

Nov. 29, 1966

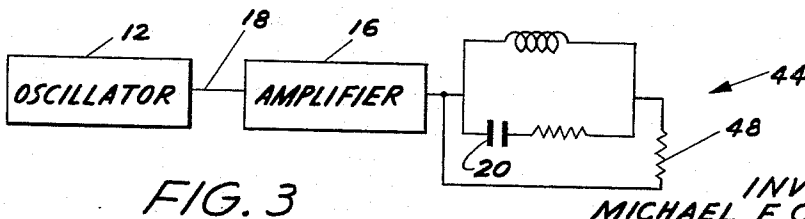
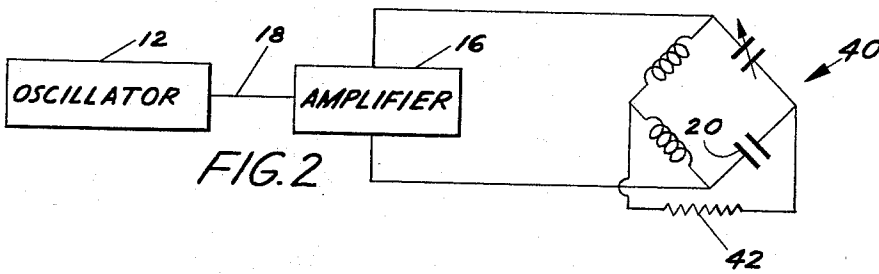
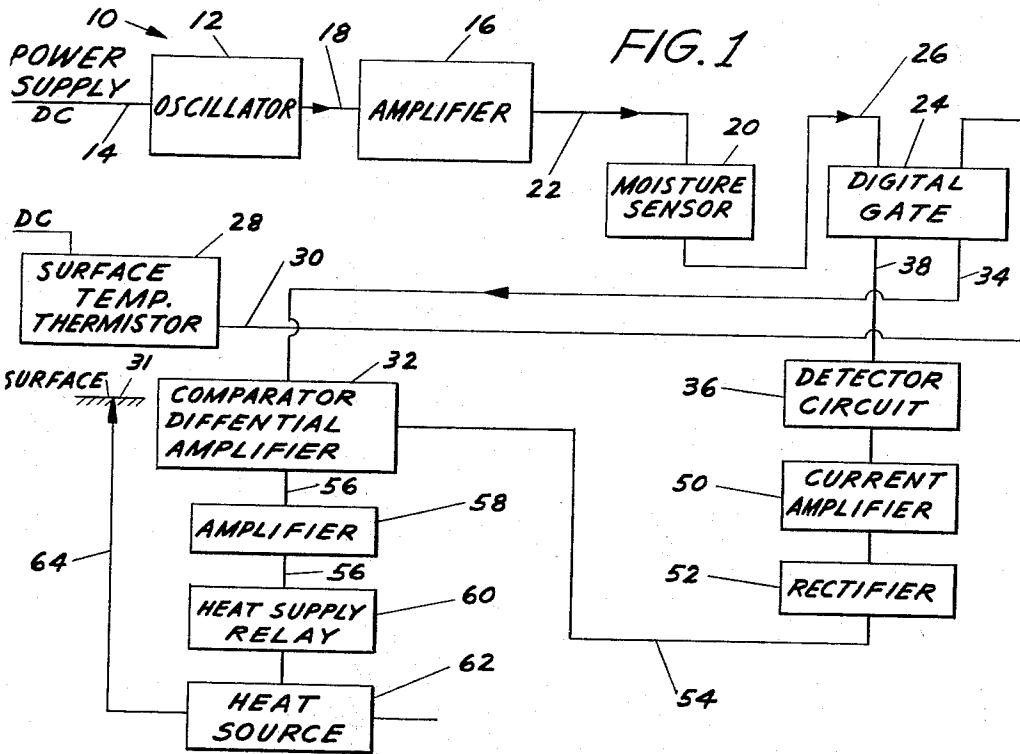
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3,287,974

ICE CONDITION DETECTION DEVICE

Filed March 30, 1964

4 Sheets-Sheet 1



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ICE CONDITION DETECTION DEVICE

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4 Sheets-Sheet 2

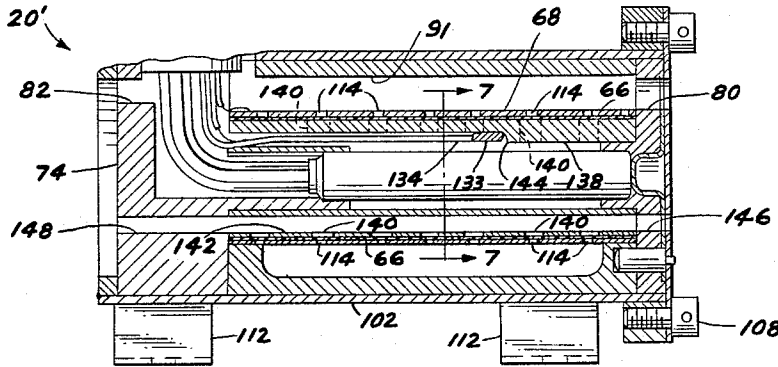
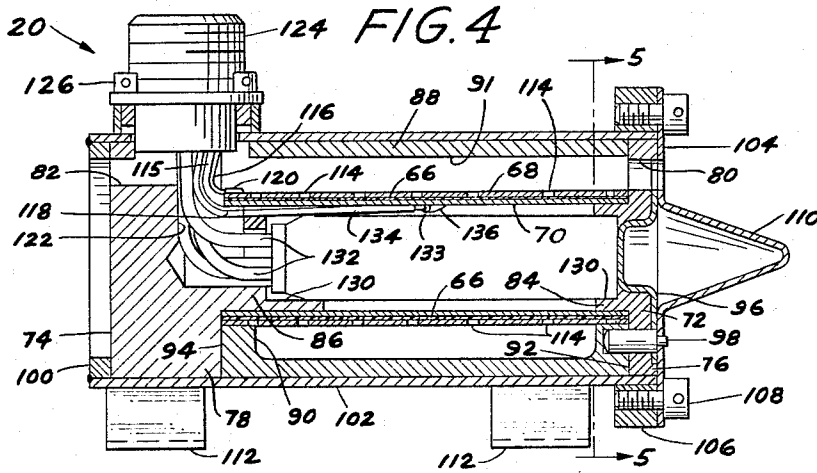


FIG. 6

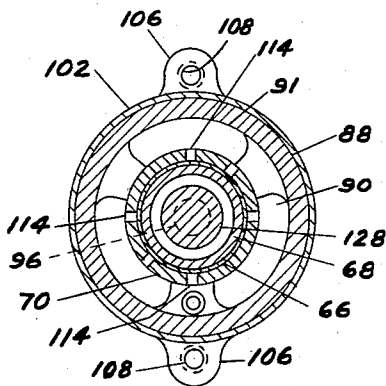


FIG. 5

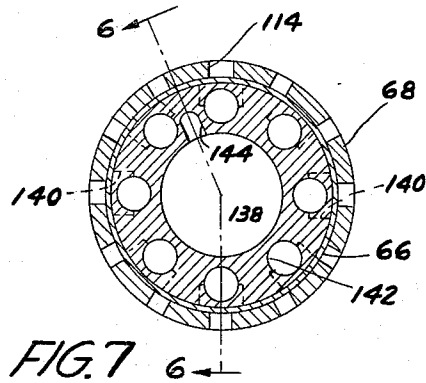


FIG. 7

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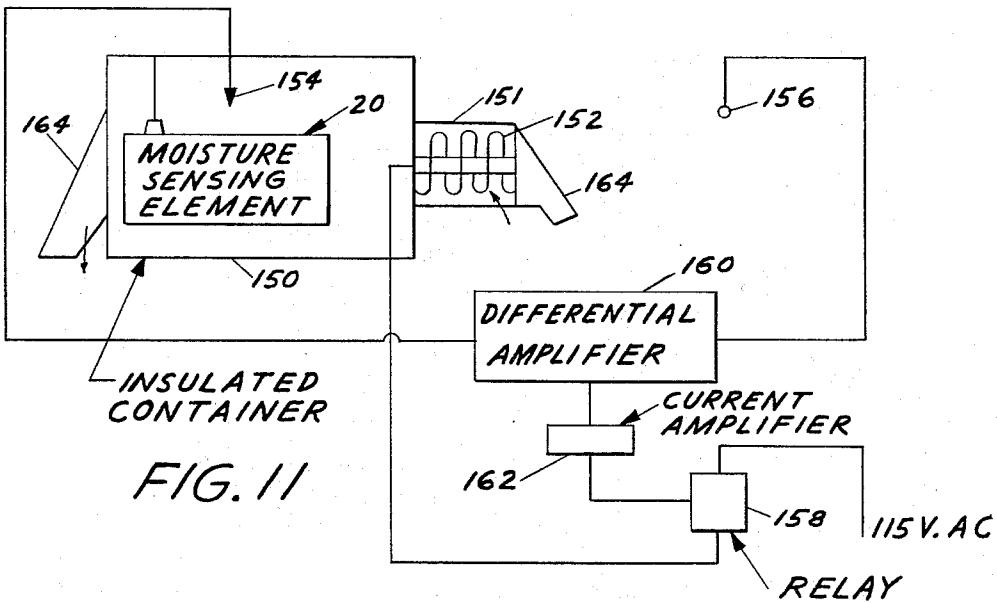
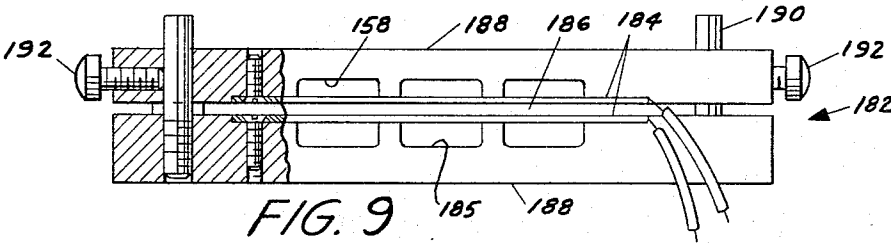
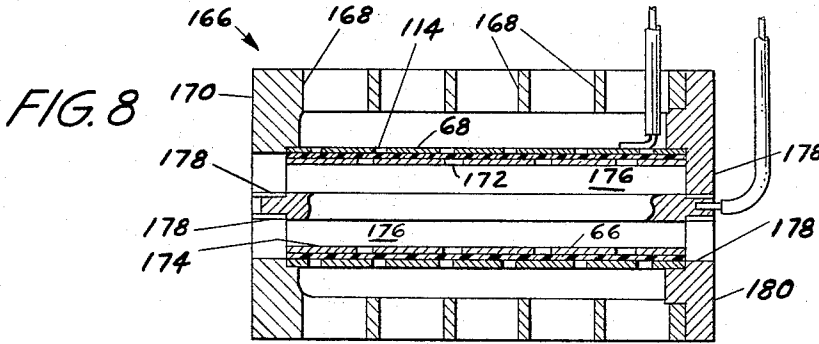
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ICE CONDITION DETECTION DEVICE

Filed March 30, 1964

4 Sheets-Sheet 3



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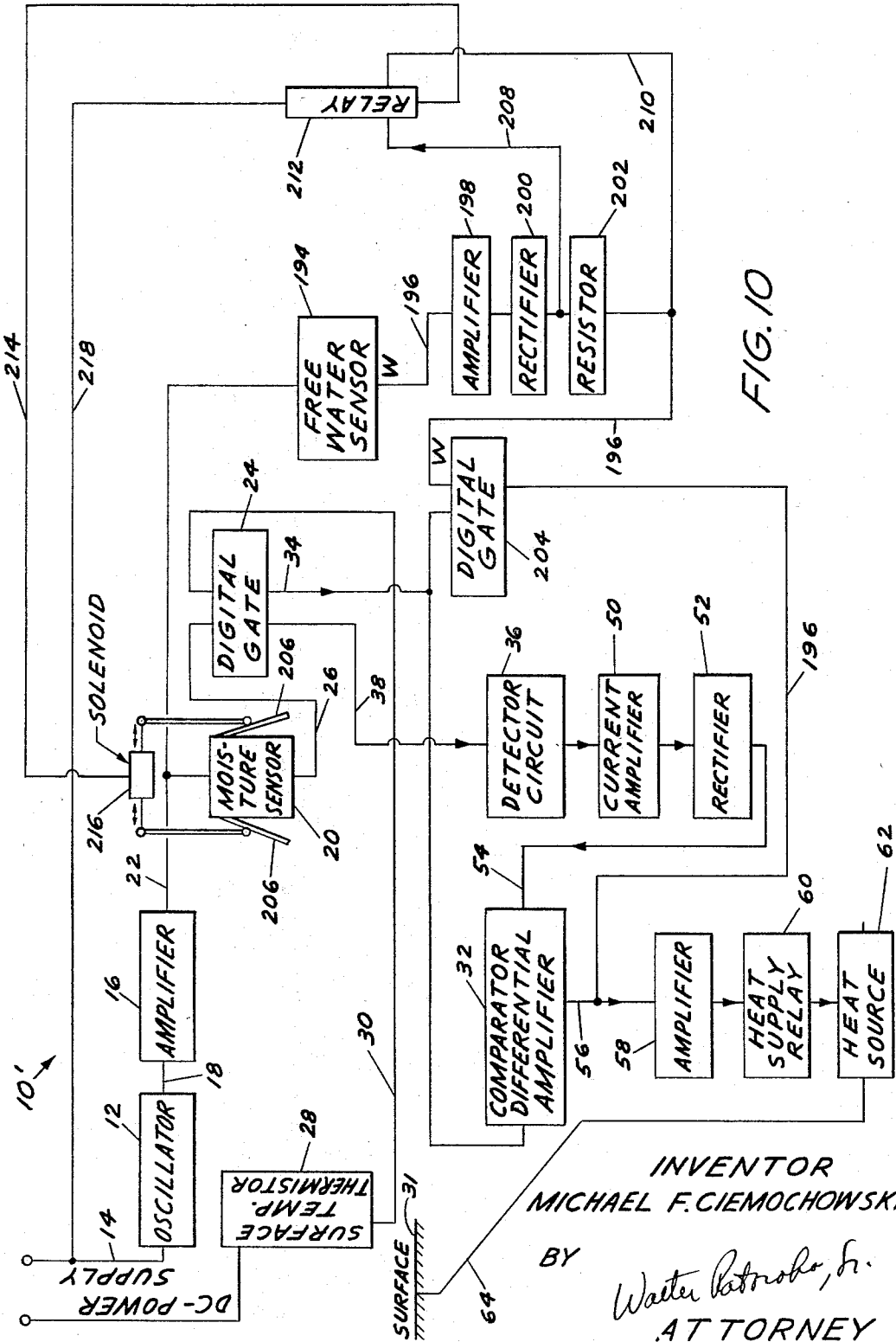
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3,287,974

ICE CONDITION DETECTION DEVICE

Filed March 30, 1964

4 Sheets-Sheet 4



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3,287,974

ICE CONDITION DETECTION DEVICE

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Filed Mar. 30, 1964, Ser. No. 355,639
9 Claims. (Cl. 73-336.5)

This invention relates generally to atmospheric condition indicating devices, and more particularly to an electronic type device for anticipating a dew point condition and actuating a heat or other source to prevent condensation and ice formation.

In a number of situations, it is necessary to prevent the formation of ice on some particular surface. For example, a very undesirable and dangerous situation is created when ice is permitted to form at the compressor stage of a gas turbine engine.

It is recognized that prior art systems have been proposed to prevent the formation of ice on certain surfaces. One type of prior art device senses condensed water vapor or so-called "free-water." However, a main disadvantage of this type of device is that no action to prevent formation of ice may be taken until after water susceptible to freezing is already present. Furthermore, in certain instances it may also be desirable to prevent condensation on the surface in question.

Another prior art device of this kind operates in response to the increase in water vapor pressure as the dew point is approached. A problem with this type of device is that accurate water vapor pressure readings are difficult to isolate, since the total vapor pressure includes vapor pressures of other substances present in the atmosphere.

Still another type of ice prevention system has been proposed in co-pending application Serial No. 335,285 filed January 2, 1964. In that system, an imminent dew point condition is anticipated by appropriate manipulation of voltage signals which reflect air temperature, surface temperature and relative humidity.

It is now proposed to provide an improved means for anticipating a dew point condition and preventing the condensation of water vapor on a surface. Obviously, since water vapor will not freeze and since the proposed device prevents condensation of free-water on the surface, it also prevents ice formation.

Very generally, the proposed device senses temperature of the selected surface and absolute humidity; then, by appropriate calibration of absolute humidity in terms of saturation temperature, an imminent dew point condition is anticipated so that heat may be supplied to the surface in question, thus preventing water from condensing thereon.

Accordingly, a primary object of this invention is to provide a novel means for anticipating atmospheric conditions likely to result in condensation of water vapor on some particular surface.

Another object of the invention is to provide such means responsive to atmospheric moisture content and temperature of the surface upon which water should not condense and ice should not form.

Still another object of the invention is to provide such means for actuating a heat supply source when condensation of water vapor on a selected surface is imminent.

Another object of this invention is to provide such means including a capacitive moisture sensing element comprising a dry hygroscopic dielectric material which absorbs and gives up moisture almost instantly and upon which a film of moisture forms as a result of the absolute

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moisture content of the air. Changes in this film are effectively detectable in terms of capacitance.

A more specific object of the invention is to provide such means wherein the capacitance moisture or dew point signal is changed into a more convenient voltage signal that is proportional to dew point or saturation temperature. This latter voltage is then compared with a second voltage which is proportional to the temperature of the surface whereon condensation and ice should not form. When the surface temperature approaches the dew point temperature, a heat source is actuated to heat the surface involved and thereby prevent condensation and ice from forming thereon.

Other objects and advantages of the invention will become more apparent when reference is made to the following specification and the accompanying drawings wherein:

FIGURE 1 is a block diagram, schematic illustration of the invention;

FIGURE 2 is a schematic illustration of a circuit suitable for use as a portion of FIGURE 1;

FIGURE 3 is a schematic illustration of a modification of FIGURE 2;

FIGURE 4 is a side elevational view illustrating the structure of the moisture sensing element shown in FIGURE 1;

FIGURE 5 is a cross-sectional view taken along the plane of line 5-5 of FIGURE 4, looking in the direction of the arrows;

FIGURE 6 is a fragmentary side elevational view of a modification of the FIGURE 4 structure;

FIGURE 7 is a cross-sectional view taken along the plane of line 7-7 of FIGURE 6, looking in the direction of the arrows;

FIGURE 8 is a side elevational view of another modification of the FIGURE 4 structure;

FIGURE 9 is an end view of still another modification of the FIGURE 4 structure;

FIGURE 10 is a fragmentary schematic illustration of a modification of the FIGURE 1 schematic system;

FIGURE 11 is a schematic illustration of a system which may be employed under certain conditions with the moisture sensing element of FIGURE 1.

Referring now to the drawings in greater detail, FIGURE 1 illustrates schematically the proposed condensation and/or ice prevention system 10. The particular system 10 shown includes a radio frequency crystal oscillator 12 which is connected to a source of direct current power by means of a lead 14. Since an oscillator will usually not provide sufficient power, a radio frequency amplifier 16 is coupled thereto by lead 18 in order to provide the required voltage to a capacitive moisture sensing element 20 through the lead 22.

The moisture sensing element 20, which will be described in greater detail later, supplies a signal, which is proportional at all times to the dew point or saturation temperature, to a digital gate 24 through lead 26.

A second sensing element, namely, a suitable temperature sensing thermistor 28, which may comprise a variable resistor (not shown in FIGURE 1) connected in a line 30 between a source of direct current power and the digital gate 24, senses the temperature of the surface (or surfaces), represented schematically as 31, whereon condensation and/or ice would normally form under certain atmospheric conditions, but whereon it is desired that it not be permitted to form. The resultant output of the thermistor 28 is a signal which is communicated to the digital gate 24 through the line 30. Thus, the digital gate 24 receives two signals.

For purposes of ice prevention only, condensation in the form of liquid water on the surface in question is not important, so long as the temperature of the surface upon which ice must not form is above the freezing point, 32° F. Therefore, when the dew point temperature is at 50° F., for example, and the surface temperature drops off to a value below 50° F. but above 32° F., condensation will occur; however, the system need not respond and may remain de-energized since ice cannot form. Hence, a function of the digital gate 24 is to prevent the passage of the two signals from elements 20 and 28 until the surface temperature signal is indicative of a temperature that is preferably near and slightly above freezing, say at 34° F. The manner in which the actual switching arrangement is accomplished may vary, many different techniques being well known in the art.

Thus, at temperatures below 34° F., the digital gate 24 will pass both the surface temperature signal and the dew point signal, the former being transmitted to a comparator differential amplifier 32 via a lead 34 and the latter to a detector circuit 36 via a lead 38. The detector circuit 36 may be in the form of an impedance bridge, a phase discriminator or a resonant circuit.

A suitable impedance bridge 40 is illustrated in FIGURE 2, wherein the legs of the bridge 40 are used to sense the voltage unbalance created by the capacitance of the moisture sensor 20. The degree of unbalance shows up as a voltage drop across a resistor 42 and is a function of absolute humidity. Thus, the change in voltage across the resistor 42 is the moisture indicative signal.

A suitable resonant circuit 44, which may be substituted for the FIGURE 2 structure, is illustrated in FIGURE 3. The capacitance of the moisture sensing element 20 is set at a low level in order to be in resonance with the fixed inductor 46. As the capacitance rises due to an increase in the absolute humidity level, the circuit becomes off resonance. This then shows up as a voltage drop across a resistor 48 and is a function of absolute humidity. Thus, the change in voltage across the resistor 48 is the moisture indicative signal.

Since resonant circuits supply little current, amplification is required. This is accomplished by a suitable current amplifier, illustrated schematically as 50 in FIGURE 1.

A full wave rectifier bridge 52 (FIGURE 1) is required to change the amplified signal from A.C., the output of the amplifier 16, to D.C. voltage. The rectified signal is then fed to the comparator 32 via a lead 54.

It is thus apparent that the comparator 32 receives two signals, namely, the surface temperature indicative signal through lead 30 and the dew point indicative signal through lead 54, both in terms of D.C. voltage.

When the surface temperature signal becomes equal to or smaller than the dew point or saturation temperature signal, the comparator 32 will transmit a command signal via a line 56 through a suitable amplifier 58 to any suitable device, such as a relay 60 for actuating a source of heat 62. The latter, in turn, will supply heat to the surface in question, as indicated by line 64, to raise the surface temperature above the dew point temperature.

When the surface temperature has been raised sufficiently above the dew point or saturation temperature, the temperature sensing thermistor 28 will signal the comparator 32 accordingly, whereupon the latter will de-energize the actuation device 60, shutting off the heat source.

While the comparator 32 may consist of any one of a plurality of well-known circuits, one such suitable circuit (not shown) may include a pair of transistors, the respective bases of which receive the two signals, compare them, and signal the relay 60 accordingly.

MOISTURE SENSING ELEMENT

The moisture sensing element 20, as illustrated in FIGURE 4, includes a sheet of dielectric material 66 which,

when confined between a pair of cylindrical electrodes 68 and 70, provides a capacitor.

The capacitor 66/68/70 is contained within a housing comprising front and rear guides 72 and 74, each including flanges 76 and 78, respectively, and a plurality of ports 80 and 82, therethrough, respectively. The guides 72 and 74 further include smaller diameter portions 84 and 86, respectively, which are slidably inserted within the inner electrode 70. A spacer 88 includes internal flange segments 90 formed at the ends thereof, as illustrated in FIGURE 5. The segments 90 support the outer electrode 68, while the internal diameter of the spacer 88 defines a circumferential passageway 91 around the outer electrode 68.

The spacer 88 is confined at its ends 92 and 94 by the front and rear flanges 76 and 78, respectively. The front guide 72 is retained against the spacer 88 by a formed front cover 96 which is fastened to the guide 72 by any suitable means such as screws or plugs 98 while the rear guide 74 is retained against the spacer 88 by a washer type member 100. The washer 100 is fixedly secured to an outer housing shell 102 which surrounds the front and rear plug and sleeve combination, and the complete assembly is held in place by means of a front retainer 104 which is fastened to a flange 106 formed on the outer housing 102 by any suitable means such as screws 108. The retainer 104 may be formed to include a nose cone 110 in order to channel the air flow into the openings 80 of the guide 72. A pair of formed brackets 112 may be fixedly attached to the outer housing 102 for mounting the assembly on any suitable structure.

It may be noted that air which enters through the front ports 80 flows toward the rear ports 82 via the passageway 91 surrounding the outer electrode 68 and thereby affects a reaction in the dielectric material 66, as will be explained later, by reason of the plurality of perforations 114 formed in the outer electrode 68.

Wire leads 115 and 116 are soldered to the inner and outer electrodes 70 and 68, as at 118 and 120. The leads 115 and 116 are directed from the ends of the electrodes 68 and 70 via an opening 122 formed in the rear guide 74 and thence into an electrical connector 124, the latter being fastened, as by screws 126, to the outer periphery of the housing shell 102.

A cartridge type heating element 128 may be confined within the inner electrode 70, spaced apart therefrom by means of an internal diameter 130 formed in the front and rear guides 72 and 74. The leads 132 from the cartridge heating element 128 are likewise directed from the housing 102 via the opening 122 formed in the rear guide 74 and thence through the connector 124. Thermistor 133, mounted in an epoxy filled groove 136 formed in the inner electrode 70, and leads 134 are required when a cartridge heater 128 is included in the moisture sensor 20 in order to control the operation of the heater 128.

The basic operating principle of the capacitive moisture sensing element 20 involves the changes occurring in the dielectric constant (specific inductive capacitance) of the selected dielectric material 70 between its moist and dry conditions. A preferred material for detecting moisture levels of very small intensity is an intermediate sensitivity grade of polyvinyl alcohol, known as Elvanol. This particular grade of dielectric material has two desirable characteristics which are associated with the moisture absorbing requirement. Being hygroscopic, the material absorbs moisture from the surrounding air, the absorbed moisture being transmitted to the micro structure of the material and held there. At the same time, with this particular grade of material, a film of moisture is formed on the surface of the material. This film is primarily responsible for the high rise in the dielectric constant and the fast response rate with respect to changes in moisture content of the air.

It has been discovered that polyvinyl alcohols of high moisture sensitivity do not possess the latter characteristic.

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This high sensitivity grade of material is more suitable for systems wherein it is desired that the change in capacitance be proportional to relative humidity, such as the system described in co-pending application, Serial No. 335,285, filed on January 2, 1964. Where it is desired to detect the absolute humidity of the air, the above described intermediate grade is preferred, since this material acquires a surface film caused by the absolute moisture condition of the air. In other words, the only factor which affects the surface moisture which becomes deposited on the dielectric material is the absolute moisture content of the air. Surface equilibrium takes place rapidly, and the changes in this surface film are readily detectable in terms of capacitance, which is proportional to the dielectric constant.

Since temperature changes above the freezing temperature do not effect the condition of surface moisture, there is no change in the dielectric constant due to changes in temperature. As just explained, the only way a change may be effected in the dielectric constant is through a change in the surface condition of the material. While temperature does have an effect on the dissipation factor, resulting in an added series resistance of the dielectric material, this effect can be compensated for in appropriate electrical circuits.

In order to take advantage of the dependence of the dielectric constant on the surface moisture conditions, it becomes necessary to produce a usable signal indicative of this condition. In other words, it is essential that changes in capacitance reflect the changes in dielectric constant. Since air at any particular absolute humidity has only one saturation or dew point temperature, as a result of the above described relationship between dielectric constant and the moisture content of the air, any signal which reflects absolute humidity will automatically reflect dew point.

When a D.C. voltage is applied across the terminals of a capacitor, there exists a condition of potential electrical energy known as dielectric polarization. Capacitance is proportional to the polarization per volt of which the electrode-dielectric structure is inherently capable. Consider, for example, a capacitor having air as the dielectric and possessing some value "C" of capacitance. In this case, the air is free of polarizable charges. The value of capacitance is increased by inserting some material between the electrodes. Thus, the capacitance and polarization increases as the dielectric constant increases.

The behavior of a capacitor under periodically alternating voltage is similar to its behavior under direct voltage just described except that, as the voltage alternates, a direct potential is applied first in one direction during one half cycle, and in the reverse direction during the succeeding half cycle.

For an accurate moisture sensor 20, another factor must be considered, namely, the exposed area of the dielectric material 66 as required to facilitate surface equilibrium, as previously described. Referring now to FIGURE 4, it may be noted that the outer electrode 68 is perforated, thereby providing the passing air access to the dielectric polyvinyl alcohol material 66. Moisture transfer and equilibrium is reached through this perforated area.

The moisture sensor 20' of FIGURE 6 is substantially identical to that of FIGURE 4, except for the center electrode 138 which is also perforated, like the outer electrode of FIGURE 4. Specifically, the center electrode 138 includes a plurality of radial perforations 140, as may be better seen in FIGURE 7 which is an enlarged complete cross-sectional view of a portion of FIGURE 6. (It will be noted that FIGURES 6 and 7 are reciprocal cross-sectional views, with FIGURE 7 being a complete rather than a half section; the same is true of FIGURES 4 and 5.) The center electrode 138 further includes a plurality of longitudinal passageways 142 adjacent the rows of

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perforations 140, as well as an axial groove 144 for receiving the thermistor 133 and its leads 134 when a cartridge heating element 128 is used. In this modification, the air has substantially double the area of contact, as compared to FIGURE 4, with the dielectric 66, perforations 114 and 140 being provided through both the inner and outer electrodes, respectively, as explained above.

Both of the units illustrated in FIGURES 4 and 6 require a continuous air flow through the unit to accurately monitor the dew point temperature. In the case of the FIGURE 6 unit, air enters the passageways 91 and 142 by means of the access openings 80 and 146 formed in the front guide 72 and exits via the rear ports 82 and 148 formed in the rear guide 74. Both of these units are designed to operate on ground based installations in applications wherein air flow through the moisture sensing elements 20 and 20' is assured.

Either of the units illustrated in FIGURES 4 and 6 can be operated without the heaters 128, the primary reason for the heater element 128 being to provide sufficient heat to the dielectric 66 and the outer electrode 68 so as to maintain their surface temperatures above dew point, thereby eliminating the possibility of erroneous signals. However, should the temperature of the heater element 128 exceed about 90° F., problems may occur if expansion of the inner electrode 70 or 138 exceeds that of the outer electrode. To prevent this, the moisture sensor 20 or 20' without a heater element 128 may be housed in a suitable insulated container 150 (FIGURE 11), the air inlet 151 of the housing having a helical heater 152. Such a system would include internal and external thermistors 154 and 156, relay 158 and differential and current amplifiers 160 and 162, all coordinated to cause the heater 152 to come on whenever there is, for example, less than a 4° F. differential between the higher inside temperature and the lower outside temperature. With such a system, the inside and outside electrodes will expand together. Scoops 164 serve to prevent free-water from entering the air inlet and outlet openings formed in the ends of the container 150.

For applications wherein forced air flow is not employed, a slightly modified unit 166 such as shown in FIGURE 8 may be used, it being understood that FIGURE 8 is a longitudinal cross-section through a symmetrical cylindrical structure. Since this unit is to be located in static air, moisture equilibrium is accomplished by means of the relatively large radial perforations 168 formed through the walls of the cylindrical outer housing 170 and the radial perforations 114 and 172 in the tubular outer and cylindrical inner electrodes 68 and 174, respectively. The cylindrical inner electrode 174 includes a plurality of longitudinal passageways 176 formed through the length thereof, the passageways 176 being aligned with ports 178 formed in the housing 170 and the end cap 180, each passageway communicating with a row of perforations 172. In other words, atmospheric air is communicated to one side of the dielectric 66 through openings 168 and 114 and to the other side thereof through ports 178, passages 176 and perforations 172. Otherwise, units 20, 20' and 166 have the same purpose, and function in the same manner.

In general, assembly of the units 20, 20' and 166 is accomplished by first wrapping the dielectric 66 tightly around the center electrode 70 or 174 and then inserting the same into the outer electrode 68.

Configurations of the parallel plate type, as shown in FIGURE 9, may also be used. Such a unit 182 may comprise either perforated or solid electrode plates 184, or any combination thereof. The dielectric 186 may consist of a sheet of the above described polyvinyl alcohol or air, and, where the plates are perforated, contact of the dielectric with the air may be through the recesses

185 in the electrode holders 188. Adjustment of the space between the electrodes 184 may be made by raising or lowering the top electrode holder 188 on rods 190 by means of screws 192.

FIGURE 10 illustrates a modified system 10 suitable for use in aircraft applications. In such an application, in addition to the moisture sensing element 20 previously described relative to FIGURE 1, it may be desirable to include an additional free-water sensor 194. While the unit 194 may also comprise a pair of electrodes and an intermediate sheet of dielectric material, similar to the unit 20, the outer and inner electrodes 68 and 70 thereof would be spaced a predetermined distance apart from the dielectric material 66 so that any free-water, such as rain, that may be encountered would more readily flow out through the intermediate spaces, permitting the dielectric material 66 to dry off more rapidly. The free-water sensor 194 would be instantaneously effective whenever liquid water is present; otherwise, the moisture sensor 20 would perform its regular function, as previously described.

Whenever free water is encountered, a current signal from the free-water sensor 194 is transmitted by a lead 196 to an amplifier 198; this signal is amplified in a manner similar to the previously described amplifier 50 and rectified by a rectifier 200 in a manner similar to the previously described rectifier 52, prior to its being converted to a voltage signal by a resistor 202. A second digital gate 204 is included in the line 196 for a purpose to be described.

Assume, for purposes of illustration, that a condition exists wherein the surface temperature is below 34° F. and the system 10' is operating in an atmosphere wherein no free-water is present. The operation of this system under these conditions is exactly the same as previously described for system 10 shown by FIGURE 1. The capacitance of the free-water sensor 194 will remain very low so long as it is dry. Opening of the digital gate 204 requires two signals of a predetermined intensity, and while the capacitance of sensor 194 is low, insufficient current will be fed to the amplifier 198 to trigger it. Consequently, the digital gate 204 will receive only one signal, namely, that indicative of surface temperature from the thermistor 28; thus, gate 204 will remain closed.

Assuming now that free-water such as rain is present, the dielectric of the free-water sensor 194 will become wet, and its capacitance will increase to a very high level. As a result of this rise in capacitance, a sufficient current will flow to the amplifier 198 to trigger it. The current is then amplified by the amplifier 198, rectified by the rectifier 200 and passed through the fixed resistor 202, causing a voltage drop which is then fed to the digital gate 204. Being thus subjected to two signals, the digital gate 204 will now pass a signal along the lead 196 which communicates with the lead 56 between the comparator 32 and the amplifier 58. The differential amplifier comparator 32 is thus bypassed, and the amplifier 58 is triggered directly, causing actuation of the heat source 62 through the relay 60. The system will again become de-energized once the surface temperature rises above 34° F.; this is so, whether or not free-water is present.

It can thus be seen that in system 10' free-water takes priority over water vapor. That is, the moisture sensor 20 will continue responding to the atmospheric moisture vapor changes; however, once free-water is present, the free-water sensor 194 will instantly signal the heat source 62, thereby overriding or making the moisture sensor 20 signal ineffective. This is due to the fact that the dry capacitance of the free-water sensor 194 is chosen such that the current through it is less than one milliamp, whereas its wet capacitance is selected such that the current therethrough is much higher than one milliamp. Transistors (not shown), as may be employed in the digital gate 204, generally require a minimum of one milliamp in order to be triggered, as described above.

In order to prevent the moisture sensor 20 from becoming saturated with the free-water, its open ends may be covered by means of pivotable covers 206 which are closed by the same signal being transmitted to the amplifier 58 when free-water is present. This signal is intercepted by leads 208 and 210 and fed to a relay 212, and thence by a lead 214 to a solenoid 216 which actuates the pivotable covers 206. The relay circuit is completed by means of a lead 218 connected to the D.C. power supply line 14.

It is believed that the invention lies more in the unique combination of the various components to provide the system, rather than in the specific design of the components. That is, one skilled in the art would recognize more than one possible construction for a particular component to perform the function required in the combination.

Thus, referring to the block diagram of FIGURE 1 it will be apparent that D.C. may be any source of direct current, such as a battery. Component 12 may be any circuit and/or device that will convert the D.C. to alternating current (A.C.) and the component 16 may be any circuit and/or device that will amplify the A.C. from 12. While components 12 and 16 are labelled "Radio Frequency," other frequencies may be employed, depending upon the nature of the dielectric material and other pertinent factors. Component 28 may be any circuit and/or device that will provide a D.C. output voltage proportional to a particular surface temperature, and component 20 may be any circuit and/or device that will provide an output current proportional to absolute humidity. Component 24 may be any circuit and/or device that will receive the output signals from 20 and 28 and pass them on only when the signal from component 28 is indicative of a surface temperature less than 34° F. Component 36 may be any circuit and/or device that will convert the A.C. output current of 20, as received from component 24, to a voltage signal proportional to absolute humidity. Component 50 may be any circuit and/or device that will amplify the A.C. signal from 36, and component 52 may be any circuit and/or device that will convert the A.C. output from 50 to D.C. Component 32 may be any circuit and/or device that will compare the output voltage from 28 with the converted output voltage from 20 and then provide an output which is amplified by a suitable circuit and/or device 58 to operate some particular actuation device, such as a heat source 62 through a suitable circuit and/or device 60, when the converted output voltage from component 20 becomes equal to or greater than the output voltage from component 28.

Suitable circuitry for the above components may be found in any electrical handbook, such as the R.C.A. Transistor Handbook, Issue 1961.

The moisture sensing element 20 is described in greater detail because it is deemed to be patentable per se. However, equivalent structures are possible, and various modifications have been illustrated in FIGURES 4, 6, 8, 9, 10 and 11.

In view of the above description, it should be readily apparent that the invention represents a novel approach to so-called ice prevention systems; that is, the icing condition, and not the ice, is efficiently and automatically detected so that the ice is prevented from forming.

It is also apparent that the invention may be used to detect the dew point in any desired temperature range for purposes other than prevention of condensation and/or icing. For example, it may be desired to spray a chemical or cause some other action when dew point is approached.

Although several embodiments of the invention have been disclosed and described for purposes of illustration, it is apparent that other modifications are possible within the scope of the appended claims.

What I claim as my invention is:

1. An electronic device for preventing condensation of moisture on a surface, said device comprising a source of direct current, means for converting the direct current to alternating current and for amplifying the alternating current, means for providing a voltage output proportional to the temperature of said surface, means for providing an alternating current output proportional to dew point temperature, means operatively connected to said last two mentioned means for preventing the passage of said two outputs so long as said output proportional to surface temperature remains higher than a predetermined value, means for converting said alternating current proportional to dew point temperature to direct current and for producing a voltage proportional to said dew point temperature, and means operatively connected to said means for preventing the passage of said two outputs for comparing said voltage proportional to dew point temperature with said voltage proportional to the temperature of said surface and providing a signal when said voltage proportional to dew point temperature is equal to or greater than said voltage proportional to the temperature of said surface.

2. The device as described in claim 1, wherein said means for providing a voltage output proportional to surface temperature includes an impedance bridge circuit having one leg thereof formed to include a capacitance type moisture sensing element.

3. The device as described in claim 1, wherein said means for providing a voltage output proportional to surface temperature includes a resonant circuit having a capacitance type moisture sensing element.

4. An electronic device for preventing condensation of moisture on a surface, said device comprising a source of electricity, means for providing a voltage output proportional to the temperature of said surface, means responsive to atmospheric moisture vapor for providing a voltage output proportional to saturation temperature, means for comparing said voltage proportional to saturation temperature to said voltage proportional to the temperature of said surface and providing a first signal when said voltage proportional to saturation temperature is equal to or greater than said voltage proportional to the temperature of said surface, and means responsive to atmospheric free-water for providing a second signal which renders said first signal ineffective.

5. A device for producing a signal proportional to dew point temperature, said device comprising a source of alternating electromotive force, a cylindrical outer casing, a pair of end guides secured to said outer casing, a pair of spaced concentric electrodes connected to said source of alternating electromotive force and confined by said end guides within said cylindrical outer casing in a manner providing a cylindrical space around the outer of said pair of spaced concentric electrodes, a body of hygroscopic dielectric material positioned between said spaced concentric electrodes, a plurality of perforations formed in said pair of spaced concentric electrodes adjacent said dielectric material, a plurality of longitudinal passageways formed through said end guides and the inner of said pair of spaced concentric electrodes for providing air access to said perforations in said inner electrode, and a plurality of ports formed in said end guides for providing air access to said cylindrical space around said outer electrode.

6. A device for either anticipating condensation of moisture on a surface or signalling the presence of free-water, ice or snow when the temperature of said surface is below a predetermined value, said device comprising means for providing a signal output indicative of the temperature of said surface, means responsive to atmospheric moisture vapor for providing a signal output reflecting saturation temperature, means for comparing said signal reflecting saturation temperature with said signal indicative of the temperature of said surface and provid-

ing a first resultant signal when said saturation temperature is substantially equal to or greater than said temperature of said surface, and means responsive to free-water, ice or snow and operatively connected to said first mentioned means for providing a second resultant signal when said temperature of said surface is below a predetermined value and free-water, ice or snow is present, means for utilizing said first resultant signal, said second resultant signal being operatively connected to and actuating said utilizing means regardless of the presence of said first resultant signal.

7. A device for either preventing condensation of moisture on a surface or signalling the presence of free-water, ice or snow when the temperature of said surface is below a predetermined value, said device comprising first means responsive to the moisture content of the air for indicating the saturation temperature of the air adjacent said surface, second means for sensing the presence of free-water, ice or snow on said surface, said first and second means being constructed and arranged so as to be continuously operative, and third means operatively connected to said first and second means for sensing the temperature of said surface and utilizing means responsive to said first and third means and providing a signal when said saturation temperature is substantially equal to or greater than the temperature of said surface and said surface temperature is below a predetermined temperature and responsive to said second and third means and providing a signal when free-water, ice or snow is present and temperature of said surface is below said predetermined temperature.

8. A device for either anticipating condensation of frost on a surface or signalling the presence of free-water, ice or snow when the temperature of said surface is below a predetermined value, said device comprising a source of electricity, means for providing a signal output indicative of the temperature of said surface, means responsive to atmospheric moisture vapor for providing a signal output reflecting saturation temperature, means for using said signal reflecting saturation temperature and said signal indicative of the temperature of said surface to provide a first resultant signal when the temperature of said surface approaches the saturation temperature and close to or below freezing temperature, and means responsive to free-water, ice or snow and operatively connected to said first mentioned means for providing a second resultant signal when said temperature of said surface is below a predetermined value and free-water, ice or snow is present, means for utilizing said first resultant signal, said second resultant signal being operatively connected to and actuating said utilizing means regardless of the presence of said first resultant signal.

9. A device for either anticipating condensation of frost on a surface or signalling the presence of free-water, ice or snow when the temperature of said surface is below a predetermined value, said device comprising a source of electricity, means for providing a signal output indicative of the temperature of said surface, means responsive to atmospheric moisture vapor for providing a signal output reflecting saturation temperature, means for using said signal reflecting saturation temperature and said signal indicative of the temperature of said surface to provide a first resultant signal when the temperature of said surface is below the saturation temperature and close to or below freezing temperature, and means responsive to free-water, ice or snow and operatively connected to said first mentioned means for providing a second resultant signal when said temperature of said surface is below a predetermined value and free-water, ice or snow is present, means for utilizing said first resultant signal, said second resultant signal being operatively connected to and actuating said utilizing means regardless of the presence of said first resultant signal.

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