigation parameters (turning, stopping, reversing, etc.) of APC **10**, to set time schedules for various functions associated with APC **10**, and to request desired output information from APC **10**. Exemplary output signals from APC **10** may provide information such as (but not limited to) connectivity signal presence and strength, current cleaning mode engaged, water characteristics (e.g. flow through the cleaner, temperature, pressure, chemistry), electrical information (e.g. system voltage, amperage, charging information), cleaning cycles completed or remaining in a warranty period or expected life), and failure codes.

[0024] The foregoing is provided for purposes of illustrating, explaining, and describing embodiments of the present invention. Modifications and adaptations to these embodiments will be apparent to those skilled in the art and may be made without departing from the scope or spirit of the invention. For example, although much of the foregoing description relates to hydraulic APCs, in some cases aspects of the invention may be utilized in connection with other equipment including, but not limited to, electric APCs. Moreover, "pool," "swimming pool," and their plurals may include within their definitions spas and other water-containing vessels used for recreational or therapeutic bathing or swimming. The entire contents of the Perling patent, the Clementi and Michelon applications, and the '408 Application are incorporated herein by this reference.

What is claimed is:

1. A method of communicating with an automatic cleaner operating within a swimming pool, comprising:

a. loading control software into a device configured to transmit and receive signals wirelessly;

b. causing the device to transmit wireless signals to a receiver on-board the operating automatic cleaner; and

c. allowing the device to receive wireless signals from a transmitter on-board the operating automatic cleaner.

2. A method according to claim **1** in which loading control software into the device comprises downloading control software from a remote source via the Internet.

3. A method according to claim **2** in which the automatic cleaner lacks any electrical cord extending outside the swimming pool.

4. A method according to claim **3** in which the automatic cleaner is a hydraulic cleaner comprising an on-board electricity generation mechanism.

5. A method according to claim **4** further comprising connecting a hose to the automatic cleaner so as to place it in fluid communication with a pump associated with the swimming pool.

6. A method according to claim **5** in which the device is hand-held.

7. A method according to claim **6** in which wireless signals transmitted by the device to the automatic cleaner change a characteristic of movement of the automatic cleaner within the swimming pool.

8. A method according to claim **7** in which wireless signals transmitted by the automatic cleaner to the device provide information about operation of the automatic cleaner or at least one characteristic of the water within the swimming pool.

9. A method according to claim **8** further comprising causing the device to transmit wireless signals to a location remote from the swimming pool.

10. A method according to claim **1** further comprising pairing the device and the automatic cleaner.

11. A method according to claim **1** in which wireless signals transmitted by the device to the automatic cleaner change a pre-programmed setting of the automatic cleaner.

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