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(54) **REMOTE MONITORING AND WATER SHUTOFF SYSTEMS**

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See application file for complete search history.

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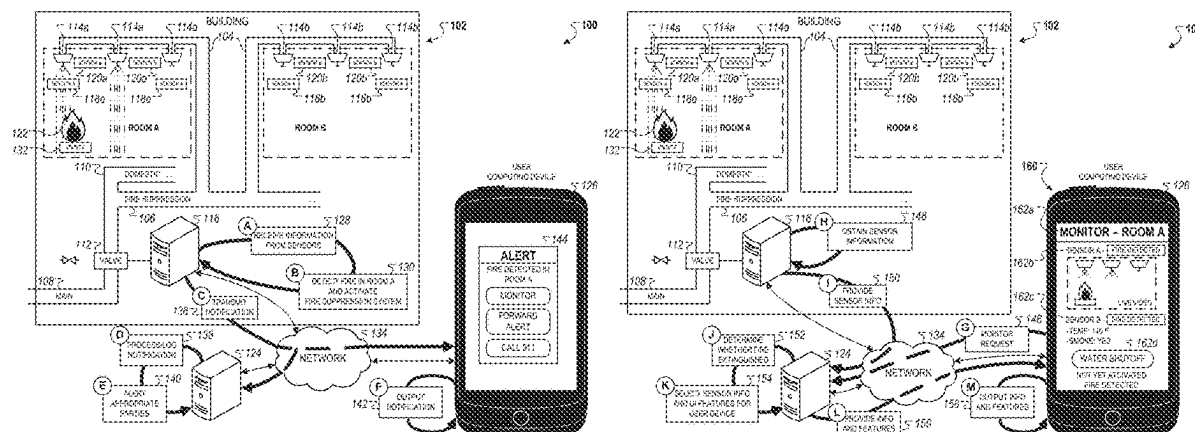
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(57) **ABSTRACT**

Disclosed is a system for detecting a water leak, the system including: a sensor that can generate sensor signals and a computer system that can receive and process the sensor signals to detect a water leak. In response to detecting the leak, the computer system can send a state change command to a valve control device, which can be configured to change a state of a solenoid valve according to the state change command. In response to detecting the leak, the computer system can transmit information to a mobile device over a communication network, the information including (i) an indication of the state change command and/or (ii) an indication that the water leak was detected. The mobile device can present the transmitted information in a graphical user interface (GUI), present a selectable option, and receive a user selection of the selectable option, which causes an action to be performed.

20 Claims, 10 Drawing Sheets



Related U.S. Application Data

continuation of application No. 18/131,474, filed on Apr. 6, 2023, now Pat. No. 11,826,594, which is a continuation of application No. 17/719,017, filed on Apr. 12, 2022, now Pat. No. 11,648,430, which is a continuation of application No. 17/004,687, filed on Aug. 27, 2020, now Pat. No. 11,331,523, which is a continuation of application No. 16/153,516, filed on Oct. 5, 2018, now Pat. No. 10,758,758, which is a continuation of application No. 15/197,399, filed on Jun. 29, 2016, now Pat. No. 10,092,785, which is a continuation of application No. 14/932,413, filed on Nov. 4, 2015, now Pat. No. 9,403,046.

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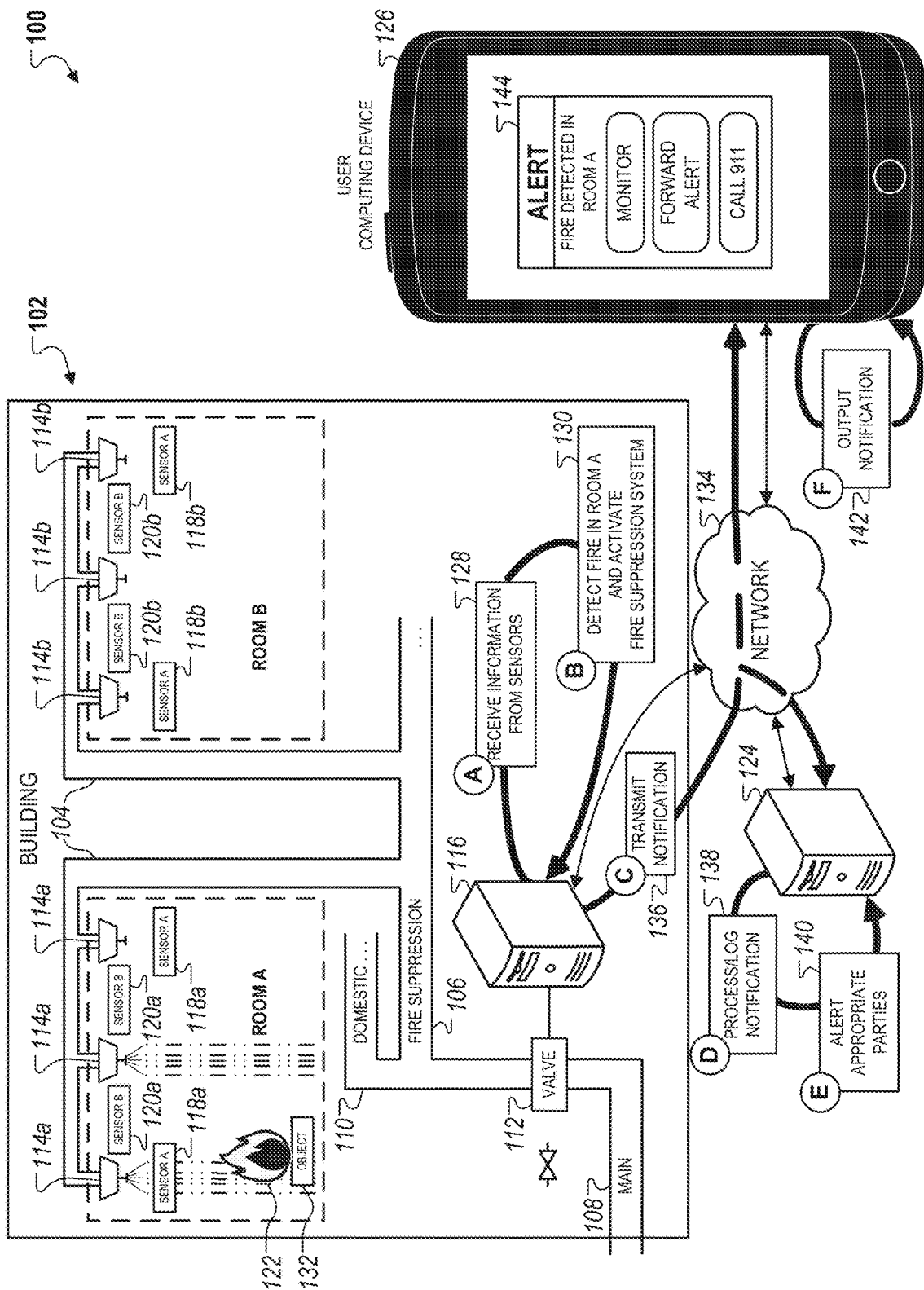
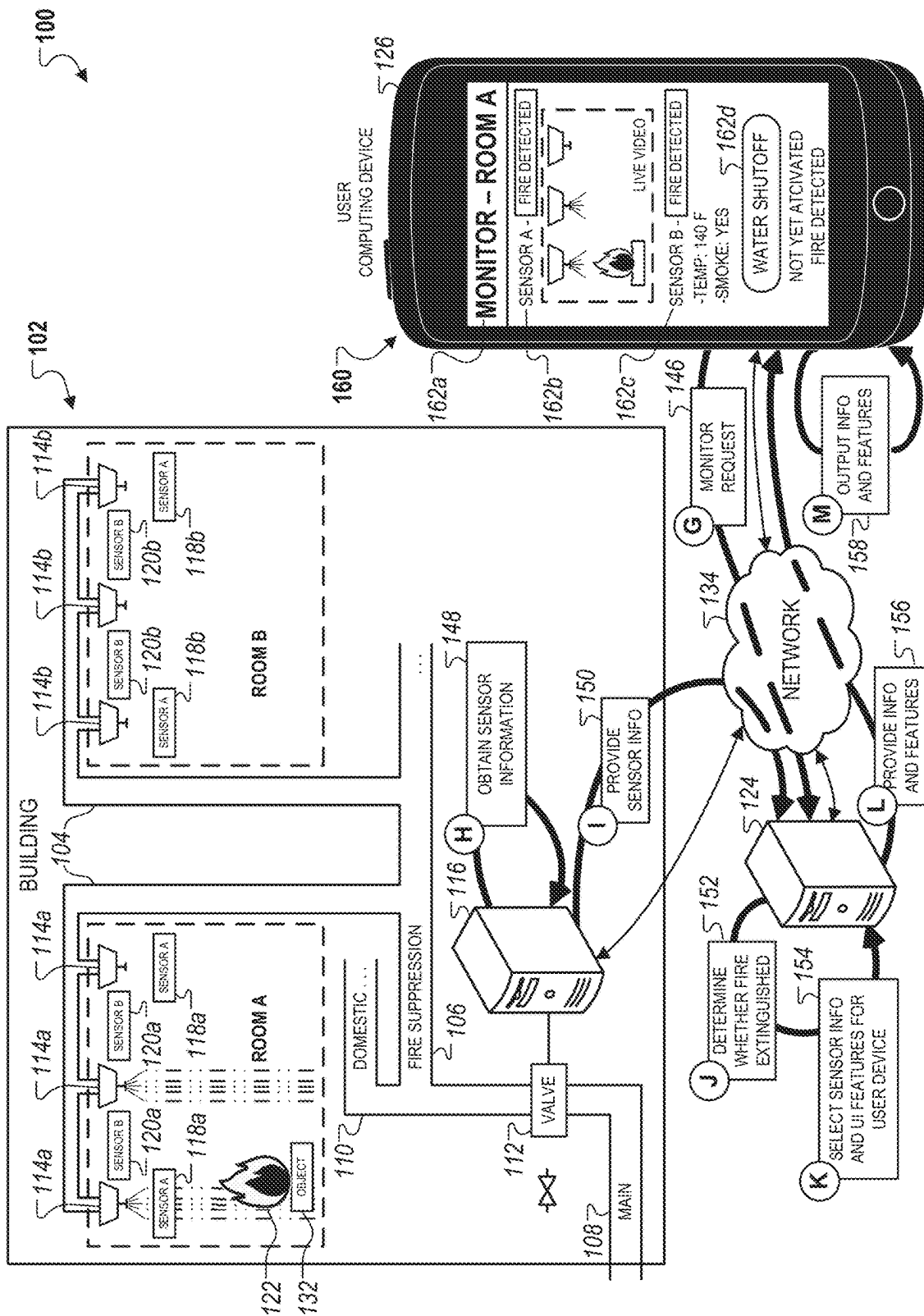




FIG. 1A



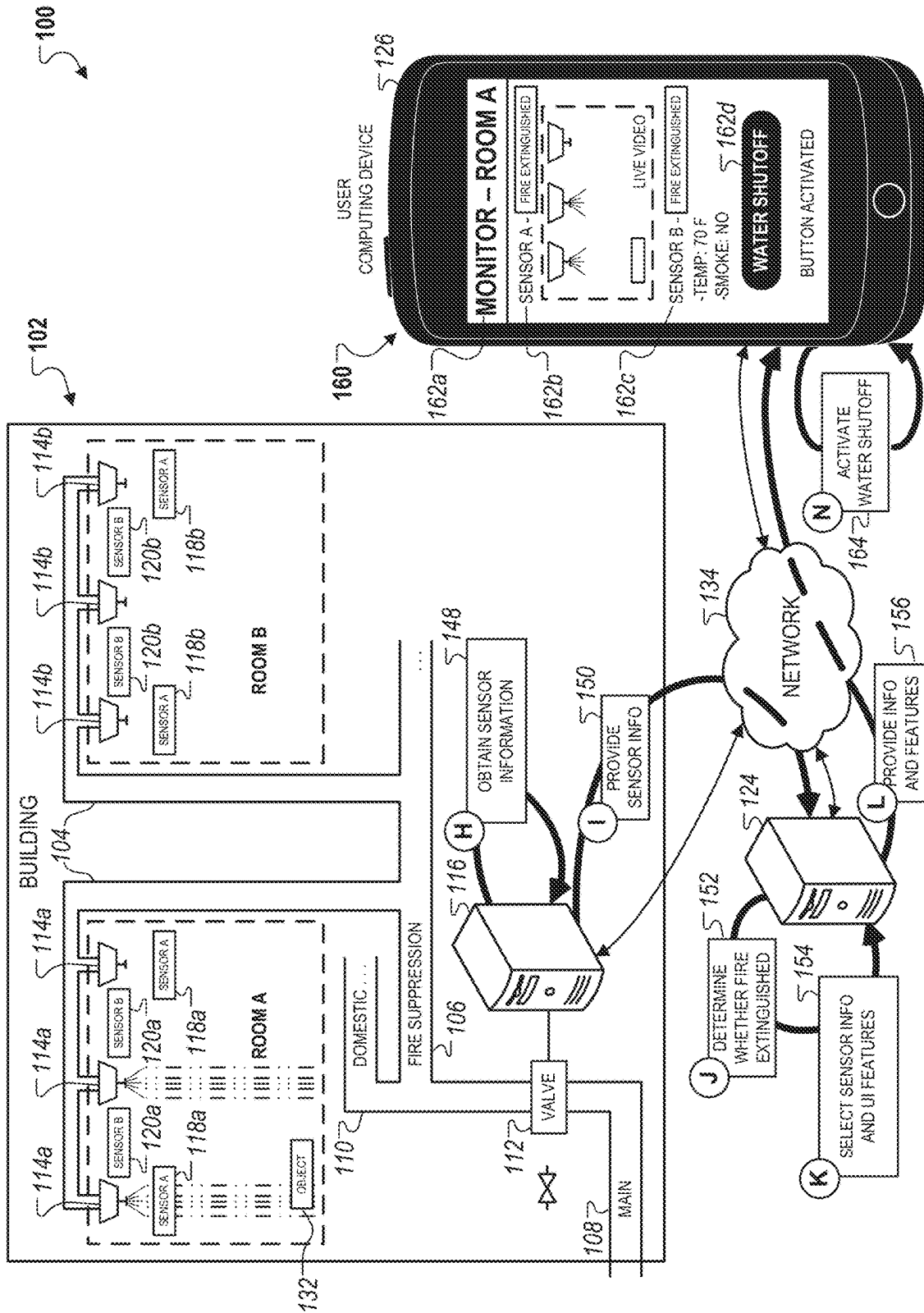


FIG. 1C

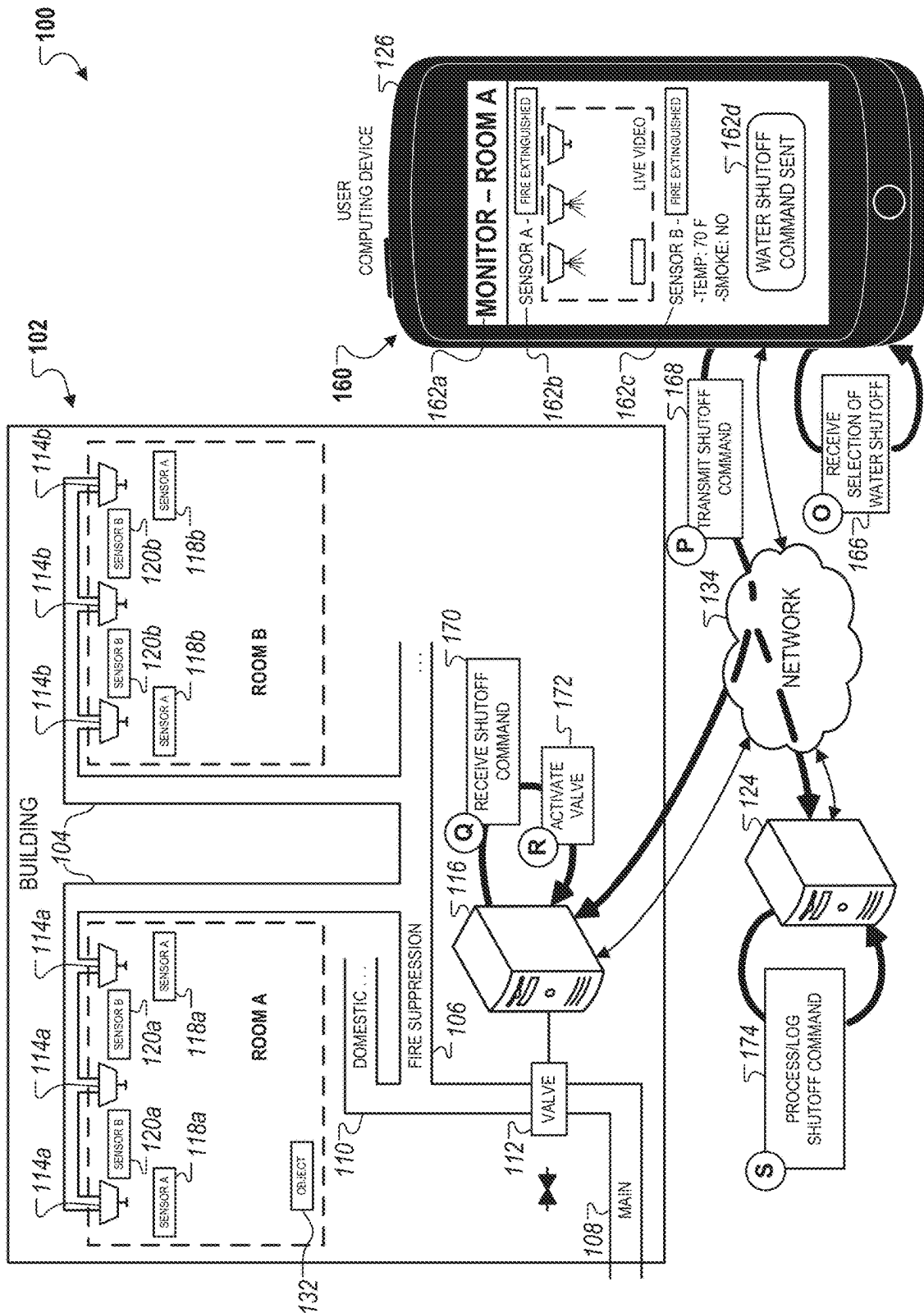


FIG. 1D

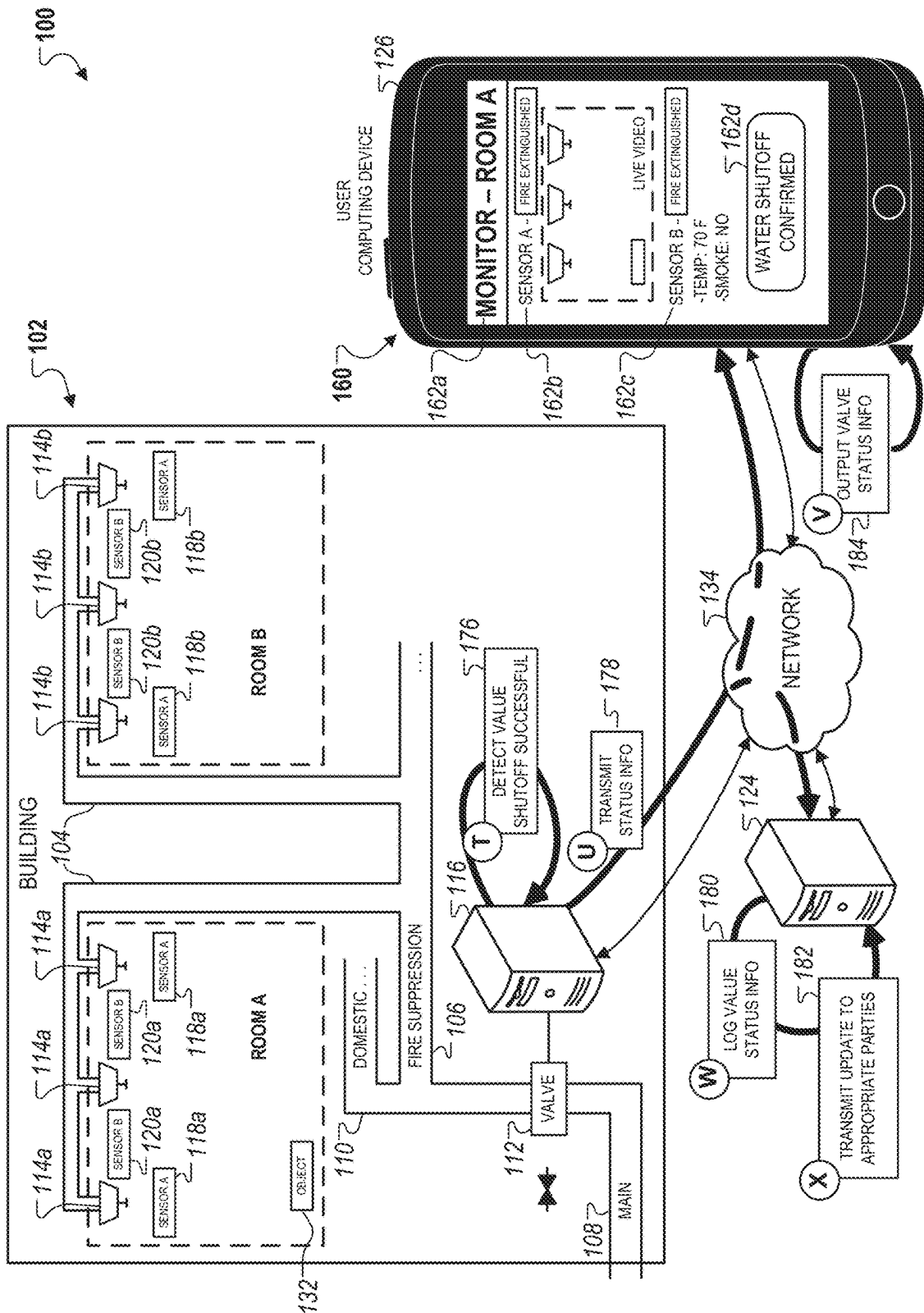


FIG. 1E

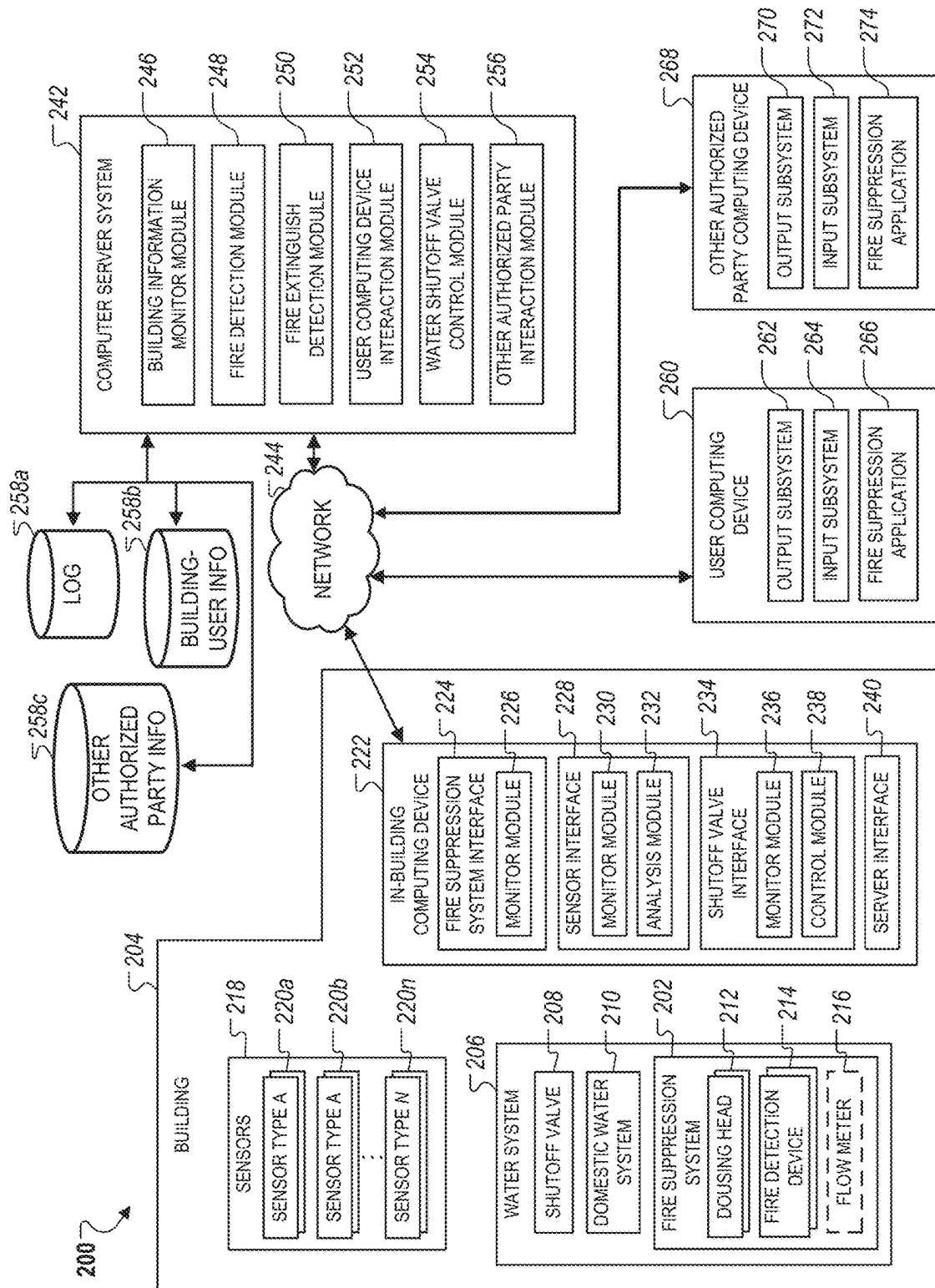
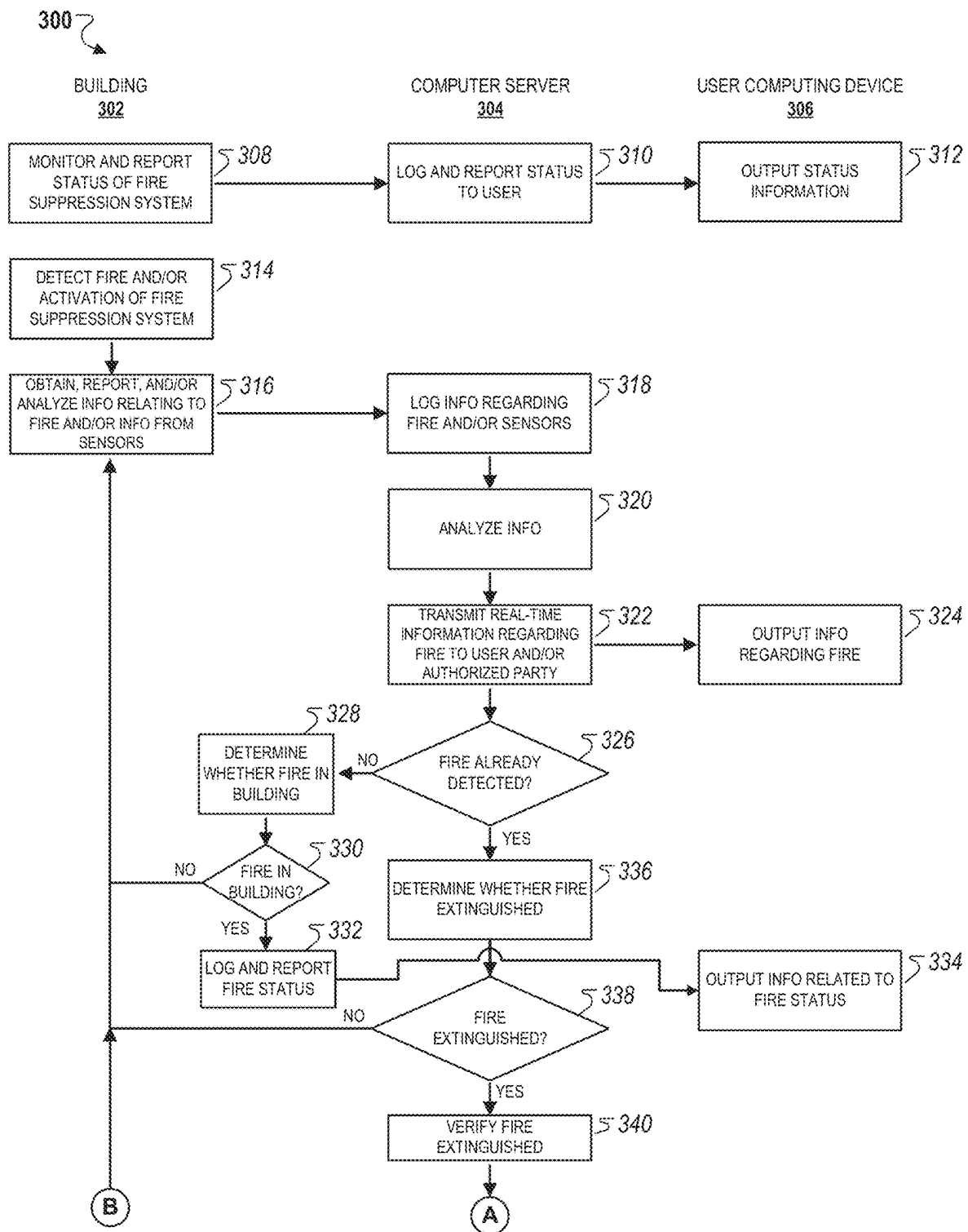


FIG. 2



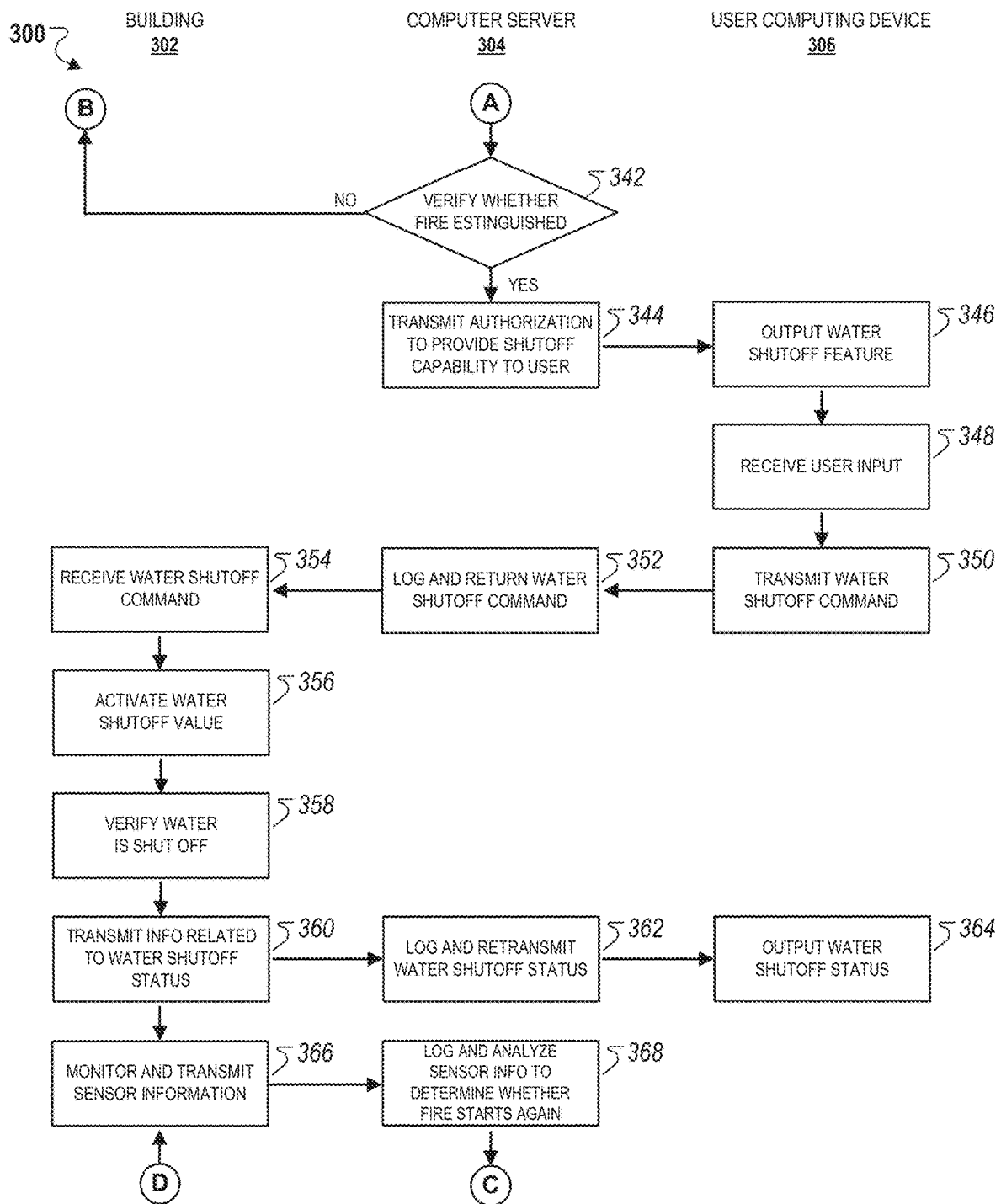


FIG. 3B

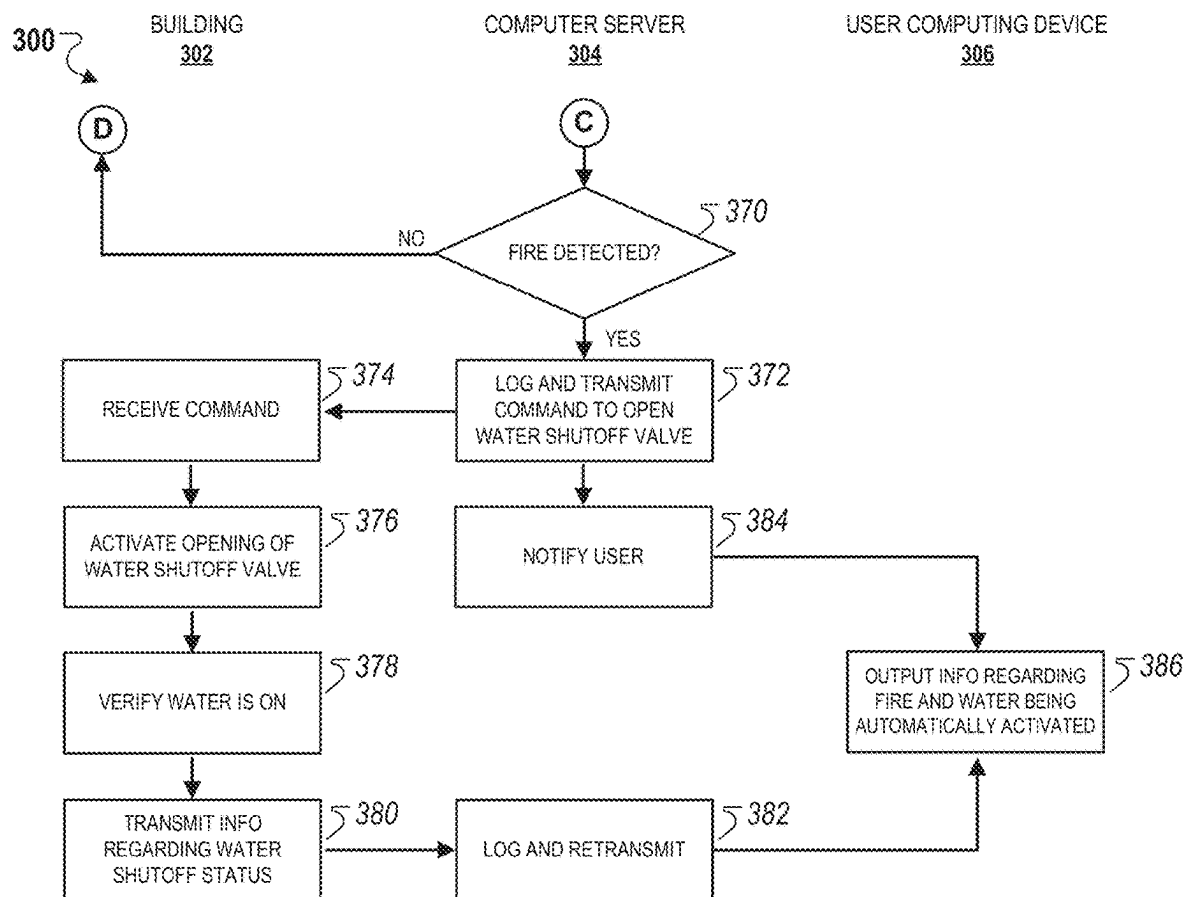
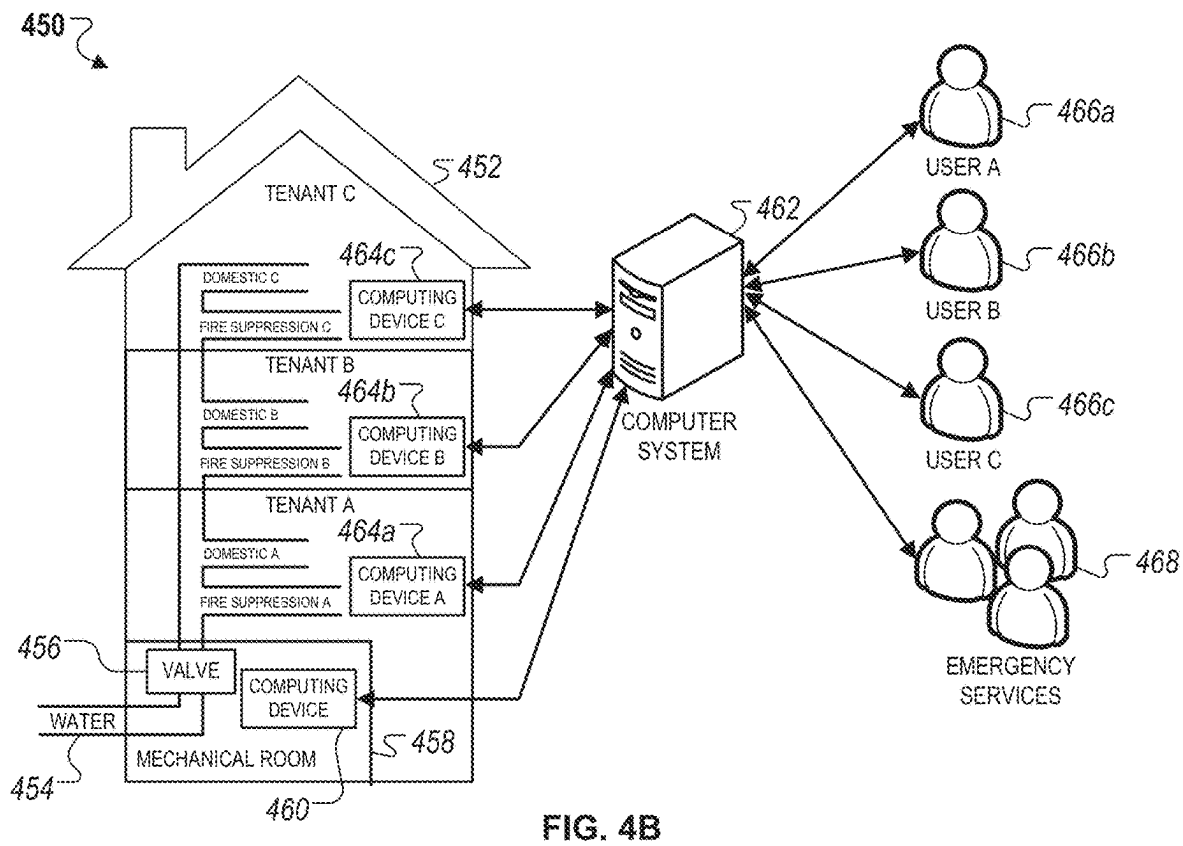
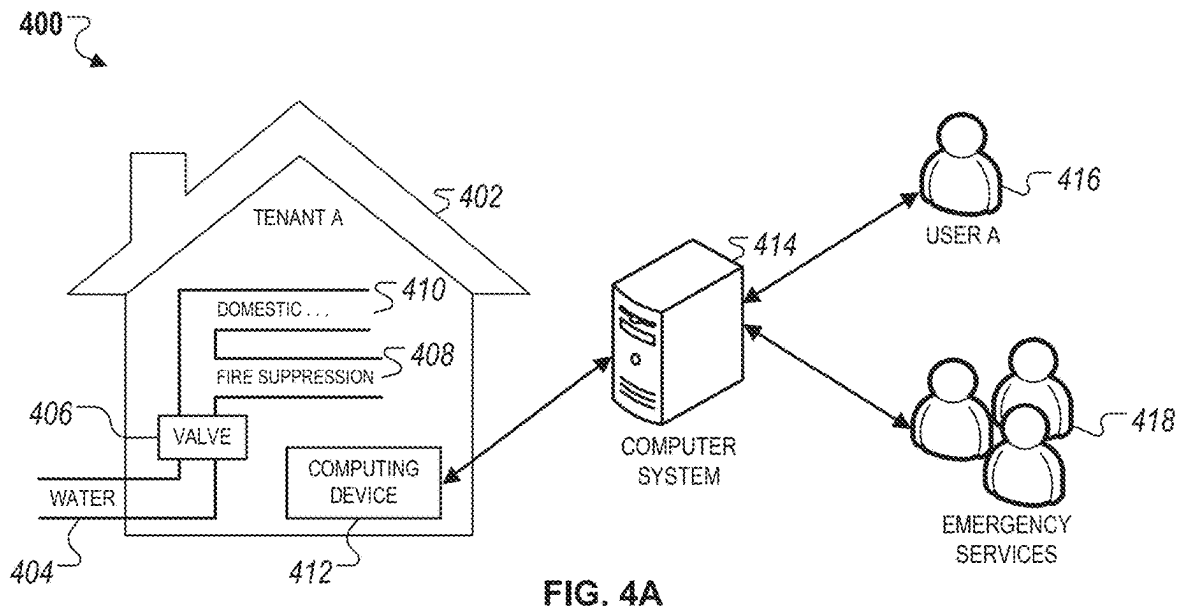


FIG. 3C



REMOTE MONITORING AND WATER SHUTOFF SYSTEMS

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 18/381,859, filed Oct. 19, 2023, which is a continuation of U.S. application Ser. No. 18/131,474, filed Apr. 6, 2023 and issued on Nov. 28, 2023 as U.S. Pat. No. 11,826,594, which is a continuation of U.S. application Ser. No. 17/719,017, filed Apr. 12, 2022 and issued on May 16, 2023 as U.S. Pat. No. 11,648,430, which is a continuation of U.S. application Ser. No. 17/004,687, filed Aug. 27, 2020 and issued on May 17, 2022 as U.S. Pat. No. 11,331,523, which is a continuation of U.S. application Ser. No. 16/153,516, filed Oct. 5, 2018 and issued on Sep. 1, 2020 as U.S. Pat. No. 10,758,758, which is a continuation of U.S. application Ser. No. 15/197,399, filed Jun. 29, 2016 and issued Oct. 9, 2018 as U.S. Pat. No. 10,092,785, which is a continuation of U.S. application Ser. No. 14/932,413, filed Nov. 4, 2015 and issued on Aug. 2, 2016 as U.S. Pat. No. 9,403,046, which claims the priority benefit of U.S. Provisional Application Ser. No. 62/075,662, filed Nov. 5, 2014. The entirety of the disclosures of the prior applications are considered part of and are incorporated by reference in the disclosure of this application.

TECHNICAL FIELD

This document generally describes technology for remotely monitoring and controlling fire suppression systems, such as sprinkler systems that are installed in homes and other buildings.

BACKGROUND

Fire suppression systems, such as installed fire sprinkler systems, have used extinguishing components, such as sprinkler heads, that are mechanically and/or electrically activated in response to the detection of the effects of a fire (e.g., heat). Once activated, such extinguishing components will continue to extinguish/douse until a water supply for the extinguishing components is turned off.

For example, some sprinkler heads have glass bulbs that apply pressure to a cap that acts as a plug to prevent water from flowing out of the sprinkler head. Such glass bulbs are heat-sensitive, such as through the use of an internal liquid that expands in response to heat, and burst when a threshold temperature is reached, which releases the pressure on the cap and allows for water to begin flowing out of the sprinkler head. Such sprinkler heads relying on mechanical components for activation are not able to be shut off individually, but instead rely upon someone to manually turn off the water supply to the heads for them to stop extinguishing/dousing.

SUMMARY

This document generally describes technology for remotely controlling fire suppression systems. While fire suppression systems will save a building from destruction by fire, they can themselves inflict an extensive amount of water damage to a building. For example, fire suppression systems are typically deactivated by fire fighters who are responding to the fire emergency. However, response times for such fire fighters can vary greatly depending on a variety of factors, such as the distance between the building and the

closest fire station and whether fire fighters in the jurisdiction are part of professional or volunteer forces (e.g., fire fighters in volunteer forces may not be on-call and instead may first need to travel to the fire station before responding to a call). During even short response times, water from an activated fire suppression system can cause a great deal of damage to a building and to personal property that is contained therein.

The technology disclosed in this document allows for minimal damage to be inflicted upon a building and property contained within the building when a fire suppression system has been activated. For instance, the technology disclosed in this document allows fire suppression systems to be activated and to fully perform their intended duty—to fully extinguish fires—while at the same time permitting for the fire suppression system to be remotely controlled and deactivated once the fire has been fully extinguished. Thus, damage can be minimized from both a fire within a building and water used to extinguish the fire in a surrounding area from the fire suppression system.

In one implementation, a computer-implemented method includes receiving, at a computer system, information that indicates that a fire has been detected in a building and that a fire suppression system within the building has begun dousing the fire; monitoring sensor information from one or more sensors located within the building; determining, by the computer system and based on the sensor information, whether the fire has been extinguished; activating, in response to determining that the fire has been extinguished, a feature to turn off a water supply to the building, the feature being presented on a computing device for a user who is associated with the building; receiving, after activating the feature and from the computing device, a command to turn off the water supply; and transmitting, by the computer system, a control signal that causes an electromechanical device to close a water valve within the building.

Such a method can optionally include one or more of the following features. The computer system can transmit the control signal to a remote computing device that is located within the building and that is in communication with the electromechanical device. The remote computing device can include a control panel for the building. The remote computing device can include a home automation computer system for the building. The electromechanical device can include a solenoid valve that is located along the water supply for the building and at a position upstream of the fire suppression system. The computer-implemented method can further include sending, in response to receiving the information, an alert to the computing device that causes details about the fire in the building to be output to the user, wherein the feature is deactivated on the computing device at the time the details are output. The computing device can be programmed to present the feature in a user interface of the computing device. Activating the feature can include the computer system transmitting activation information to the computing device to cause the computing device to activate the feature. The computing device can be programmed to prohibit user selection of the feature when the feature is deactivated, and the computing device can be programmed to permit user selection of the feature when the feature is activated. The feature can include a selectable button that is displayed in the user interface. The computer-implemented method can further include verifying, after determining that the fire has been extinguished and before activating the feature, that the fire has been extinguished. The verifying can include, after determining a first time that the fire has been extinguished, repeatedly determining whether the fire

is still extinguished for a period of time using real-time sensor information from the sensors in the building. The verifying can include, after determining that the fire has been extinguished using sensor information from a first type of the sensors, determining whether sensor information from a second type of the sensors also indicates that the fire has been extinguished. The one or more sensors can include one or more of: temperature sensors, smoke detectors, thermographic cameras detecting infrared (IR) light, thermal imaging cameras, and flame detecting devices. The computing device can include a mobile computing device.

In one implementation, a computer-implemented method includes receiving, at a mobile computing device and from a computer system, a notification that a fire has been detected at a building with a fire suppression system supplied with water from a water supply; presenting, by the mobile computing device in response to receiving the notification, a user interface providing real time status information for the fire, the real time status information being provided by the computer system based on information detected by one or more sensors within the building; automatically disabling, by the mobile computing device when the user interface is initially presented, a feature for remotely turning off the water supply in the building; receiving, at the mobile computing device, extinguish information indicating that the fire has been extinguished; activating, by the mobile computing device and in response to receiving the extinguish information, the feature in the user interface; receiving, at the mobile computing device, user input selecting the activated feature in the user interface; and transmitting, by the mobile computing device and to the computer system, instructions to turn off the water supply in the building, the instructions causing the computer system to send a control signal to a device at the building to turn off the water supply to the fire suppression system.

Such a method can optionally include one or more of the following features. The notification can include a push notification on the mobile computing device, and the user interface can be presented by a mobile app that is being executed by the mobile computing device. The feature can include a selectable button, and the real time status information can include (i) information indicating whether the fire is still burning and (ii) information indicating whether the fire suppression system has been begun dispensing water onto the fire.

In one implementation, a system includes one or more sensors located within a building that are configured to detect fires in the building; an electromechanical device configured to control a water valve located along a water supply for the building and at a position upstream of a fire suppression system for the building; and a computer system with one or more processors that are programmed to: receive information that indicates that a fire has been detected in the building and that the fire suppression system within the building has begun dousing the fire; monitor sensor information from the one or more sensors located within the building; determine, based on the sensor information, whether the fire has been extinguished; activate, in response to determining that the fire has been extinguished, a feature to turn off the water supply to the building, the feature being presented on a computing device for a user who is associated with the building; receive, after activating the feature and from the computing device, a command to turn off the water supply; and transmit a control signal that causes the electromechanical device to close the water valve within the building.

Such a system can optionally include one or more of the following features. The system can further include a remote computing device that is located within the building, that is in communication with the electromechanical device, and that is programmed to: receive the control signal transmitted by the computer system, and control operation of the electromechanical device to close the water valve in response to receiving the control signal. The electromechanical device can include a solenoid valve that is located along the water supply for the building and at a position upstream of the fire suppression system. The computer system can be further programmed to send, in response to receiving the information, an alert to the computing device that causes details about the fire in the building to be output to the user. The feature can be deactivated on the computing device at the time the details are output. The computing device can be programmed to present the feature in a user interface of the computing device. The computer system can be programmed to activate the feature by transmitting activation information to the computing device to cause the computing device to activate the feature. The computing device can be programmed to prohibit user selection of the feature when the feature is deactivated, and the computing device can be programmed to permit user selection of the feature when the feature is activated.

Other embodiments of these aspects include corresponding apparatus and computer programs recorded on one or more computer storage devices, configured to perform the actions of the methods. A system of one or more computers can be configured to perform particular operations or actions by virtue of having software, firmware, hardware, or a combination of them installed on the system that in operation causes or cause the system to perform the actions. One or more computer programs can be configured to perform particular operations or actions by virtue of including instructions that, when executed by data processing apparatus, cause the apparatus to perform the actions.

The details of one or more implementations are depicted in the associated drawings and the description thereof below. Certain implementations may provide one or more advantages. For example, the disclosed technology can minimize the aggregate damage that is caused to buildings and personal property contained therein when fire suppression systems are used to extinguish fires in buildings. For instance, by allowing a user, such as a homeowner, to have the ability to turn off a fire suppression system once a fire has been extinguished by a fire suppression system, the damage that would be caused by a fire can be minimized and the damage that would be caused from water used by the fire suppression system can be minimized. In contrast, without such technology, a fire suppression system will continue to run until a person is able to arrive at the building to physically turn off the fire suppression system, during which time extensive water damage can be incurred.

In another example, the disclosed technology can use redundancies to verify that a fire has been extinguished by a fire suppression system before allowing a user to remotely turn off the fire suppression system, which can allow for the technology to operate effectively and safely. For instance, without redundancies to determine whether a fire has been extinguished, a fire may incorrectly be detected as being extinguished and the fire suppression system may be turned off prematurely. In such a situation, the fire could reemerge and cause extensive damage to the building. By using redundancies, such as multiple different sensors and sensor systems to verify whether a fire has been extinguished, the risk of a fire reemerging after the fire suppression system has

been shut off can be minimized, which can minimize both the risk of fire and water damage to the building. Additionally, the use of redundancies can improve the likelihood that the disclosed technology will be permitted for use by fire marshals and others overseeing the installation and operation of fire suppression systems, which can improve the reach and aggregate benefit of the disclosed technology.

In a further example, through the use of a central computer system to determine whether a fire has been extinguished by a fire suppression system, the disclosed technology can provide reliable, independent, and consistent determinations of when fires have been extinguished by fire suppression systems. Such centralized determinations can improve the accuracy and performance of the disclosed technology.

Other features, objects, and advantages of the technology described in this document will be apparent from the description and the drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A-E are conceptual diagrams of an example system for remotely controlling a fire suppression system.

FIG. 2 depicts a system for remotely controlling a fire suppression system.

FIGS. 3A-C depict flowcharts of an example technique for remotely monitoring and controlling a fire suppression system.

FIGS. 4A-B are conceptual diagrams of systems that include examples of other authorized parties who may receive and control water shut off valves within a building.

Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

FIGS. 1A-E are conceptual diagrams of an example system 100 for remotely controlling a fire suppression system. The conceptual diagrams depict operation of the system 100 in response to a fire that is suppressed and extinguished by the fire suppression system, including the remote shut off of the fire suppression system.

Referring to FIG. 1A, the example system 100 includes an example building 102 (e.g., house, office, apartment) that has a fire suppression system 104 installed throughout the building 102, for example, in rooms A and B of the building 102. The example fire suppression system 104 that is depicted is supplied by a fire suppression water line 106 that branches off of a main water line 108 and, according to fire codes in many jurisdictions, before a domestic branch 110 of the water line. The main 108 can further include a valve 112 that, as indicated by the symbol to the left of the valve, is open in FIG. 1A.

The fire suppression system 104 includes sprinkler heads 114a in room A of the building 102 and sprinkler heads 114b in room B of the building 102. The sprinkler heads 114a-b can be any of a variety of appropriate types of sprinkler heads, such as glass bulb sprinklers (e.g., heads that are activated by a glass bulb with heat-sensitive material that causes the bulb to break and allows a cap to fall away to release water from the sprinkler head), fusible link sprinklers (e.g., heads with a two-part heat sensitive metal alloy that holds a cap/plug in place and, in response to the alloy reaching a threshold temperature, causes the cap/plug to fall away to release water from the head), pendant sprinkler heads (e.g., heads that hang down from the ceiling), concealed pendant sprinkler heads (e.g., heads that are recessed

and covered within the ceiling and drop down when activated), upright sprinkler heads (e.g., heads that project up into space), and/or side wall sprinkler heads (e.g., heads that stand out from a wall). Other types of sprinkler heads are also possible.

In response to detecting a fire or conditions that would indicate a fire, such as smoke and/or heat, one or more of the sprinkler heads 114a-b in the fire suppression system 104 can be activated and can begin extinguishing/dousing the building with water supplied to the fire suppression water line 106 from the main 108. The sprinkler heads 114a-b can include fire and/or fire condition sensitive elements that can cause the sprinkler heads 114a-b to be activated and to begin extinguishing/dousing, such as glass bulbs and heat sensitive metal alloy components. For example, the fire suppression system 104 can be a wet pipe system (the fire suppression water line 106 always being filled with water) such that, when the sprinkler heads 114a-b are individually activated by their fire sensitive elements (e.g., glass bulb bursts when threshold temperature reached), they can immediately begin extinguishing/dousing the nearby area with water. In another example, the fire suppression system 104 can be a dry pipe system (the fire suppression water line 106 containing pressurized air (or other gases) that applies pressure to a clapper blocking water from entering the fire suppression water line 106) that fills with water after a fire sensitive element of an individual sprinkler head 114a-b is activated.

The sprinkler heads 114a-b may additionally, or alternatively, be activated by other devices and/or sensors that are external from the heads 114a-b, such as smoke detectors, heat sensors, and/or other devices/sensors that may detect the presence of fire and/or fire conditions. For example, the fire suppression system 104 can be a pre-action system that requires two or more sensors/devices to detect the presence of a fire for the heads 114a-b to begin extinguishing. For instance, an example pre-action system can initially have no water in the fire suppression water line 106 and can use a valve/cap that releases water into the water line 106 in response to a smoke detector in the building 102 detecting smoke. After water is released into the water line 106, the line 106 becomes wet and the sprinkler heads 114a-b can begin extinguishing/dousing once their fire sensitive elements are individually activated (e.g., glass bulb bursting from heat reaching threshold temperature).

When activated, the sprinkler heads 114a-b can send signals to a computing device 116 (e.g., control panel, home automation computer system, computing device within the building 102 transmitting information to one or more remote computer server systems, smartphones, tablets, desktop computers) that indicate that they have been activated. For example, the sprinkler heads 114a-b can be part of a low voltage system and can be supplied by power over one or more low voltage lines. Through the use of the low voltage system, wired and/or wireless signals indicating that the sprinkler heads 114a-b have been activated can be sent to the computing device 116. For example, activation of the sprinkler heads 114a-b can cause one or more circuits of the low voltage system to be completed, which can be detected by the computing device 116 (or other devices in communication with the computing device 116). In another example, the sprinkler heads 114a-b can include wireless transmitters that, when activated, transmit one or more wireless signals to the computing device 116 that indicate that they have been activated.

Remote control of the fire suppression system 104 can include the use of sensors that are located throughout the building 102, such as a first type of sensors (sensors A

118a-b) and a second type of sensors (sensors **B 120a-b**) that are positioned in rooms A and B. The sensors **118-120** can be sensors that are capable of sensing fires and/or conditions (e.g., smoke, heat) that indicate the presence of fires, such as smoke detector devices, heat detector devices (e.g., thermometers), imaging devices that are capable visually detecting fire/heat across one or more portions of the light spectrum (e.g., thermographic camera detecting the infrared (IR) light spectrum, thermal imaging camera), and/or flame detector devices (e.g., devices that detect fires by analyzing and/or comparing one or more portions of the ultraviolet (UV) and IR spectrums). The sensors **A 118a-b** and **B 120a-b** can be different types. For example, the sensors **A 118a-b** can be heat detectors and the sensors **B 120a-b** can be imaging devices to visibly detect fire/heat.

Like the sprinkler heads **114a-b**, the sensors **118-120** can transmit signals indicating the current state within the rooms A and B to the computing device **116**. For example, the sensors **118-120** can be part of the same or different low voltage system as the sprinkler heads **114a-b** and can transmit signals through one or more wired and/or wireless connections to the computing device **116**. These signals can be used to verify whether there is a fire within the rooms A and B, and when such a fire has been sufficiently extinguished to permit the water supply for the fire suppression line **106** to be turned off.

FIGS. 1A-E depict an example scenario of a fire **122** being detected and extinguished in room A by the fire suppression system **104**, and the remote control of the fire suppression system **104** through the use of a remote computer system **124** (e.g., one or more computer servers, cloud computing system, desktop computer) and a user computing device **126** (e.g., mobile computing device (e.g., smartphone, personal digital assistant (PDA), tablet computing device), laptop, desktop computer). At a high level, the remote computer system **124** can receive information from the computing device **116** regarding the state of the fire **122**, as detected by the sensors **118-120**, and the fire suppression system **104**. The remote computer system **124** can provide the user computing device **126** with alerts and real-time (or near real-time) information as to what is going on in the building **102** with regard to the fire **122**, and can only provide the user computing device **126** with the option to turn off water supply to the fire suppression system **104** once the remote computer system **124** has sufficiently verified, based on the information provided by the sensors **118-120**, that the fire **122** has been extinguished.

Referring to FIG. 1A, the computing device **116** can receive information from the sprinkler heads **114a-b** and the sensors **118-120**, as indicated by step A (**128**). The computing device **116** can detect that one or more of the heads **114a-b** of the fire suppression system **104** have been activated and, from the sensor **118-120**, that there is a fire **122** in room A, as indicated by step B (**130**). For example, an example object **124** (e.g., couch, carpet) in room A is on fire, which causes two of the sprinkler heads **114a** in room A to be activated and to begin extinguishing the fire **122** with water. Being part of a low voltage system, the sprinkler heads **114a** activate a water flow switch that can transmit a signal to the computing device **116** that they have been activated. The sensors **118a** and **120a** can also transmit information to the computer system **116** regarding the fire **122**, such as temperature information, smoke information, and/or thermal images of the room A, the object **132**, and the fire **122**.

In response to detecting the fire **122** and activation of the fire suppression system **104**, the computing device **116** can

transmit a notification to the remote computer system **124** over a communication network **134**, as indicated by step C (**136**). The communication network can be any of a variety of appropriate networks over which the computing device **116**, the remote computer system **124**, and the user computing device **126** can communicate, such as the internet, mobile data networks (e.g., 3G/4G mobile data networks), wireless networks (e.g., Wi-Fi networks, BLUETOOTH networks), local area networks (LANs), wide area networks (WANs), virtual private networks (VPNs), fiber optic networks, cellular networks, and/or any combination thereof.

As indicated by step D (**138**), the computer system **124** can process and log the notification received from the computing device **116**. For example, the computer system **124** can determine that there is a fire in the building **102** and can retrieve contact information (e.g., username, identifier for user computing device **126** (e.g., telephone number)) for the users associated with the building **102** (e.g., owners, landlords, tenants, emergency response system for the jurisdiction within which the building **102** is situated) for alerting the users. As indicated by step E (**140**), the computer system **124** can alert the appropriate parties, such as the owners of the building **102** and fire department in the jurisdiction where the building **102** is located. For example, an alert can be transmitted over the network **134** to the user computing device **126**.

As indicated by step F (**142**), the user computing device **126** can receive the alert (e.g., push notification, email, text message) and can output the notification on the device **126**. An example alert **144** is depicted as being displayed by the device **126**. The alert **144** includes a notice that a fire has been detected in Room A of the building **102**, and provides the user with selectable options to remotely monitor the fire from the device **126**, to forward the alert **144** to another user and/or device, and to contact (e.g., place a phone call) to emergency services, such as 911.

Referring to FIG. 1B, in response to the user of the device **126** selecting the monitor option, the user computing device **126** can transmit a request to computer system **124** to monitor the fire, as indicated by step G (**146**). Before and around this same time, the computing device **116** can continue to obtain sensor information from the sensors **118-120**, as indicated by step H (**148**), and to provide the sensor information to the computer system **124**, as indicated by step I (**150**). The computer system **124** can receive the continual stream of sensor information from the computing device **116** and can use it to determine the state of the fire, including whether the fire has been extinguished, as indicated by step J (**152**). In response to the request from the user device **126** to monitor the fire and based on the determined state of the fire, the computer system **124** can select sensor information and user interface (UI) features to provide to the user device **126** for monitoring the fire, as indicated by step K (**154**).

For example, the computer system **124** can be programmed to only provide the user computing device **126** with the option to remotely shut off the water supply to the fire suppression system **104** once the fire **122** has been verified, through one or more of the sensor systems **118** and **120**, to have been extinguished. In the example depicted in FIG. 1B, the fire **122** on the object **132** has not yet been extinguished, so the computer system **124** may not provide the user computing device **126** with the option to turn off the fire suppression system **104**.

The computer system **124** can provide the selected information and UI features to the user computing device **126**, as indicated by step L (**156**), which can be output by the user

computing device 126, as indicated by step M (158). An example user interface 160 is depicted as including a variety of information 162a-d regarding the fire 122.

For example, a first portion of information 162a identifies the information 162b-d as pertaining to monitoring of room A in the building 102. The second portion of information 162b provides the current status of the fire 122 as detected by the sensors A 118a that are located in room A, which in this example are image-based sensors (e.g., IR imaging devices, visible light cameras). The information 162b provides a real-time (or near real-time) image/video of the room A and also status information for the fire 122 ("fire detected") from those sensors 118a, as determined by the computing device 116 and/or the computer system 124 based on the information from the sensors 118a. The third portion of information 162c provides the current status of the fire 122 as detected by the sensors B 118b that are located in room A, which in this example are combination smoke and heat sensors. Current temperature and smoke information for room A are provided and updated in real-time (or near real-time), and a status of the fire 122 is provided, as determined by the computing device 116 and/or the computer system 124. A fourth portion of information 162d includes a deactivated user interface feature (e.g., button, slider) that, once activated, can allow the user of the device 126 to shut off the water supply to the fire suppression system 104.

Referring to FIG. 1C, the fire 122 in room A has now been extinguished by the fire suppression system 104. However, even though the two sprinklers 114a that were activated have extinguished the fire 112, they are still extinguishing/dousing room A of the building 102, as depicted in FIG. 1C. As described above, many types of the sprinklers 114a-b will continue to extinguish/douse once activated (e.g., cap/plug released by glass bulb breaking or metal alloys reaching threshold temperature), will not shut off on their own, and will continue to so long as water being supplied the fire suppression water line 106. To stop the activated sprinklers 114a from extinguishing/dousing room A, the water supply to the fire suppression water line 106 may need to be shut off so that the activated sprinkler heads 114a can be replaced/ repaired (e.g., replaced with heads having unbroken glass bulbs holding caps/plugs in place). Under many building codes to ensure that the fire suppression system 104 is not selectively disabled, the fire suppression water line 106 branches off of the main line 108 with the domestic water line 110 and does not have a separate or independent shut off valve. In such situations, to turn off the water supply to the water supply line 106, the valve 112 for the main water line 108 to the building 102 will have to be shut off.

During the period of time when the fire 122 has been extinguished and the sprinklers 114a are still extinguishing/dousing room A, as depicted in FIG. 1C, additional and unnecessary water damage may be caused to room A as well as to other parts of the building 102. To minimize this additional damage to the building 102, the computing device 116 and the computer system 124 can allow for remote control of the water supply for the fire suppression line 106 (e.g., the main line 108 and the valve 112) to be controlled and turned off from the user computing device 126 once the fire 122 has been verified to be extinguished. As depicted in FIG. 1C, the computing device 116 can continue to obtain sensor information (step H, 148) and to provide the sensor information to the computer system (step I, 150). The computer system 124 can also continue to determine whether the fire has been extinguished (step J, 152) and to

select appropriate information and UI features to present to a user on the user device 126 (step K, 154).

When performing step J (determining whether the fire has been extinguished), the computer system 124 can examine a variety of factors to hedge against the risk of the fire suppression system 104 being turned off prematurely (before the fire 122 has been fully extinguished, which would allow for it to reemerge in room A or other parts of the building 102). For example, the determination made by the computer system 124 as to whether the fire 122 has been extinguished can be based on whether each of the sensor systems (e.g., sensors A 118a-b and sensors B 120a-b) has provided information that indicates that the fire or fire conditions have ceased for at least a threshold period of time (e.g., 5 seconds, 15 seconds, 30 seconds, 1 minute, 2 minutes, 3 minutes, 5 minutes). Disagreement among information provided by the sensors systems as to the state of the fire 122 can indicate that the fire still exists, that it may reemerge if the extinguishing/dousing does not continue, and that the fire suppression system 104 should not yet be shut off. Information from each sensor system (e.g., sensors A 118a-b and sensors B 120a-b) can be compared against thresholds that indicate whether the sensors are detecting a fire and/or conditions that indicates a fire. For instance, the thermal images provided by the example sensors A 118a can be analyzed to determine whether any portions of the images indicate heat in excess of a threshold value (e.g., 70° F., 80° F., 90° F., 100° F.), smoke information provided by the example sensors 120a can be analyzed to determine whether smoke is currently detected, and ambient temperature information for the room A provided by the sensors 120a can be compared against threshold values (e.g., 70° F., 80° F., 90° F., 100° F.). Temperature threshold values, for example, may be specified as an appropriate fixed value, or as a variable value that depends on (e.g., is 5 degrees, 10 degrees, or another suitable number of degrees greater than) an ambient air temperature (e.g., a setpoint temperature, a measured temperature) of the building 102 at a time (e.g., a half hour, an hour, two hours) before the fire activation system 104 was activated.

In the example depicted in FIG. 1C, the computer system 124 can determine whether the fire 122 has been extinguished and, based on that determination, can enable the UI feature for remotely shutting off the water supply to the fire suppression system 104 on user computing device 126. The computer system 124 can provide the updated sensor information and the UI features, including the water shut off feature, to the client computing device 126, as indicated by step L (156).

In response to receiving the information and UI features, the user computing device 126 can update the user interface 160 and can activate the water shut off button, as indicated by step N (164). For example, the information 162a-d that is presented in the user interface 160, can be updated to indicate that the current status of the fire in room A. For instance, the second portion of the information 162b is updated to depict a current image/video of the room A, which includes the fire being out, the sprinklers still extinguishing/dousing the room A, and a status determined by the computer system 124 (and/or the computing device 116) that, based on sensor A, the fire has been extinguished. The third portion of the information 162c is updated with the current temperature and smoke status for room A, as well as with the status determined by the computer system 124 (and/or the computing device 116) that, based on sensor B, the fire has been extinguished. The fourth portion of the information 162d is updated to provide the user with a

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selectable feature (e.g., button, slider) to shut off the water and information indicating that the feature has been activated.

Referring to FIG. 1D, the user computing device 126 can receive selection of the water shut off feature, as indicated by step O (166), and in response can transmit a shut off command to the computer system 124 and/or to the computing device 116, as indicated by step P (168). The user interface 160 can be updated to reflect that the shut off command has been sent, as indicated in the fourth portion of the information 162d. In some implementations, the shut off command can be sent to the computer system 124, which can verify the command as being appropriate and/or authorized given the determined state of the fire and can retransmit the command to the computing device 116. In some implementations, the shut off command may be sent from the user computing device 126 directly to the computing device 116 in addition/alternative to the command being sent to the computer system 116.

As indicated by step Q (170), the computing device 116 can receive the shut off command and, as indicated by step R (172) and in response to receiving the command, can activate the valve 112. The computing device 116 can send a signal (e.g., wired signal, wireless signal) to one or more devices that are able to electromechanically control the valve, such as a solenoid valve. A valve control device can open and close the valve in response to the signal using electrical, hydraulic, pneumatic, or other appropriate actuators, and may include one or more sensors that monitor changes in valve condition (e.g., an open or closed state). Such a device may be part of or separate from the valve 112, and may be able to report the state of the valve to the computing device 116 (e.g., valve 112 is open, valve 112 is closed). As indicated by the symbol next to the valve 112 in FIG. 1D, the valve 112 closes and is in a closed state following direction from the computing device 116.

As indicated by step S (174), the computer system 124 can process and log the shut off command received from the user computing device 126. The computer system 124 can log some or all of the information that is received from the computing device 116 and/or the user computing device 126 in conjunction with the building 102, which can be used by any of a variety of parties at a later time, such as fire investigators, insurers, manufacturers, and/or builders.

Referring to FIG. 1E, the computing device 116 can detect whether the valve 112 has been successfully shut off, as indicated by step T (176). For example, the computing device 116 can receive information from the valve 112 and/or electromechanical device used to shut off the valve 112 indicating the state of the valve 112. The computing device 116 may additionally and/or alternatively obtain readings from one or more flow meters that are installed along the water supply after the valve 112, such as a flow switch that is installed on the fire suppression line 106.

The computing device 116 can transmit information about the status of the valve to the computer system 124, as indicated by step U (178). The computer system 124 can receive and log the status information regarding the valve, as indicated by step W (180), and can transmit an update regarding the status to the appropriate parties (e.g., user computing device, fire department, emergency response services, insurer), as indicated by step X (182).

The user computing device 126 can receive the update and can output the valve status information, as indicated by step V (184). For example, the fourth portion of the infor-

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mation 162d can be updated to indicate that the water shut off has been confirmed by the computing device 116 and/or the computer system 124.

A variety of additional and/or alternative features can be used in association with the system 100. For example, the computing device 116 and/or the computer system 124 can be programmed to automatically transmit a shut off command without user involvement. Such an automated shut-off command may be generated based on a variety of factors, such as whether the user computing device 126 is active and monitoring the fire 122, the estimated time for the fire department to arrive at the building 102, the confidence with which the fire 122 has been determined to be extinguished based on the information from the sensors 118-120, and/or an amount of time that has elapsed since the fire 122 was determined to be extinguished and/or that the shut off command was made available without being activated. Such factors may be designated by any of a variety of appropriate parties, such as the owners of the building 102, the tenants of the building 102, fire officials (e.g., fire marshals), and/or insurers of the building 102.

In another example, the user of the user computing device 126 who is able to shut off the fire suppression system can include one or more parties, such as the building owner, tenants of the building 102, private and/or public emergency response groups (e.g., home security company, fire department), fire officials (e.g., fire marshal), and/or other proxies who may be designated. In some implementations, there may need to be consent from multiple parties for the fire suppression system to be shut off. For instance, there may be another user computing device, such as one associated with a fire department and/or fire marshal, that has the same view of the building 102 and the fire 122, and which also has to consent to the water being shut off for the computer system 124 and/or the computing device 116 to act upon the command.

In another example, the computing device 116 and the other low voltage components of the system 100 can be supplied with power from one or more backup power supplies, as needed. For example, the building 102 can have a battery backup that can be used to power the computing device 116, the sensors 118-120, and/or the electromechanical control of the valve 112.

FIG. 2 depicts a system 200 for remotely controlling a fire suppression system 202. The system 200 can be similar to the system 100, described above with regard to FIG. 1.

The system 200 includes a building 204 (e.g., the building 102) that includes a water system 206 with a shut off valve 208 (e.g., the valve 112), a domestic water system 210 (e.g., the domestic water line 110), and the fire suppression system 202 (e.g., the fire suppression system 104 with fire suppression line 106). The fire suppression system 202 can include a plurality of extinguishing/dousing heads 212, such as the sprinkler heads 114a-b described above with regard to FIG. 1. The fire suppression system 202 further includes a plurality of fire detection devices 214 that can detect a fire and/or the presence of conditions that indicate that is a fire, and that can trigger, either directly or indirectly, the activation of the extinguishing/dousing heads 212. For example, the fire detection devices 214 can be glass bulbs that are positioned within the extinguishing/dousing heads 212 and that burst when a threshold temperature is reached, thus releasing a cap/plug in the extinguishing/dousing heads 212 and allowing water out of the heads 212. The fire detection devices 214 can also be other devices, such as the metal alloy discussed above and/or appropriate sensors. In some implementations, the fire suppression system 202 can further

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include a flow switch **216** to provide an indication of whether water is flowing through and out of the fire suppression system **202**.

The building **204** can also include sensors **218**, including sensors of multiple different types **220a-n**. The sensors **218** can be positioned throughout the building **204** and near/around the extinguishing/dousing heads **212** so that information regarding state of fires that may be extinguished/doused by the heads **212** is accurately obtained and reported. The sensors can be similar to the sensors **118-120** described above with regard to FIGS. 1A-E.

The building **204** can further include an in-building computing device **222**, which can be similar to the computing device **116**. The computing device **222** can be any of a variety of appropriate computing devices and/or systems, such as computer servers, desktop computers, laptop computers, mobile computing devices, cloud computing systems, and/or other appropriate computing devices/systems.

The computing device **222** includes a fire suppression system interface **224** that is programmed to receive information from the fire suppression system **202**, such as signals transmitted by the fire detection devices **214** indicating that a fire and/or fire conditions have been detected, and that the extinguishing/dousing heads **212** have been activated. For example, the fire suppression system **202** can include a low voltage system over which signals from the fire detection devices **214** are transmitted. The fire suppression system interface **224** can include a monitor module **226** that is programmed to continuously monitor and interpret signals from the fire suppression system **202**.

The computing device **222** also includes a sensor interface **228** that is similar to the interface **224** and that is programmed to receive information from the sensors **218**. The sensor interface **228** includes a monitor module **230** that is programmed to continuously monitor and interpret signals from the sensors **218**. The sensor interface **228** can further include an analysis module **232** that is programmed to analyze the signals from the sensors **218** to determine various states/conditions throughout the building **204**, such as whether a fire or fire conditions exist at various locations within the building **204**. For example, the analysis module **232** can use various threshold values for parameters that are sensed/detected by the sensors **218** to determine states/conditions.

The computing device **222** can further include a shut off valve interface **234** that is programmed to interface with the shut off valve **208** and to control an electromechanical device that controls the shut off valve **208**. The shut off valve interface **234** includes a monitor module **236** that is programmed to continuously monitor information transmitted by the electromechanical device, such as information indicating whether the shut off valve **208** is open or closed. The shut off valve interface **234** also includes a control module **238** that is programmed to control the operation of the shut off valve, such as transmitting control signals to the electromechanical device that controls the shut off valve **208**.

The computing device **222** further includes a server interface **240** that enables communication between the computing device **222** and a computer server system **242** over a network **244**. For example, the server interface **240** can include one or more communication interfaces, such as the TCP/IP protocol stack, Ethernet interfaces, wireless networking interfaces, and/or mobile data networking interfaces.

The network **244** can be similar to the network **134**, as described above with regard to FIGS. 1A-E, and be any of a variety of communication networks over which the com-

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puting devices and computer systems that are part of the system **200** can communicate, such as the internet, mobile data networks (e.g., 3G/4G mobile data networks), wireless networks (e.g., Wi-Fi networks, BLUETOOTH networks), local area networks (LANs), wide area networks (WANs), virtual private networks (VPNs), fiber optic networks, cellular networks, and/or any combination thereof.

The computer server system **242** can be similar to the computer system **124** that is discussed above with regard to FIGS. 1A-E. The computer server system **242** can include one or more computing devices (e.g., one or more computer server, cloud computing system, desktop computer, laptop computer) that are programmed to respond to requests from client devices, such as the in-building computing device **222**, and to perform processes to allow for remote control of the fire suppression system **202**, as described throughout this document.

The computer server system **242** includes a building information monitor module **246** that is programmed to receive information for buildings, such as the building **204** and other buildings not depicted, from one or more computing devices that are monitoring and transmitting such information, such as the in-building computing device **222** and other computing devices associated with other buildings. Information that is received and monitored by the module **246** can be stored in one or more data repositories **258a-c**, such as a log **258a** that logs building information, such as timestamped information from the sensors **218**, the state of the shut off valve **208**, the state of the fire suppression system **202**, and commands to perform water shut off operations. The other data repositories include a building-user information repository **258b** that stores information about users associated with buildings, such as contact information and computing device identifiers for owners and tenants of the building **204**; and other authorized party information data repository **258c** that stores information about other parties that may be authorized to receive building information and alerts, such as fire departments, fire marshals, and insurers.

The computer server system **242** further includes a fire detection module **248** that is programmed to determine whether there is a fire in the building **204**. The computer system **242** also includes a fire extinguishing detection module that is programmed to determine, after a fire has been detected by the fire detection module **248**, when the fire has been sufficiently extinguished that it is safe to allow for remote shut off of the water system **206** and the fire suppression system **202**. Such determinations made by the modules **248** and **250** can additionally be stored in the log **258a**.

The computer system also includes a user computing device interaction module **252** that is programmed to coordinate and manage communication with a user computing device **260**, which can be associated with a user with a connection to the building **204** (e.g., owner, tenant, landlord). The module **252** can perform operations similar to steps E, K, and X (**140**, **154**, and **182**, respectively), described above with regard to FIG. 1, and can communicate with the user computing device **260** over the network **244**. For example, the module **252** can determine when it is appropriate to provide/enable UI features on the computing device **260** through which the user can remotely control the fire suppression system **202**.

The user computing device **260** can be similar to the computing device **126**, as described above with regard to FIGS. 1A-E. The user computing device **260** can be any of a variety of appropriate computing devices, such as com-

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puter servers, desktop computers, laptop computers, and/or mobile computing devices (e.g., smartphones (e.g., IPHONE, ANDROID smartphones), cell phones (e.g., feature phones), tablet computing devices (e.g., IPADS, ANDROID tablets), personal digital assistants (PDAs), computing devices embedded within vehicles (e.g., in-vehicle computer systems with displays and/or user interfaces built into the vehicles' consoles, vehicle mounted computing devices, golf carts with embedded computing devices), wearable computing devices (e.g., GOOGLE GLASS), laptop computers, netbook computers, and/or other appropriate mobile computing devices).

The computing device 260 includes an output subsystem 262 that can output UI features through which a user of the computing device 260 can monitor the status of the building 204 and, when appropriate, deactivate a fire suppression system 202. The output subsystem 262 can include one or more appropriate output devices through which information can be provided to a user, such as a display, speakers, haptic feedback devices (e.g., vibration device), and/or other devices that are in communication with the device 206 (e.g., wireless headset). The computing device 260 further includes an input subsystem 264 through which a user can provide input, such as a command to turn off the fire suppression system 202. The input subsystem 264 can include one or more appropriate input devices through which a user of the device 260 can provide input, such as a touchscreen, physical buttons/keys, microphones, cameras, and/or other appropriate input devices (e.g., accelerometers, gyroscopes).

The user computing device 260 further includes a fire suppression application 266 that is programmed to communicate with the server system 242 to obtain information about the building 204, to provide an interface through which the user can view information about the building 204, and through which a user can provide input, such as a command to turn off the fire suppression system 202. The application 266 can be of any of a variety of appropriate types, such as software (e.g., mobile app), hardware (e.g., application specific integrated circuit (ASIC)), and/or firmware.

Water shut off commands can be transmitted by the device 260 and provided to a water shut off valve control module 254 of the computer system 242. The module 254 can monitor the status of the shut off valve 208 and can transmit commands to the electromechanical component of the valve 208, such as commands to open the valve 208 and commands to close the valve 208. Commands that are received and/or sent by the module 254 can be stored in the log 258a.

The computer system 242 can further include an other authorized party interaction module 256, which can control the interactions with other parties who may be authorized to receive information about the building 204 and/or to control the valve 208, such as other tenants of the building 204, insurers, and/or fire professionals (e.g., fire marshals, fire departments). The module 256 can interface with one or more other authorized party computing devices 268 that are associated with such other parties.

The computing device 268 can be similar to the user computing device 260, and can include an output subsystem 270 (similar to the output subsystem 262), an input subsystem 272 (similar to the input subsystem 264), and a fire suppression application (similar to the application 266).

FIGS. 3A-C depict flowcharts of an example technique 300 for remotely monitoring and controlling a fire suppression system. The technique 300 is performed in part by a building computing device 302, a computer server system

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304, and a user computing device 306. The building computing device 302 can be any of a variety of appropriate computing devices, such as the computing device 116, the computing device 222, and/or other appropriate computing devices. The computer server system 304 can be any of a variety of appropriate computer systems, such as the computer system 124, the computer system 242, and/or other appropriate computer systems. The user computing device 306 can be any of a variety of appropriate computer devices, such as the user computing device 126, the user computing device 260, the other authorized party computing device 268, and/or other appropriate computing devices.

The building computing device 302 can provide status information to the computer server 304 and the device 306 without there being a fire at a corresponding building. For example, the building device 302 can periodically (e.g., every minute, every 5 minutes, every 15 minutes, every 30 minutes, every hour, every 6 hours, every 12 hours) monitor and report the status of the fire suppression system to the computer sever system 304 and/or the user computing device 306 (308). The computer server system 304 can log and report to the user the status of the fire suppression system (310), which can output the status information (312).

The building computing device 302 can detect a fire (or conditions that indicate a fire) and/or activation of the fire suppression system within the building (314). In response to such a detection, the building computing device 302 can obtain, report, and/or analyze information regarding the fire and/or other information from the sensors within the building to the computer system 304 (316).

The computer server system 304 can receive and log the information regarding the fire and/or sensors (318), and can analyze the information to determine the status of the fire (e.g., location within building, extinguished, fire still active) (320). The computer server system 304 can transmit real-time information about the fire to the user and/or other authorized parties (322). The user computing device 306 can receive and output the information (324).

The computer server system 304 can determine whether fire has already been detected in the building (326) and, if it has not yet been detected, the computer server system 304 can determine whether there is a fire in the building (328). If there is determined to be a fire in the building (330), the computer system can log and report the fire status (332), which can be output on the user computing device 306 (334). If no fire has been detected, then the technique can loop back to step 316.

If a fire has already been detected, then a determination can be made as to whether the fire has been extinguished (336). If the fire is determined to not have yet been extinguished (338), then the process can loop back to step 316 and can repeatedly monitor the information from the building computer system 302 until the fire has been determined to be extinguished.

If the fire is determined to have been extinguished (338), then the computer sever system 304 can perform a verification alert that the fire is extinguished (340). Such a verification can include any of a variety of techniques, such as monitoring whether the extinguished determination for the fire remains constant for a period of time (e.g., 15 seconds, 30 seconds, 1 minute, 5 minutes) and/or whether a second or redundant set of sensors provides a consistent verification that the fire has been extinguished. Referring to FIG. 3B, if the fire is verified as having been extinguished (342), then the computer server system 304 can transmit authorization to provide shut off capability to the user or

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other authorized parties (344). If the fire is not verified as having been extinguished, then the technique 300 can loop back to step 316.

The user computing device 306 can receive the authorization and output the water shut off feature (346). In response to receiving user input with regard to the feature (348), the user computing device 306 can transmit a water shut off command to the computer server system 304 (350). Such a command can be received, logged, and retransmitted by the computer server system 304 (352).

The building computing device 302 can receive the water shut off command (354) and, in response to receiving the command, can activate the water shut off valve (356). The building computing device 302 can verify that the water is shut off (358) and can transmit information regarding the water shut off status to the computer server system 304 (360). The computer server system 304 can receive, log, and retransmit the water shut off status information (362), which can be output by the user computing device 302 (364).

The building computing device 302 can continue to monitor and transmit sensor information to the computer server system 304 (366), which can be logged and analyzed by the computer server system 304 to determine whether the fire has reemerged (368). Referring to FIG. 3C, the computer server system 304 can determine whether the fire has been detected again (370). If the fire has not been detected again, then the technique 300 can loop back to step 366. If the fire has been detected again, the computer server system 304 can log and automatically transmit a command to open the water shut off valve to the building computing device 302 (372). The computer server system 304 can additionally notify the user computing device 306 that the fire has reemerged and that the water is being automatically turned on (384).

The building computing device 302 can receive such a command (374), can activate opening of the water shut off valve (376), can verify that the water in the building has been turned on again (378), and can transmit information regarding the water shut off status to the computer server system 304 (380). The computer server system 304 can log and retransmit the status information (382), which can be output by the user computing device 306 (386). Once the water has been turned on again, the technique 300 can loop back to step 316.

FIGS. 4A-B are conceptual diagrams of systems 400 and 450 that include example other authorized parties who may receive and control water shut off valves within a building.

Referring to FIG. 4A, the example system 400 includes a building 402 that includes one tenant/unit A that is supplied by a main water line 404 with a valve 406 that branches into a fire suppression water line 408 and a domestic water line 410. The building 402 includes a computing device 412 that can be used to transmit information about the building 402 to a computer system 414 and that can allow for remote operation of the valve 406 to shut off the water supplied to the fire suppression line 408. The computer system 414 can communicate with a computing device associated with a single user A (or group of users A, such as a family) and computing devices associated with other authorized users 418, which in this example are emergency services personnel, such as a fire department and fire marshal with jurisdiction over the building 402.

Referring to FIG. 4B, the example system 450 depicts a scenario in which a building 452 includes multiple tenants/units A-C who share a common main water line 454 that is controlled by a common valve 456. In such a situation, the fire suppression water lines A-C and domestic water lines A-C for each of the tenants/units A-C can branch off of the

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common main water line 454. In such a situation, the valve 456 may be located in a mechanical room/area 458 for the building 452 that can also include a computing device 460 that can communicate with a computer system 462 and can receive commands to control the valve 456. Each of the tenants/units A-C can also include computing devices A-C 464a-c that can obtain and provide information regarding components with the tenants/units A-C, such as status information from sprinkler heads and/or sensors that are located within the units A-C. The computing device A-C 464a-c can transmit such information to the computer system 462.

The computer system 462 can communicate status information for any one of the tenant/units A-C to computing devices that are associated with users for each of the units A-C, such as users A-C 466a-c. The computer system 462 can provide a tenant of a unit that has a fire to view all information about the fire and to control the valve 456 for the building, and may provide some or all of these features to the other users. For users who do not have a fire in their unit, the computer system 462 can additionally provide status information about their units, including sensor information, to the corresponding users so that they can track whether fire has spread to their unit as well. These other users may additionally be given the ability to reactivate the valve 456 to turn the water supply to the building 452 back on. The ability to reactivate the valve 456 may be restricted (similar to the water deactivation button being deactivated until a fire has been verified as being extinguished) to situations in which a fire or conditions that appear to be close to a fire are detected within one of the other units of the building 452.

Other authorized parties who may be able to access status information for the building 452 and/or control the valve 456 include, in this example, emergency services personnel 468, such as fire departments and/or fire marshals.

Computing devices and computer systems described in this document that may be used to implement the systems, techniques, machines, and/or apparatuses can operate as clients and/or servers, and can include one or more of a variety of appropriate computing devices, such as laptops, desktops, workstations, servers, blade servers, mainframes, mobile computing devices (e.g., PDAs, cellular telephones, smartphones, and/or other similar computing devices), computer storage devices (e.g., Universal Serial Bus (USB) flash drives, RFID storage devices, solid state hard drives, hard-disc storage devices), and/or other similar computing devices. For example, USB flash drives may store operating systems and other applications, and can include input/output components, such as wireless transmitters and/or USB connectors that may be inserted into a USB port of another computing device.

Such computing devices may include one or more of the following components: processors, memory (e.g., random access memory (RAM) and/or other forms of volatile memory), storage devices (e.g., solid-state hard drive, hard disc drive, and/or other forms of non-volatile memory), high-speed interfaces connecting various components to each other (e.g., connecting one or more processors to memory and/or to high-speed expansion ports), and/or low speed interfaces connecting various components to each other (e.g., connecting one or more processors to a low speed bus and/or storage devices). Such components can be interconnected using various busses, and may be mounted across one or more motherboards that are communicatively connected to each other, or in other appropriate manners. In some implementations, computing devices can include pluralities of the components listed above, including a plurality

of processors, a plurality of memories, a plurality of types of memories, a plurality of storage devices, and/or a plurality of buses. A plurality of computing devices can be connected to each other and can coordinate at least a portion of their computing resources to perform one or more operations, such as providing a multi-processor computer system, a computer server system, and/or a cloud-based computer system.

Processors can process instructions for execution within computing devices, including instructions stored in memory and/or on storage devices. Such processing of instructions can cause various operations to be performed, including causing visual, audible, and/or haptic information to be output by one or more input/output devices, such as a display that is configured to output graphical information, such as a graphical user interface (GUI). Processors can be implemented as a chipset of chips that include separate and/or multiple analog and digital processors. Processors may be implemented using any of a number of architectures, such as a CISC (Complex Instruction Set Computers) processor architecture, a RISC (Reduced Instruction Set Computer) processor architecture, and/or a MISC (Minimal Instruction Set Computer) processor architecture. Processors may provide, for example, coordination of other components computing devices, such as control of user interfaces, applications that are run by the devices, and wireless communication by the devices.

Memory can store information within computing devices, including instructions to be executed by one or more processors. Memory can include a volatile memory unit or units, such as synchronous RAM (e.g., double data rate synchronous dynamic random access memory (DDR SDRAM), DDR2 SDRAM, DDR3 SDRAM, DDR4 SDRAM), asynchronous RAM (e.g., fast page mode dynamic RAM (FPM DRAM), extended data out DRAM (EDO DRAM)), graphics RAM (e.g., graphics DDR4 (GDDR4), GDDR5). In some implementations, memory can include a non-volatile memory unit or units (e.g., flash memory). Memory can also be another form of computer-readable medium, such as magnetic and/or optical disks.

Storage devices can be capable of providing mass storage for computing devices and can include a computer-readable medium, such as a floppy disk device, a hard disk device, an optical disk device, a Microdrive, or a tape device, a flash memory or other similar solid state memory device, or an array of devices, including devices in a storage area network or other configurations. Computer program products can be tangibly embodied in an information carrier, such as memory, storage devices, cache memory within a processor, and/or other appropriate computer-readable medium. Computer program products may also contain instructions that, when executed by one or more computing devices, perform one or more methods or techniques, such as those described above.

High speed controllers can manage bandwidth-intensive operations for computing devices, while the low speed controllers can manage lower bandwidth-intensive operations. Such allocation of functions is exemplary only. In some implementations, a high-speed controller is coupled to memory, display 616 (e.g., through a graphics processor or accelerator), and to high-speed expansion ports, which may accept various expansion cards; and a low-speed controller is coupled to one or more storage devices and low-speed expansion ports, which may include various communication ports (e.g., USB, Bluetooth, Ethernet, wireless Ethernet) that may be coupled to one or more input/output devices, such as keyboards, pointing devices (e.g., mouse, touchpad, track

ball), printers, scanners, copiers, digital cameras, microphones, displays, haptic devices, and/or networking devices such as switches and/or routers (e.g., through a network adapter).

Displays may include any of a variety of appropriate display devices, such as TFT (Thin-Film-Transistor Liquid Crystal Display) displays, OLED (Organic Light Emitting Diode) displays, touchscreen devices, presence sensing display devices, and/or other appropriate display technology. Displays can be coupled to appropriate circuitry for driving the displays to output graphical and other information to a user.

Expansion memory may also be provided and connected to computing devices through one or more expansion interfaces, which may include, for example, a SIMM (Single In Line Memory Module) card interfaces. Such expansion memory may provide extra storage space for computing devices and/or may store applications or other information that is accessible by computing devices. For example, expansion memory may include instructions to carry out and/or supplement the techniques described above, and/or may include secure information (e.g., expansion memory may include a security module and may be programmed with instructions that permit secure use on a computing device).

Computing devices may communicate wirelessly through one or more communication interfaces, which may include digital signal processing circuitry when appropriate. Communication interfaces may provide for communications under various modes or protocols, such as GSM voice calls, messaging protocols (e.g., SMS, EMS, or MMS messaging), CDMA, TDMA, PDC, WCDMA, CDMA2000, GPRS, 4G protocols (e.g., 4G LTE), and/or other appropriate protocols. Such communication may occur, for example, through one or more radio-frequency transceivers. In addition, short-range communication may occur, such as using a Bluetooth, Wi-Fi, or other such transceivers. In addition, a GPS (Global Positioning System) receiver module may provide additional navigation and location-related wireless data to computing devices, which may be used as appropriate by applications running on computing devices.

Computing devices may also communicate audibly using one or more audio codecs, which may receive spoken information from a user and convert it to usable digital information. Such audio codecs may additionally generate audible sound for a user, such as through one or more speakers that are part of or connected to a computing device. Such sound may include sound from voice telephone calls, may include recorded sound (e.g., voice messages, music files, etc.), and may also include sound generated by applications operating on computing devices.

Various implementations of the systems, devices, and techniques described here can be realized in digital electronic circuitry, integrated circuitry, specially designed ASICs (application specific integrated circuits), computer hardware, firmware, software, and/or combinations thereof. These various implementations can include implementation in one or more computer programs that are executable and/or interpretable on a programmable system including at least one programmable processor, which may be special or general purpose, coupled to receive data and instructions from, and to transmit data and instructions to, a storage system, at least one input device, and at least one output device.

These computer programs (also known as programs, software, software applications, or code) can include machine instructions for a programmable processor, and can

be implemented in a high-level procedural and/or object-oriented programming language, and/or in assembly/machine language. As used herein, the terms “machine-readable medium” “computer-readable medium” refers to any computer program product, apparatus and/or device (e.g., magnetic discs, optical disks, memory, Programmable Logic Devices (PLDs)) used to provide machine instructions and/or data to a programmable processor.

To provide for interaction with a user, the systems and techniques described here can be implemented on a computer having a display device (e.g., LCD display screen, LED display screen) for displaying information to users, a keyboard, and a pointing device (e.g., a mouse, a trackball, touchscreen) by which the user can provide input to the computer. Other kinds of devices can be used to provide for interaction with a user as well; for example, feedback provided to the user can be any form of sensory feedback (e.g., visual feedback, auditory feedback, and/or tactile feedback); and input from the user can be received in any form, including acoustic, speech, and/or tactile input.

The systems and techniques described here can be implemented in a computing system that includes a back end component (e.g., as a data server), or that includes a middleware component (e.g., an application server), or that includes a front end component (e.g., a client computer having a graphical user interface or a Web browser through which a user can interact with an implementation of the systems and techniques described here), or any combination of such back end, middleware, or front end components. The components of the system can be interconnected by any form or medium of digital data communication (e.g., a communication network). Examples of communication networks include a local area network (“LAN”), a wide area network (“WAN”), peer-to-peer networks (having ad-hoc or static members), grid computing infrastructures, and the Internet.

The computing system can include clients and servers. A client and server are generally remote from each other and typically interact through a communication network. The relationship of client and server arises by virtue of computer programs running on the respective computers and having a client-server relationship to each other.

The above description provides examples of some implementations. Other implementations that are not explicitly described above are also possible, such as implementations based on modifications and/or variations of the features described above. For example, the techniques described above may be implemented in different orders, with the inclusion of one or more additional steps, and/or with the exclusion of one or more of the identified steps. Additionally, the steps and techniques described above as being performed by some computing devices and/or systems may alternatively, or additionally, be performed by other computing devices and/or systems that are described above or other computing devices and/or systems that are not explicitly described. Similarly, the systems, devices, and apparatuses may include one or more additional features, may exclude one or more of the identified features, and/or include the identified features combined in a different way than presented above. Features that are described as singular may be implemented as a plurality of such features. Likewise, features that are described as a plurality may be implemented as singular instances of such features. The drawings are intended to be illustrative and may not precisely depict some implementations. Variations in sizing, placement, shapes, angles, and/or the positioning of features relative to each other are possible.

What is claimed is:

1. A system for detecting a leak, the system comprising:
 - a sensor system that monitors water usage, temperature, and pressure in a building, wherein the sensor system is configured to generate sensor signals; and
 - a computer system that is remote from a location of the sensor system, wherein the computer system is configured to:
 - receive water usage and temperature sensor signals generated by the sensor system;
 - process the received water usage and temperature sensor signals to determine whether the received water usage and temperature sensor signals exceed first threshold water usage and temperature conditions indicative of a deviation from expected water usage and temperature conditions in the building;
 - based on a determination that the received water usage and temperature sensor signals exceed the first threshold water usage and temperature conditions indicative of the deviation from the expected water usage and temperature conditions in the building, transmit information to a mobile device of a user associated with the building over a communication network, wherein the information comprises (i) a portion of the received water usage and temperature sensor signals, and (ii) a user interface element that, when selected by the user, causes a state change command to be transmitted to a valve control device to change a state of a valve in the building;
 - process the received water usage and temperature sensor signals to determine whether the received water usage and temperature sensor signals exceed second threshold water usage and temperature conditions that are different from the first threshold water usage and temperature conditions and indicative of an emergency event in the building;
 - based on a determination that the received water usage and temperature sensor signals exceed the second threshold water usage and temperature conditions indicative of the emergency event in the building, transmit a state change command to the valve control device over the communication network to automatically change the state of the valve without first transmitting the information to the mobile device of the user and without receiving user input from the mobile device to control the state of the valve in the building; and
 - in response to automatically changing the state of the valve in the building, transmitting second information to the mobile device of the user, the second information comprising at least (i) the portion of the water usage and temperature sensor signals and (ii) an indication that the emergency event was detected in the building.
2. The system of claim 1, wherein the sensor comprises a temperature sensor and the sensor signals comprise temperature data.
3. The system of claim 1, wherein the sensor comprises a water flow sensor and the sensor signals comprise water flow information.
4. The system of claim 1, wherein the transmitted information comprises temperature information.
5. The system of claim 1, wherein the mobile device is configured to:
 - present the transmitted information in a graphical user interface (GUI),
 - present a selectable option in the GUI, and

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receive a user selection of the selectable option, which causes an action to be performed.

6. The system of claim 5, wherein the action comprises shutting off the valve, wherein the computer system is configured to (i) receive the user selection of the selectable option to shut off the valve and (ii) send a state change command, based on the user selection, to the valve to cause the valve to change its state.

7. The system of claim 5, wherein the action comprises shutting off the valve, wherein the computer system is configured to (i) receive the user selection of the selectable option to shut off the valve and (ii) send a state change command, based on the user selection, to the valve control device, wherein the valve control device is configured to change a state of the valve according to the state change command.

8. The system of claim 5, wherein the action comprises shutting off the valve, wherein the mobile device is configured to transmit, over a communication network, a state change command to the valve control device, wherein the valve control device is configured to change a state of the valve according to the state change command.

9. The system of claim 1, wherein in response to the valve control device automatically changing the state of the valve, the computer system is further configured to transmit second information to the mobile device over the communication network indicating a change in the state of the valve.

10. A system for automatically shutting off a water supply, the system comprising:

a sensor system that monitors water usage, temperature, and pressure in a building, wherein the sensor system is configured to generate sensor signals; and

a computer system that is remote from a location of the sensor system, wherein the computer system is configured to:

receive water usage and temperature sensor signals generated by the sensor system;

process the received water usage and temperature sensor signals to determine whether the received water usage and temperature sensor signals exceed first threshold water usage and temperature conditions indicative of a deviation from expected water usage and temperature conditions in the building or (ii) second threshold conditions indicative of an emergency event in the building;

based on a determination that the received water usage and temperature sensor signals exceed the first threshold water usage and temperature conditions indicative of the deviation from the expected water usage and temperature conditions in the building, send a state change command to a valve control device, wherein the valve control device is configured to automatically change a state of a valve according to the state change command;

in response to automatically changing the state of the valve in the building, transmitting first information to a mobile device of a user, the first information comprising at least (i) a first portion of the received water usage and temperature sensor signals and (ii) an indication that the emergency event was detected in the building;

process the received water usage and temperature sensor signals to determine whether the received water usage and temperature sensor signals exceed second threshold water usage and temperature conditions that are different from the first threshold water usage

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and temperature conditions and indicative of an emergency event in the building; and

based on a determination that the received water usage and temperature sensor signals exceed the second threshold water usage and temperature conditions, transmit second information to the mobile device of a user associated with the building, wherein the second information comprises (i) a second portion of the received water usage and temperature sensor signals, and (ii) a user interface element that, when selected by the user, causes a state change command to be transmitted to the valve control device to automatically change the state of the valve in the building.

11. The system of claim 10, wherein the system further comprises the valve control device.

12. The system of claim 10, wherein the building has a main water line with a first extent and a second extent, and wherein the valve is configured to be positioned between the first and second extents of the main water line.

13. The system of claim 10, wherein if the state change command was sent to the valve control device, the computer system is further configured to selectively transmit information to a mobile device over a communication network, wherein the information includes an indication of the state change command.

14. The system of claim 10, wherein the transmitted information further comprises an indication that a water leak was detected.

15. The system of claim 10, wherein the sensor signals comprise temperature data and the information comprises the temperature data.

16. A system for detecting a water leak, the system comprising:

a sensor system that monitors water usage, temperature, and pressure in a building, wherein the sensor is configured to generate sensor signals; and

a computer system that is remote from a location of the sensor system, wherein the computer system is configured to:

receive the sensor signals generated by the sensor system;

process the received water usage and temperature sensor signals to determine whether the received water usage and temperature sensor signals exceed first threshold water usage conditions and first threshold temperature conditions indicative of a deviation from expected water usage and temperature conditions in the building;

based on a determination that the received water usage and temperature sensor signals exceed the first threshold water usage and the first threshold temperature conditions indicative of the deviation from the expected water usage and temperature conditions in the building, transmit information to a mobile device of a user associated with the building over a communication network, wherein the information comprises (i) a portion of the received water usage and temperature sensor signals, and (ii) a user interface element that, when selected by the user, causes a state change command to be transmitted to a valve control device to change a state of a valve in the building;

process the received water usage and temperature sensor signals to determine whether the received water usage sensor signals exceed second threshold water usage conditions that are different from the first

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threshold water usage conditions and indicative of
 water leak in the building; and
 based on a determination that the received water usage
 and temperature sensor signals exceed the second
 water usage threshold conditions indicative of the
 water leak:
 send a state change command to a valve control
 device, wherein the valve control device is con-
 figured to automatically change a state of a valve
 according to the state change command without
 first transmitting the information to the mobile
 device of the user and without receiving user input
 from the mobile device to control the state of the
 valve in the building, and
 in response to automatically changing the state of the
 valve in the building, transmit information to the
 mobile device over a communication network,
 wherein the transmitted information comprises (i)
 an indication of the state change command, (ii) an
 indication that the water leak was detected, and a

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user interface element that, when selected by the
 user, causes another state change command to be
 transmitted to the valve control device to auto-
 matically change the state of the valve to another
 state.

17. The system of claim **16**, wherein the mobile device is
 configured to:

present the transmitted information in a graphical user
 interface (GUI),

present a selectable option in the GUI, and

receive a user selection of the selectable option, which
 causes an action to be performed.

18. The system of claim **16**, wherein the system further
 comprises the valve control device.

19. The system of claim **16**, wherein the sensor signals
 comprise temperature data and the information comprises
 the temperature data.

20. The system of claim **16**, wherein the system further
 comprises the valve.

* * * * *