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(54) THERMOSTAT WITH UTILITY MESSAGING

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(51) **Int. Cl.**
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(52) **U.S. Cl.** ..... **236/46 R**; 236/51; 236/94; 715/710; 455/412.1; 340/691.1

(58) **Field of Classification Search** ..... 236/46 R, 236/51, 94; 340/691.1–691.6; 345/204; 455/412.1; 715/752, 755, 705, 708, 710
See application file for complete search history.

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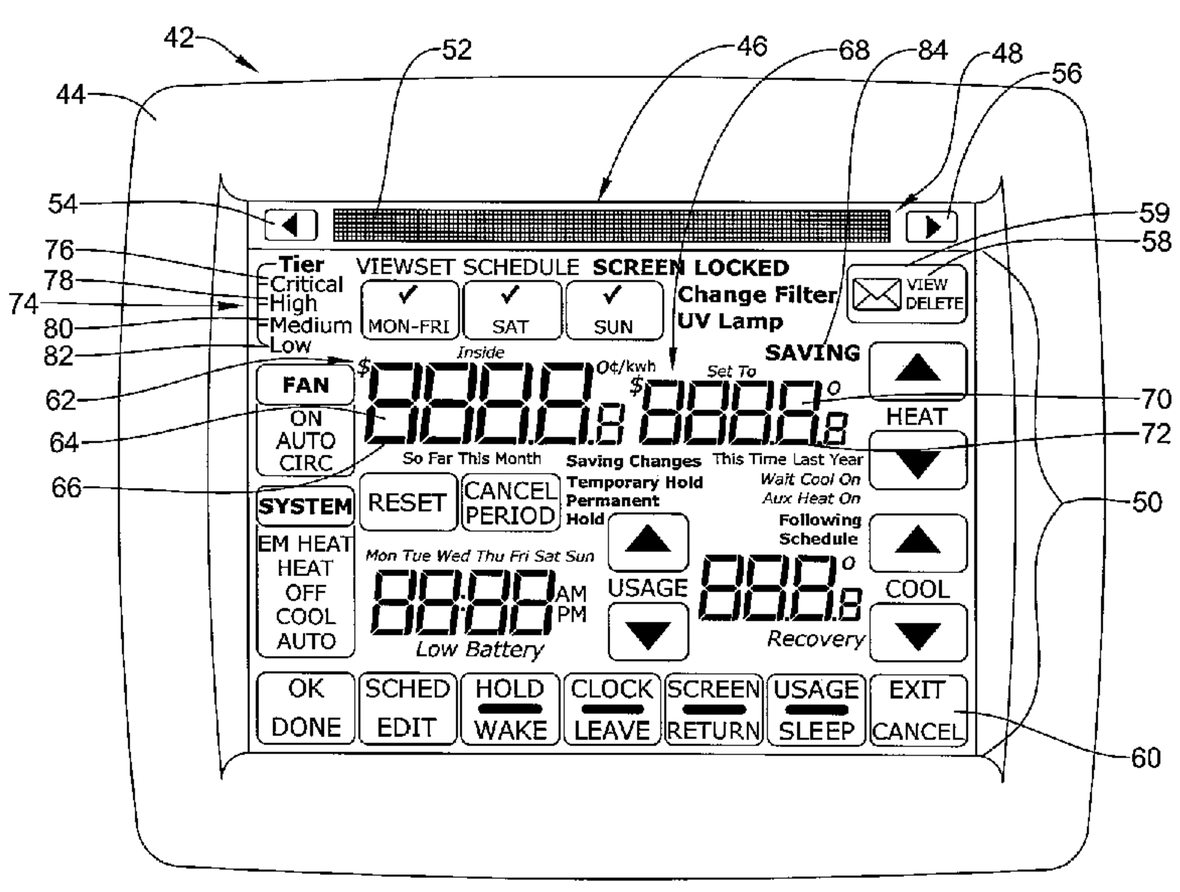
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(57) **ABSTRACT**

The present disclosure pertains generally to thermostats that are adapted to assist utilities in communicating with its customers. In particular, the present disclosure relates to a thermostat having a display, a controller and a receiver that is coupled to the controller. The receiver is adapted to receive messages from a utility, and the controller is adapted to display one or more related display messages on the display.

26 Claims, 17 Drawing Sheets



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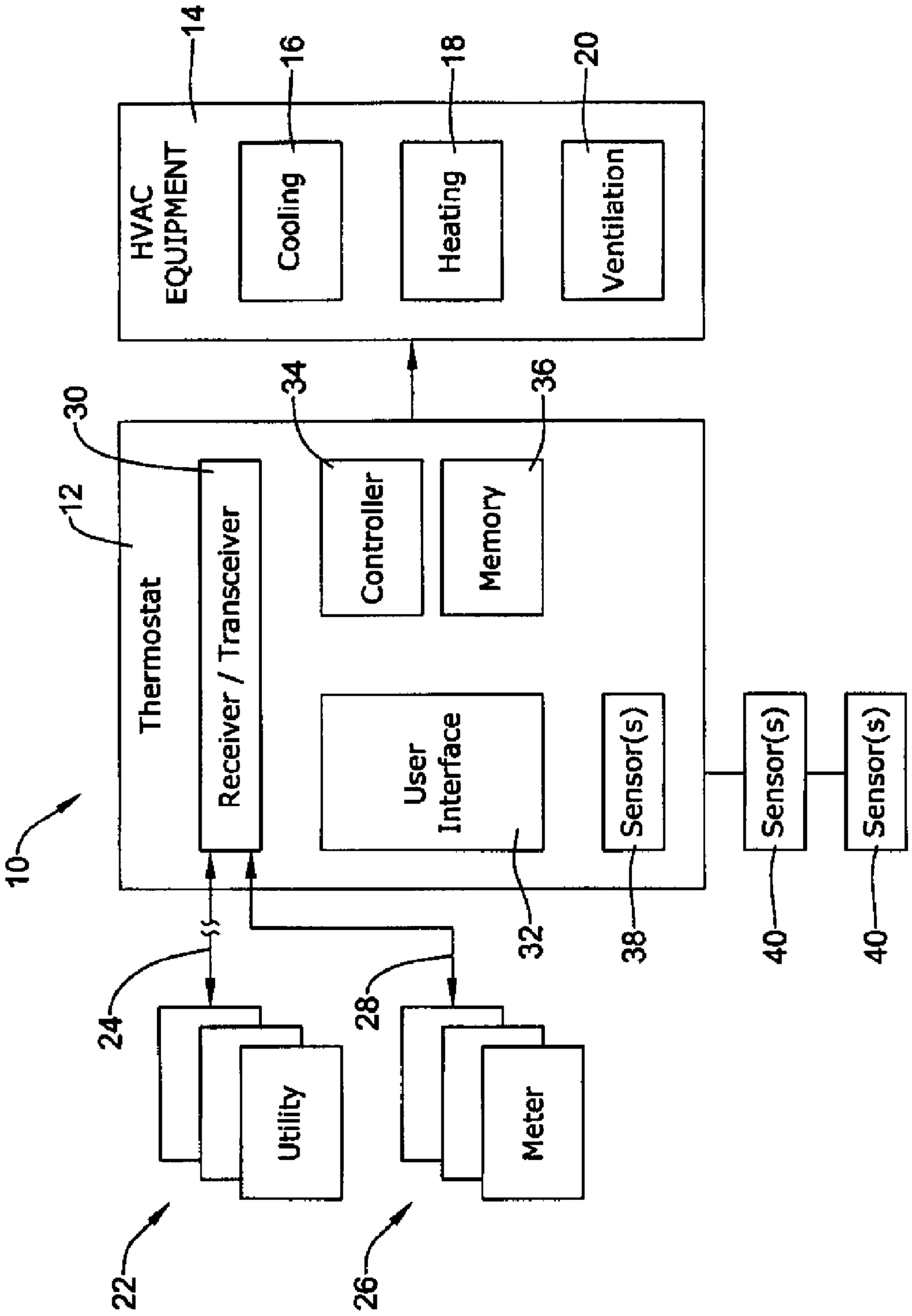

HVAC EQUIPMENT
14
Cooling
16
Heating
18
Ventilation
20
Thermostat
12
Receiver / Transceiver
30
Controller
34
Memory
36
User Interface
32
Sensor(s)
38
Sensor(s)
40
Sensor(s)
40
10
Utility
24
22
Meter
28
26

Figure 1

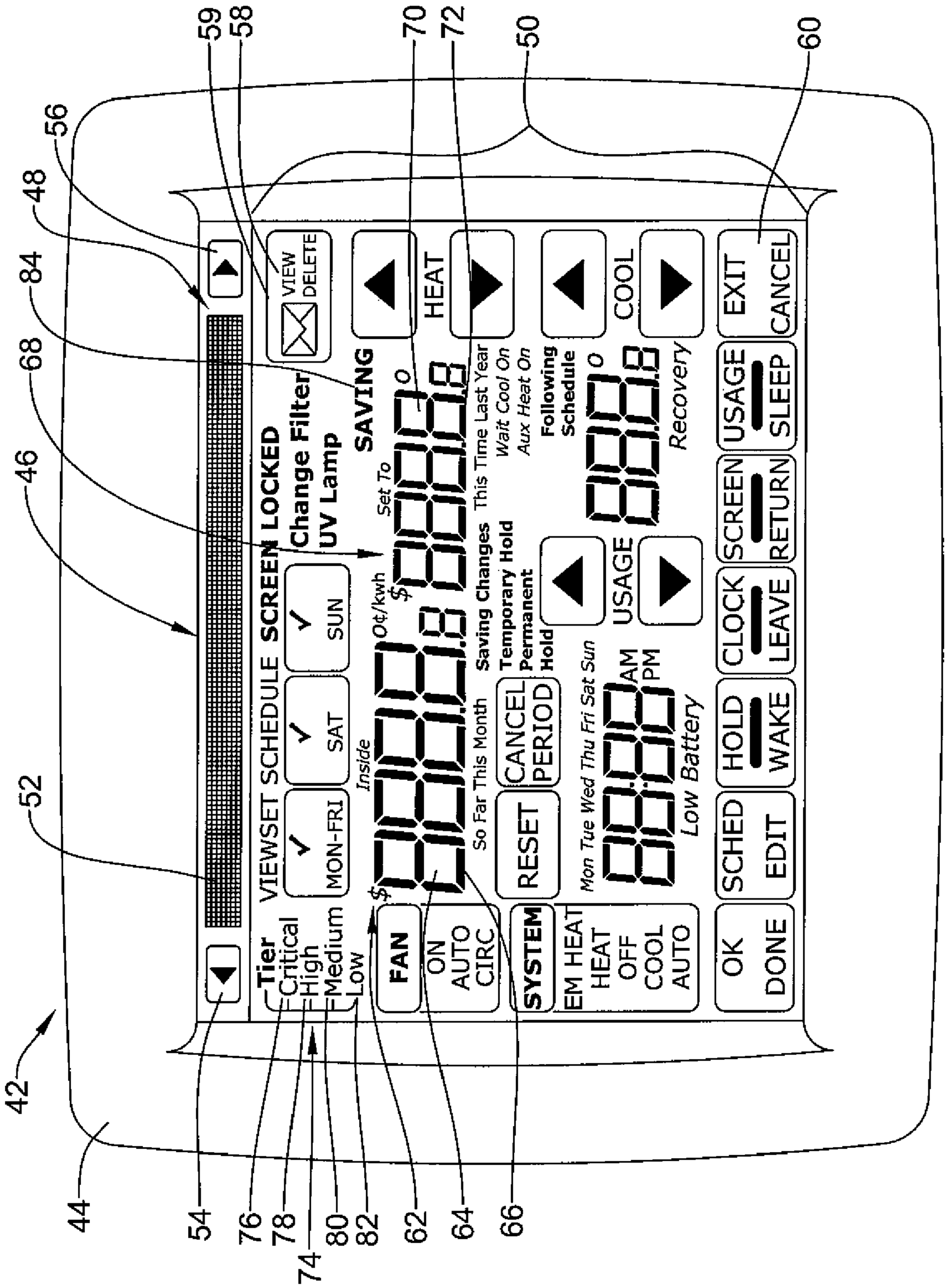

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78
80
82
84
VIEW
DELETE
SAVING
Set To
0¢/kwh
Inside
So Far This Month
Saving Changes
Temporary
Permanent
Hold
This Time Last Year
Wait Cool On
Aux Heat On
Following Schedule
Recovery
Low Battery
Mon Tue Wed Thu Fri Sat Sun
AM
PM
USAGE
HEAT
COOL
VIEW
SET SCHEDULE
SCREEN LOCKED
Change Filter
UV Lamp
MON-FRI
SAT
SUN
RESET
CANCEL PERIOD
SCHED EDIT
HOLD WAKE
CLOCK LEAVE
SCREEN RETURN
USAGE SLEEP
EXIT
CANCEL
Tier
Critical
High
Medium
Low
FAN
ON
AUTO
CIRC
SYSTEM
EM HEAT
HEAT
OFF
COOL
AUTO
OK
DONE

Figure 2

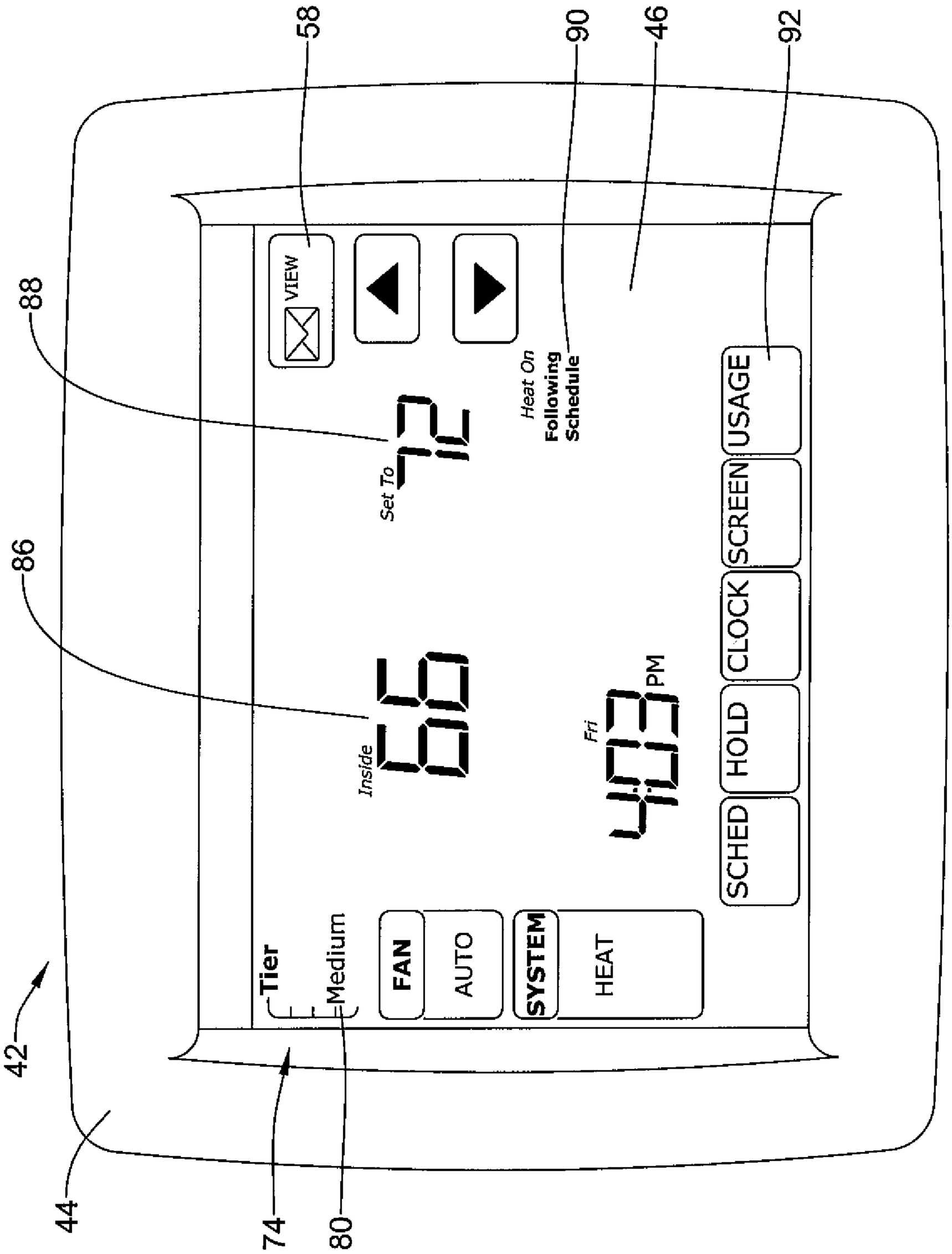

58
90
46
92
88
86
42
44
74
80
VIEW
Set To
72
Heat On
Following
Schedule
Inside
69
Fri
4:03
PM
SCHED
HOLD
CLOCK
SCREEN
USAGE
Tier
Medium
FAN
AUTO
SYSTEM
HEAT

Figure 3

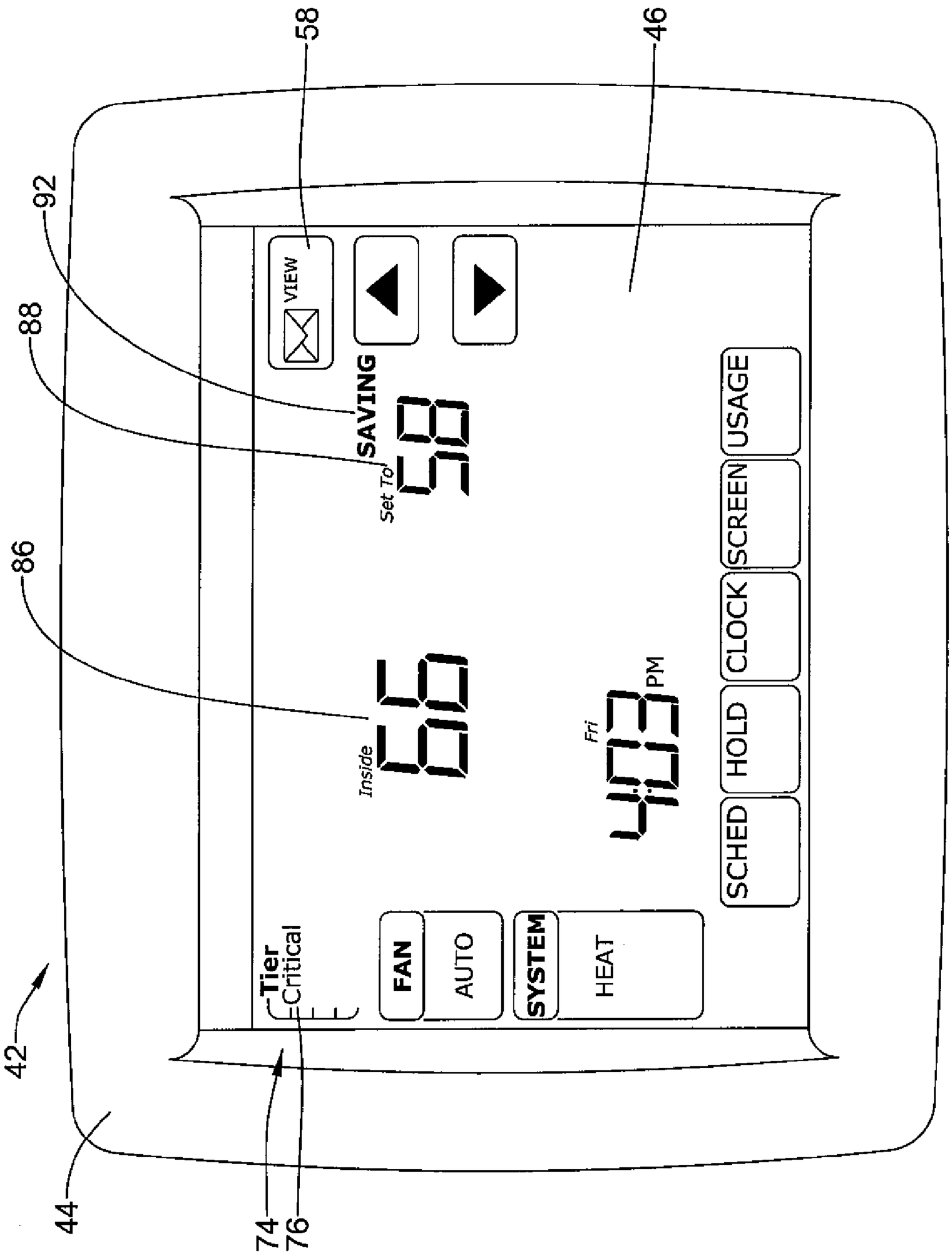

58
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SAVING
Set To
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Inside
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SCHED
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CLOCK
SCREEN
USAGE
Tier
Critical
FAN
AUTO
SYSTEM
HEAT

Figure 4

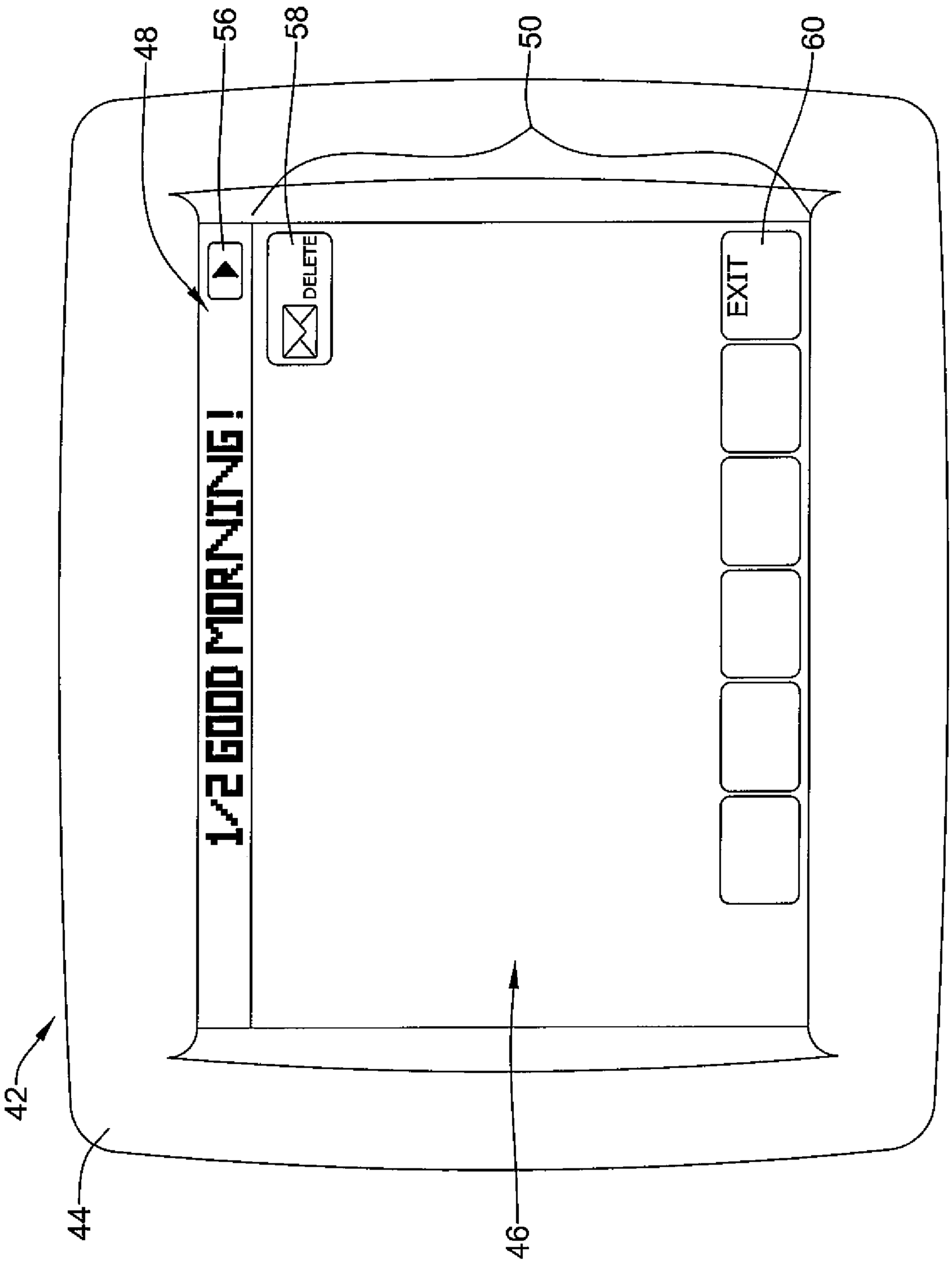


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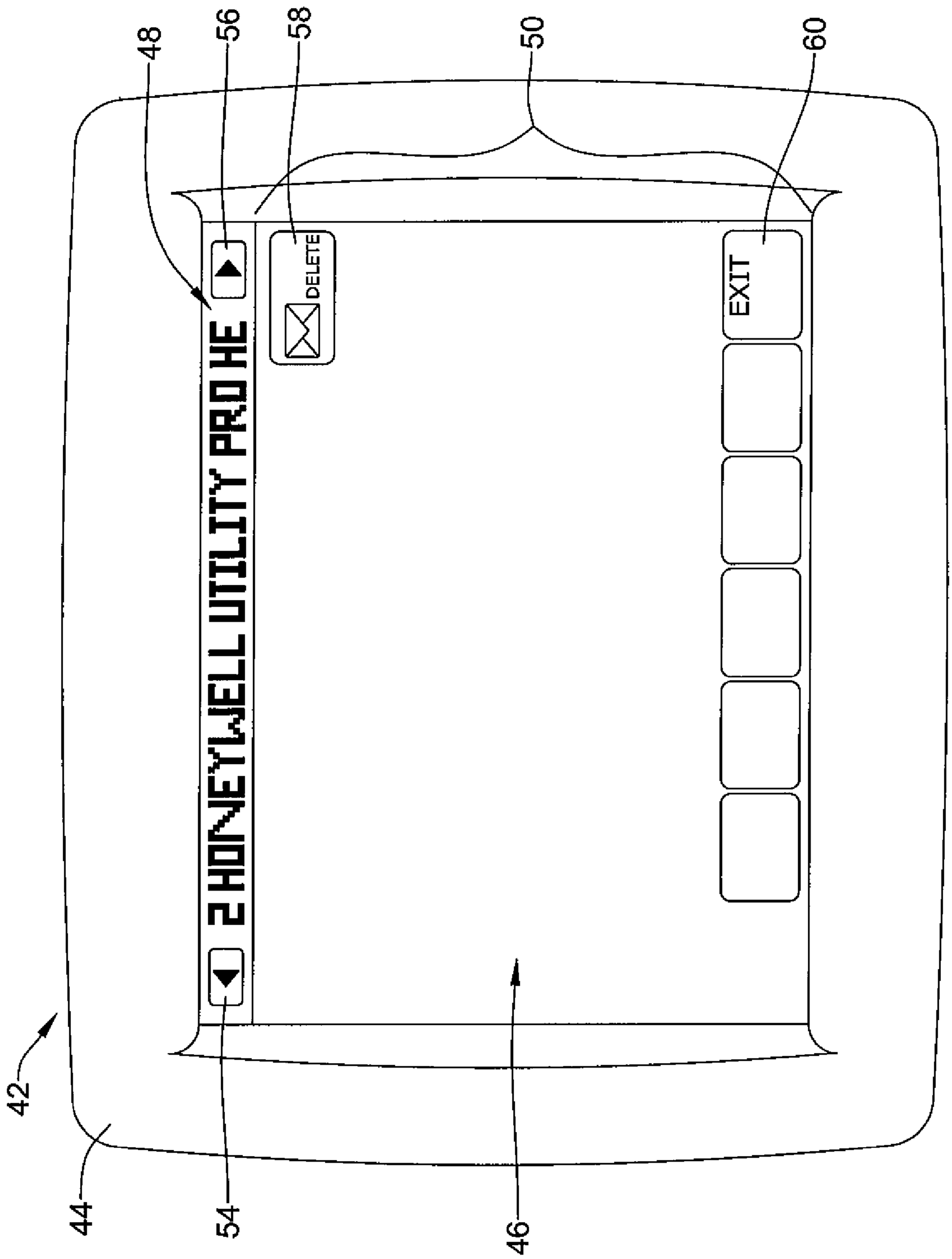


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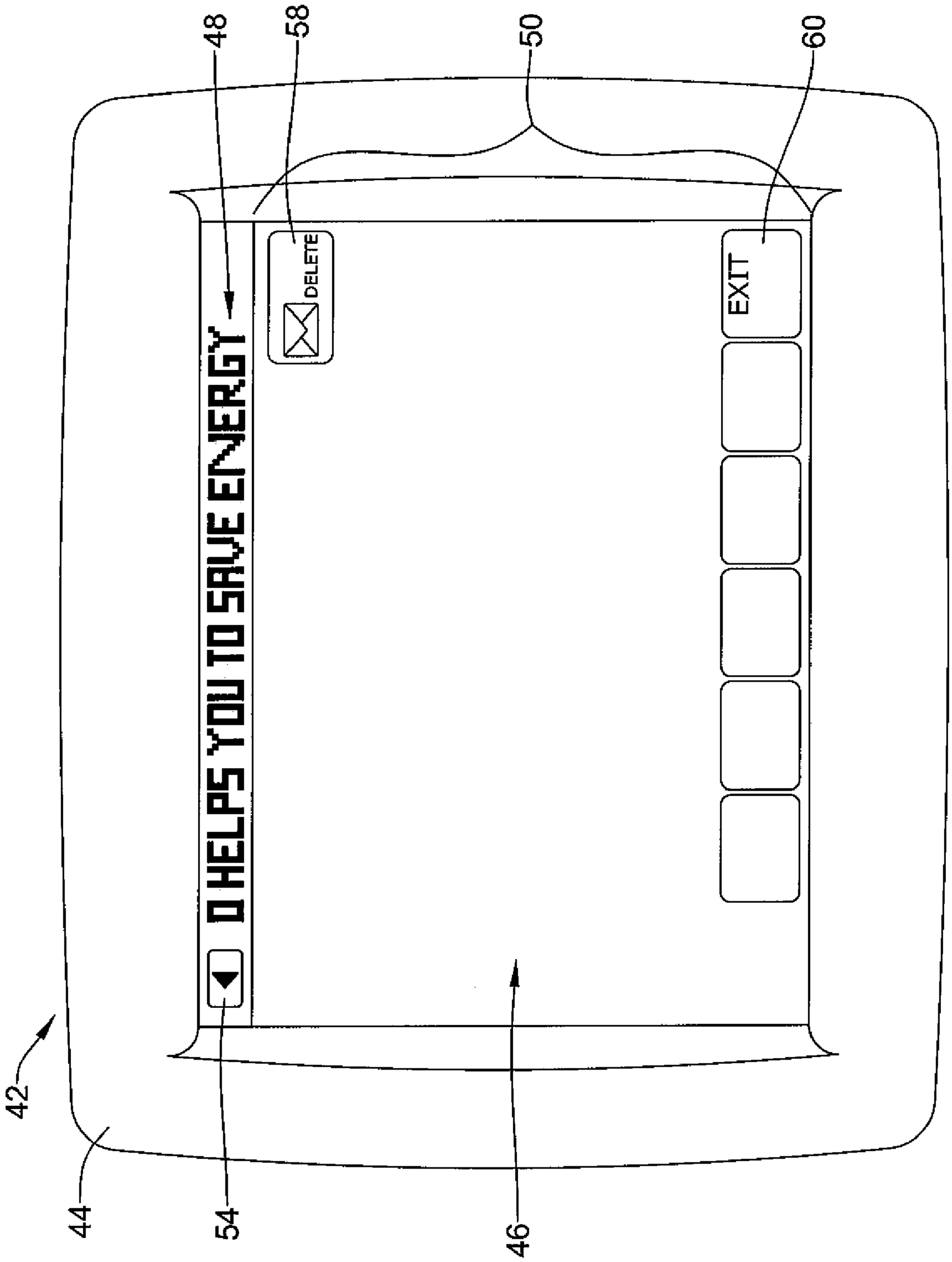


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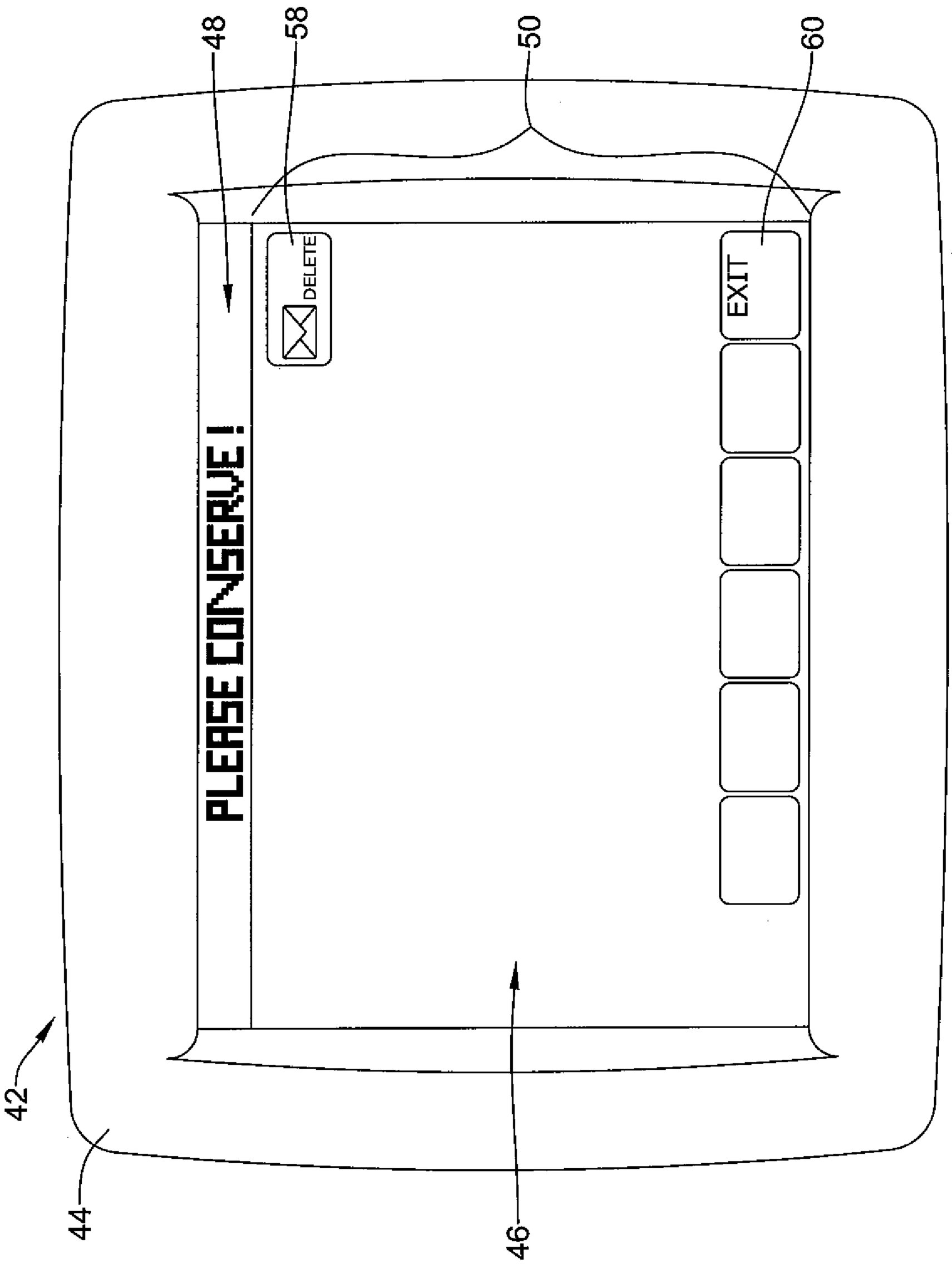


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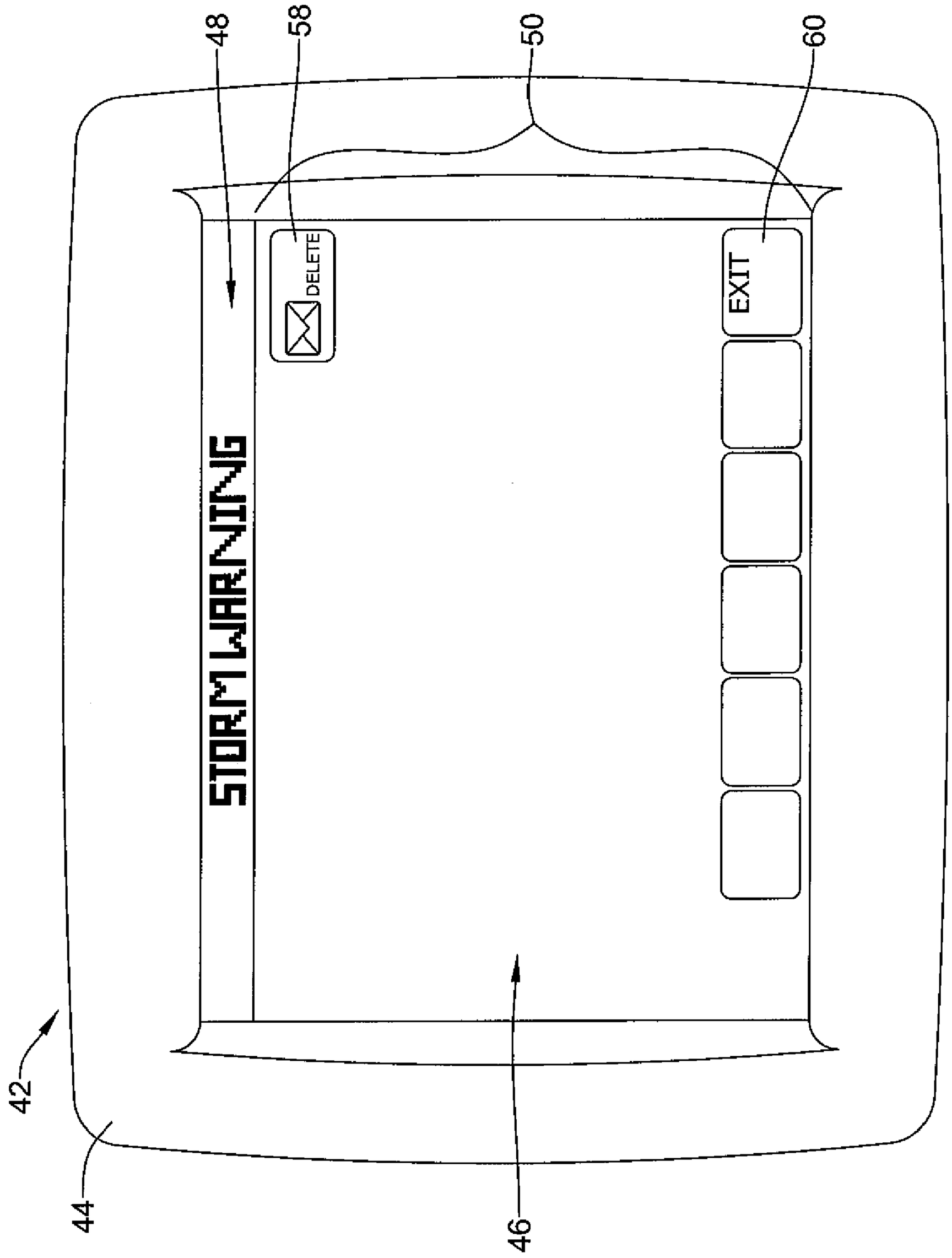


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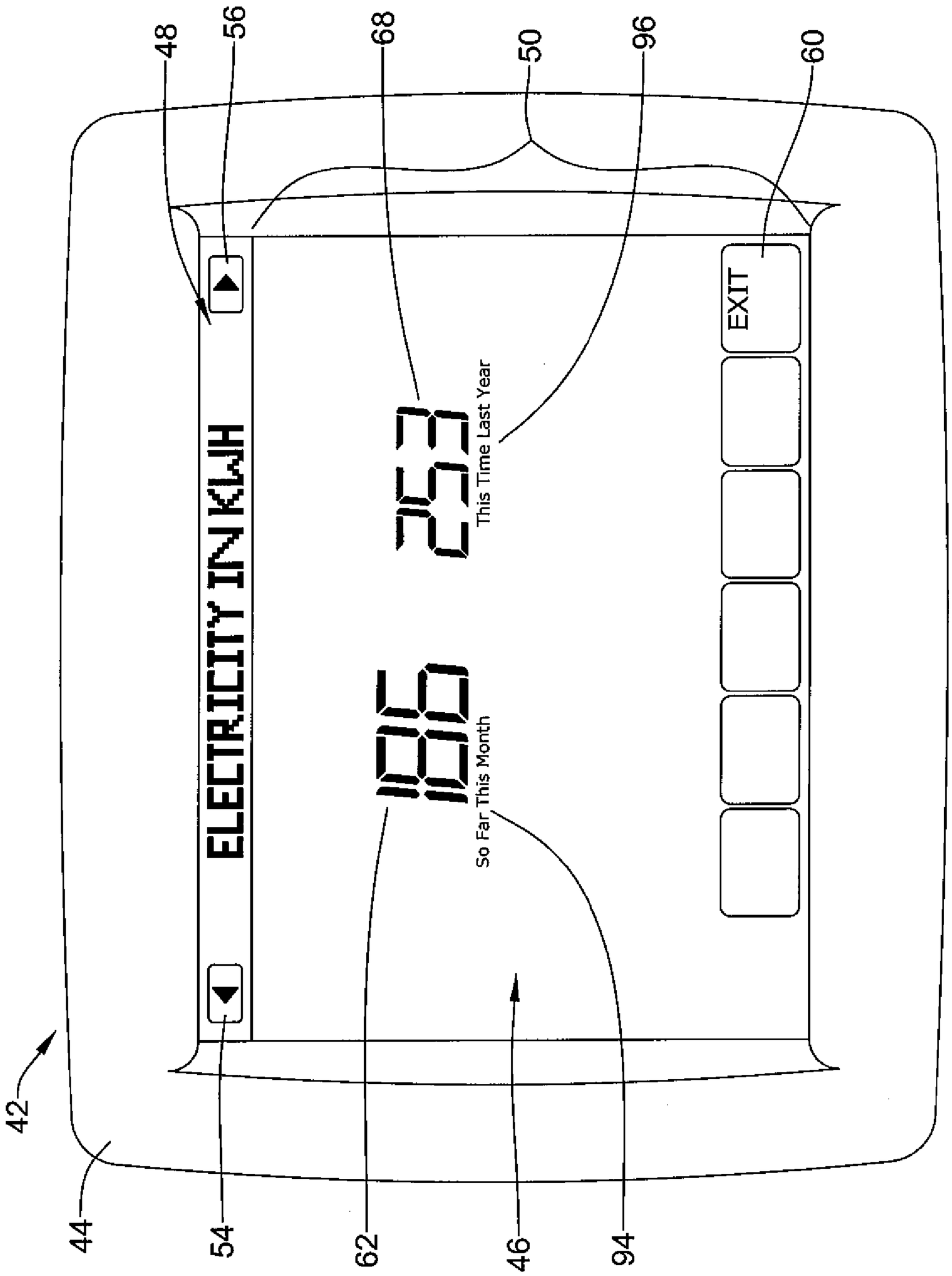

48
56
68
50
96
60
EXIT
ELECTRICITY IN KWH
This Time Last Year
253
So Far This Month
186
42
44
54
62
46
94

Figure 10

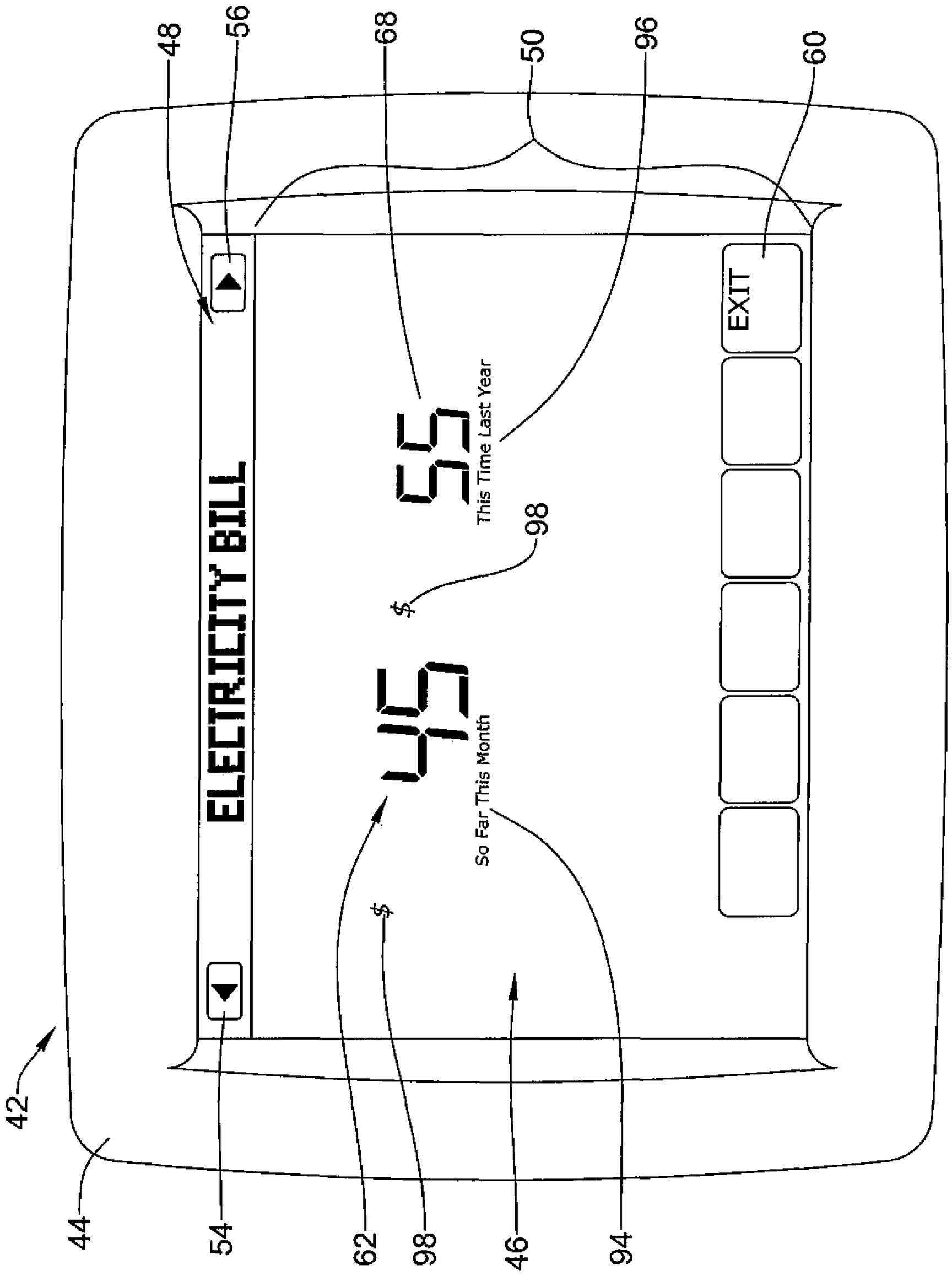

48
56
68
50
96
60
ELECTRICITY BILL
EXIT
45
So Far This Month
$
55
This Time Last Year
98
42
44
54
62
98
46
94

Figure 11

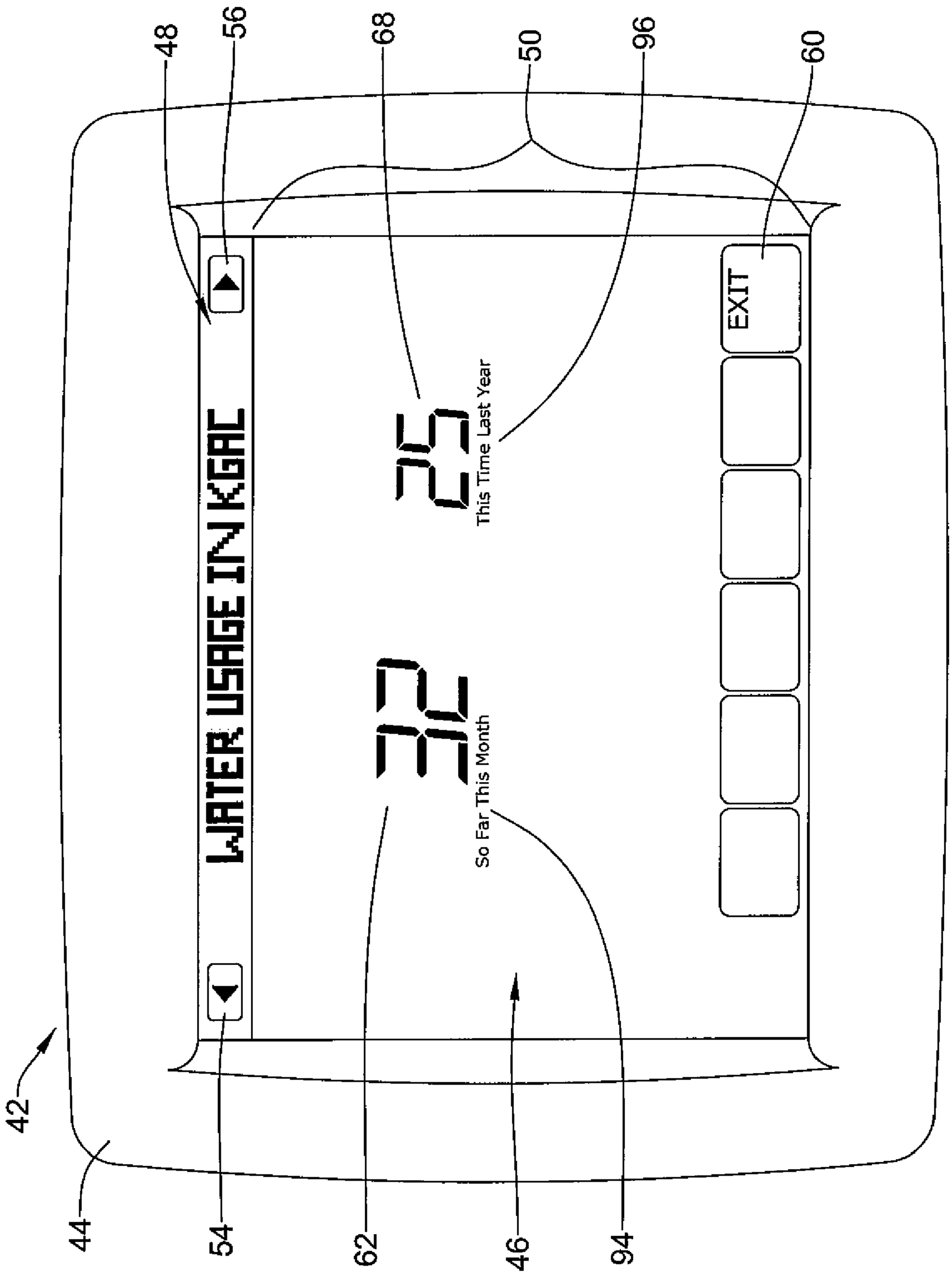

48
56
68
50
96
60
WATER USAGE IN KGAL
This Time Last Year
So Far This Month
EXIT
42
44
54
62
46
94

Figure 12

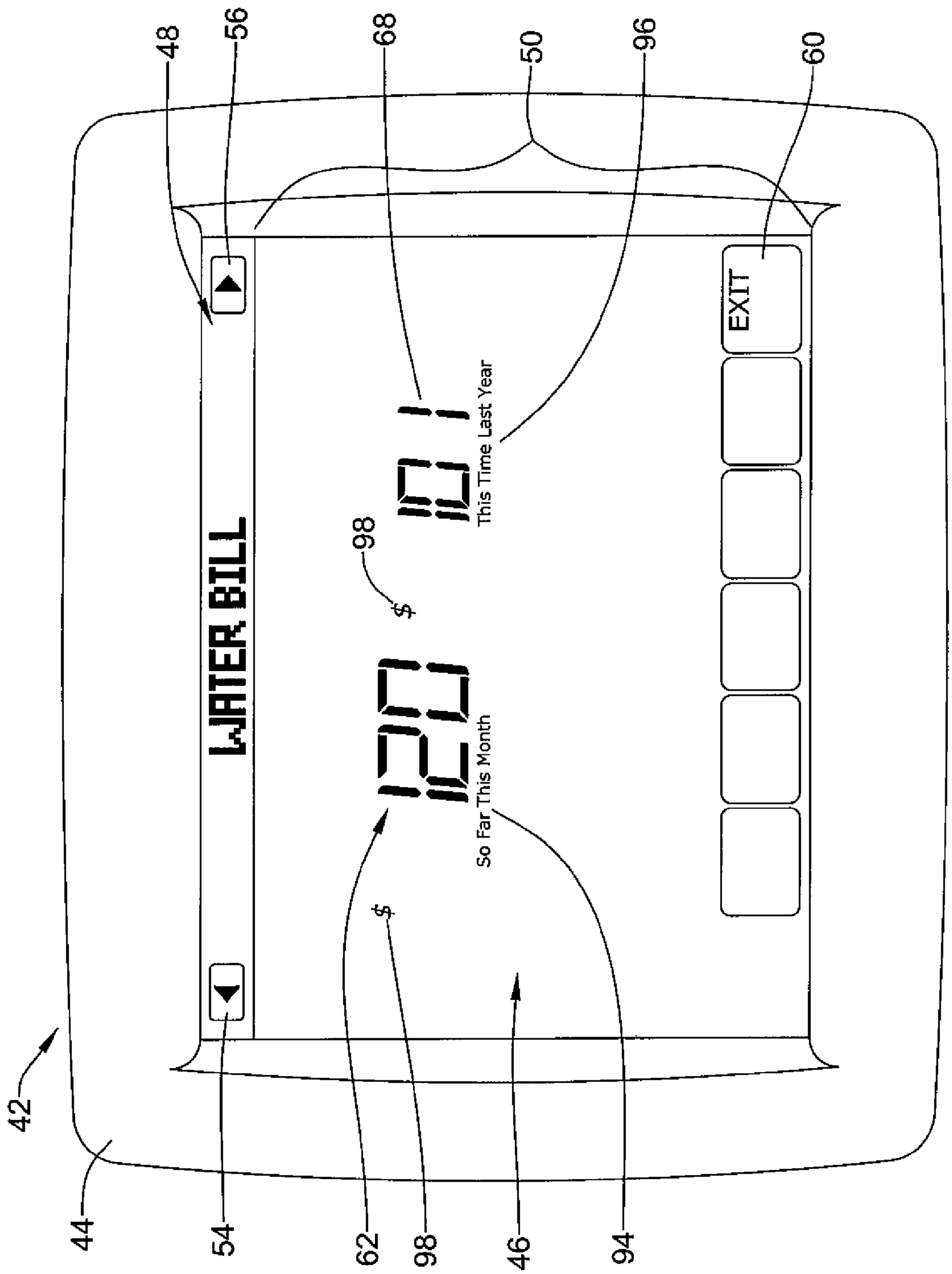

48
56
68
50
96
60
WATER BILL
EXIT
98
$
120
So Far This Month
$
111
This Time Last Year
42
44
54
62
98
46
94

Figure 13

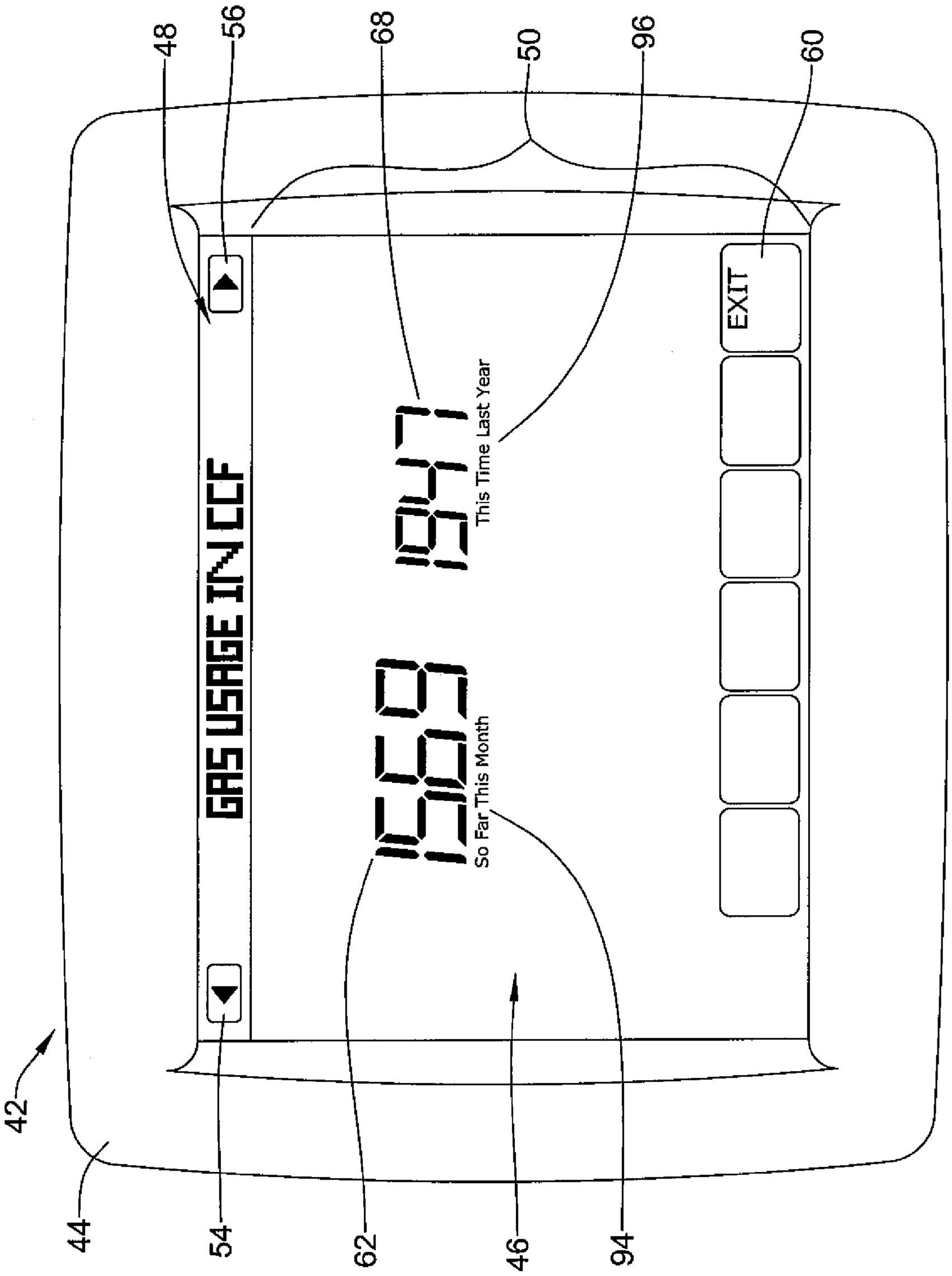

48
56
68
50
96
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EXIT
GAS USAGE IN CCF
1847
This Time Last Year
1269
So Far This Month
42
44
54
62
46
94

Figure 14

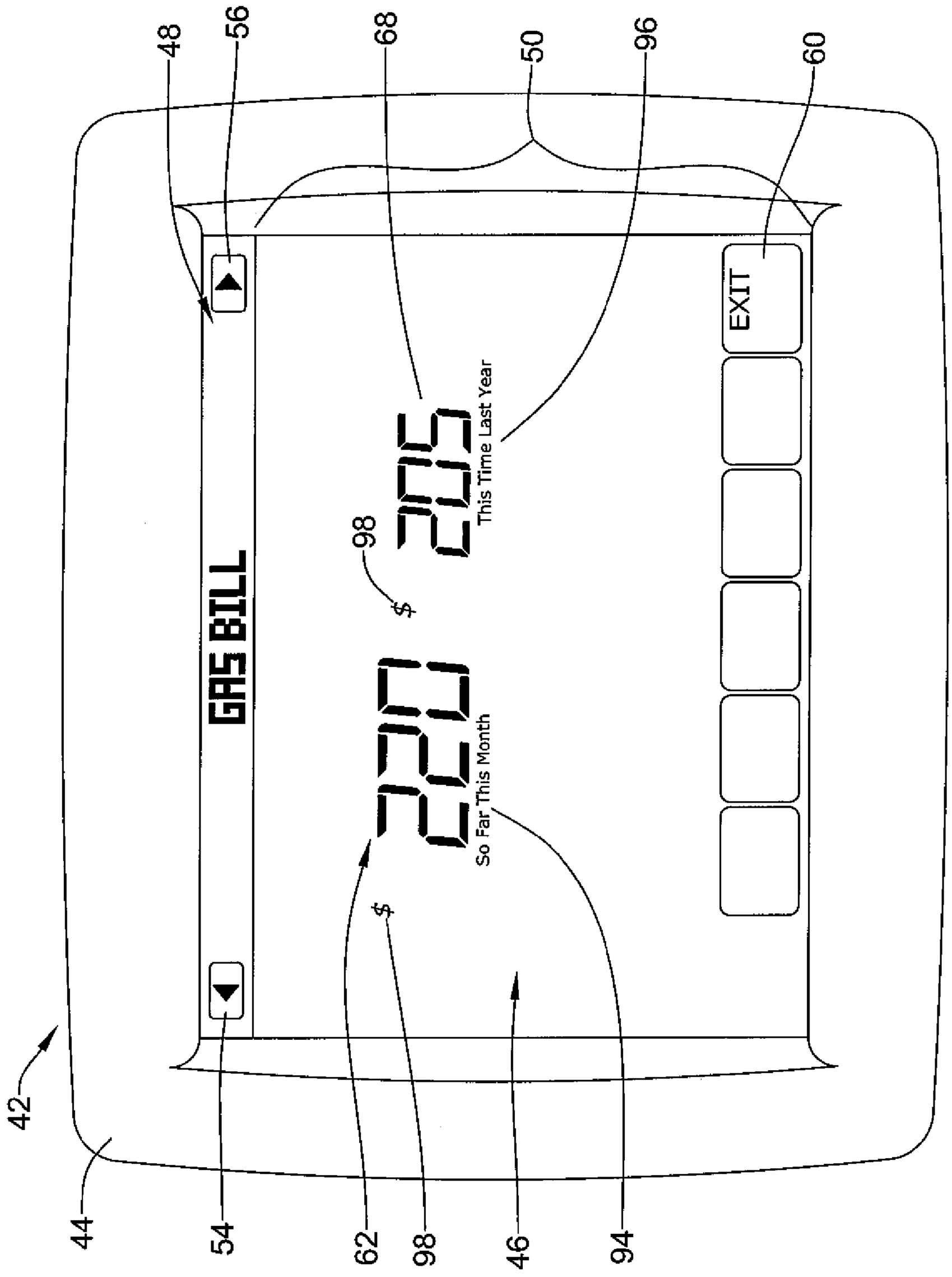

48
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68
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96
60
EXIT
GAS BILL
This Time Last Year
98
$
So Far This Month
$
42
44
54
62
98
46
94

Figure 15

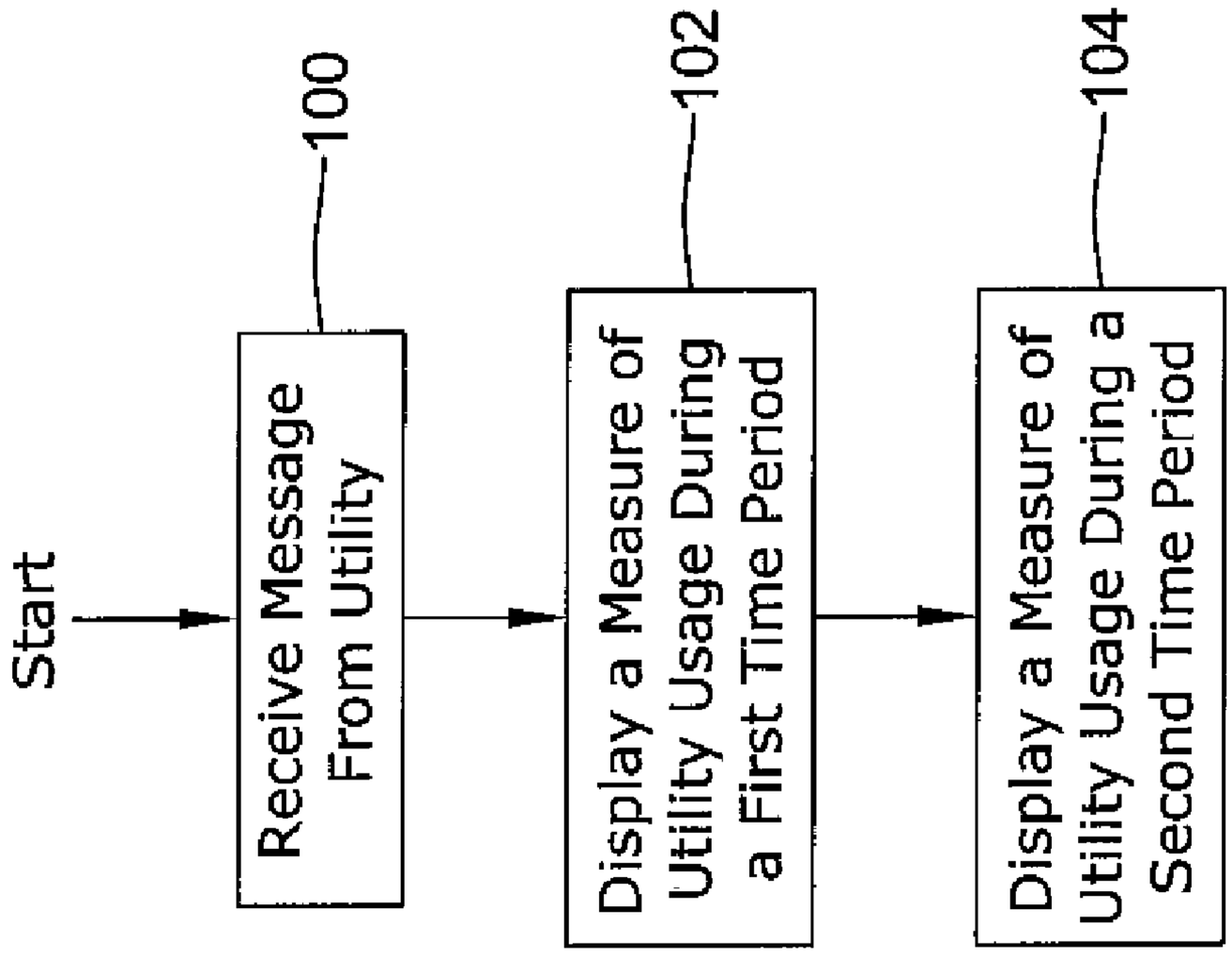

Start
Receive Message From Utility
100
Display a Measure of Utility Usage During a First Time Period
102
Display a Measure of Utility Usage During a Second Time Period
104

Figure 16

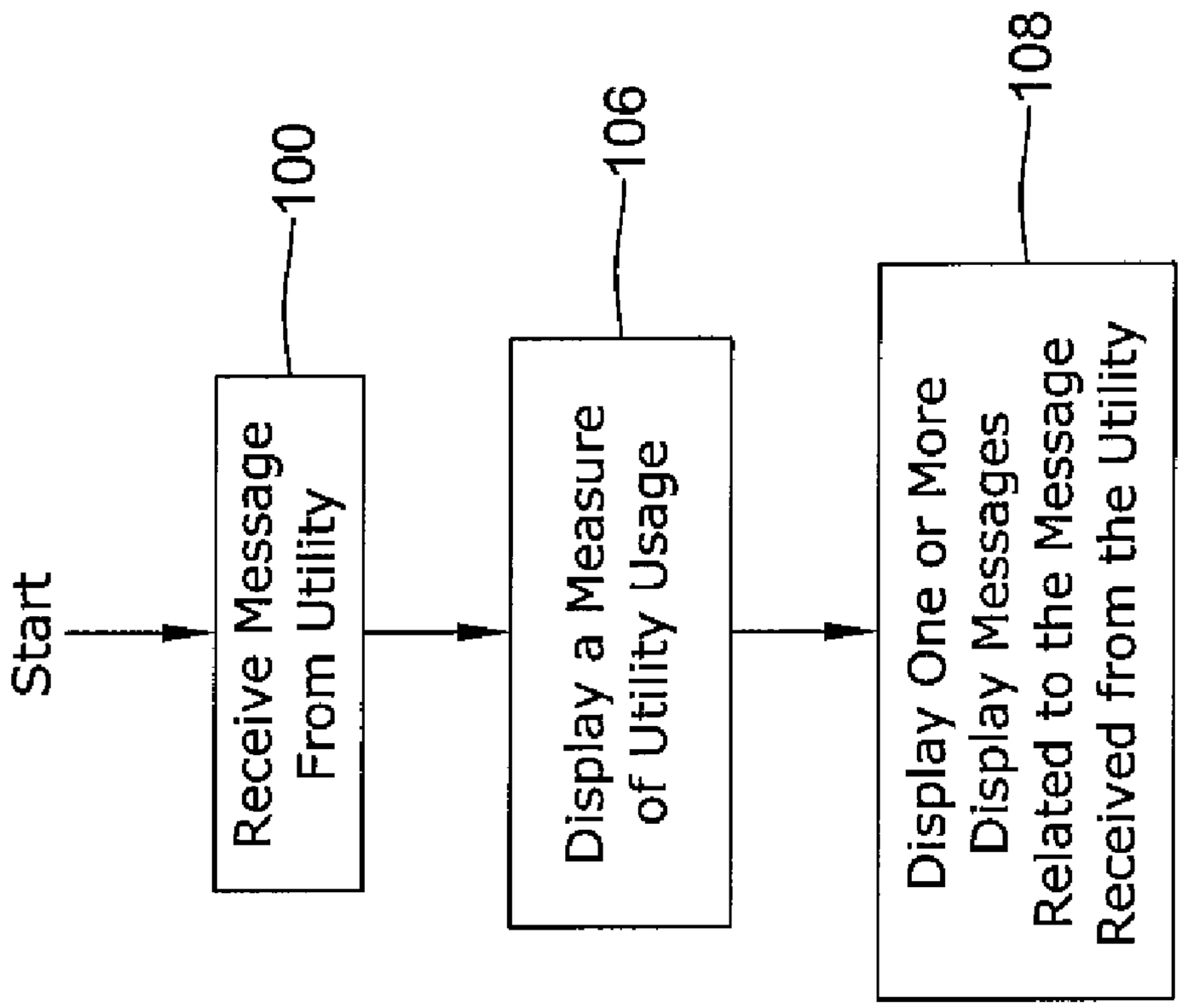

Start
Receive Message From Utility
100
Display a Measure of Utility Usage
106
Display One or More Display Messages Related to the Message Received from the Utility
108

Figure 17

THERMOSTAT WITH UTILITY MESSAGING

TECHNICAL FIELD

The disclosure pertains generally to controllers and more particularly to HVAC controllers such as thermostats that include a display panel.

BACKGROUND

Controllers are used on a wide variety of devices and systems for controlling various functions in homes and/or buildings and their related grounds. Some controllers have schedule programming that modifies device parameters such as set points as a function of date and/or time. Some such device or system controllers that utilize schedule programming for controlling various functions in homes and/or buildings and their related grounds include, for example, HVAC controllers, water heater controllers, water softener controllers, security system controllers, lawn sprinkler controllers, and lighting system controllers.

HVAC controllers, for example, are employed to monitor and, if necessary, control various environmental conditions within a home, office, or other enclosed space. Such devices are useful, for example, in regulating any number of environmental conditions with a particular space including for example, temperature, humidity, venting, air quality, etc. The controller may include a microprocessor that interacts with other components in the system. For example, in many modern thermostats for use in the home, a controller unit equipped with temperature and/or humidity sensing capabilities may be provided to interact with a heater, blower, flue vent, air compressor, humidifier and/or other components, to control the temperature and humidity levels at various locations within the home. A sensor located within the controller unit and/or one or more remote sensors may be employed to sense when the temperature or humidity reaches a certain threshold level, causing the controller unit to send a signal to activate or deactivate one or more component in the system.

The controller may be equipped with a user interface that allows the user to monitor and adjust the environmental conditions at one or more locations within the building. With more modern designs, the interface typically includes a liquid crystal display (LCD) panel inset within a housing that contains the microprocessor as well as other components of the controller. In some designs, the user interface may permit the user to program the controller to activate on a certain schedule determined by the user. For example, the interface may include a separate menu routine that permits the user to change the temperature at one or more times during a particular day. Once the settings for that day have been programmed, the user can then repeat the process to change the settings for the other remaining days. Such a schedule may help reduce energy consumption of the HVAC system by changing the set point to an energy saving set back temperature during certain times.

Most structures are serviced by one or more utilities, such as an electric utility, a gas utility, a water utility and others. The expense of using these utility services continues to rise, particularly during peak demand periods. In order to better serve its customers, and in some cases to help reduce demand during peak or other periods, it would be advantageous for a utility to be able to directly and more efficiently communicate with its customers.

SUMMARY

The present disclosure pertains generally to thermostats that are adapted to assist utilities in communicating with its customers. In particular, the present disclosure relates to a thermostat having a display, a controller and a receiver that is coupled to the controller. The receiver is adapted to receive messages from a utility, and the controller is adapted to display related display messages on the display.

The above summary is not intended to describe each disclosed embodiment or every implementation of the present invention. The Figures and Detailed Description that follow more particularly exemplify these embodiments.

BRIEF DESCRIPTION OF THE FIGURES

The invention may be more completely understood in consideration of the following detailed description of various embodiments of the invention in connection with the accompanying drawings, in which:

FIG. **1** shows an illustrative but non-limiting HVAC control system.

FIG. **2** shows an illustrative but non-limiting example of a thermostat of FIG. **1**;

FIG. **3** shows an illustrative thermostat operating in accordance with its programming;

FIG. **4** shows the illustrative thermostat of FIG. **3** after the current energy demand and/or current energy cost has reached a critical level;

FIG. **5** shows the illustrative thermostat of FIG. **3** displaying a first stored or received message;

FIGS. **6-7** shows the illustrative thermostat of FIG. **5** displaying a second stored or received message;

FIG. **8** shows the illustrative thermostat of FIG. **3** displaying a "Please Conserve" message received from a utility;

FIG. **9** shows the illustrative thermostat of FIG. **3** displaying a "Storm Warning" message received from a utility or other source;

FIG. **10** show the illustrative thermostat of FIG. **3** displaying information related to electrical consumption including historical electrical consumption information;

FIG. **11** show the illustrative thermostat of FIG. **3** displaying information related to electrical costs including historical electrical cost information;

FIG. **12** show the illustrative thermostat of FIG. **3** displaying information related to water usage including historical water usage information;

FIG. **13** show the illustrative thermostat of FIG. **3** displaying information related to water usage costs including historical water usage cost information;

FIG. **14** show the illustrative thermostat of FIG. **3** displaying information related to gas usage including historical gas usage information;

FIG. **15** show the illustrative thermostat of FIG. **3** displaying information related to gas usage costs including historical gas usage cost information;

FIG. **16** is a flow diagram of an illustrative method in accordance with the present invention; and

FIG. **17** is a flow diagram of another illustrative method in accordance with the present invention.

While the invention is amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail. It should be understood, however, that the intention is not to limit the invention to the particular illustrative embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention.

DETAILED DESCRIPTION

The following description should be read with reference to the drawings, in which like elements in different drawings are

numbered in like fashion. The drawings, which are not necessarily to scale, depict selected embodiments and are not intended to limit the scope of the invention. Although examples of construction, dimensions, and materials may be illustrated for the various elements, those skilled in the art will recognize that many of the examples provided have suitable alternatives that may be utilized.

FIG. **1** shows an illustrative but non-limiting HVAC control system **10**. The illustrative HVAC control system **10** includes a thermostat **12** that may be adapted to interact with and control HVAC equipment **14**. HVAC equipment **14** may include one or more of cooling equipment **16**, heating equipment **18** and/or ventilation equipment **20**. In some cases, cooling equipment **16** and heating equipment **18** may, for example, be combined in a forced air system, or perhaps a heat pump system, particularly in residential and/or light commercial applications. In other cases, one or more of cooling equipment **16**, heating equipment **18** and/or ventilation equipment **20** may be distinct systems controlled by thermostat **12**. In some instances, it is contemplated that thermostat **12** may represent two or more distinct thermostats, each controlling different equipment within HVAC equipment **14**, and or different zones within a structure.

In the illustrative embodiment, thermostat **12** may be adapted to interact and/or communicate with a utility **22**. Utility **22** may represent a utility company or another entity that produces or otherwise provides an energy source such as electricity, natural gas and the like, or provides another utility such as water and/or sewer service. Utility **22** may represent a utility company or other entity that provides a source of hot water that can be used for heating and/or any other desired use. Utility **22** may provide hot water from a geothermal source, or by heating water using biomass or even microwave energy.

In some instances, thermostat **12** may receive signals from utility **22** via a communication network **24**. Communication network **24** may include wireless communication between utility **22** and thermostat **12**, using radio frequencies and the like. In some cases, communication network **24** may represent a hard-wired communication network between utility **22** and thermostat **12**, such as copper wiring, coaxial cable, CAT **5** cable, fiber optics, and the like. In some instances, especially if utility **22** provides electrical power to the building in which thermostat **12** is located, communication network **24** may represent signals sent over the power lines themselves. some cases, part of communication network **24** may be a wired and another part may be wireless. More generally, communication network **24** may be any suitable communication path between utility **22** or the like and thermostat **12**.

In some instances, thermostat **12** may receive information from utility **22** pertaining to utility usage, utility usage history, current and/or historical rate information, and the like. Alternatively, or in addition, thermostat **12** may receive information from meter **26** pertaining to utility usage, utility usage history, current and/or historical rate information, and the like. In some cases, thermostat **12** may receive information from utility **22** and/or meter **26** pertaining to a current electrical rate, say in cents per kilowatt-hour. In some instances, thermostat **12** may receive information regarding a remaining balance on a prepaid account, or perhaps monthly garbage and/or sewer charges.

Utility **22** and/or meter **26** may, for example provide information to thermostat **12** regarding a measure of utility usage. In some cases, the measure of utility usage may be related to current utility costs over a designated period of time (e.g. over a past year, a past month, a past week, a past day, a past hour, etc.), i.e., a current electrical cost over a designated period of time, a current gas cost over a designated period of time, a current water cost of a designated period or time and the like. In some instances, a measure of utility usage may include a quantity of utility usage, and thus utility **22** may provide thermostat **12** with information pertaining to how much energy (e.g. in KWH, which are kilowatt-hours), for example is currently being used over a designated period of time (e.g. over a past year, a past month, a past week, a past day, a past hour, schedule period, etc.).

In some instances, utility **22** and/or meter **26** may provide messages relating to utility usage. For example, utility **22** may provide, via communication network **24**, one or more messages intended for a homeowner, facilities manager or the like. In some cases, if utility demand is high, utility **22** may provide one or more messages that permit or instruct thermostat **12** to display suggestions on how to save energy, water or other resource. For example, if utility energy demand is high or expected to be high, thermostat **12** may display one or more messages suggesting that the homeowner or facilities manager conserve energy by changing a temperature set point, or perhaps suggesting that they wait and run energy intensive appliances later in the day, when utility demand may be lower. Utility **22** may, in some instances, provide one or more messages that permit or instruct thermostat **12** to display information pertaining to current or expected weather, current or expected energy demand, current or expected pricing tiers, etc.

In some cases, utility **22** and/or meter **26** may provide one or more messages that cause thermostat **12** to display information relating to utility billing. This may include utility billing history, current utility billing rates and/or current utility costs, and the like. Thermostat **12** may display information pertaining to a measure of utility usage during a first time period (e.g. a designated month such as the current month) and information pertaining to a measure of utility usage during a second time period (e.g. the designated month one year ago) that is different from the first time period. While not required, the first time period may occur temporally before the second time period. In some cases, controller **34** may compute a measure of utility usage that is consumed by the HVAC system of the building or other structure by monitoring the on-time of one or more HVAC system components **16**, **18** and/or **20**.

The first time period and the second time period may each, independently, be any desired length of time, and may be temporally separated by any desired time interval. In some cases, the first time period may immediately precede the second time period. The first time period may, if desired, be one or more months before the second time period. In some cases, the first time period may be about a year or more prior to the second time period.

In some cases, the first time period and the second time period may each correspond to a one week (168 hours) time period, and the first time period may correspond to an immediately preceding week relative to the second time period. In some instances, the first time period and the second time period may each correspond to a one month time period. The first time period may be a one month time period that immediately precedes the second time period. In some cases, the first time period (e.g. June 2006) may be a one month time period that is about one year prior to the second time period (e.g. June 2007).

In some cases, the indication of the measure of utility usage that is displayed for the first time period may include an indication of the cost of utility usage during the first time period, and the indication of the measure of utility usage that is displayed for the second time period includes an indication

of the cost of utility usage during the second period of time. In some instances, the indication of the measure of utility usage that is displayed for the first time period includes an indication of the quantity of utility usage during the first period of time, and the indication of the measure of utility usage that is displayed for the second time period include an indication of the quantity of utility usage during the second period of time.

In some embodiments, thermostat **12** may be adapted to interact and/or communicate with a meter **26** over a communication line **28**. Meter **26** may, for example, be adapted to measure and/or regulate a flow of energy or other resource (e.g. water) from utility **22**, and may also provide thermostat **12** with usage information via a wireless, wired, optical, or any other suitable communication path. In some instances, although direct communication therebetween is not expressly shown in FIG. **1**, meter **26** may provide utility **22** with usage information.

Communication line **28** may represent wireless communication between meter **26** and thermostat **12**. In some cases, communication line **28** may represent a hard-wired line between meter **26** and thermostat **12**, such as copper wiring, coaxial cable, CAT **5** cable, fiber optic cable, and the like. In some instances, although not expressly illustrated in FIG. **1**, it is contemplated that meter **26** may also communicate with utility **22**, and may receive utility rate information and the like from utility **22**, but this is not required in all embodiments.

The preceding discussion describes communication that may occur between utility **22** and thermostat **12** and/or between meter **26** and thermostat **12**. In order to accommodate this communication, thermostat **12** may include a receiver and/or transceiver **30** that permits thermostat **12** to communicate with utility **22** via communication network **24** and/or to communicate with meter **26** via communication line **28**. As noted, one or both of communication network **24** and/or communication line **28** may be wired or wireless. In some cases, communication network **24** may, for example, include a wireless paging system, and receiver and/or transceiver **30** may be a load control receiver that uses, for example, a 900 MHz paging technology such as the FLEX® paging technology available from Motorola. One such load control receiver is available from Cannon Technologies, located in Wayzata, Minn., although it is contemplated that any suitable communication equipment may be used, as desired.

Thermostat **12** may include a user interface **32** that may be adapted to accept information from a user as well as to provide information to the user. In some cases, user interface **32** may include a liquid crystal display (LCD) as well as a keypad or similar entry device. In some instances, user interface **32** may include a touch screen LCD that provides both functions.

Thermostat **12** may include a controller **34** that is adapted to oversee the aforementioned communications between thermostat **12** and utility **22** and/or meter **26**. Controller **34** may regulate information that is solicited and/or displayed on user interface **32**. Controller **34** may be adapted to implement a control algorithm that is adapted to at least partially control one or more components of HVAC equipment **14**. Thermostat **12** may include a memory block **36** that can be used to store operating parameters, utility usage history and the like.

Thermostat **12** may include a sensor **38**, which may be located within thermostat **12** as well as one or more external sensors **40**, as desired. Each of sensors **38** and **40** may be any type of sensor, or may represent multiple sensors, such as temperature sensors, humidity sensors and the like. External sensors **40** may be hard wired to thermostat **12**, or may communicate wirelessly, as desired.

FIG. **2** shows an illustrative but non-limiting example of a thermostat **42** that may be considered as representing thermostat **12** (FIG. **1**), but showing additional detail regarding user interface **32**. Thermostat **42** includes a thermostat housing **44** and an LCD display **46** that is visible from outside thermostat housing **44**. Thermostat housing **44** may be formed of any suitable material and having any suitable dimensions. In some cases, thermostat housing **44** is stamped or molded from a polymeric material. In some cases, LCD display **46** is a touch screen LCD, but this is not required in all embodiments.

LCD display **46** may be considered as including a first region **48** and a second region **50**. In the illustrative embodiment, first region **48** includes an array of pixels **52** that are arranged into a plurality of rows and a plurality of columns to form an array of pixels that is suitable for displaying alphanumeric characters such as text in a dot matrix format. In some cases, one or more of pixels **52** may be square or round fixed segment pixels. For example, first region **48** may include an array of pixels **52** that are arranged into 7 rows and a total of 125 columns. To more clearly illustrate the individual pixels, pixels **52** are schematically illustrated in FIG. **2** as unlit.

First region **48** may be constructed using either fixed segment type LCD display or a graphic type LCD display. When first region **48** is constructed as a fixed segment LCD display, a number of relatively small fixed segments dots are provided, and in some cases, may be arranged into character blocks, with each character block having, for example, 5×7 dots. In some cases, each character block can be addressed separately and can form numbers, letters and a limited number of symbols. In other cases, each fixed segment dot can be addressed separately. When first region **48** is constructed as a graphics type LCD display, a relatively larger number of pixels are arranged in rows and columns, and each pixel can typically be individually addressed.

In an illustrative but non-limiting example, first region **48** may include or be formed as fixed segment LCD display, and may include a total of 25 5×7 characters, for a total of 875 individual pixels **52**. Each pixel **52** may be square and may be 0.5 millimeters by 0.5 millimeters in size. There may be a small gap between adjacent pixels **52**. In some cases, there may be a 0.05 millimeter gap between adjacent pixels **52**. These pixels **52** may be formed as part of the fixed segment mask used in fabricating the fixed segment LCD display.

In some cases, first region **48** may be used to display messages and other similar text. Controller **34** may be coupled to user interface **32** and may be adapted to display a message including two or more text characters in first region **48** using the array of fixed segment pixels **52**. If desired, controller **34** may be adapted to scroll messages across at least part of first region **48**. This may be useful in displaying messages that are too long to simultaneously fit in their entirety within first region **48**. Scrolling may also be useful in attracting attention to messages being displayed within first region **48**. In some cases, a message may be flashed, i.e., repeatedly turned on and off, within first region **48** to draw attention to the particular message.

In some cases, display **46** may include a left arrow icon **54** and/or a right arrow icon **56**, which may be used to scroll through a long message, or perhaps to scroll through multiple messages. Left arrow icon **54** and right arrow icon **56** may be constructed as fixed segment icons, and may not be considered part of first region **48**, even though they are located within an upper portion of display **46**. In some embodiments, pressing right arrow icon **56** may cause controller **34** (FIG. **1**) to display another message, if another message is available, or

to cause a message to scroll, Pressing left arrow icon **54** may cause controller **34** to display a previous message or to cause a message to scroll.

Second region **50** of user display **46** may include a plurality of fixed segment graphical icons. At least some of the fixed segment graphical icons within second region **50** may be or may include a word, a perimeter boundary and/or a word within a perimeter boundary. In some instances, LCD display **46** is a touch screen LCD, and one or more of the fixed segment graphical icons may coincide with one or more touch sensitive buttons.

For example, second region **50** may include a message icon **58**. If thermostat **42** has received or otherwise generated a text message to be displayed within first region **48**, controller **34** (FIG. **1**) may flash message icon **58** and/or may illuminate the "VIEW" text within message icon **58**. The "VIEW" text may be formed as part of a fixed segment graphical icon, if desired. Message icon **58** may coincide with a touch sensitive button or portion of LCD display **46**. In some cases, message icon **58** may include a fixed segment perimeter boundary **59**.

Pressing message icon **58** may cause controller **34** to proceed with displaying and/or scrolling one or more messages within first region **48** of display **46** using the array of fixed segment pixels **52**. In some cases, once the message has been displayed, the "DELETE" text within message icon **58** may be illuminated, although this is not required. Pressing message icon **58** at this stage may cause controller **34** to delete the message that has been displayed or is currently being displayed. Second region **50** may include an "EXIT" icon **60**. Pressing EXIT icon **60** instead of message icon **58** may cause controller **34** to return to a previous screen without deleting the displayed message or messages. Example messages are shown and discussed with respect to subsequent Figures.

Fixed segment LCD displays are often configured to display Arabic numbers (0-9) using seven segments. In contrast, fourteen segments are often needed to display other characters such as the Roman alphabet, measurement units and other symbols. In some instances, second region **50** of display **46** may include a set **62** of fixed segments that are configured to display numbers. In particular cases, set **62** may be configured to display utility usage data including utility usage quantity data and/or utility usage cost data. In some cases, set **62** may include a total of five fixed segment numbers **64**, with each fixed segment number **64** having a total of seven distinct bar segments **66**.

Similarly, second region **50** of display **46** may include a set **68** of fixed segments that are configured to display numbers. In some cases, set **68** may be configured to display historical utility usage data including historical utility usage quantity and/or historical utility usage cost data. In some cases, set **68** may include a total of five fixed segment numbers **70**, with each fixed segment number **70** having a total of seven distinct bar segments **72**.

In some instances, second region **50** of display **46** may include a TIER icon **74** that may include one or more of a CRITICAL fixed segment **76**, a HIGH fixed segment **78**, a MEDIUM fixed segment **80** and/or a LOW fixed segment **82**. In some cases, utility **22** (FIG. **1**) may provide a signal to thermostat **42** informing thermostat **42** that current energy costs and/or current energy demand has reached a particular tier or level. For example, if energy demand and/or energy cost is low, the LOW fixed segment **82** may be illuminated. The other fixed segments may be illuminated in accordance with the energy demand and/or energy cost data provided by utility **22**. In some situations, TIER icon **74** may not be illuminated.

If the current energy demand and/or current energy costs reach a critical level, controller **34** (FIG. **1**) may illuminate CRITICAL fixed segment **76**. In some cases, when the current energy demand and/or current energy costs reaches a certain level (e.g. high or critical), a SAVING icon **84** may be illuminated or even flash indicating that controller **34** has altered a temperature set point in accordance with the energy demand information provided by utility **22** (FIG. **1**). In some cases, SAVING icon **84** may be illuminated irrespective of the current tier level.

In some instances, utility **22** may, in response to energy demand and/or energy cost data, may determine how temperature set points are to be altered. A customer may, for example, sign a contract permitting utility **22** to alter temperature set points and/or to determine temperature differentials as necessary and/or appropriate. If utility **22** determines that a particular tier level has been reached, utility **22** may send a signal to thermostat **42** temporarily altering a temperature set point, either by providing a temporary temperature set point or by providing a temperature differential that can be applied to the temperature set point specified by the current schedule under which thermostat **42** is otherwise operating. The contract may permit utility **22** to send a signal to thermostat **42** instructing thermostat **42** to shut down HVAC equipment **14** (FIG. **1**) for a length of time that may be predetermined and/or may be calculated based, for example, on current energy demand and/or current energy rates.

In some instances, for example, utility **22** may provide a signal to thermostat **42** instructing thermostat **42** to change to a temporary temperature set point. The temporary set point may vary, depending on the current energy tier. For example, utility **22** may suggest or require, based at least in part on the contract signed by the owner, a heating temperature set point of 70° F. for a low energy cost, 65° F. for a medium energy cost, 60° F. for a high energy cost, and 50° F. for a critical energy cost. Utility **22** may suggest or require, based at least in part on the contract, a cooling temperature set point of 72° F. for a low energy cost, 77° F. for a medium energy cost, 82° F. for a high energy cost, 86° F. for a critical energy cost. These temperatures are merely illustrative and are not intended to limit or define in any way or manner. In some cases, utility **22** may provide thermostat **42** with the heating and cooling temperature set point values corresponding to each tier level.

Controller **34** (FIG. **1**) may issue a control signal to HVAC equipment **14** for operating cooling equipment **16** and/or heating equipment **18** when the temperature is different than the temperature set point associated with the acceptable energy cost level. In the above example, when the current energy price is high, the control signal may issue control information for operating heating equipment **18** when the temperature fell to 60° F. or below. For cooling equipment **16**, the control signal would issue control information for operating cooling equipment **16** when the temperature rose to or above 82° F. Additionally, the receiver and/or transceiver **30** may receive information from the utility(s) for an energy (and/or water) bill for usage of energy (and/or water) during a time period. In some cases, the user may authorize payment of the energy (and/or water) bill and have the authorization transmitted to utility **22** via the thermostat **12**.

In some instances, utility **22** may send a signal instructing thermostat **42** to temporarily change its temperature set point by a particular temperature differential that depends on tier level. For example, utility **22** may provide a signal including a temperature differential or offset of 0° F. for a low energy cost, a temperature differential or offset of 2° F. for a medium

energy cost, a temperature differential or offset of 6° F. for a high energy cost and a temperature differential or offset of 10° F. for a high energy costs.

If, for example, the current temperature set point for heating is set at 68° F. and the energy demand reaches the critical level, thermostat **42** may temporarily operate with a temperature set point of 58° F. (68° F.-10° F.). If for example, the current temperature set point for cooling is set at 76° F. and the energy demand reaches the high level, thermostat **42** may temporarily operate with a temperature set point of 86° F. (76° F.+10° F.).

Depending on the specifics of the contract between the owner and utility **22**, in some cases the owner may be able to override the temporary temperature set points provided by the utility. In some cases, the owner may not be permitted to make any changes, and in fact thermostat **42** may be instructed to not accept set point changes while utility **22** is providing a temporary temperature set point and/or a temperature differential to thermostat **42**.

In some cases, it is contemplated that a homeowner, a facilities manager and/or an installer may program thermostat **42** with information pertaining to how temperature set points are to be altered in response to various energy demand and/or energy cost levels provided by utility **22**. In some cases, setback information that has been programmed into thermostat **42** may be based at least in part upon which time period (WAKE, LEAVE, RETURN, SLEEP) thermostat **42** is currently operating under.

FIG. **3** shows the illustrative thermostat **42** operating in accordance with its programming. On second region **50** of display **46**, controller **34** (FIG. **1**) is displaying a current inside temperature value **86** and a current temperature set point **88**. If message icon **58** is blinking or otherwise illuminated, pressing message icon **58** may cause one or more messages to be displayed, as will be illustrated subsequently.

As TIER icon **74** is indicating that the current energy demand and/or current energy cost is at a medium level, the illustrative thermostat **42** may continue to operate in accordance with its schedule, as indicated by the "Following Schedule" fixed segment icon **90**. It can be seen that as the temperature set point **88** is higher than the current temperature value **86**, the heat is currently operational.

In FIG. **4**, TIER icon **74** is indicating that the current energy demand and/or current energy cost has reached a critical level **76**. While current inside temperature value **86** remains constant at 66° F., it can be seen that the temperature set point **88** has dropped from the 72° F. value shown in FIG. **3** to a savings temperature value of 58**20** F., and the heat has thus shut off. In some cases, controller **34** monitors the communication with utility **22**. In some cases, if the communication is broken or otherwise not functioning properly for some reason, thermostat **42** may return to its normal schedule until such time as communication is reestablished.

Returning to FIG. **3**, assume for illustrative purposes that message icon **58** is blinking or is otherwise illuminated. In the illustrative embodiment, pressing message icon **58** will cause controller **34** (FIG. **1**) to display stored or received messages, as shown in FIG. **5**. First region **48** of display **46** can be seen as displaying a message "Good Morning!". Because there is more than one message to display (two, in this example), the message includes "½" in front of the message, and right arrow icon **56** is illuminated. Pressing right arrow icon **56** may cause controller **34** to display the second message, as shown in FIGS. **6** and **7**. It can be seen that once the message has been viewed, message icon **58** changes from illuminating the VIEW fixed segment icon to illuminating the DELETE fixed segment icon.

In this particular example, the second message is "2 Honeywell UtilityPRO Helps You to Save Energy", which is too large to display within the 25 character blocks forming first region **48**. Thus, controller **34** (FIG. **1**) may scroll the message. This can be seen by comparing FIGS. **6** and **7**, In FIG. **6**, first region **48** includes "2 Honeywell UtilityPRO He", which is the first 25 characters of the message while in FIG. **7**, first region **48** includes "O Helps You to Save Energy", which represents the last 25 characters of the message. These are screen captures illustrating how text fits within first region **48**. While the message is broken over two Figures, it will be understood that the message actually scrolls smoothly across first region **48** of display **46**. In some cases, it is contemplated that text may be scrolled vertically, rather than horizontally.

Because a second or subsequent message is being displayed, it can be seen that left arrow icon **54** is illuminated, so that a user may move back to the previous message. In some cases, if only one message is available or otherwise appropriate for display, neither left arrow icon **54** nor right arrow icon **56** may be illuminated.

A wide variety of messages may be displayed. For example, as shown in FIG. **8**, first region **48** of display **46** may, in response to a signal from utility **22** (FIG. **1**), display a message reading "Please Conserve!" This message may be displayed when, for example, the utility demand is high or expected to be high. Similar messages may suggest that the person refrain from running energy intensive appliances such as washing machines until the energy demand drops Another illustrative message is seen in FIG. **9**, in which first region **48** of display **46** displays a message reading "Storm Warning", perhaps in response to utility **22** forwarding a signal from the local weather authorities, or perhaps the local weather authorities are equipped to broadcast a warning signal directly to receiver and/or transceiver **30** (FIG. **1**). It is contemplated that at least some of the messages may be targeted toward certain customers. For example, a tornado warning message may only be sent to those thermostats that are within the geographic region that is currently under a tornado warning. In another example, an ozone or UV warning message may only be sent to those thermostats that are within the geographic region that is currently experiencing high ozone or UV. Likewise, if the demand for energy is particularly high or expected to be high for only some of a utility's customers or part of the utility's grid, a message may be directed to only those thermostats that correspond to those customers (e.g. a unique message to a particular group of customers).

It is also contemplated that promotional messages may be sent to certain thermostats. For example, messages that inform users of certain promotional or other events or services, such as sales at local stores, may be provided. Tips on saving energy and/or the maintenance of equipment may also be provided. In some cases, a water utility may have certain restrictions on water usage, such as limiting the watering of lawns to ever other day. In some cases, the water utility may send a message to the thermostat to notify the user of the water restrictions. In some cases, the water utility may send a message indicating that watering of lawns is prohibited for the customer on a particularly day (e.g. today) or during some other time period.

In some cases, thermostat **42** may be adapted to provide a user with information regarding current and/or historical energy consumption data and corresponding energy costs. For example, FIGS. **10-15** illustrative this feature. Returning briefly to FIG. **3**, in which thermostat **42** is operating in accordance with its schedule, it can be seen that lower region

50 of display 46 includes a USAGE icon 92. In the illustrative embodiment, pressing USAGE icon 92 brings the user to the screen shown in FIG. 10.

In FIG. 10, controller 34 (FIG. 1) is displaying information pertaining to electrical consumption. In particular, controller 34 is instructing first region 48 of display 46 to display "ELECTRICITY IN KWH", so that the user can put into context the numerical data displayed within second region 50 of display 46 using set 62 of fixed segments and set 68 of fixed segments. Set 62 is displaying a value for the amount of electricity used thus far this month while set 68 is being used to display a value for the corresponding time period last year. Fixed segment icon 94 informs the user of the current time period while fixed segment icon 96 informs the user of the corresponding historical time period. As discussed above, other time periods may also be chosen or otherwise selected or displayed, as desired.

Pressing right arrow icon 56 brings the user to FIG. 11, in which controller 34 (FIG. 1) is displaying information regarding electrical costs, while instead pressing EXIT button 60 would return the user to FIG. 3. In FIG. 11, first region 48 of display 46 now reads "ELECTRICITY BILL". Fixed segment icon 98, representing a dollar sign, provides additional context for the information being displayed. In some cases, fixed segment icon 98 may be omitted, if desired.

Set 62 is being used by controller 34 to display the electrical bill to date for the month while set 68 is being used by controller 34 to provide the corresponding historical data. Pressing left arrow icon 54 would return the user to the screen shown in FIG. 10 while pressing right arrow icon 56 will bring the user to the screen shown in FIG. 12. Pressing EXIT button 60 would return the user to FIG. 3.

In FIG. 12, controller 34 (FIG. 1) is displaying information pertaining to water consumption. In particular, controller 34 is instructing first region 48 of display 46 to display "WATER USAGE IN KGAL", so that the user can put into context the numerical data displayed within second region 50 of display 46 using set 62 of fixed segments and set 68 of fixed segments. Set 62 is displaying a value for the amount of water used thus far this month while set 68 is being used to display a value for the corresponding time period last year. Fixed segment icon 94 informs the user of the current time period while fixed segment icon 96 informs the user of the corresponding historical time period. As discussed above, other time periods may also be chosen or otherwise selected or displayed.

Pressing right arrow icon 56 brings the user to FIG. 13, in which controller 34 (FIG. 1) is displaying information regarding water costs, while instead pressing EXIT button 60 would return the user to FIG. 3. In FIG. 13, first region 48 of display 46 now reads "WATER BILL". Fixed segment icon 98, representing a dollar sign, provides additional context for the information being displayed. In some cases, fixed segment icon 98 may be omitted, if desired.

Set 62 is being used by controller 34 to display the water bill to date for the month while set 68 is being used by controller 34 to provide the corresponding historical data. Pressing left arrow icon 54 would return the user to the screen shown in FIG. 12 while pressing right arrow icon 56 will bring the user to the screen shown in FIG. 14. Pressing EXIT button 60 would return the user to FIG. 3.

In FIG. 14, controller 34 (FIG. 1) is displaying information pertaining to gas consumption. In particular, controller 34 is instructing first region 48 of display 46 to display "GAS USAGE IN CCF", so that the user can put into context the numerical data displayed within second region 50 of display 46 using set 62 of fixed segments and set 68 of fixed segments. Set 62 is displaying a value for the amount of gas used thus far this month while set 68 is being used to display a value for the corresponding time period last year. Fixed segment icon 94 informs the user of the current time period while fixed segment icon 96 informs the user of the corresponding historical time period. As discussed above, other time periods may also be chosen or otherwise selected or displayed.

Pressing right arrow icon 56 brings the user to FIG. 15, in which controller 34 (FIG. 1) is displaying information regarding gas costs, while instead pressing EXIT button 60 would return the user to FIG. 3. In FIG. 15, first region 48 of display 46 now reads "GAS BILL". Fixed segment icon 98, representing a dollar sign, provides additional context for the information being displayed. In some cases, fixed segment icon 98 may be omitted, if desired.

Set 62 is being used by controller 34 to display the water bill to date for the month while set 68 is being used by controller 34 to provide the corresponding historical data. Pressing left arrow icon 54 would return the user to the screen shown in FIG. 14 while pressing right arrow icon 56 will return the user to the screen shown in FIG. 10, unless thermostat 42 is equipped to display additional consumption or cost data. Pressing EXIT button 60 would return the user to FIG. 3.

FIGS. 16 and 17 are flow diagrams illustrating methods that may be carried out using thermostat 42 (FIG. 2). In FIG. 16, control begins at block 100, where thermostat 42 receives a message from utility 22 (FIG. 1). The message received from utility 22 may be related to energy demand, current and/or past energy costs, energy conservation, weather alerts, promotional and/or advertisements and the like. At block 102, controller 34 (FIG. 1) displays on display 46 an indication of a measure of utility usage during a first time period. At block 104, controller 34 displays on display 46 an indication of a measure of utility usage during a second time period. In some cases, the first time period may predate the second time period, but this is not required.

In FIG. 17, control begins at block 100, where thermostat 42 (FIG. 2) receives a message from utility 22 (FIG. 1). At block 106, controller 34 (FIG. 1) displays on display 46 an indication of a measure of utility usage during a period of time, Control passes to block 108, where controller 34 displays on display 46 one or more display messages that are related to the message received from utility 22. These messages may pertain to energy demand, current energy costs, energy conservation, weather alerts, advertisements and the like.

In some cases, the indication of the measure of utility usage during the period of time may be displayed on display 46 at the same time or nearly the same time as the one or more messages arc displayed on display 46. In some cases, they are not displayed simultaneously.

The present invention should not be considered limited to the particular examples described above, but rather should be understood to cover all aspects of the invention as fairly set out in the attached claims. Various modifications, equivalent processes, as well as numerous structures to which the present invention can be applicable will be readily apparent to those of skill in the art to which the present invention is directed upon review of the instant specification.

We claim:

1. A thermostat for controlling an HVAC system of a building or other structure, the thermostat comprising:

a thermostat housing;

a controller situated in the thermostat housing, the controller implementing a control algorithm that is configured to at least partially control one or more components of an HVAC system;

a display viewable from outside of the thermostat housing;

a receiver coupled to the controller configured to receive one or more messages either directly or indirectly from a utility;

a memory configured to store the one or more messages from the utility;

the controller configured to display a message icon on the display when at least one message has been received from the utility, the controller further configured to display the one or more messages in a predetermined display region of the display when prompted by the user, wherein the predetermined display region is sized to only simultaneously display an entire message that has a first message length or less, and if a longer message is received that is longer than the first message length, the controller is programmed to automatically identify the longer message and scroll the longer message across the predetermined display region when the longer message is displayed, wherein the longer message does not include a corresponding scroll command from the utility;

a user input coupled to the controller and accessible by a user from outside of the thermostat housing, the user input including a first button; and

wherein, if two or more messages are received from the utility, the controller is configured to allow a user to select a next one of the two or more messages for display in the redetermined display region of the dis by activating the first button.

2. The thermostat of claim **1** wherein one or more of the display messages include a suggestion on how to save energy.

3. The thermostat of claim **1** wherein one or more of the display messages are weather related.

4. The thermostat of claim **1** wherein one or more of the display messages are related to utility usage.

5. The thermostat of claim **1** wherein the controller is configured to display on the display an indication of a measure of utility usage during a first time period and an indication of a measure of utility usage during a second time period, wherein the first time period is before the second time period.

6. The thermostat of claim **5** wherein at least one message of the one or more messages from the utility provides a current indication of cost for utility usage.

7. The thermostat of claim **5** wherein the measure of utility usage includes a quantity of utility usage.

8. The thermostat of claim **5** wherein the measure of utility usage includes a cost of utility usage.

9. The thermostat of claim **5** wherein the indication of the measure of utility usage that is displayed for the first time period includes an indication of the cost of utility usage during the first period of time, and the indication of the measure of utility usage that is displayed for the second time period includes an indication of the cost of utility usage during the second period of time.

10. The thermostat of claim **5** wherein the indication of the measure of utility usage that is displayed for the first time period includes an indication of the quantity of utility usage during the first period of time, and the indication of the measure of utility usage that is displayed for the second time period include an indication of the measure of the quantity of the utility usage during the second period of time.

11. The thermostat of claim **1** wherein the predetermined display region is fixed and is configured to display a text based message.

12. The thermostat of claim **1** wherein the controller is configured to allow a user to delete a selected message.

13. The thermostat of claim **1**, wherein the display is a touch screen display, wherein the message icon is displayed in a first specific region of the touch screen display, and when touched by the user, a first message of the one or more messages is displayed in the predetermined display region of the display.

14. The thermostat of claim **1**, wherein the user input includes a second button, and wherein the controller allows a user to select the selected one of the two or more messages for display in the predetermined display region of the display by activating the first button to select a next one of the two or more messages and/or activating the second button to select a previous one of the two or more messages.

15. The thermostat of claim **1**, wherein the first button is defined as a touch region on the display.

16. A thermostat for controlling an HVAC system of a building or other structure, the thermostat comprising:

a thermostat housing;

a controller situated in the thermostat housing, the controller implementing a control algorithm that is configured to at least partially control one or more components of an HVAC system;

a display viewable from outside of the thermostat housing;

a receiver coupled to the controller configured to receive one or more messages either directly or indirectly from a utility;

a memory configured to store the one or more messages from the utility;

the controller configured to display one or more thermostat control parameters on the display, and simultaneously display a message icon on the display when at least one message has been received from the utility;

the controller configured to display the one or more messages in a predetermined display region of the display, wherein the predetermined display region is sized to only simultaneously display an entire message that has a first message length or less, and if a longer message is received that is longer than the first message length, the controller is programmed to automatically identify the longer message and scroll the longer message across the predetermined display region when the longer message is selected for display, wherein the longer message does not include a corresponding scroll command from the utility; and

if two or more messages have been received from the utility, the controller is configured to allow a user to select a selected one of the two or more messages for display in the predetermined display region of the display.

17. The thermostat of claim **16**, wherein the one or more thermostat control parameters includes a current inside temperature value.

18. The thermostat of claim **16**, wherein the one or more thermostat control parameters includes a current temperature set point.

19. The thermostat of claim **16**, wherein the one or more thermostat control parameters includes a current time.

20. The thermostat of claim **16**, wherein the one or more thermostat control parameters includes a fan mode.

21. The thermostat of claim **16**, wherein the one or more thermostat control parameters includes a system mode.

22. The thermostat of claim **16**, wherein the display is a fixed segment display.

23. The thermostat of claim **22**, wherein the fixed segment display is a touch screen display.

24. The thermostat of claim **22**, wherein the predetermined display region of the display includes a two dimensional array

of pixels that can be individually controlled to display the selected one of the two or more messages in the predetermined display region.

25. The thermostat of claim **24**, wherein if a longer message is received that is longer than the first message length, the controller scrolls the selected message across the two dimensional array of pixels of the predetermined display region.

26. The thermostat of claim **25**, wherein the controller scrolls the selected message across the two dimensional array of pixels of the predetermined display region when the selected message has more characters that can be accommodated at one time by the two dimensional array of pixels.

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