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(54) **SYSTEMS, METHODS AND DEVICES FOR CONTROLLING HUMIDITY IN A CLOSED ENVIRONMENT WITH AUTOMATIC AND PREDICTIVE IDENTIFICATION, PURCHASE AND REPLACEMENT OF OPTIMAL HUMIDITY CONTROLLER**

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See application file for complete search history.

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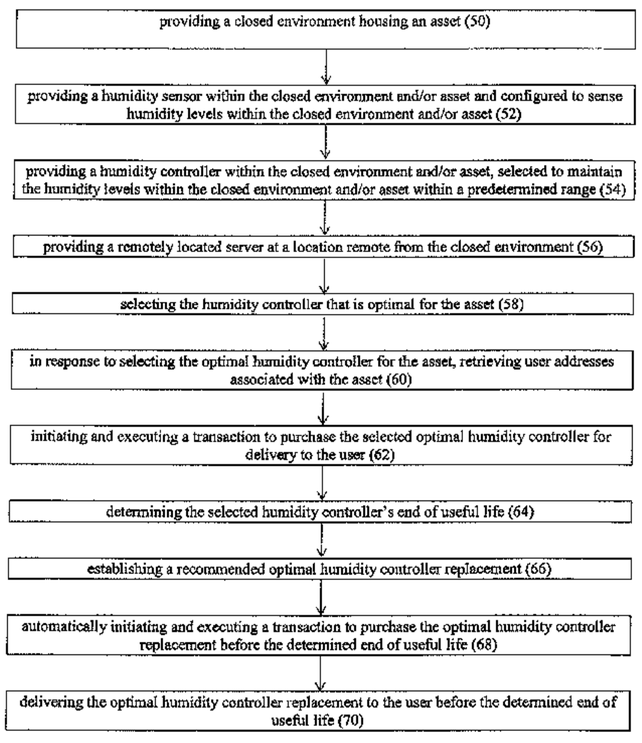
(57) **ABSTRACT**

The invention relates to systems and methods for monitoring and providing humidity control for an asset within a closed environment such as a storage container, with transmission of sensed humidity levels to at least one server that stores current and historical humidity levels and comprises a processor and stored executable instructions that, when executed by the processor, may recommend an optimal humidity controller to use for the asset, determine when the recommended humidity controller requires replacement and predictively recommend an optimal replacement humidity controller based on at least historical humidity data and trending thereof, execution of a sales transaction, that may be pre-scheduled based on asset type, asset size and/or historical data, for the optimal replacement humidity controller, and providing the proper replacement humidity controller to the user.

21 Claims, 4 Drawing Sheets



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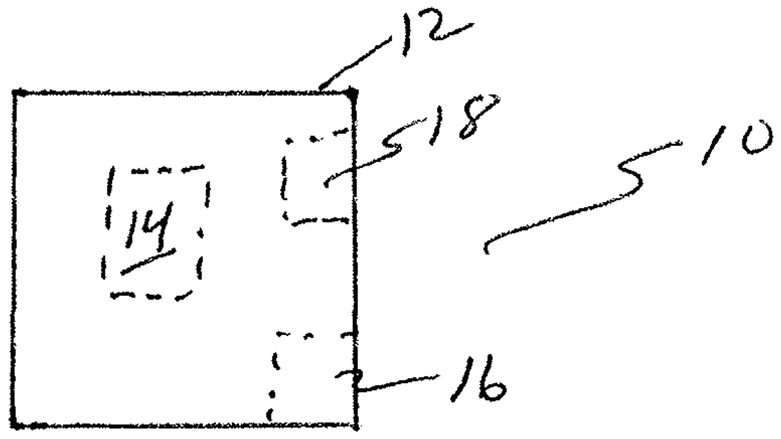

FIG 1A

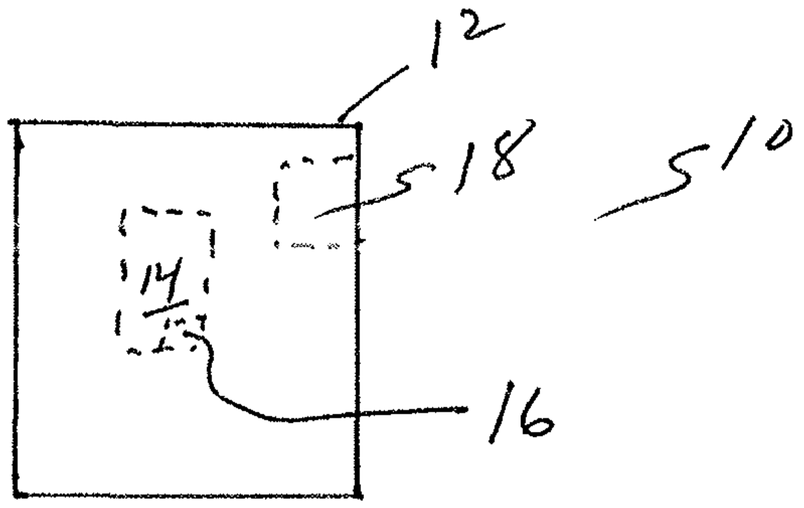

FIG 1B

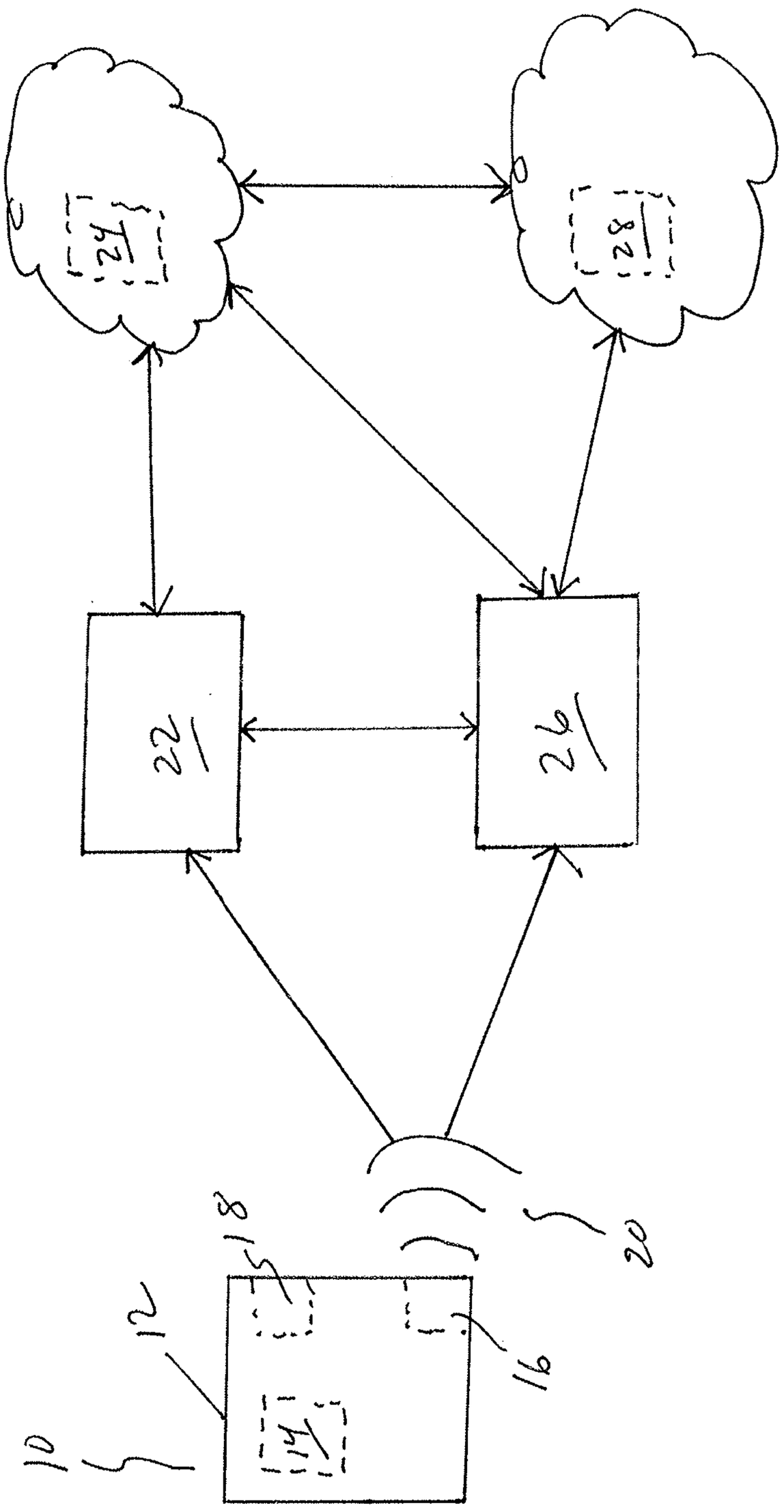

FIG. 2

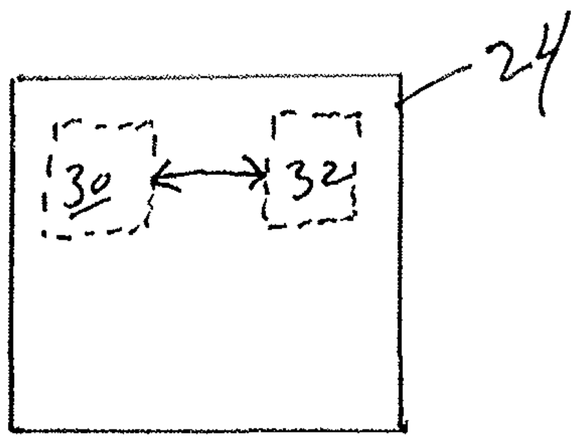

FIG. 3

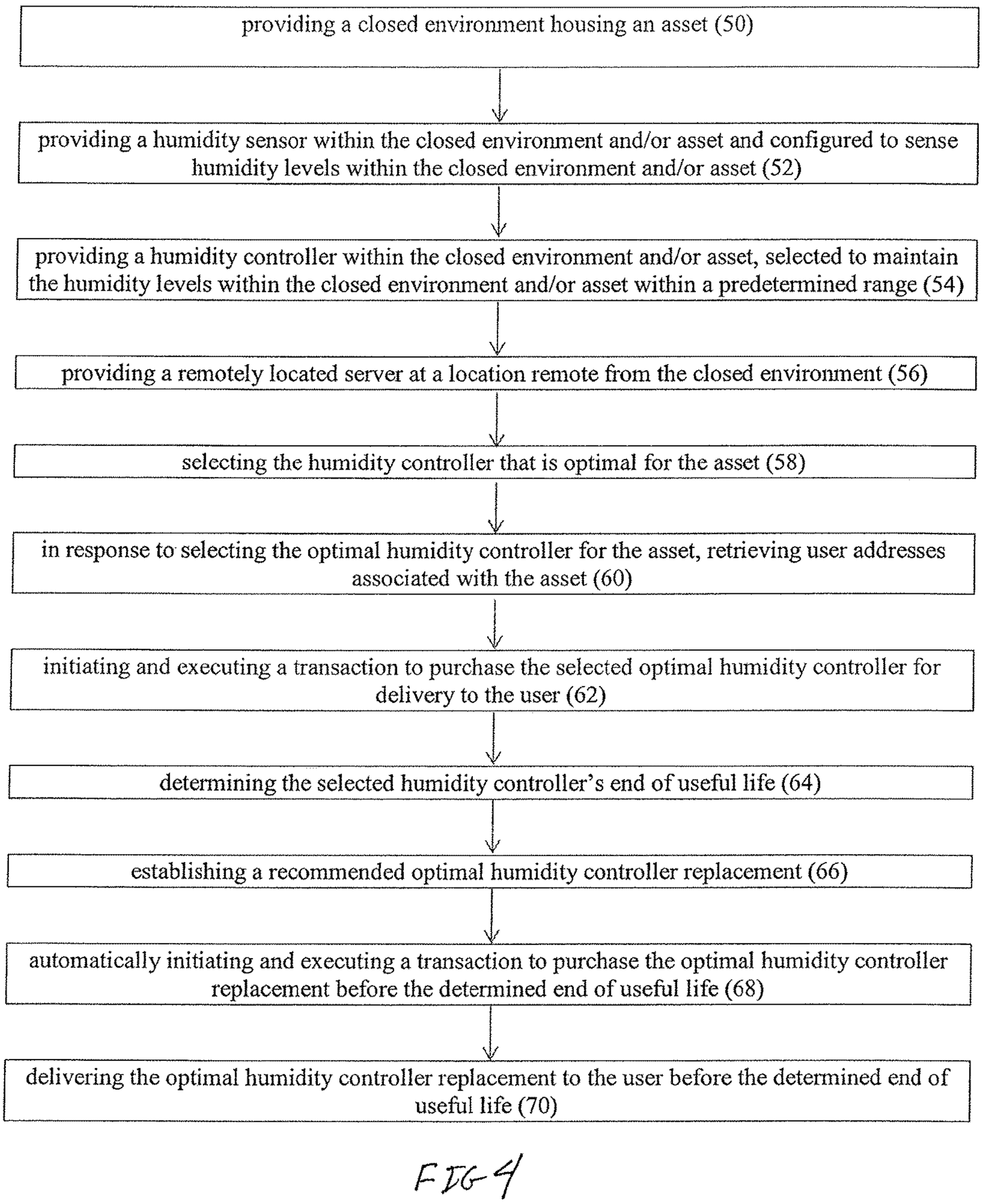
providing a closed environment housing an asset (50)
providing a humidity sensor within the closed environment and/or asset and configured to sense humidity levels within the closed environment and/or asset (52)
providing a humidity controller within the closed environment and/or asset, selected to maintain the humidity levels within the closed environment and/or asset within a predetermined range (54)
providing a remotely located server at a location remote from the closed environment (56)
selecting the humidity controller that is optimal for the asset (58)
in response to selecting the optimal humidity controller for the asset, retrieving user addresses associated with the asset (60)
initiating and executing a transaction to purchase the selected optimal humidity controller for delivery to the user (62)
determining the selected humidity controller's end of useful life (64)
establishing a recommended optimal humidity controller replacement (66)
automatically initiating and executing a transaction to purchase the optimal humidity controller replacement before the determined end of useful life (68)
delivering the optimal humidity controller replacement to the user before the determined end of useful life (70)

FIG 4

SYSTEMS, METHODS AND DEVICES FOR CONTROLLING HUMIDITY IN A CLOSED ENVIRONMENT WITH AUTOMATIC AND PREDICTIVE IDENTIFICATION, PURCHASE AND REPLACEMENT OF OPTIMAL HUMIDITY CONTROLLER

CROSS-REFERENCE TO RELATED APPLICATIONS

Not Applicable

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

FIELD OF THE INVENTION

The invention relates to systems and methods for monitoring and tracking while providing humidity control for an asset within a closed environment and automatic and predictive replacement of the humidity controller before reaching its end of life.

BACKGROUND OF THE INVENTION

Closed environments such as storage cases for instruments, particularly stringed instruments, cigars or other tobacco products require controlling of the relative humidity levels within the closed environments to optimally maintain the assets stored or housed therein.

In the case of musical instruments, atmospheric humidity can affect the lifespan and sound quality for stringed, woodwind, brass and percussion instruments. The presence or absence of optimal humidity levels can lead to swelling, splits, cracks, checking, movement in joins and general distortion of materials susceptible to too much or too little humidity.

Similarly, too much or too little atmospheric humidity can adversely affect the quality and/or lifespan of stored cigars or other tobacco products. Thus, humidors are provided to assist in maintaining not only humidity levels, but also temperature levels, within a desired range.

Humidity controllers are known in the art and may be considered for use in conjunction with the present invention. Particularly effective humidity controllers are marked by Boveda, Inc., and are described in detail in U.S. Pat. Nos. 5,936,178 and 8,748,723, the full disclosures of which are hereby incorporated by reference. See also U.S. Pat. No. 6,209,717, also incorporated in its entirety by reference. Generally, however, any humidity controller may be suitable for operation with the present invention as described and claimed.

Also known to the skilled artisan are systems and methods for wirelessly transmitting sensed humidity data, obtained within a closed environment by known humidity sensors, via a communication system for remote viewing by a user on a computing device such as a computer, tablet, and/or a smartphone.

There are, however, no known systems or methods that provide a predictive notification and automated purchase of an optimal humidity controller designed to maintain humidity levels for a specific type of asset. Further, there are no known systems or methods that predict and automatically set a replacement frequency for identifying and purchasing an optimal humidity controller for a specific asset type.

BRIEF SUMMARY OF THE INVENTION

Various embodiments of the invention comprise systems, server(s) and methods for monitoring and providing humidity control for an asset within a closed environment such as a storage container, with transmission of sensed humidity levels to at least one server that stores current and historical humidity levels and comprises a processor and stored executable instructions that, when executed by the processor, may recommend an optimal humidity controller to use for the asset, determine when the recommended humidity controller requires replacement and predictively recommend an optimal replacement humidity controller based on at least historical humidity data and trending thereof, execution of a sales transaction, that may be pre-scheduled based on asset type, asset size and/or historical data, for the optimal replacement humidity controller, and providing the proper replacement humidity controller to the user.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The following drawings are illustrative of embodiments of the invention and are not intended or to be interpreted as limiting the scope of the invention as encompassed by the claims.

FIG. **1**A is a schematic diagram of one embodiment of the present invention;

FIG. **1**B is a schematic diagram of one embodiment of the present invention;

FIG. **2** is a schematic diagram of one embodiment of the present invention;

FIG. **3** is a schematic diagram of one embodiment of the present invention; and

FIG. **4** is a flowchart of one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The description of the invention and its applications as set forth herein is illustrative and is not intended to limit the scope of the invention. Variations and modifications of the embodiments disclosed herein are possible, and practical alternatives to and equivalents of the various elements of the embodiments would be understood to those of ordinary skill in the art upon study of this patent document. These and other variations and modifications of the embodiments disclosed herein may be made without departing from the scope and spirit of the invention.

Generally, the present invention comprises systems, methods and servers configured to monitor and control humidity levels within a closed environment such as an instrument case or humidor or other closed environments housing assets in need of humidity control. More specifically, the invention comprises identification of an optimal humidity controller for the specific asset under consideration and/or identification of an optimal replacement humidity controller for the specific asset. In certain embodiments, these steps are executed automatically when the system, method and/or server determines that the currently used humidity controller is nearing the end of its useful life. In still further embodiments, a replacement frequency may be established for replacing the currently used humidity con-

troller, and subsequently used replacement humidity controllers, shortly before the presently used humidity controller reaches the end of its useful life.

As illustrated in FIGS. **1**A and **1**B, a closed environment **10** is provided which may consist of a container **12** housing an asset **14** and humidity sensor **16** therein. Humidity sensor **16** may, alternatively, be located within the asset **14**. Humidity controller **18** is also disposed within closed environment **10**.

FIG. **1**A illustrates the case where humidity controller **18** is located or disposed generally within the closed environment **10** and specifically within the container **12**, but not inside the asset **14**. FIG. **1**B provides an alternative arrangement wherein the humidity controller **18** is disposed or located generally within the closed environment **10** and specifically within the asset **14**.

FIG. **2** illustrates one embodiment of a system according to the present invention. There, closed environment **10** is shown as a container **12** with asset **14**, humidity sensor **16** and humidity controller **18**, generally configured as in FIG. **1**A.

As discussed above, the humidity controller **18** may comprise many alternatives or configurations. However, one highly preferred humidity controller **18** humidity controller controls the relative humidity in the container and/or asset housed within the container in the general range of 40% to 60%, the device comprising: (a) a pouch formed of a thin-walled polymeric material permeable to water vapor but not to liquid solutions; (b) a humidity control solution comprising saturated or unsaturated aqueous salt solution containing an amount of alkali metal formate selected from sodium formate, potassium formate, sodium or potassium lactate and combinations thereof sealed in said pouch wherein said salt solution contains from about 30% to 90% salt; and (c) wherein the water vapor permeability of the pouch is such that the moisture transfer capacity of the pouch transmits at least from about 1% to about 50% by weight of the initial pouch contents when exposed to an atmosphere of less than 10% relative humidity and absorbs at least from about 1% to about 50% by weight of the initial pouch content when exposed to an atmosphere having greater than 85% relative humidity.

In some embodiments, the pouch is disposed in a fabric holder for insertion into and retraction from a "bell hole" of an instrument. In certain embodiments, the pouch may be further configured to prevent leakage of the contents thereof.

FIG. **2** further provides that the humidity sensor **16** is in wireless operative communication **20**, via in the illustration, a Wi-Fi bridge **22**, with a cloud-based remotely located server, or set of servers **24**. In addition, humidity sensor **16** is also in wireless operative communication with a computing device **26** which may also be remotely located from both the sensor **16** and the cloud-based server(s) **24**. Further, the computing device **26** is in operative and wireless communication with the cloud-based server(s) **24** as well as a commerce platform **28** comprising servers and capable of an internet-based transaction. Finally, the cloud-based server(s) **25** and the commerce platform servers **28** are in wireless and operative communication.

The skilled artisan will recognize that computing device **26** may comprise a computer or a smartphone or the like.

The skilled artisan will also readily understand that the wireless communication ability of the humidity sensor to operatively communicate with the cloud-based server(s) **24** and/or the computing device **26** may be achieved in a number of ways, including but not limited to Bluetooth, RFID and/or QR code(s).

The skilled artisan will also realize that commerce platform servers **28** and the purchasing and delivery systems and methods embodied thereby are well known in the art.

Thus, FIG. **2** provides for a system wherein the humidity sensor **16** periodically provides humidity data from within the closed environment, e.g., within the container **12**, wirelessly via, Bluetooth to e.g., a Wi-Fi bridge **22** and ultimately to the cloud-based server(s) **24** and/or the computing device **26**.

As best seen in FIGS. **2** and **3**, the cloud-based server(s) **24** comprise a processor **30** configured to control at least some operations of the server(s) **24** and a memory **32** in operative communication with the processor **30**. The memory **32** is capable of storing at least computer executable instructions, user addresses associated with an asset that is located at a remote location and that at least part of the time is stored within a container, and a look-up table listing more than one humidity controller arranged by humidity control capacity and/or useful life under known humidity conditions and a plurality of asset types associated with at least one of the listed humidity controllers, wherein the associated listed humidity controllers are optimized for controlling the humidity of the associated asset type.

The computer executable instructions stored in the server memory **32** are configured to be executed by the processor **30** that, when executed cause the server(s) **24** to:

look up the asset located at a remote location and the at least one associated humidity controller **18** in the look-up table;

select or identify the humidity controller **18** that is optimal for the asset **14**;

in response to selecting or identifying the optimal humidity controller **18** for the asset **14**, retrieve stored user addresses associated with the asset **14**;

transmits the optimal humidity controller selection to the user addresses; and

initiate and execute a transaction to purchase the optimal humidity controller **18** for delivery to the user.

In this way, the present invention may automatically select or identify, purchase and deliver the optimal humidity controller **18** to a user for a particular asset **14**.

In addition, the present invention may be used to automatically identify/select, purchase and deliver an optimal replacement controller **18** to a user for a particular asset **14**.

Thus, in addition to the above steps, the servers' processor (**30**) may further execute the programmed and executable instructions to:

determine the selected humidity controller's end of useful life;

identify an optimal humidity controller replacement;

automatically initiate and execute a transaction to purchase the optimal humidity controller replacement before the determined end of useful life; and

deliver the optimal humidity controller replacement to the user before the determined end of useful life.

In some embodiments, identifying the optimal humidity controller may include one or more of:

Tracking the humidity levels over a duration. In certain embodiments, the tracking starts from when the humidity controller is first placed in service. In other embodiments, the tracking is over a pre-specified period;

Retrieving information that identifies the asset for which the humidity controller is or will be used for;

Retrieving information on the humidity controller currently in use. Such information may include one or more of the total number of humidity controllers in use and the identity of each humidity controller in use such as, but not

limited to, the product model number and serial number. The retrieved information may also include information on when each humidity controller was placed into service such as, but not limited to, the installation date and/or time;

Retrieving information on where the asset is located including, but not limited, the geographic location and locale;

Determining the optimal replacement humidity controller for the housed asset based on tracked humidity levels, the retrieved asset identity, the retrieved information on the humidity controller currently in use with the asset, and the retrieved information on where the asset is located. In some embodiments, such determination may be made from a database of all the humidity controller products available. The database may include information such as, but not limited to, the performance, engineering and/or technical specifications for all the humidity controller products; and

Recommending the determined optimal replacement humidity controller for purchase. In some embodiments, the user is provided comparative information on the humidity controller currently in service and the recommended replacement humidity controller. Such comparative information may be useful to the user in understanding why the recommended humidity controller is different from that in service. In certain embodiments, if the in-service and replacement humidity controller are the same, it may not be necessary to provide the comparative information. In other embodiments, the recommendation may include information such as the performance of the humidity controller in service.

In some embodiments, the initiation and/or execution of the transaction to purchase the humidity controller replacement may be manual or partly automated, i.e., not fully automated. In a non-limiting exemplary embodiment, the user is provided an option to select, for purchase, between the recommended and the in-service humidity controller. In some embodiments, the user may be provided an option to change the quantity and/or the type (e.g., product number) of the recommended or the in-service humidity controller being purchased. In certain embodiments, the user may be provided an option to select and/or order the desired quantity and/or the type of the humidity controller which may be different from the humidity controller currently in-service and/or the recommended humidity controller.

In some embodiments, the initiation and/or purchase of the humidity controller may include providing the user to select a payment method from a plurality of choices presented to the user. It will be appreciated that such transaction processing systems and methods are well known in the art. In a non-limiting exemplary embodiment, the purchase transaction may include a "one-click" payment option as is well known in the art. In certain embodiments, the payment transaction may further include providing the user an ability to change the payment method and/or update any previously stored payment related information.

In a non-limiting exemplary embodiment, the user is always provided an ability to cancel the transaction at any point in the process.

Still further, the present invention may be used to establish an optimal humidity controller replacement frequency, storing same within the server's memory. In this embodiment, the processor **30** may execute computer executable instructions that cause the server to:

establish an optimal humidity controller replacement frequency based on asset type and the determined end of useful life of the selected humidity controller;

automatically initiate and execute at least one transaction to purchase a first optimal humidity controller replacement before the selected humidity controller's determined end of useful life and in accordance with the established replacement frequency; and

deliver the first optimal humidity controller replacement to the user before the selected humidity controller's determined end of useful life.

Thus, using an established replacement frequency enables repeated automated replacement, including identification/selection, purchase and delivery of the optimal replacement humidity controllers **18**.

Turning now to FIG. **4**, one embodiment of the inventive method is illustrated.

Initially, a closed environment **10** housing an asset **14** is provided in step **50**.

Next, a humidity sensor is provided and located within the closed environment, either within a container **12** or within the asset **14** housed within the container **12** and configured to sense humidity levels therein in step **52**.

A humidity controller **18** is provided within the closed environment **10** and is selected, either automatically using the invention or manually, to maintain the humidity levels within the closed environment and/or asset within a predetermined range in step **54**.

A remotely located, cloud-based, server(s) **24** is provided at a location remote from the closed environment **10** is provided in step **56**. The server(s) **24** are in operative and wireless communication with the humidity sensor **16**. Generally, as described above, Bluetooth or similar wireless communication method may be used to facilitate wirelessly communicating the humidity data sensed within closed environment **10** to the server(s) **24** via, e.g., a Wi-Fi bridge **22**.

Further, in response to selecting the optimal humidity controller for the asset, user addresses associated with the asset stored in the server(s) **24** memory are retrieved from the server(s) **24** memory **32** at step **60**.

Next, a transaction to purchase the selected optimal humidity controller for delivery to the user is automatically initiated and executed, with subsequent delivery to the user addresses previously accessed in step **62**.

In certain embodiments, the selected humidity controller's end of useful life is determined, accessing the relevant data from the memory **32** of server(s) **24** at step **64**.

In certain embodiments, a recommended optimal humidity controller replacement may be determined and established in step **64**, with subsequent automatically initiation and execution of a transaction to purchase the optimal humidity controller replacement before the determined end of useful life in step **68** and delivery of the optimal humidity controller replacement to the user before the determined end of useful life in step **70**.

We claim:

1. A system for automatically providing a replacement humidity controller to replace a user's humidity controller used to maintain humidity levels within a closed environment housing an asset, the system comprising:

a humidity controller controlling the relative humidity within the closed environment in the general range of 30%-95%, the humidity controller comprising:

a pouch formed of a thin-walled polymeric material permeable to water vapor but not to liquid solutions; and

a humidity control material comprising at least one of: a salt, sugar, sugar alcohol, polybasic acid, and salt of a polybasic acid;

wherein the water vapor permeability of the pouch is such that the moisture transfer capacity of the pouch transmits at least from about 1% to about 50% by weight of the initial pouch contents when exposed to an atmosphere of less than 10% relative humidity and absorbs at least from about 1% to about 50% by weight of the initial pouch content when exposed to an atmosphere having greater than 85% relative humidity;

a humidity sensor located within the container, wherein the humidity sensor senses the humidity level within the closed environment;

a server located remotely from the humidity sensor, the server in operative wireless communication with the humidity sensor; and

a database storing, as non-transitory computer readable media, user address information, asset identifying information, humidity controller information, and a lookup table listing a plurality of humidity controllers and a plurality of asset types, each asset type associated with at least one of the listed humidity controllers, wherein the associated listed humidity controllers are optimized for controlling the humidity of the associated asset type, the database further storing computer executable instructions for:

receiving a sensed humidity condition from the humidity sensor and tracking the sensed humidity condition over a duration;

comparing the sensed humidity condition to a controlled humidity range for the asset and, if the sensed humidity condition is outside of the controlled humidity range, determining the humidity controller is nearing the end of its useful life;

based, at least in part, on the sensed humidity condition tracked over a duration, stored lookup table, stored asset identifying information, and stored humidity controller information, forming a recommendation of an optimal replacement humidity controller for the housed asset, wherein the recommendation comprises a type of controller and number of controllers; and

sending the recommendation of the optimal replacement humidity controller to a user device.

2. The system of claim **1**, wherein the stored humidity controller information comprises:

total number of humidity controllers in use;

identity of each humidity controller in use; and

installation date of each humidity controller in use.

3. The system of claim **1**, the database further storing computer executable instructions for retrieving the stored user address information and initiating a purchase transaction for the optimal replacement humidity controller.

4. The system of claim **3**, wherein initiating the purchase transaction comprises providing the user an ability to change the purchase.

5. The system of claim **4**, wherein initiating the purchase transaction further comprises providing the user a purchasing option selected from the group consisting of the recommended optimal replacement humidity controller and the stored humidity controller information.

6. The system of claim **3**, wherein initiating the purchase transaction comprises the user selecting a payment method comprising one of a previously provided payment method and a new payment method.

7. The system of claim **1**, the database further storing computer executable instructions for:

establishing a frequency for purchasing and replacing the user's humidity controller; and

automatically identifying, purchasing, initiating delivery of an optimal replacement humidity controller to the user address in accordance with the established frequency.

8. The system of claim **1**, further comprising computer executable instructions for initiating delivery of the replacement humidity controller to the user address.

9. The system of claim **1**, wherein the humidity controller controls the relative humidity within the closed environment in the general range of 40%-75%.

10. The system of claim **1**, wherein the recommended optimal humidity controller is different from the humidity controller within the enclosed environment.

11. The system of claim **1**, wherein the recommended optimal humidity controller comprises a plurality of controllers.

12. A system for monitoring and controlling humidity levels within a container that houses an asset owned or operated by a user, the system comprising:

a humidity sensor located within the container, wherein the humidity sensor periodically senses the humidity experienced by the asset;

a remote server in operative wireless communication with the humidity sensor, wherein the server receives and stores sensed humidity data transmitted from the humidity sensor;

a humidity controller controlling the relative humidity within the closed environment in the general range of 30%-95%, the humidity controller comprising:

a pouch formed of a thin-walled polymeric material permeable to water vapor but not to liquid solutions; and

a humidity control material comprising at least one of: a salt, sugar, sugar alcohol, polybasic acid, and salt of a polybasic acid;

wherein the water vapor permeability of the pouch is such that the moisture transfer capacity of the pouch transmits at least from about 1% to about 50% by weight of the initial pouch contents when exposed to an atmosphere of less than 10% relative humidity and absorbs at least from about 1% to about 50% by weight of the initial pouch content when exposed to an atmosphere having greater than 85% relative humidity;

a remote computing device in wireless operable communication with at least one of the server and the humidity sensor to enable the user to view the stored sensed humidity data; and

the at least one server further configured to:

based on the stored sensed humidity data, predict an end of the humidity controller's useful life;

before the end of the humidity controller's predicted useful life, automatically form a recommendation of an optimal replacement humidity controller based at least in part on the stored sensed humidity data and identifying information for the asset and the humidity controller, the recommendation comprising a type of controller and number of controllers; and

send the recommendation of the optimal replacement humidity controller to the remote computing device.

13. The system of claim **12**, wherein the asset comprises a stringed instrument or tobacco products.

14. The system of claim **12**, wherein the humidity control material comprises a saturated aqueous salt solution containing an amount of alkali metal formate selected from

sodium formate, potassium formate, sodium or potassium lactate and combinations thereof sealed in said pouch wherein said salt solution contains from about 30% to about 90% salt.

15. The system of claim **12**, wherein the at least one server is further configured to, before the end of the optimal humidity controller's predicted useful life, initiate a transaction to purchase the determined optimal replacement humidity controller with notification to the user's computing device.

16. The system of claim **15**, wherein the at least one server is further configured to, before the end of the optimal humidity controller's predicted useful life, initiate delivery of the purchased optimal replacement humidity controller to the user.

17. The system of claim **12**, wherein the humidity controller controls the relative humidity within the closed environment in the general range of 40%-75%.

18. A method of controlling humidity in a closed environment, the method comprising:

providing a closed environment housing an asset;

providing a humidity sensor within the closed environment and configured to sense humidity levels within the closed environment;

providing a humidity controller within the closed environment, selected to maintain the humidity levels within the closed environment in the general range of 30%-95%, the humidity controller comprising:

a pouch formed of a thin-walled polymeric material permeable to water vapor but not to liquid solutions; and

a humidity control material comprising at least one of: a salt, sugar, sugar alcohol, polybasic acid, and salt of a polybasic acid;

wherein the water vapor permeability of the pouch is such that the moisture transfer capacity of the pouch transmits at least from about 1% to about 50% by weight of the initial pouch contents when exposed to an atmosphere of less than 10% relative humidity and absorbs at least from about 1% to about 50% by weight of the initial pouch content when exposed to an atmosphere having greater than 85% relative humidity;

providing a remotely located server at a location remote from the closed environment, the server comprising:

a processor in the remotely located server configured to control at least some operations of the server; and

a memory in operative communication with the processor and storing computer executable instructions, user addresses associated with the asset, asset identifying information, humidity controller information, and a look-up table listing a plurality of humidity controllers and a plurality of asset types, each asset type associated with at least one of the listed humidity controllers, wherein the associated listed humidity controllers are optimized for controlling the humidity of the associated asset type; and

executing the computer executable instructions to enable:

receiving data from a humidity sensor arranged within the container, the data comprising a sensed humidity condition within the container, and tracking the sensed humidity condition over a duration;

comparing the sensed humidity condition to a controlled humidity range for the asset and, if the sensed humidity condition is outside of the controlled humidity range, determining the humidity controller is nearing the end of its useful life;

using the stored asset identifying information, looking up the asset and the at least one associated humidity controller in the look-up table;

based, at least in part, on the sensed humidity condition tracked over a duration and the stored humidity controller information, forming a recommendation of an optimal humidity controller for the asset;

retrieving user addresses associated with the asset;

transmitting the recommendation of an optimal humidity controller to the user addresses; and

determining the selected humidity controller's end of useful life based on the sensed humidity condition within the container.

19. The method of claim **18**, further comprising:

establishing a recommended optimal humidity controller replacement;

automatically initiating and executing a transaction to purchase the optimal humidity controller replacement before the determined end of useful life; and

initiating delivery of the optimal humidity controller replacement to the user before the determined end of useful life.

20. The method of claim **18**, wherein the humidity control material comprises a saturated aqueous salt solution containing an amount of alkali metal formate selected from sodium formate, potassium formate, sodium or potassium lactate and combinations thereof sealed in said pouch wherein said salt solution contains from about 30% to about 90% salt.

21. The method of claim **18**, wherein the humidity controller within the closed environment and/or asset is selected to maintain the humidity levels within the closed environment and/or asset in the general range of 40%-75%.

* * * * *