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CONTROL APPARATUS

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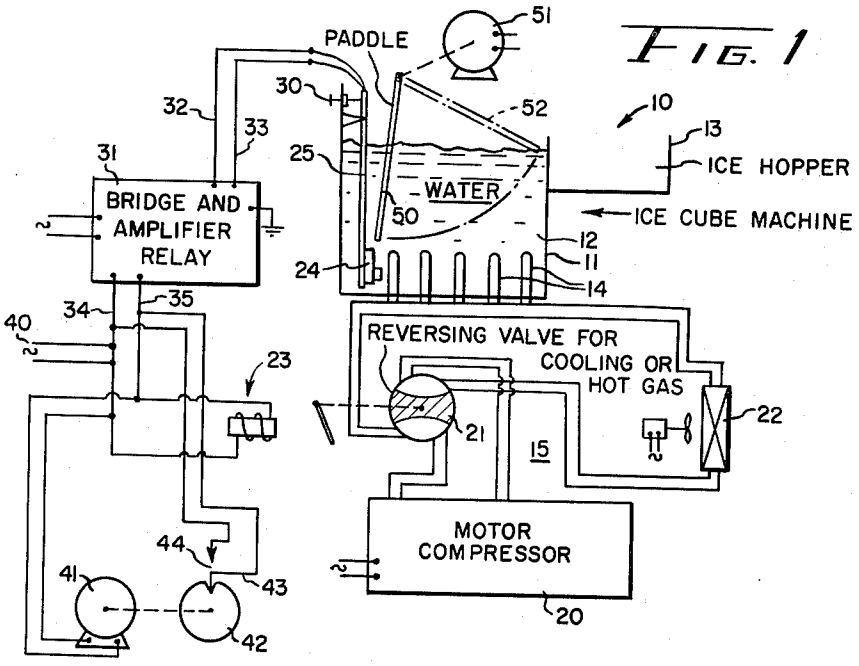



FIG. 1

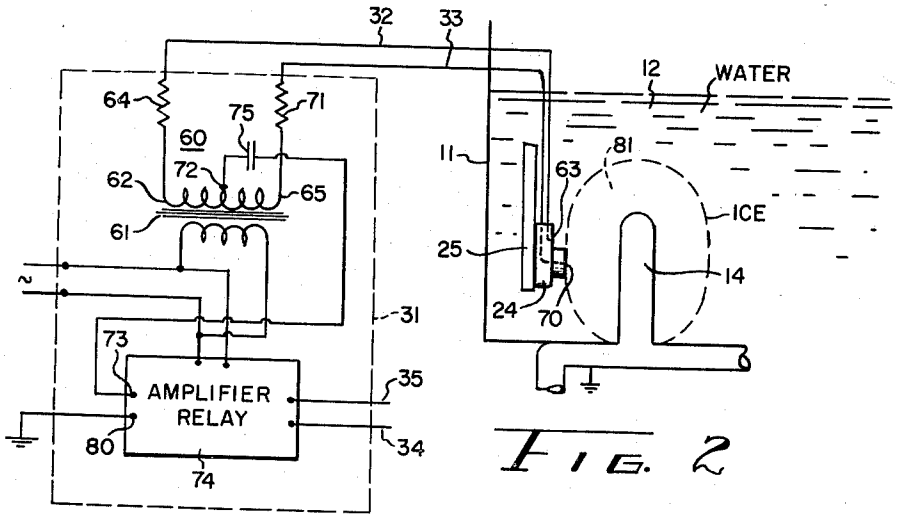



FIG. 2

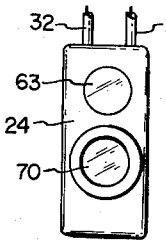



FIG. 3

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# CONTROL APPARATUS

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The present invention is concerned with an improvement in ice detection and control apparatus; in particular, the improvement being in the use of two electrodes submerged in the water so that the changes in the resistance of the water has no effect upon the control apparatus.

The use of an electrode submerged in the water of a water freezing device; so that, as ice forms to contact the electrode the resistance between the electrode and ground changes is a common method of electronically controlling ice making apparatus. The electrode is generally mounted a predetermined distance from the cooling coil depending upon the thickness of the ice desired. As the ice forms and builds up to contact the electrode, a definite change in the resistance between the electrode and ground takes place since the resistance of ice is much more than the resistance of water.

A similar arrangement having two electrodes is quite common. The resistance between each of the electrodes and ground is detected, and the spacing of the electrodes from the coil is selected; so that, the maximum and minimum thickness of the ice has predetermined limits. The circuit connected to the two electrodes is commonly known as a series 10 circuit. The ice builds up to cover the first electrode and to touch the second electrode which is farther away from the coil. The cooling apparatus is then de-energized until both electrodes are uncovered.

In such ice making apparatus the impurities in the water constantly pose a problem in the proper calibration of such apparatus as the resistance of the water changes greatly with the presence of different impurities. When apparatus of this sort is used in one locality, the control equipment must be calibrated for the water at that locality as the mineral content may be different than the mineral content of water where the apparatus is manufactured. Even when the control apparatus is calibrated for a specific type of water, the level of contamination or impurities can change requiring additional recalibration if the equipment is to maintain a given thickness of ice as it forms on the cooling apparatus.

The change of impurity content of water becomes quite drastic where control equipment of this type is used in a tank such as in an ice cube making machine. When the water freezes the impurities of water do not remain in the ice, but the impurities move into the water which is not frozen. As ice is manufactured, the quantity of impurities in the water in the storage tank increases greatly even though fresh water is continually added to the tank. Of course, such tanks are cleaned quite often, but experience has shown that the concentration of impurities in the water tank increases in a very short time to definitely change the resistance of the water and to prevent correct operation of the equipment.

The present invention provides a control system with two electrodes submerged in the water and connected to opposite sides of a balanceable type electric circuit. One electrode is spaced closer to the grounded cooling coil than the other. The resistance between each of the electrodes and ground is connected in opposition by the balanceable circuit; so that, no matter what the impurity content of the water is, a change in the impurity content has no affect upon the control circuit. As the ice forms on the cooling coil and contacts the nearest electrode, a change in the resistance between that electrode and ground is sensed and the cooling apparatus is de-energized. Specifically, the resistance between each of the two electrodes and ground is connected in adjacent legs of a balanceable bridge circuit; so that, when the electrodes are exposed to the same media, the bridge remains balanced.

In order to prevent the polarization of the electrodes a blocking condenser is placed in the connection between the balanceable circuit and ground; so that, any D.C. component of current originating from an A.C. power source of the bridge cannot flow through the electrode circuit.

Therefore, an object of the present invention is to provide an improved control apparatus.

Another object of the present invention is to provide an improved control apparatus for an ice making device having means for compensating for changes in the resistance of the water.

And still another object of the present invention is to provide a control apparatus for an ice making device wherein two electrodes are submerged in the water and the resistance between each of the electrodes through the water to ground is balanced out and has no effect upon the controlled apparatus.

A further object of the present invention is to provide a blocking condenser in the detection circuit of a control apparatus to prevent the flow of D.C. to an electrode submerged in water for sensing the change in resistance between the electrode and ground as the ice changes to water.

These and other objects of the present invention will become apparent upon the study of the specification and drawing of which:

Figure 1 is a schematic drawing of one particular use for the present invention on an ice cube machine.

Figure 2 is a more detailed showing of the present invention wherein the electric circuit connected to the submerged electrodes is disclosed.

Figure 3 is a front view of the electrode unit as shown in Figure 2.

Referring to Figure 1 of the drawing, an ice making machine 10 is shown as having a main tank 11 filled with water 12 and an ice hopper 13 adjacent the main tank. Extending upward in the bottom of tank 11 are a plurality of cooling surfaces 14 having the form of a nipple. The cooling surfaces 14 are connected to a conventional refrigeration apparatus 15. A motor compressor 20 connected to a suitable source of power supplies refrigerant through a reversing valve 21 to cooling surfaces 14. When the refrigerant picks up heat from the cooling surfaces, the refrigerant returns through condenser 22 and valve 21 to the compressor. The refrigeration apparatus can be reversed by the operation of valve 21; so that, hot gas is supplied to the cooling surface 14 for melting the ice which has formed on the nipples to produce ice cubes. When the valve 21 is rotated from the position as shown by the operation of an associated relay 23, coil 22 becomes the evaporator and nipples 14 act as the condenser of the refrigeration apparatus.

Upon the operation of the refrigeration apparatus 15, the water surrounding nipples 14 freezes to form an ice cube. A sensor or electrode 24, which can be adjustably positioned by movement of its support lever 25 when screw 30 is rotated, is positioned a predetermined distance from nipple 14. Sensor 24 is connected to a con-

ventional bridge and amplifier relay **31** by conductors **32** and **33**. The remaining part of the circuit from sensor **24** is obtained through the ground connection between the tank and cooling surfaces **14** and the ground connection of bridge and amplifier **31**.

Connected to bridge and amplifier relay **31** is relay **23**. Upon the shorting of conductors **34** and **35** connected to the amplifier relay, a source of power **40** is connected to the winding of relay **23** to operate the reversing valve **21** to supply hot gas to surfaces **14**. Connected in parallel with relay **23** is a timer motor **41**. The timer motor drives a cam **42** which is shown to have a cam rider **43** contained in a notch in the cam to open a shorting switch **44**. Switch **44** is connected in parallel with the output of amplifier relay **31** between conductors **34** and **35**. Timer cam **42**, upon the energization of motor **41**, closes the circuit between conductors **34** and **35** for a predetermined period until cam rider **43** again drops into the notch. The timer apparatus provides for a predetermined operation of the refrigeration apparatus in a manner to supply the hot gas to surfaces **14** after the ice has formed; so that, the cubes can be released from surfaces **14** and rise upward in the water tank **11**. For example, let us assume that sensor **24** senses a growth of ice on surface **14** of a predetermined thickness. Amplifier relay **31** is energized to short conductors **34** and **35** to operate the reversing valve **21**. At the same time, timer motor **41** is energized, and cam **43** begins to move in a clockwise direction to immediately close switch **44**. Even though the cube is released from the first surface **14** associated with sensor **24** to de-energize the amplifier relay valve **21** will remain in the position to furnish hot gas to the cooling surfaces **14** as long as rider **43** is on the higher portion of cam **42** to keep switch **44** closed. After a selected time, such as one minute, the cam **42** will have made one revolution and the reversing valve **21** would return to the position as shown to begin the cooling operation for another group of cubes.

A paddle **50** is shown in tank **11**. The paddle is connected to a motor **51**. By means of an associated control circuit, not shown and not a part of this invention, paddle **50** periodically moves upward to the position **52** to lift the cubes which are floating on the water **12** into the hopper **13**. While the paddle is shown schematically obviously there are other ways of accomplishing this operation. Besides lifting the cubes out of the tank **11**, paddle **50** agitates the water which apparently is quite important in providing clear ice cubes.

Referring to Figure 2, the bridge amplifier relay is shown in more detail. A bridge circuit **60** is made up of a conventional, bifilar, center-tapped secondary of transformer **61**. One extremity **62** of the secondary is connected to one electrode **63** of sensor **24** through a circuit comprising resistor **64** and conductor **32**. The other extremity **65** of the secondary is connected to a second electrode **70** of sensor **24** through a circuit of a resistor **71** and conductor **33**. An output is available from bridge circuit **60** between a center tap **72** of the secondary of transformer **61** and the grounded cooling surface **14**. Center tap **72** is connected to one input terminal **73** of a conventional amplifier relay **74** through a blocking condenser **75**. A second input terminal **80** of the amplifier is connected to ground.

Sensor **24**, as shown in Figures 2 and 3, is positioned with respect to the cooling surface **14**; so that, electrode **70** is closer than electrode **63**. Electrode **63** is for compensation purposes and does not engage ice **81** as it forms on the cooling surface. The relative position of electrode **70** with respect to the cooling surface **14** determines the size of the growth of ice on the cooling surface, and thus the size of the ice cube being formed. The position of sensor **24** can be adjusted by moving lever **25** with respect to the cooling surface **14**.

Before the ice is formed on cooling surface **14**, the resistance between each of the electrodes **63** and **70** and ground is connected in the adjacent legs of the bridge circuit **60**. Thus, since any change in the resistance of the water affects the resistance of the adjacent legs of the bridge **60**, bridge **60** is compensated. For example, let us assume that the bridge is calibrated; so that, a predetermined change in the resistance between electrode **70** and ground energizes amplifier relay **74**. When this resistance is selected, no matter what the resistance of the water **12** is, the calibration of bridge **60** is not changed. The change in the mineral content or the impurities varies the resistance between each of the electrodes **63** and **70** and ground equally.

In a control system of the type described, the presence of direct current produces a phenomena around the electrodes **63** and **70** known as polarization. To provide the operating results desired, a blocking condenser **75** is placed in the output circuit of bridge **60**. This condenser blocks the flow of direct current from each of the electrodes **63** and **70** to ground and thus minimizes the polarization affect.

*Operation*

Referring to Figure 1, the refrigeration apparatus **15** supplies cooling medium to cooling surfaces **14**. As the water surrounding the surfaces freezes and a cube forms as shown in Figure 2, the ice will eventually contact electrode **70**. As the resistance between electrodes **70** and ground increases sharply when ice engages electrode **70**, a definite unbalance of bridge circuit **60** takes place to energize the amplifier relay and short the conductors **34** and **35** to bring about the operation of the reversing valve **21**. The refrigeration apparatus then supplies hot gas to cooling surfaces **14** for a predetermined period depending upon the length of cam **42** of the timing mechanism. The ice cube formed on surface **14** is released to float upward in the water tank **11**. The size of the cube is determined by the position of the sensor **24**.

Before the ice is formed on cooling surface **14**, the resistance between each of the probes **63** and **70** and ground is through water **12**. By having the two electrodes **63** and **70** in adjacent legs of the bridge, any change in the resistance of the water as affected by the resistance of the supply water or the change in the contamination of the water in tank **11** has appreciably no effect upon the operation of circuit **60**.

Obviously electrodes **63** could be mounted at some other locality in tank **11**; however, a location close to electrode **70** has been selected so that any variation in the temperature of water **12** in tank **11** from one position to another will not affect the compensation apparatus. The temperature of the water near sensor **24** surrounding electrode **63** or **70** would be substantially the same and thus the temperature of the water would have not affect upon the compensation. If electrode **63** were mounted in some other locality in the tank, the possibility exists that the water in that locality might be warmer and thus the operation of the compensation would not be as effective. The spacing between the electrodes **63** and **70** must be sufficient so that ice does not contact electrode **63** as this would cause the bridge circuit **60** to become balanced and the refrigeration apparatus would continue to operate in a cooling manner.

While the invention has been described with one particular application in mind, it should be understood that the scope of the present invention should be only limited by the appended claims, in which I claim:

1. In a control system for use with refrigeration apparatus for changing water surrounding a cooling surface in a tank to ice, a balanceable type electrical circuit having two legs which upon having an unequal resistance an output signal is obtained from said circuit, a control device adapted to control the effect of the refrigeration apparatus on the cooling surface, means connecting said

control device to said circuit to be responsive to said output, a pair of electrodes mounted in the tank, means connecting said electrodes to said circuit so that the resistance of one of said legs is the resistance between a first of said electrodes and the cooling surface and the resistance of a second of said legs in the resistance between a second of said electrodes and the cooling surface, said first electrode being mounted closer to said cooling surface than said second electrode so that as ice forms on said cooling surface and contacts said first electrode the resistance of said legs is unequal and the cooling of the surface is stopped, said second electrode being a compensation electrode for balancing out the effects experienced by said first and second electrode simultaneously.

2. In a control system for use with refrigeration apparatus for changing water surrounding a cooling surface in a tank to ice, an alternating voltage balanceable type electrical circuit having two legs which upon having an unequal resistance an output signal is obtained from said circuit, a control device adapted to control the effect of the refrigeration apparatus on the cooling surface, means connecting said control device to said circuit to be responsive to said output, a pair of electrodes adapted to be mounted in the tank, means connecting said electrodes to said circuit so that the resistance of one of said legs is the resistance between a first of said electrodes and the cooling surface and the resistance of a second of said legs is the resistance between a second of said electrodes and the cooling surface, a condenser, means connecting said condenser between said cooling surface in the ground of said circuit, said first electrode being mounted closer to said cooling surface than said second electrode so that as ice forms on said cooling surface and contacts said first electrode the resistance of said legs is unequal and the cooling of the surface is stopped, said second electrode being a compensation electrode for balancing out the effects experienced by said first and second electrodes simultaneously, said condenser blocking any direct current from said electrodes to prevent polarization.

3. In a control system adapted for use with a water cooling device wherein ice is formed when water surrounds a cooled surface, said surface being electrically grounded to an electrical ground, a first electrode adapted to be mounted a predetermined distance from the grounded cooled surface, a control device adapted to control the water cooling device, circuit means connecting said electrode to said control device so that when the resistance between said electrode and ground increases a predetermined amount said control device is energized, a second electrode adapted to be mounted to sense the resistance of the water between said second electrode and ground, and means connecting said second electrode to said device to compensate for the effect of the resistance of water on said first electrode.

4. In a control system adapted for use with a water cooling device wherein ice is formed when water surrounds a cooled surface, a first electrode adapted to be mounted a predetermined distance from the cooled surface, said surface being electrically grounded, a control device adapted to control the water cooling device, circuit means connecting said electrode to said control device so that when the resistance between said electrode and ground increases a predetermined amount said control device is energized, a second electrode adapted to be mounted to sense the resistance of the water between said second electrode and ground, and means connecting said second electrode to said device so that only the presence of ice between said first electrode and the cooling surface has an effect upon said device.

5. In a device of the class described, a balanceable circuit having an A.C. source of power, a first electrode, means connecting said electrode to said circuit, said electrode being adapted to be placed in water of a water



freezing device, a relay adapted to control the water freezing device, a condenser, and connection means connecting said circuit to said relay through said condenser to block direct current to prevent the polarization of said electrode, said circuit having an output for controlling said relay depending upon the change in resistance between said electrode and the water freezing device as the water freezes.

6. In a control system adapted for use with a water freezing device having an electrically ground cooled surface wherein ice is formed when water surrounding the cooled surface freezes, an ice contacting electrode adapted to be mounted a predetermined distance from the grounded cooled surface, a control device adapted to control the temperature of the cooled surface to freeze ice on the surface when said control device is in a first circuit controlling condition and to release the ice when said control device is in a second circuit controlling condition, circuit means connecting said electrode to said control device so that when the resistance between said electrode and the cooled surface is a predetermined amount said control device is in one of said circuit controlling conditions, a compensating electrode adapted to be mounted to sense the resistance of the water between said second electrode and ground, and means connecting said compensating electrode to said control device to compensate for the change of the resistance of water between said contacting electrode and ground, said ice contacting electrode having a contacting surface resisting attachment to the ice as it forms between the surface and said contacting electrode so that upon the release of the ice from the surface the ice is not held by said contacting electrode.

7. In apparatus for making bodies of ice including a cooling surface surrounded by water, an electrode means adapted to be spaced a predetermined distance from the cooling surface, a control device adapted to control the temperature of the cooling surface, connection means connecting said electrode to said control device so that when the space between said electrode and the cooling surface is filled with unfrozen water the temperature of the cooling surface is maintained below the freezing temperature of water, said electrode having an ice engaging surface resisting its attachment to a body of ice as it grows on the cooling surface so that when ice is formed between said electrode and the cooling surface the temperature of the cooling surface is raised above said freezing temperature and the body of ice is released from the cooling surface and is not held by said electrode.

8. In apparatus for making bodies of ice in a tank of water by cooling a surface submerged in the water, probe means for contacting a body of ice as the ice forms on the cooled surface, control means for controlling the temperature of the surface, and electrical means connecting said probe to said control means so that when ice builds up on the surface to contact said probe said temperature is increased to release the body of ice from the cooling surface, said probe means having an ice contacting surface resisting the attachment of said probe means to the body of ice so that the body is free to float upward when released from the cooling surface.

9. In apparatus for making bodies of ice in a tank of water, electrode means for contacting a body of ice as the ice forms on a cooled surface submerged in the water, control means for controlling the temperature of the surface, and means for electrically connecting said electrode means to said control means so that when ice has formed between said probe and the cooled surface the temperature of the surface is increased and the body of ice is released from the cooling surface, said electrode means having an ice contacting surface resisting the attachment of said electrode means to the body of ice so

that the body is free to float upward when released from the cooling surface.

10. In a device adapted to control apparatus for changing the state of a media, a balanceable type circuit having two branches in which the resistance is compared to provide an output, first and second electrodes, an electrical ground, circuit means connecting said first electrode and said ground in one of said branches, circuit means connecting said second electrode and said ground in another of said branches so that the resistance between said first electrode and ground is compared with the resistance between said second electrode and ground, said resistance between said second electrode and ground cancels the effect of the resistance between said first



electrode and ground when said electrodes are each exposed to the media in the same state, a control means adapted to control the apparatus, and means connecting said output to said control means, said control means being adapted to deenergize the apparatus when the state of the media between said first electrode and ground changes to vary the resistance value between said branches a predetermined amount.

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