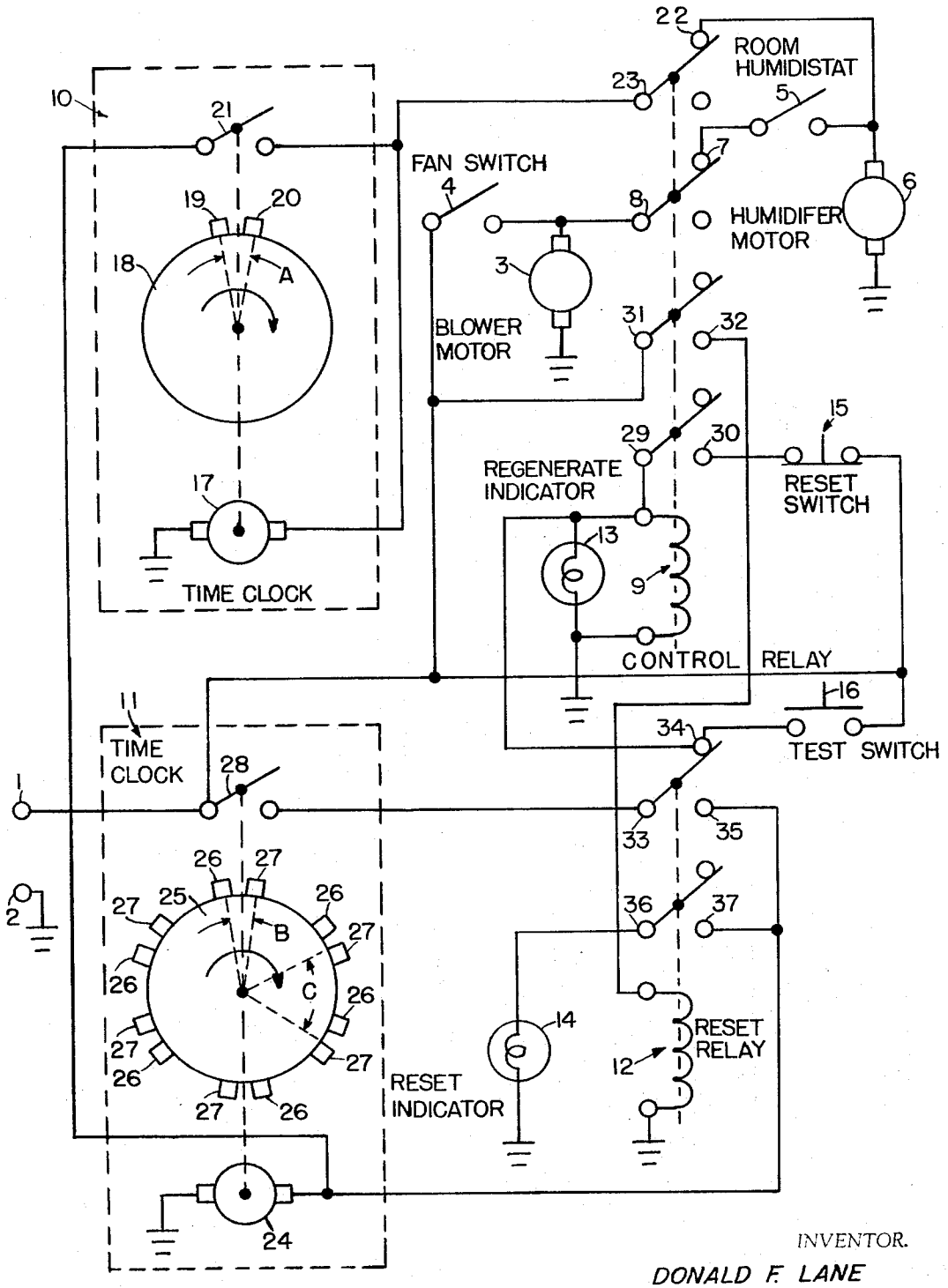
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DEMINERALIZER CONTROL SYSTEM

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DEMINERALIZER CONTROL SYSTEM

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This invention relates to a combined automatic humidifier control system and a visual indicator for signalling when a demineralizer cartridge has been exhausted. Demineralizers are installed between a water supply and a humidifier for the purpose of supplying mineral free water to the humidifier. The control system described herein is used in conjunction with atomizer type humidifiers wherein an electric motor operates a pump which in turn atomizes water. Humidifiers of this type release a fine water spray into the cold or warm air ducts of a forced air furnace when the furnace blower motor is running. One unhappy characteristic of such a system is that the minerals in the water are suspended in the air stream and are precipitated on any available surface (usually furniture) in the form of mineral dust. In addition, spray nozzles, pumps, etc., become clogged and hence must be cleaned or replaced. In more sophisticated systems, a demineralizer is employed to remove the minerals from the humidifier water supply before the water enters the humidifier. After supplying a given quantity of water, demineralizer cartridges lose their effectiveness and must be regenerated.

The need for a practical device for providing a visual indication when demineralizer cartridge regeneration is necessary, and which will in addition interrupt humidifier operation until the cartridge has been regenerated, has become increasingly apparent in recent years as manifested by the increased sale of humidifying equipment and the high cost of regenerating demineralizer cartridges (approximately half of their initial cost).

An unpatented system is known wherein the conductivity of a demineralizer cartridge is measured by a bridge circuit. A meter connected between appropriate bridge legs is calibrated in terms of percent demineralizer cartridge usefulness remaining. The adjustment of bridge legs in this system is critical and cartridge regeneration usually results prematurely, i.e., before the effectiveness of the demineralizer has been fully utilized. In addition, the bridge circuit is not automatic; it must be manually energized.

It is accordingly a primary object of this invention to provide automatically a visual indication when demineralizer cartridge regeneration is necessary, and to interrupt humidifier operation at this time.

The foregoing and other objects, advantages, and features of this invention and the manner in which same are accomplished will become readily apparent upon consideration of the following detailed description of the invention taken in conjunction with the accompanying drawing.

Briefly stated, this invention concerns a device which triggers a control circuit after a given quantity of water has passed through a demineralizer cartridge, and it provides a visual indication that cartridge regeneration is necessary.

The figure is a schematic diagram of the demineralizer control system. In the arrangement shown in the figure, reference numerals 1 and 2 indicate the terminals connected to the 120 volt power source required for the operation of the furnace blower motor 3 and the control system. The contacts of a fan switch 4 make when the air temperature within the furnace plenum (not shown) reaches a preset value and at this time the furnace blower motor 3 operates. It is during this time that atomizing or spray-type humidifiers introduce water into the furnace duct work. Generally, the humidifier motor which operates a pump is electrically connected in parallel with the furnace blower motor and operates when the furnace blower motor is running. In more elaborate systems, such as the one illustrated in the figure, a room humidistat 5 allows the humidifier motor 6 to operate only when the relative humidity in the controlled area is less than indicated by the room humidistat setting. The 120 volt power source required for the operation of the humidifier motor 6 is supplied through the normally closed contacts 7 and 8 of the control relay 9. When the control relay 9 is deenergized, operation of the humidifier motor 6 occurs when the furnace blower motor 3 is running and the contacts of the room humidistat 5 are closed. The control circuit described in the following paragraphs operates the control relay 9 when demineralizer cartridge regeneration is necessary and it interrupts the humidifier motor 6 by breaking control relay 9 contacts 7 and 8.

The control circuit consists of two conventional time clocks 10 and 11, two relays 9 and 12, two indicators 13 and 14, a reset push-switch 15, and a test push-switch 16.

Time clock 10 consists of a motor 17 that drives a gear train (not shown), a circular twenty-four hour time dial 18 driven by the gear train, a circumferentially adjustable off tab 19, a circumferentially adjustable on tab 20, and a switch 21. The adjustable on-off tabs 20 and 19 operate the switch 21. These tabs are locked on the twenty-four hour time dial 18 and are separated by an angular segment (indicated by the reference character A) corresponding to a time interval of fifteen minutes. The twenty-four hour time dial 18 is initially set such that the switch 21 is at the off position; hence, the contacts of switch 21 make after twenty-three hours and forty-five minutes, and break after twenty-four hours of running time of motor 17.

Time clock 11 consists of a motor 24 that drives a gear train (not shown), a twenty four hour time dial 25 driven by the gear train, six circumferentially adjustable off tabs 26, six circumferentially adjustable on tabs 27, and a switch 28. The adjustable tabs 26 and 27 operate the switch 28. Adjacent on-off tabs are separated by an angular segment (indicated by the reference character B) corresponding to a time interval of slightly more than fifteen minutes, and each pair of adjustable on-off tabs 26 and 27, is separated by an angular segment (indicated by the reference character C) corresponding to a time interval of four hours. The twenty-four hour time dial 25 is initially set such that the contacts of switch 28 are open; hence the contacts of switch 28 make after three hours and forty five minutes of running time, and break after four hours of running time of motor 24.

The control relay 9 is employed to interrupt humidifier operation after a preset time interval, and the reset relay 12 is employed to reset both time clocks 10 and 11, following the initiation of a humidifier interrupt cycle.

The regenerate indicator 13 is used to indicate when the demineralizer cartridge should be changed and the reset indicator 14 is lighted when both time clocks 10 and 11 are being reset.

The reset push-switch 15 is used to reset the control relay 9 and the reset relay 12 after the time clocks 10 and 11 have been reset and the demineralizer cartridge has been replaced. The test push-switch 16 is used to test the control system.

Demineralizer cartridges are available in various sizes ranging from 1500 to 6000 grains capacity. For example, a demineralizer cartridge having a 2000 grain capacity may adequately provide 100 gallons of mineral free water before requiring regeneration based on a water

hardness of 20 grains in accordance with the following relationship:

$$\frac{\text{demineralizer capacity in grains}}{\text{water hardness in grains}} = \text{capacity in gallons}$$

hence;

$$2000/20 = 100 \text{ gallons}$$

Conventional humidifiers of the atomizing type consume approximately three pounds of water per hour or 3/8.34 (0.36) gallon of water per hour.

In the detailed description which follows, it is assumed that the humidifier consumes 3/8.34 or 0.36 gallon of water per hour running time, that the demineralizer cartridge has a 2000 grain capacity, and that the water hardness is 14.5 grains. From these values the quantity of water processed by the demineralizer cartridge before the latter requires regeneration is:

$$2000/14.5 = 138 \text{ gallons}$$

Since it has been assumed that the humidifier in this application consumes 0.36 gallon of water per hour, the total hours running time of the humidifier before regeneration of the demineralizer cartridge is necessary is 138/0.36 or 384 hours. It will now be shown how the control circuit hereinabove described and illustrated in the figure is employed to interrupt humidifier operation and operate the regenerate indicator after 384 hours of humidifier running time.

Initially, the control relay **9** and the reset relay **12** are deenergized, the adjustable off tab **19**, locked on the twenty four hour time dial **18**, is set such that it has just opened the contacts of switch **21**, and the off tab **26**, locked on the twenty four hour time dial **25**, is set such that it has just opened the contacts of switch **28**.

When the air temperature within the furnace plenum (not shown) rises to a pre-set value, the contacts of the furnace fan switch **4** make and the furnace blower motor **3** operates. If the relative humidity within the controlled area is less than indicated by the setting of the room humidistat **5**, the contacts of the room humidistat **5** make and the humidifier motor **6** operates. When this motor operates, atomized water is sprayed into the cold air return duct of the furnace and is absorbed by the air stream moving through the furnace duct. This process continues as long as the furnace blower motor **3** operates and the relative humidity within the controlled area remains less than indicated by the setting of the room humidistat **5**. When this setting is exceeded, the contacts of the room humidistat **5** break and the humidifier motor **6** stops operating.

When the humidistat motor **6** operates and the control relay **9** is deenergized, the time clock **10**, motor **17** operates and drives the twenty four hour time dial **18**, through a gear train (not shown). After twenty three hours and forty five minutes of humidifier (and motor **17**) running time, the contacts of switch **21** make. During the fifteen minute interval in which the contacts of switch **21** are closed, the motor **24** of time clock **11** operates; hence, for every twenty four hours of humidifier running time, time clock **11** runs for fifteen minutes; hence, for every four revolutions of the twenty four hour time dial **18** the twenty four hour time dial **25** advances through an angular segment corresponding to a time interval of one hour. With this one-to-four relationship, one hour running time of motor **24** results only after 24×4 or 96 hours running time of motor **17**. Since a pair of adjustable on-off tabs **27** and **26** respectively are locked on the twenty four hour time dial **25** every sixty degrees (four hours), the contacts of switch **28** make after $24 \times 4 \times 4$ or 384 hours of humidifier motor **6** running time. This method of connecting two twenty four hour time clocks to obtain an adjustable and extended time interval is one of the unique features of this invention.

When the contacts of switch **28** make (after 384 hours of humidifier operation), the control relay **9** is energized and the regenerate indicator **13** lights. The control relay **9** is energized through the normally closed contacts **33** and **34** of the reset relay **12**, and remains energized through the control relay **9** holding contacts **29** and **30** and the normally closed contacts of the reset push-switch **15**. When the control relay **9** is energized, its normally closed contacts **8** and **7** break and 120 volt power to the humidifier motor **6** (obtained from the furnace blower motor **3**), is interrupted; in addition, the normally open contacts **31** and **32** of control relay **9** make and the reset relay **12** is energized. Finally, when the normally closed contacts **22** and **23** of control relay **9** break, the 120 volt power source, which operates the time clock motors **17** and **24**, is interrupted.

The function of the reset relay **12** is to automatically reset time clocks **10** and **11**. The automatic reset cycle is initiated when the reset relay **12** is energized. When this relay is energized, its contacts **36** and **37** make and the reset indicator lights; in addition, its contacts **33** and **34** break and its contacts **33** and **35** make.

The function of a lighted reset indicator **14** is to advise the equipment user that the time clocks **10** and **11** are being automatically reset and that the manually operated reset push-switch **15** should not be depressed until the reset indicator **14** is extinguished. The reset indicator **14** is extinguished automatically when the time clock **11** is reset.

When the reset relay **12** is energized, 120 volts is supplied to both time clock motors **24** and **17** through the time clock **11** contacts of switch **28** and the reset relay **12** contacts **33** and **35**. The time required to reset time clock **10** (when its switch contacts **21** break) is fifteen minutes. The time clock **10** is reset when the adjustable off tab **19** causes the switch **21** contacts to break. When this action occurs, time clock **10**, motor **17** ceases to operate.

The time required to reset time clock **11** (when its switch contacts **28** break) is slightly greater than fifteen minutes. The time clock **11** is reset when any of the adjustable off tabs **26** cause the contacts of switch **28** to break. When this action occurs, the time clock **11** motor **24** ceases to operate, and the reset indicator is extinguished. After the reset indicator **14** is extinguished, the reset push-switch **15** may be depressed to deenergize the control relay **9** and the reset relay **12**. The control system is then ready to begin accumulating time on the replaced demineralizer cartridge.

It is evident that changes within the skill of those versed in the art may be made without departing from the spirit of the invention. In many instances, features may be added; in others, features may be omitted. Where the same or similar results may be achieved by the use of equivalents, substitution of the equivalent may be made without departing from the inventive concept.

It is intended that the patent shall cover, by summarization in the appended claims, all features of patentable novelty residing in the invention.

I claim:

1. In a self resetting device for indicating when the demineralizer cartridge in an automatic humidifier control system needs replacement, the said system including electrically operated humidifying means, the combination of:

a first and second circuit timing means including switch means series connected to said humidifying means operable to close said first circuit after said humidifying means has operated a time period substantially equal to the useful life of a demineralizer cartridge,

a control relay connected to the said first circuit and operated by the switch means of said timing means operable when energized to interrupt said humidifying means and said timing means, and close said second circuit, and

means connected to said second circuit and operated by said control relay when it is energized to supply power to said timing means whereby to reset the same to its original position.

2. The device described in claim 1 wherein said timing means includes a first time clock and switch means connected therewith,

said first time clock having means for closing its switch means periodically for a predetermined time,

a second time clock and switch means connected therewith,

said second time clock being operable during the period that the switch means of said first time clock is closed and having means for closing its switch means periodically for a predetermined time,

the said first and second time clock means being sequentially operable to close the switch means of said second time clock after a time period corresponding to the life of a demineralizer cartridge, and

wherein said control relay is connected to the switch means of said second time clock.

3. The device described in claim 1 wherein means are provided to indicate when said control relay is energized.

4. The device described in claim 1 wherein said reset means is provided with means indicating when the same is energized.

5. In a self resetting device for indicating when a demineralizer cartridge in an automatic humidifier control system needs replacement, the said system including an humidifier motor, the combination of:

a first 24 hour time clock series connected to said motor,

circumferentially adjustable switch actuating means connected with said first time clock,

a first switch in the circuit between said motor and said first time clock operated by said last mentioned means,

a second 24 hour time clock series connected to said first time clock,

circumferentially adjustable switch actuating means connected with said second time clock,

a second switch,

said second switch being actuated by the sequential action of said time clocks whereby to close a control relay circuit after said motor has run a period of time substantially equivalent to the useful life of a demineralizer cartridge,

a control relay circuit including a control relay connected to said second switch,

contacts operated by said control relay for interrupting said motor and said time clocks when said control relay is energized,

contacts operated by said control relay for energizing a reset relay circuit when said control relay is energized,

a reset relay circuit including a reset relay connected to said last mentioned contacts,

contacts operated by said reset relay for energizing said time clocks whereby to reset the same through the action of the switch actuating means therein in opening said first and second switches.

6. The device set forth in claim 5 wherein said switch actuating means of said first time clock is set to close said first switch before said switch actuating means of said second time clock closes said second switch.

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